THE PICTURE OF THE TAOIST GENII PRINTED ON THE COVER of this book is part of a painted temple scroll, recent but traditional, given to Mr Brian Harland in Szechuan province (1946). Concerning these four divinities, of respectable rank in the Taoist bureaucracy, the following particulars have been handed down. The title of the first of the four signifies 'Heavenly Prince', that of the other three 'Mysterious Commander'.

At the top, on the left, is Liu *Thien Chün*, Comptroller-General of Crops and Weather. Before his deification (so it was said) he was a rain-making magician and weather forecaster named Liu Chün, born in the Chin dynasty about +340. Among his attributes may be seen the sun and moon, and a measuring-rod or carpenter's square. The two great luminaries imply the making of the calendar, so important for a primarily agricultural society, the efforts, ever renewed, to reconcile celestial periodicities. The carpenter's square is no ordinary tool, but the gnomon for measuring the lengths of the sun's solstitial shadows. The Comptroller-General also carries a bell because in ancient and medieval times there was thought to be a close connection between calendrical calculations and the arithmetical acoustics of bells and pitch-pipes.

At the top, on the right, is Wên *Yuan Shuai*, Intendant of the Spiritual Officials of the Sacred Mountain, Thai Shan. He was taken to be an incarnation of one of the Hour-Presidents (*Chia Shen*), i.e. tutelary deities of the twelve cyclical characters (see Vol. 4, pt. 2, p. 440). During his earthly pilgrimage his name was Huan Tzu-Yü and he was a scholar and astronomer in the Later Han (b. +142). He is seen holding an armillary ring.

Below, on the left, is Kou *Yuan Shuai*, Assistant Secretary of State in the Ministry of Thunder. He is therefore a late emanation of a very ancient god, Lei Kung. Before he became deified he was Hsin Hsing, a poor woodcutter, but no doubt an incarnation of the spirit of the constellation Kou-Chhen (the Angular Arranger), part of the group of stars which we know as Ursa Minor. He is equipped with hammer and chisel.

Below, on the right, is Pi *Yuan Shuai*, Commander of the Lightning, with his flashing sword, a deity with distinct alchemical and cosmological interests. According to tradition, in his early life he was a countryman whose name was Thien Hua. Together with the colleague on his right, he controlled the Spirits of the Five Directions.

Such is the legendary folklore of common men canonised by popular acclamation. An interesting scroll, of no great artistic merit, destined to decorate a temple wall, to be looked upon by humble people, it symbolises something which this book has to say. Chinese art and literature have been so profuse, Chinese mythological imagery so fertile, that the West has often missed other aspects, perhaps more important, of Chinese civilisation. Here the graduated scale of Liu Chün, at first sight unexpected in this setting, reminds us of the ever-present theme of quantitative measurement in Chinese culture; there were rain-gauges already in the Sung (+12th century) and sliding calipers in the Han (+1st). The armillary ring of Huan Tzu-Yü bears witness that Naburiannu and Hipparchus, al-Naqqāsh and Tycho, had worthy counterparts in China. The tools of Hsin Hsing symbolise that great empirical tradition which informed the work of Chinese artisans and technicians all through the ages.

SCIENCE AND CIVILISATION IN CHINA

Among the Chinese frequent examples are to be found of discoveries, especially in the arts, which other nations made independently whereas the Chinese had come upon them long before.

WILLEM TEN RHIJNE
De Arthritide (+1683)

And if we look so far as the Sun-rising, and hear *Paulus Venetus* what he reporteth of the uttermost Angle and *Island* thereof, wee shall finde that those Nations have sent out, and not received, lent knowledge, and not borrowed it from the West. For the farther East (to this day) the more civill, the farther West the more salvage.

SIR WALTER RALEIGH
'History of the World', +1614 (+1652)
Pt. I, Bk. 1, ch. 7, § 10, sect. 4, p. 98

I take my own intelligence as my teacher.

A-NI-KO, master-artisan of Nepal,
addressing the emperor Shih Tsu, +1263
(*Yuan Shih*, ch. 203, p. 12*a*)

I hear, and I forget.
I see, and I remember.
I do, and I understand.

Ten thousand words are not worth one seeing.

Chinese proverbs.

I am not yet so lost in lexicography, as to forget that words are the daughters of earth, and that things are the sons of heaven.

SAMUEL JOHNSON
Preface to his 'Dictionary of the English Language' (+1755)

By studying the organic patterns of heaven and earth a fool can become a sage.
So by watching the times and seasons of natural phenomena we can become true philosophers.

LI CHHÜAN
Yin Fu Ching (*c.* +735)

中國科學技術史

李約瑟著

冀朝鼎

SCIENCE AND CIVILISATION IN CHINA

BY

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and a contribution by

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VOLUME 5

CHEMISTRY AND CHEMICAL TECHNOLOGY

PART IV: SPAGYRICAL DISCOVERY AND INVENTION: APPARATUS, THEORIES AND GIFTS

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To

WU HSÜEH-CHOU

sometime Director of the Chemical Institute of Academia Sinica

and

CHANG TZU-KUNG

sometime Chemical Adviser to the National Resources Commission

in warmest recollection of long
and enlightening discussions at
Kunming and Nan-wên-chhüan
1942 to 1946

as also in memory of an earlier friend

LOUIS RAPKINE

sometime Professor of Biochemistry at the Institut de Biologie Physico-Chimique, Paris

in our youth
colleague at the Marine Station at Roscoff
compass-needle for truth and social justice
Spinoza redivivus

this volume is dedicated

CONTENTS

LIST OF ILLUSTRATIONS

LIST OF TABLES

LIST OF ABBREVIATIONS

The following abbreviations are used in the text and footnotes. For abbreviations used for journals and similar publications in the bibliographies, see pp. 511ff.

B	Bretschneider, E. (*1*), *Botanicon Sinicum.*
CC	Chia Tsu-Chang & Chia Tsu-Shan (*1*), *Chung-Kuo Chih Wu Thu Chien* (Illustrated Dictionary of Chinese Flora), 1958.
CCIF	Sun Ssu-Mo, *Chhien Chin I Fang* (Supplement to the Thousand Golden Remedies), between +660 and +680.
CCYF	Sun Ssu-Mo, *Chhien Chin Yao Fang* (Thousand Golden Remedies), between +650 and +659.
CHS	Pan Ku (and Pan Chao), *Chhien Han Shu* (History of the Former Han Dynasty), *c.* +100.
CJC	Juan Yuan, *Chhou Jen Chuan* (Biographies of Mathematicians and Astronomers), +1799. With continuations by Lo Shih-Lin, Chu Kho-Pao and Huang Chung-Chün. In *HCCC*, chs. 159ff.
CLPT	Thang Shen-Wei *et al.* (ed.), *Chêng Lei Pên Tshao* (Reorganised Pharmacopoeia), ed. of +1249.
CSHK	Yen Kho-Chün (ed.), *Chhüan Shang-Ku San-Tai Chhin Han San-Kuo Liu Chhao Wên* (Complete Collection of prose literature (including fragments) from remote antiquity through the Chhin and Han Dynasties, the Three Kingdoms, and the Six Dynasties), 1836.
CTPS	Fu Chin-Chhüan (ed.), *Chêng Tao Pi Shu Shih Chung* (Ten Types of Secret Books on the Verification of the Tao), early 19th cent.
EB	*Encyclopaedia Britannica.*
HCCC	Yen Chieh (ed.), *Huang Chhing Ching Chieh* (monographs by Chhing scholars on classical subjects), 1829, contd. 1860.
HCSS	*Hsiu Chen Shih Shu* (Ten Books on the Regeneration of the Primary Vitalities, physiological alchemy), *c.* +1250.
HFT	Han Fei, *Han Fei Tzu* (Book of Master Han Fei), early −3rd cent.
HHPT	Su Ching *et al.* (ed.), *Hsin Hsiu Pên Tshao* (Newly Improved Pharmacopoeia), +659.
HHS	Fan Yeh & Ssuma Piao, *Hou Han Shu* (History of the Later Han Dynasty), +450.
HNT	Liu An *et al.*, *Huai Nan Tzu* (Book of the Prince of Huai-Nan), −120.
ICK	Taki Mototane, *I Chi Khao* (*Iseki-kō*) (Comprehensive Annotated Bibliography of Chinese Medical Literature [Lost or Still Existing]), finished *c.* 1825, pr. 1831; repr. Tokyo 1933, Shanghai 1936.

ITCM	Wang Khên-Thang & Chu Wên-Chen (ed.), *I Thung Chêng Mo Chhüan* (Complete Collection of Works on Medicine and Sphygmology), +1601.
K	Karlgren, B. (1), *Grammata Serica* (dictionary giving the ancient forms and phonetic values of Chinese characters).
KCCY	Chhen Yuan-Lung, *Ko Chih Ching Yuan* (Mirror of Scientific and Technological Origins), an encyclopaedia of +1735.
KHTT	Chang Yü-Shu (ed.), *Khang-Hsi Tzu Tien* (Imperial Dictionary of the Khang-Hsi reign-period), +1716.
Kr	Kraus, P., *Le Corpus des Écrits Jābiriens* (*Mémoires de l'Institut d'Égypte*, 1943, vol. 44, pp. 1–214).
LPC	Lung Po-Chien (*1*), *Hsien Tshun Pên Tshao Shu Lu* (Bibliographical Study of Extant Pharmacopoeias and Treatises on Natural History from all Periods).
LS	Tsêng Tshao (ed.), *Lei Shuo* (Classified Commonplace-Book), +1136.
MCPT	Shen Kua, *Mêng Chhi Pi Than* (Dream Pool Essays), +1089.
N	Nanjio, B., *A Catalogue of the Chinese Translations of the Buddhist Tripiṭaka*, with index by Ross (3).
NCCS	Hsü Kuang-Chhi, *Nung Chêng Chhüan Shu* (Complete Treatise on Agriculture), +1639.
NCNA	New China News Agency.
PPT/NP	Ko Hung, *Pao Phu Tzu* (*Nei Phien*) (Book of the Preservation-of-Solidarity Master; Inner Chapters), *c.* +320.
PPT/WP	*Idem* (*Wai Phien*), the Outer Chapters.
PTKM	Li Shih-Chen, *Pên Tshao Kang Mu* (The Great Pharmacopoeia), +1596.
PWYF	Chang Yü-Shu (ed.), *Phei Wên Yün Fu* (encyclopaedia), +1711.
R	Read, Bernard E. *et al.*, Indexes, translations and précis of certain chapters of the *Pên Tshao Kang Mu* of Li Shih-Chen. If the reference is to a plant see Read (1); if to a mammal see Read (2); if to a bird see Read (3); if to a reptile see Read (4 or 5); if to a mollusc see Read (5); if to a fish see Read (6); if to an insect see Read (7).
RBS	*Revue Bibliographique de Sinologie.*
RP	Read & Pak (1), Index, translation and précis of the mineralogical chapters in the *Pên Tshao Kang Mu.*
S/	Stein Collection of Tunhuang MSS, British Museum, London, catalogue number.
SC	Ssuma Chhien, *Shih Chi* (Historical Records), *c.* −90.
SF	Thao Tsung-I (ed.), *Shuo Fu* (Florilegium of (Unofficial) Literature), *c.* +1368.
SHC	*Shan Hai Ching* (Classic of the Mountains and Rivers), Chou and C/Han.

SIC Okanishi Tameto, *Sung I-Chhien I Chi Khao* (Comprehensive Annotated Bibliography of Chinese Medical Literature in and before the Sung Period). Jen-min Wei-shêng, Peking, 1958.

SKCS *Ssu Khu Chhüan Shu* (Complete Library of the Four Categories), +1782; here the reference is to the *tshung-shu* collection printed as a selection from one of the seven imperially commissioned MSS.

SKCS/TMTY Chi Yün (ed.), *Ssu Khu Chhüan Shu Tsung Mu Thi Yao* (Analytical Catalogue of the *Complete Library of the Four Categories*), +1782; the great bibliographical catalogue of the imperial MS. collection ordered by the Chhien-Lung emperor in +1772.

SNPTC *Shen Nung Pên Tshao Ching* (Classical Pharmacopoeia of the Heavenly Husbandman), C/Han.

SSIW Toktaga (Tho-Tho) *et al.*; Huang Yü-Chi *et al.* & Hsü Sung *et al.* *Sung Shih I Wên Chih, Pu, Fu Phien* (A Conflation of the Bibliography and Appended Supplementary Bibliographies of the History of the Sung Dynasty). Com. Press, Shanghai, 1957.

STTH Wang Chhi, *San Tshai Thu Hui* (Universal Encyclopaedia), +1609.

SYEY Mei Piao, *Shih Yao Erh Ya* (The Literary Expositor of Chemical Physic; or, Synonymic Dictionary of Minerals and Drugs), +806.

TCTC Ssuma Kuang, *Tzu Chih Thung Chien* (Comprehensive Mirror (of History) for Aid in Government), +1084.

TFYK Wang Chhin-Jo & Yang I (eds.), *Tshê Fu Yuan Kuei* (Lessons of the Archives, encyclopaedia), +1013.

TKKW Sung Ying-Hsing, *Thien Kung Khai Wu* (The Exploitation of the Works of Nature), +1637.

TMITC Li Hsien (ed.), *Ta Ming I Thung Chih* (Comprehensive Geography of the Ming Empire), +1461.

TPHMF *Thai-Phing Hui Min Ho Chi Chü Fang* (Standard Formularies of the (Government) Great Peace People's Welfare Pharmacies), +1151.

TPKC Li Fang (ed.), *Thai-Phing Kuang Chi* (Copious Records collected in the Thai-Phing reign-period), +978.

TPYL Li Fang (ed.), *Thai-Phing Yü Lan* (the Thai-Phing reign-period (Sung) Imperial Encyclopaedia), +983.

TSCC Chhen Mêng-Lei *et al.* (ed.), *Thu Shu Chi Chhêng* (the Imperial Encyclopaedia of +1726). Index by Giles, L. (2).
References to 1884 ed. given by chapter (*chüan*) and page.
References to 1934 photolitho reproduction given by *tshê* (vol.) and page.

TSCCIW Liu Hsü *et al.* & Ouyang Hsiu *et al.*; *Thang Shu Ching Chi I Wên Ho Chih*. A conflation of the Bibliographies of the *Chiu Thang Shu* by Liu Hsü (H/Chin, +945) and the *Hsin Thang Shu* by Ouyang Hsiu & Sung Chhi (Sung, +1061). Com. Press, Shanghai, 1956.

TSFY	Ku Tsu-Yu, *Tu Shih Fang Yü Chi Yao* (The Historian's Geographical Companion), begun before +1666, finished before +1692, but not printed till the end of the eighteenth century (1796 to 1821).
TT	Wieger, L. (6), *Taoïsme*, vol. 1, Bibliographie Générale (catalogue of the works contained in the Taoist Patrology, *Tao Tsang*).
TTC	*Tao Tê Ching* (Canon of the Tao and its Virtue).
TTCY	Ho Lung-Hsiang & Phêng Han-Jan (ed.). *Tao Tsang Chi Yao* (Essentials of the Taoist Patrology), pr. 1906.
TW	Takakusu, J. & Watanabe, K., *Tables du Taishō Issaikyō* (nouvelle édition (Japonaise) du Canon bouddhique chinoise), Index-catalogue of the Tripiṭaka.
V	Verhaeren, H. (2) (ed.), Catalogue de la Bibliothèque du Pé-T'ang (the Pei Thang Jesuit Library in Peking).
WCTY/CC	Tsêng Kung-Liang (ed.), *Wu Ching Tsung Yao* (*Chhien Chi*), military encyclopaedia, first section, +1044.
YCCC	Chang Chün-Fang (ed.), *Yün Chi Chhi Chhien* (Seven Bamboo Tablets of the Cloudy Satchel), Taoist collection, +1022.
YHL	Thao Hung-Ching (attrib.), *Yao Hsing Lun* (Discourse on the Natures and Properties of Drugs).
YHSF	Ma Kuo-Han (ed.), *Yü Han Shan Fang Chi I Shu* (Jade-Box Mountain Studio collection of (reconstituted and sometimes fragmentary) Lost Books), 1853.

ACKNOWLEDGEMENTS

List of those who have kindly read through Sections in Draft

The following list, which applies only to Vol. 5, pts 2–5, brings up to date those printed in Vol. 1, pp. 15 ff., Vol. 2, p. xxiii, Vol. 3, pp. xxxix ff., Vol. 4, pt. 1, p. xxi, Vol. 4, pt. 2, p. xli and Vol. 4, pt. 3, pp. xliii ff.

Dr F. R. Allchin (Cambridge)	Apparatus (alcohol).
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Prof. R. McLachlan Wilson (St Andrews)	Comparative (Gnostic), and Theories.
Dr John Winter (Washington, D.C.)	Apparatus and Lacquer.
Mr James Zimmerman (New Haven, Conn.)	Theories.

AUTHOR'S NOTE

IT is now some sixteen years since the preface for Vol. 4 of this series (Physics and Physical Technology) was written; since then much has been done towards the later volumes. We are now happy to present a further substantial part of Vol. 5 (Spagyrical Discovery and Invention), i.e. alchemy and early chemistry, which go together with the arts of peace and war, including military and textile technology, mining, metallurgy and ceramics. The point of this arrangement was explained in the preface of Vol. 4 (e.g. pt. 3, p. l). Exigences not of logic but of collaboration are making it obligatory that these other topics should follow rather than precede the central theme of chemistry, which here is printed as Vol. 5, parts 2, 3, 4 and 5, leaving parts 1 and 6 to appear at a later date.

The number of physical volumes (parts) which we are now producing may give the impression that our work is enlarging according to some form of geometrical progression or along some exponential curve, but this would be largely an illusion, because in response to the reactions of many friends we are now making a real effort to publish in books of less thickness, more convenient for reading. At the same time it is true that over the years the space required for handling the history of the diverse sciences in Chinese culture has proved singularly unpredictable. One could (and did) at the outset arrange the sciences in a logical spectrum (mathematics—astronomy—geology and mineralogy—physics—chemistry—biology) leaving estimated room also for all the technologies associated with them; but to foresee exactly how much space each one would claim, that, in the words of the Jacobite blessing, was 'quite another thing'. We ourselves are aware that the disproportionate size of some of our Sections may give a mis-shapen impression to minds enamoured of classical uniformity, but our material is not easy to 'shape', perhaps not capable of it, and appropriately enough we are constrained to follow the Taoist natural irregularity and surprise of a romantic garden rather than to attempt any compression of our lush growths within the geometrical confines of a Cartesian parterre. The Taoists would have agreed with Richard Baxter that ''tis better to go to heaven disorderly than to be damned in due order'. By some strange chance our spectrum meant (though I thought at the time that the mathematics was particularly difficult) that the 'easier' sciences were going to come first, those where both the basic ideas and the available source-materials were relatively clear and precise. As we proceeded, two phenomena manifested themselves, first the technological achievements and amplifications proved far more formidable than expected (as was the case in Vol. 4, pts. 2 and 3), and secondly we found ourselves getting into ever deeper water, as the saying is, intellectually (as will fully appear in the Sections on medicine in Vol. 6).

Alchemy and early chemistry, the central subjects of the present volume, exemplified the second of these difficulties well enough, but they have had others of their own.

At one time I almost despaired of ever finding our way successfully through the inchoate mass of ideas, and the facts so hard to establish, relating to alchemy, chemistry, metallurgy and chemical industry in ancient, medieval and traditional China. The facts indeed were much more difficult to ascertain, and also more perplexing to interpret, than anything encountered in subjects such as astronomy or civil engineering. And in the end, one must say, we did not get through without cutting great swathes of briars and bracken, as it were, through the muddled thinking and confused terminology of the traditional history of alchemy and early chemistry in the West. Here it was indispensable to distinguish alchemy from proto-chemistry and to introduce words of art such as aurifiction, aurifaction and macrobiotics. It is also fair to say that the present subject has been far less well studied and understood either by Westerners or Chinese scholars themselves than fields like astronomy and mathematics, where already in the eighteenth century a Gaubil could do outstanding work, and nearer our own time a Chhen Tsun-Kuei, a de Saussure, and a Mikami Yoshio could set them largely in order. If the study of alchemy and early chemistry had advanced anything like so far, it would be much easier today than it actually is to differentiate with clarity between the many divergent schools of alchemists at the many periods, from the −3rd century to the +17th, with which we have to deal. More adequate understanding would also have been achieved with regard to that crucial Chinese distinction between inorganic laboratory alchemy and physiological alchemy, the former concerned with elixir preparations of mineral origin, the latter rather with operations within the adept's own body; a distinction hardly realised to the full in the West before the just passed decade. As we shall show in these volumes, there was a synthesis of these two age-old trends when in iatro-chemistry from the Sung onwards laboratory methods were applied to physiological substances, producing what we can only call a proto-biochemistry. But this will be read in its place.

Now a few words on our group of collaborators. Dr Ho Ping-Yü,[1] since 1972 Professor of Chinese and Dean of the Faculty of Asian Studies at Griffith University, Brisbane, in Queensland, was introduced to readers in Vol. 4 pt. 3, p. lv; here he has been responsible for drafting the major part of the sub-section (*e*) on the history of alchemy in China. Dr Lu Gwei-Djen[2], my oldest collaborator, dating (in historian's terms) from 1937, has been involved at all stages of the present volumes, especially in that seemingly endless mental toil of ours which resulted in the introductory subsections on concepts, definitions and terminology (*b*), with all that that implies for theories of alchemy, ideas of immortality, and the physiological pathology of the elixir complex. But her particular domain has been that of physiological alchemy, and it was her discoveries, just at the right moment, of what was meant by the three primary vitalities, mutationist inversion, counter-current flow, and such abstruse matters, which alone permitted the unravelling, at least in the provisional form here presented (in the relevant sub-section *j*) of that strange and unfamiliar system, quasi-Yogistic perhaps, but full of interest for the pre-history of biochemical thought.[a]

[a] Some of her findings have appeared separately (Lu Gwei-Djen, 2).

[1] 何丙郁 [2] 魯桂珍

A third collaborator is now to be welcomed for the first time, Dr Nathan Sivin, Professor of Chinese in the University of Pennsylvania at Philadelphia, who has contributed the sub-section on the general theory of elixir alchemy (*h*).

Although Prof. Sivin has helped the whole group much by reading over and suggesting emendations for all the rest, it is needful to make at this point a proviso which has not been required in previous volumes. This is that my collaborators cannot take a collective responsibility for statements, translations or even general nuances, occurring in parts of the book other than that or those in which they each themselves directly collaborated. All incoherences and contradictions which remain after our long discussions must be laid at my door, in answer to which I can only say that the state of the art is as yet very imperfect, that it will certainly be improved by later scholars, and that in the meantime we have done the best we can. If fate had granted to the four of us the possibility of all working together in one place for half-a-dozen years, things could have been rather different, but in fact Prof. Ho and Prof. Sivin were never even in Cambridge at one and the same time. Thus these volumes have come into existence the hard way, drafted by different hands at fairly long intervals of time, and still no doubt containing traces of various levels of sophistication and understanding.[a] Indeed it would have been reasonable to mark the elixir theory sub-section 'by Nathan Sivin', rather than 'with Nathan Sivin', if it had not been for the fact that some minor embroideries were offered by me, and that a certain part of it, not perhaps the least interesting, is a revised version of a memoir by Ho Ping-Yü and myself first published in 1959. Lacking the unities of time and place, complete credal unity, as it were, has been unattainable, but that does not mean that we are not broadly at one over the main facts and problems of the field as a whole; so that rightly we may be called co-workers.

Besides this I am eager to make certain further acknowledgements. During the second world war I was instrumental in securing for Cambridge copies of the *Tao Tsang* and the *Tao Tsang Chi Yao*. At a somewhat later time (1951–5) Dr Tshao Thien-Chhin,[1] then a Fellow of Caius, made a valuable pioneer study of the alchemical books in the Taoist Patrology, using a microfilm set in our working collection (now the East Asian History of Science Library, an educational charity). After his return to the Biochemical Institute of Academia Sinica, Shanghai, of which he has been in recent years Vice-Director, these notes were of great help to Dr Ho and myself, forming the ultimate basis for another sub-section (*g*), on aqueous reactions. Secondly, before he left Cambridge in 1958, Dr Wang Ling[2] accomplished a good work by making an analytical index of the names and synonyms of substances mentioned in the *Shih Yao Erh Ya*. Third, when we were faced with the fascinating but difficult study of the evolution of chemical apparatus in East and West, Dr Dorothy Needham put in a

[a] No less than eight years have now elapsed since Prof. Sivin first drafted the theoretical sub-section in this volume, and it could hardly be expected that during such a period insights and understanding would not mature and grow. Consequently this material should be supplemented by reference to Sivin (14), which gives a concise summary of his present views.

[1] 曹天欽 [2] 王鈴

considerable amount of work, including some drafting, in what happened to be a convenient interval in work on her own book on the history of muscle biochemistry, *Machina Carnis*. She has also read all our pages—perhaps the only person in the world who ever does so!

While readers of sub-sections in typescript and proof have not been as numerous, perhaps, as for previous volumes, a special debt of gratitude is due to Mr J. A. Charles of St John's College, chemist, metallurgist and archaeologist, whose advice to Prof. Ho and myself from the earliest days was extremely precious. Valuable consultations also took place with Mr H. J. Sheppard of Warwick, especially during his time in Cambridge as a Schoolmaster-Fellow of Churchill College. The late Dr Ladislao Reti was prodigal in his helpful advice on all aspects of the history of distillation, based on a lifetime's experience in chemical industry. Dr F. R. Allchin later communicated to us valuable unpublished information on the Gandhāran stills of Taxila and Pushkalāvatī. Subsequently we were able to benefit by an extensive correspondence on spirit production with Mr H. G. Thurm of the Asbach Distillery at Rüdesheim-am-Rhein; while Prof. E. J. Wiesenberg of London guided us with great expertise through the labyrinths of possible Semitic connections with the origin of the root 'chem-'. Few chemists in Cambridge, by some chance, happen to be interested at the present time in the history of their subject, but if Dr A. J. Berry and Prof. J. R. Partington had lived we could have profited greatly from their help. With the latter, indeed, we did have fruitful and most friendly contact, but it was in connection mainly with the gunpowder epic, Prof. Wang Ling and I endeavouring, not unsuccessfully, to convince him of the real and major contribution of China in that field; those were days however before any word of the present volumes had been written. In 1968, well after it had been started, there was convened the First Conference of Taoist Studies at the Villa Serbelloni at Bellagio on Lake Como; Ho Ping-Yü, Nathan Sivin and myself were all of the party, and here much stimulus was obtained from that remarkable *Tao shih* Kristofer Schipper—hence the unexpected sub-section on liturgiology and alchemical origins in our introductory material (*b*). In addition to the invaluable advice of many other colleagues in particular areas, we record especially the kindness of Professor Cyril Stanley Smith in commenting upon the sub-sections on metallurgy (*c*) and on the theory of elixir alchemy (*h*). Dr N. Sivin also expresses gratitude to Prof. A. F. P. Hulsewé and his staff for the open-hearted hospitality which they gave him during the gestation of the latter study, carried out almost entirely at the Sinologisch Instituut, Leiden.

It is right to record that certain parts of these volumes have been given as lectures to bodies honouring us by such invitations. Thus various excerpts from the introductory sub-sections on concepts, terminology and definitions, were given for the Rapkine Lecture at the Pasteur Institute in Paris (1970) and the Bernal Lecture at Birkbeck College in London in the following year. Portions of the historical sub-sections, especially that on the coming of modern chemistry, were used for the Ballard Matthews Lectures of the University of Wales at Bangor. A considerable part of the physiological alchemy material formed the basis of the Fremantle Lectures at Balliol

College, Oxford,[a] and had been given more briefly as the Harvey Lecture to the Harveian Society of London the year before. Four lectures covering the four present parts of this volume were given at the Collège de France in Paris at Easter, 1973, in fulfilment of my duties as Professeur Étranger of that noble institution. Lastly, the contrasts between Hellenistic proto-chemistry and Chinese alchemy, with the spread of the elixir concept from China throughout the Old World, were expounded at the Universities of Hongkong and at the University of British Columbia at Vancouver, in 1975; while further aspects of the chemical relationships of the civilisations, east and west, formed the subject of the Bowra Lecture at Wadham College, Oxford, in 1976.

If there is one question more than any other raised by this present Section 33 on alchemy and early chemistry, now offered to the republic of learning in these volumes, it is that of human unity and continuity. In the light of what is here set forth, can we allow ourselves to visualise that some day before long we shall be able to write the history of man's enquiry into chemical phenomena as one single development throughout the Old World cultures? Granted that there were several different foci of ancient metallurgy and primitive chemical industry, how far was the gradual flowering of alchemy and chemistry a single endeavour, running contagiously from one civilisation to another?

It is a commonplace of thought that some forms of human experience seem to have progressed in a more obvious and palpable way than others. It might be difficult to say how Michael Angelo could be considered an improvement on Pheidias, or Dante on Homer, but it can hardly be questioned that Newton and Pasteur and Einstein did really know a great deal more about the natural universe than Aristotle or Chang Hêng. This must tell us something about the differences between art and religion on one side and science on the other, though no one seems able to explain quite what, but in any case within the field of natural knowledge we cannot but recognise an evolutionary development, a real progress, over the ages. The cultures might be many, the languages diverse, but they all partook of the same quest.

Throughout this series of volumes it has been assumed all along that there is only one unitary science of Nature, approached more or less closely, built up more or less successfully and continuously, by various groups of mankind from time to time. This means that one can expect to trace an absolute continuity between the first beginnings of astronomy and medicine in Ancient Babylonia, through the advancing natural knowledge of medieval China, India, Islam and the classical Western world, to the break-through of late Renaissance Europe when, as has been said, the most effective method of discovery was itself discovered. Many people probably share this point of view, but there is another one which I may associate with the name of Oswald Spengler, the German world-historian of the thirties whose works, especially *The Decline of the West*, achieved much popularity for a time. According to him, the sciences produced by different civilisations were like separate and irreconcilable works

[a] The relevant volume is therefore offered to the Trustees of the late Sir Francis Fremantle's benefaction in discharge of the duty of publication of his Lectures.

of art, valid only within their own frames of reference, and not subsumable into a single history and a single ever-growing structure.

Anyone who has felt the influence of Spengler retains, I think, some respect for the picture he drew of the rise and fall of particular civilisations and cultures, resembling the birth, flourishing and decay of individual biological organisms, in human or animal life-cycles. Certainly I could not refuse all sympathy for a point of view so like that of the Taoist philosophers, who always emphasised the cycles of life and death in Nature, a point of view that Chuang Chou himself might well have shared. Yet while one can easily see that artistic styles and expressions, religious ceremonies and doctrines, or different kinds of music, have tended to be incommensurable; for mathematics, science and technology the case is altered—man has always lived in an environment essentially constant in its properties, and his knowledge of it, if true, must therefore tend towards a constant structure.

This point would not perhaps need emphasis if certain scholars, in their anxiety to do justice to the differences between the ancient Egyptian or the medieval Chinese, Arabic or Indian world-views and our own, were not sometimes tempted to follow lines of thought which might lead to Spenglerian pessimism.[a] Pessimism I say, because of course he did prophesy the decline and fall of modern scientific civilisation. For example, our own collaborator, Nathan Sivin, has often pointed out, quite rightly, that for medieval and traditional China 'biology' was not a separated and defined science. One gets its ideas and facts from philosophical writings, books on pharmaceutical natural history, treatises on agriculture and horticulture, monographs on groups of natural objects, miscellaneous memoranda and so on. He urged that to speak without reservations of 'Chinese biology' would be to imply a structure which historically did not exist, disregarding mental patterns which did exist. Taking such artificial rubrics too seriously would also imply the natural but perhaps erroneous assumption that medieval Chinese scientists were asking the same questions about the living world as their modern counterparts in the West, and merely chanced, through some quirk of national character, language, economics, scientific method or social structure, to find different answers. On this approach it would not occur to one to investigate what questions the ancient and medieval Chinese scientists themselves were under the impression that they were asking. A fruitful comparative history of science would have to be founded not on the counting up of isolated discoveries,

[a] Just recently a relevant polemical discussion has been going on among geologists. Harrington (1, 2), who had traced interesting geological insights in Herodotus and Isaiah, was taken to task by Gould (1), maintaining that 'science is no march to truth, but a series of conceptual schemes each adapted to a prevailing culture', and that progress consists in the mutation of these schemes, new concepts of creative thinkers resolving anomalies of old theories into new systems of belief. This was evidently a Kuhnian approach, but no such formulation will adequately account for the gradual percolation of true knowledge through the successive civilisations, and its general accumulation. Harrington himself, in his reply (3), maintained that 'there is a singular state of Nature towards which all estimates of reality converge', and therefore that we can and should judge the insights of the ancients on the basis of our own knowledge of Nature, while at the same time making every effort to understand their intellectual framework. In illustration he took the medieval Chinese appreciation of the meaning of fossil remains (cf. Vol. 3, pp. 611 ff.). We are indebted to Prof. Claude Albritton of Texas for bringing this discussion to our notice.

insights or skills meaningful for us now, but upon 'the confrontation of integral complexes of ideas with their interrelations and articulations intact'. These complexes could be kept in one piece only if the problems which they were meant to solve were understood. Chinese science must, in other words, be seen as developing out of one state of theoretical understanding into another, rather than as any kind of abortive development towards modern science.

All this was well put; of course one must not see in traditional Chinese science simply a 'failed prototype' of modern science, but the formulation here has surely to be extremely careful. There is a danger to be guarded against, the danger of falling into the other extreme, and of denying the fundamental continuity and universality of all science. This could be to resurrect the Spenglerian conception of the natural sciences of the various dead (or even worse, the living) non-European civilisations as totally separate, immiscible thought-patterns, more like distinct works of art than anything else, a series of different views of the natural world irreconcilable and unconnected. Such a view might be used as the cloak of some historical racialist doctrine, the sciences of pre-modern times and the non-European cultures being thought of as wholly conditioned ethnically, and rigidly confined to their own spheres, not part of humanity's broad onward march. However, it would leave little room for those actions and reactions that we are constantly encountering, those subtle communicated influences which every civilisation accepted from time to time.

In another place Nathan Sivin has written: 'The question of why China never spontaneously experienced the equivalent of our scientific revolution lies of course very close to the core of a comparative history of science. My point is that it is an utter waste of time, and distracting as well, to expect any answer until the Chinese tradition has been adequately comprehended from the inside.' The matter could not be better put; we must of course learn to see instinctively through the eyes of those who thought in terms of the Yin and Yang, the Five Elements, the symbolic correlations, and the trigrams and hexagrams of the *Book of Changes*. But here again this formulation might suggest a purely internalist or ideological explanation for the failure of modern natural science to arise in Chinese culture. I don't think that in the last resort we shall be able to appeal primarily to inhibiting factors inherent in the Chinese thought-world considered as an isolated Spenglerian cell. One must always expect that some of these intellectual limiting factors will be identifiable, but for my part I remain sceptical that there are many factors of this kind which could not have been overcome if the social and economic conditions had been favourable for the development of modern science in China. It may indeed be true that the modern forms of science which would then have developed would have been rather different from those which actually did develop in the West, or in a different order, that one cannot know. There was, for example, the lack of Euclidean geometry and Ptolemaic planetary astronomy in China, but China had done all the ground-work in the study of magnetic phenomena, an essential precursor of later electrical science;[a] and Chinese culture was permeated by conceptions much more organic, less mechanistic, than that of the

[a] See our discussions in Vols. 3 and 4, pt. 1.

West.[a] Moreover Chinese culture alone, as we shall see, perhaps, provided that materialist conception of the elixir of life which, passing to Europe through the Arabs, led to the macrobiotic optimism of Roger Bacon and the iatro-chemical revolution of Paracelsus, hardly less important in the origins of modern science than the work of Galileo and Newton. Whatever the ideological inhibiting factors in the Chinese thought-world may turn out to have been, the certainty always remains that the specific social and economic features of traditional China were connected with them. They were clearly part of that particular pattern, and in these matters one always has to think in terms of a 'package-deal'. In just the same way, of course, it is impossible to separate the scientific achievements of the ancient Greeks from the fact that they developed in mercantile, maritime, city-state democracies.

To sum it up, the failure of China to give rise to distinctively modern science while having been in many ways ahead of Europe for some fourteen previous centuries is going to take some explaining.[b] Internalist historiography is likely to encounter grave difficulties here, in my opinion, because the intellectual, philosophical, theological and cultural systems of ideas of the Asian civilisations are not going to be able to take the causal stress and strain required. Some of these idea-systems, in fact, such as Taoism and Neo-Confucianism, would seem to have been much more congruent with modern science than any of the European ones were, including Christian theology. Very likely the ultimate explanations will turn out to be highly paradoxical—aristocratic military feudalism seeming to be much stronger than bureaucratic feudalism but actually weaker because less rational—the monotheism of a personal creator God being able to generate modern scientific thought (as the San Chiao could never do) but not to give it an inspiration enduring into modern times—and so on. We do not yet know.

A similar problem has of late been worrying Said Husain Nasr, the Persian scholar who is making valuable contributions to the history of science in Islam. He, for his part, faces the failure of Arabic civilisation to produce modern science. But far from regretting this he makes a positive virtue of it, rejecting belief in any integral, social-evolutionary development of science. Opening one of his recent books we read as follows:[c]

> The history of science is often regarded today as the progressive accumulation of techniques and the refinement of quantitative methods in the study of Nature. Such a point of view considers the present conception of science to be the only valid one; it therefore judges the sciences of other civilisations in the light of modern science, and evaluates them primarily with respect to their 'development' with the passage of time. Our aim in this work however, is not to examine the Islamic sciences from the point of view of modern science and of this 'evolutionist' conception of history; it is on the contrary to present certain aspects of the Islamic sciences as seen from the Islamic point of view.

[a] This was emphasised in Vol. 2, *passim*.

[b] We set forth in a preliminary way what is at issue here in Vol. 3, pp. 150ff. Some 'thinking aloud' done at various times has also been assembled in Needham (65).

[c] (1), p. 21.

Now Nasr considers that the Sufis and the universal philosophers of medieval Islam sought and found a kind of mystical *gnosis*, or cosmic *sapientia*, in which all the sciences 'knew their place', as it were (like servitors in some great house of old), and ministered to mystical theology as the highest form of human experience. In Islam, then, the philosophy of divinity was indeed the *regina scientiarum*. Anyone with some appreciation of theology as well as science cannot help sympathising to some extent with this point of view, but it does have two fatal drawbacks: it denies the equality of the forms of human experience, and it divorces Islamic natural science from the grand onward-going movement of the natural science of all humanity. Nasr objects to judging medieval science by its outward 'usefulness' alone. He writes:[a] 'However important its uses may have been in calendrical computation, in irrigation or in architecture, its ultimate aim always was to relate the corporeal world to its basic spiritual principle through the knowledge of those symbols which unite the various orders of reality. It can only be understood, and should only be judged, in terms of its own aims and its own perspectives.' I would demur. It was part, I should want to maintain, of all human scientific enterprise, in which there is neither Greek nor Jew, neither Hindu nor Han. 'Parthians, Medes and Elamites, and the dwellers in Mesopotamia, and in Judaea and Cappadocia, in Pontus and Asia... and the parts of Libya about Cyrene... we do hear them speak in our tongues the marvellous works of God.'[b]

The denial of the equality of the forms of human experience comes out clearly in another work of Said Husain Nasr (2). Perhaps rather under-estimating the traditional high valuation placed within Christendom upon Nature—'that universal and publick manuscript', as Sir Thomas Browne said,[c] 'which lies expans'd unto the eyes of all'—he sees in the scientific revolution at the Renaissance a fundamental desacralisation of Nature, and urges that only by re-consecrating it, as it were, in the interests of an essentially religious world-view, will mankind be enabled to save itself from otherwise inevitable doom. If the rise of modern science within the bosom of Christendom alone had any causal connections with Christian thought that would give it a bad mark in his view. 'The main reason why modern science never arose in China or Islam', he says,[d]

> is precisely because of the presence of a metaphysical doctrine and a traditional religious structure which refused to make a profane thing of Nature....Neither in Islam, nor India nor the Far East, was the substance and the stuff of Nature so depleted of a sacramental and spiritual character, nor was the intellectual dimension of these traditions so enfeebled, as to enable a purely secular science of Nature and a secular philosophy to develop outside the matrix of the traditional intellectual orthodoxy....The fact that modern science did not develop in Islam is not a sign of decadence [or incapacity] as some have claimed, but of the refusal of Islam to consider any form of knowledge as purely secular, and divorced from what it conceived to be the ultimate goal of human existence.

[a] (1), pp. 39–40.
[b] Acts, 2. 1.
[c] *Religio Medici* I, xvi. 'Thus there are two Books from whence I collect my Divinity; besides that written one of God, another of his servant Nature....'
[d] (2), p. 97.

These are striking words,[a] but are they not tantamount to saying that only in Europe did the clear differentiation of the forms of experience arise? In other terms, Nasr looks for the synthesis of the forms of experience in the re-creation of a medieval world-view, dominated by religion,[b] not in the existential activity of individual human beings dominated by ethics. That would be going back, and there is no going back. The scientist must work *as if* Nature was 'profane'. As Giorgio di Santillana has said:[c]

> Copernicus and Kepler believed in cosmic vision as much as any Muslim ever did, but when they had to face the 'moment of truth' they chose a road which was apparently not that of *sapientia*; they felt they had to state what appeared to be the case, and that on the whole it would be more respectful of divine wisdom to act thus.

And perhaps it is a sign of the weakness of what can only be called so conservative a conception that Nasr is driven to reject the whole of evolutionary fact and theory, both cosmic, biological and sociological.

In contemplating the estimate of modern physical science as a 'desacralisation of Nature' many ideas and possibilities come to mind,[d] but one very obvious cause for surprise is that it occurred in Christendom, the home of a religion in which an incarnation had sanctified the material world, while it did not occur in Islam, a culture which had never developed a soteriological doctrine.[e] This circumstance might offer an argument in favour of the primacy of social and economic factors in the breakthrough of the scientific revolution. It may be that while ideological, philosophical and theological differences are never to be undervalued, what mattered most of all were the facilitating pressures of the transition from feudalism to mercantile and then industrial capitalism, pressures which did not effectively operate in any culture other than that of Western, Frankish, Europe.

In another place Nasr wonders what Ibn al-Haitham or al-Bīrūnī or al-Khāzinī would have thought about modern science. He concludes that they would be amazed at the position which exact quantitative knowledge has come to occupy today. They would not understand it because for them all *scientia* was subordinated to *sapientia*. Their quantitative science was only one interpretation of a segment of Nature, not the means of understanding all of it. '"Progressive" science', he says,[f] 'which in the Islamic world always remained secondary, has now in the West become nearly everything, while the immutable and "non-progressive" science or wisdom which was then primary, has now been reduced to almost nothing.' It happened that I read these words

[a] Views such as this are by no means restricted to eastern Muslim scholars. From within the bosom of the West a very similar attitude is to be found in the book on alchemy by Titus Burckhardt (1), cf. esp. pp. 66, 203.

[b] It seems very strange to us that he should regard Chinese culture as having been dominated by religion at any time.

[c] In his preface to Said Husain Nasr (1), p. xii.

[d] This, for example, is one of the outstanding questions in the attack on the uncontrolled manifestations of modern science and technology led by today's 'counter-culture'. There is much food for thought in the books of Roszak (1, 2) and Leiss (1); while Pirsig's famous meditation (1) inspired the defence of science (though not of misapplied technology) in Waddington's Bernal Lecture (5).

[e] This point was made by the Rev. D. Cupitt in discussion following a lecture for the Cambridge Divinity Faculty (1970) in which some of these paragraphs were used. It was afterwards published in part (Needham, 68). The contrast may be to some extent a matter of degree, since Islamic philosophy tended to recognise the material world as an emanation of the divine.

[f] (1), p. 145.

at a terrible moment in history. If there were any weight in the criticism of the modern scientific world-view from the standpoint of Nasr's perennial Muslim *sapientia* it would surely be that modern science and the technology which it has generated have far outstripped morality in the Western and modern world, and we shudder to think that man may not be able to control it. Probably none of the human societies of the past ever were able to control technology, but they were not faced by the devastating possibilities of today, and the moment I read Nasr's words was just after the Jordanian civil war of September, 1970, that dreadful fratricidal catastrophe within the bosom of Islam itself. Since then we have had the further shocking example of Bengali Muslims being massacred by their brothers in religion from the Indus Valley. *Sapientia* did not prevent these things, nor would it seem, from the historical point of view, that wars and cruelties of all kinds have been much less within the realms of Islam or of East Asia than that of Christendom. Modern science, at all events, is not guilty as such of worsening men's lot, on the contrary it has immensely ameliorated it, and everything depends on what use humanity will make of these unimaginable powers for good or evil. Something new is needed to make the world safe for mankind; and I believe that it can and will be found.

In later discussions Nathan Sivin has made it clear that he is just as committed to a universal comparative history of science as any of the rest of us. That would be the ultimate justification of all our work. His point is not that the Chinese (or Indian, or Arabic) tradition should be evaluated only in the light of its own world-view, then being left as a kind of museum set-piece, but that it must be understood as fully as possible in the light of this as a prelude to the making of wide-ranging comparisons. The really informative contrasts, he suggests, are not those between isolated discoveries, but between those whole systems of thought which have served as the matrices of discovery.[a] One might therefore agree that not only particular individual anticipations of modern scientific discoveries are of interest as showing the slow development of human natural knowledge, but also that we need to work out exactly how the world-views and scientific philosophies of medieval China, Islam or India, differed from those of modern science, and from each other. Each traditional system is clearly of great interest not only in itself but in relation to our present-day patterns of ideas. In this way we would not only salute the Chinese recording of sun-spots from the − 1st century,[b] or the earliest mention of the flame test for potassium salts by Thao Hung-Ching in the + 5th century,[c] or the first correct explanation of the optics of the rainbow by Quṭb al-Dīn al-Shīrāzī in + 1300,[d] as distinct steps on the way to modern science, but also take care to examine the integral systems of thought and practice which generated these innovations. Modern science was their common end, but their evolution can only be explained (that is to say, causally accounted for) in the context of the various possibilities opened and closed by the totality of ideas, values and social attitudes of their time.

Section 33(*h*), on the theoretical background of proto-chemical alchemy, may be

[a] Cf. Sivin (10). [b] Cf. Vol. 3, p. 435. [c] Cf. Vol. 5, pt. 3, p. 139.
[d] Cf. Vol. 3, p. 474.

taken as an exemplification and a test of this way of looking at early science.[a] Nathan Sivin's contribution deals with an abstract approach to Nature which has little to do with post-Galilean physical thought. Looking at the aims of the theoretically-minded alchemists as expressed in their own words, they turn out to be concerned with the design and construction of elaborate chemical models of the cyclic Tao of the cosmos which governs all natural change. A multitude of correspondences and resonances inspire the design of these models. One can distinguish as elements in their rationale the archaic belief in the maturation of minerals within the earth, the complex role of time, and the subtle interplay of quantity and numerology in ensuring that the elaboratory would be a microcosmos. Once we have reached at least a rough comprehension of the system which unites these elements, we can apprehend the remarkable culmination envisaged by the Chinese alchemists: to telescope time by reducing the grand overriding cycles of the universe to a compass which would allow of their contemplation by the adept—leading, as we have phrased it, to perfect freedom in perfect fusion with the cosmic order. But in the course of our reconnaissance we gather a rich harvest of ideas worth exploring and comparing with those of other cultures, including those of the modern world—for instance, the notion of alchemy as a quintessentially temporal science, springing from a unique concept of material immortality, a sublime conviction of the possibility of the control of change and decay. And we make a beginning towards understanding how the alchemist's concepts determined the details—the symmetries and innovations of materials, apparatus, and exquisitely phased combustions—of his Work, and how new results were reflected in new theoretical refinements as the centuries passed.

It is no less important to be aware that every anticipatory feature of a pre-modern system of science had its Yin as well as its Yang, side, disadvantages as well as advantages. Thus the polar-equatorial system of Chinese astronomy delayed Yü Hsi's recognition of the precession of the equinoxes by six centuries after Hipparchus, but on the other hand it gave to Su Sung an equal priority of time over Robert Hooke in the first application of a clock-drive to an observational instrument; and the mechanisation of a demonstrational one by I-Hsing and Liang Ling-Tsan was no less than a thousand years ahead of George Graham and Thomas Tompion with their orrery of 1706.[b] In a similar way, perhaps, the conviction of the existence of material life-elixirs cost the lives of untold numbers of royal personages and high officials no less than of Taoist adepts, but it did lead to the accumulation of a great fund of knowledge about metals and their salts, in the pursuit of which such earth-shaking discoveries as that of gunpowder were incidentally made. So also the ancient idea of urine and other secretions as drugs might easily be written off as 'primitive superstition' if we did not know that it led, by rational if quasi-empirical trains of thought, combined with the use of chemical techniques originally developed for quite different purposes, to the preparation of steroid and protein hormones many centuries before the time of experimental endocrinology and biochemistry.

[a] Another attempt at this approach, applied to mathematical astronomy, will be found in Sivin (9).
[b] On all these subjects see Vol. 3 and Vol. 4, pt. 2.

The only danger in the conception of human continuity and solidarity, as I have outlined it, is that it is very easy to take modern science as the last word, and to judge everything in the past solely in the light of it. This has been justly castigated by Joseph Agassi, who in his lively monograph on the historiography of science (1) satirises the mere 're-arranging of up-to-date science textbooks in chronological order', and the awarding of black and white marks to the scientific men of the past in accordance with the extent to which their discoveries still form part of the corpus of modern knowledge. Of course this Baconian or inductivist way of writing the history of science never did justice to the 'dark side' of Harvey and Newton, let alone Paracelsus, that realm of Hermetic inspirations and idea-sources which can only be regained by us with great difficulty, yet is so important for the history of thought, as the life-work of Walter Pagel has triumphantly shown. One can see immediately that this difficulty is even greater in the case of non-European civilisations, since their thought-world has been even more unfamiliar. Not only so, but the corpus of modern knowledge is changing and increasing every day, and we cannot foresee at all what its aspect will be a century from now. Fellows of the Royal Society like to speak of the 'true knowledge of natural phenomena', but no one knows better than they do how provisional this knowledge is. It is neither independent of the accidents of Western European history, nor is it a final court of appeal for the eschatological judgment of the value of past scientific discoveries, either in West or East. It is a reliable measuring-stick so long as we never forget its transitory nature.

My collaborators and I have long been accustomed to use the image of the ancient and medieval sciences of all the peoples and cultures as rivers flowing into the ocean of modern science. In the words of the old Chinese saying: 'the Rivers pay court to the Sea'.[a] In the main this is indubitably right. But there is room for a great deal of difference of opinion on how the process has happened and how it will proceed. One might think of the Chinese and Western traditions travelling substantially the same path towards the science of today, that science against which, on the inductivist view, all ancient systems can be measured. But on the other hand, as Nathan Sivin maintains, they might have followed, and be following, rather separate paths, the true merging of which lies well in the future. Undoubtedly among the sciences the point of fusion varies, the bar where the river unites at last with the sea. In astronomy and mathematics it took but a short time, in the seventeenth century; in botany and chemistry the process was much slower, not being complete until now, and in medicine it has not happened yet.[b] Modern science is not standing still, and who can say how far the molecular biology, the chemistry or the physics of the future will have to adopt conceptions much more organicist than the atomic and the mechanistic which have so far prevailed? Who knows what further developments of the psycho-somatic conception in medicine future advances may necessitate? In all such ways the thought-complex of traditional Chinese science may yet have a much greater part to play in

[a] *Chhao tsung yü hai.*[1] Cf. Vol. 3, p. 484.

[b] This picture has been elaborated elsewhere; Needham (59), reprinted in (64), pp. 396ff.

[1] 朝宗于海

the final state of all science than might be admitted if science today was all that science will ever be. Always we must remember that things are more complex than they seem, and that wisdom was not born with us. To write the history of science we have to take modern science as our yardstick—that is the only thing we can do—but modern science will change, and the end is not yet. Here as it turns out is yet another reason for viewing the whole march of humanity in the study of Nature as one single enterprise. But we must return to the volume now being introduced.

Although the other parts of Vol. 5 are not yet ready for press we should like to make mention of those who are collaborating with us in them. Much of the Section on martial technology for Vol. 5, pt. 1 has been in draft for many years now,[a] but it has been held up by delays in the preparation of the extremely important sub-section on the invention of the first chemical explosive known to man, gunpowder, even though all the notes and books and papers necessary for this have long been collected.[b] At last we can salute the advent of a relevant draft of substantial size from Dr Ho Ping-Yü at Brisbane, recently Visiting Professor at Keio University in Tokyo, aided by Dr Wang Ling (Wang Ching-Ning[1]) of the Institute of Advanced Studies at Canberra. Meanwhile Prof. Lo Jung-Pang,[2] of the University of California at Davis, spent the winter of 1969–70 in Cambridge, accomplishing not only the sub-section on the history of armour and caparison in China, but also the draft of the whole of Section 37 on the salt industry, including the epic development of deep borehole drilling (Vol. 5, pt. 6). Other military sub-sections, such as those on poliorcetics, cavalry practice and signalling, we have been able to place in the capable hands of Dr Korinna Hana of München. About the same time we persuaded Dr Tsien Tsuen-Hsuin (Chhien Tshun-Hsün[3]), the Regenstein Librarian at the University of Chicago, to undertake the writing of Section 32 on the great inventions of paper and printing and their development in China; this is now more than half done. For ceramic technology (Section 35) we have obtained the collaboration of Mr James Watt (Chhü Chih-Jen[4]), Curator of the Art Gallery at the Institute of Chinese Studies in the Chinese University of Hongkong. The story of these marvellous applications of science will be anticipated by many with great interest. Finally non-ferrous metallurgy and textile technology, for which abundant notes and documentation have been collected, found their organising genii in two other widely separated places. For the former we have Prof. Ursula Martius Franklin and Dr Hsü Chin-Hsiung[5] at Toronto; for the latter Dr Ohta Eizō[6] of Kyoto and Dr Dieter Kühn. When their work becomes available, Volume 5 will be substantially complete. This by no means exhausts the list of our

[a] Including an introduction on the literature, a study of close-combat weapons, the sub-sections on archery and ballistic machines, and a full account of iron and steel technology as the background of armament. The first draft of this last has been published as a Newcomen Society monograph; Needham (32), (60).

[b] A preliminary treatment of the subject, still, we think, correct in outline, was given in an article in the *Legacy of China* thirteen years ago; Needham (47). This has recently been re-issued in paper-back form.

[1] 王靜寧 [2] 羅榮邦 [3] 錢存訓 [4] 屈志仁 [5] 許進雄
[6] 太田英藏

invaluable collaborators, for several others are concerned with Volumes 6 and 7; but they will be introduced to readers in due time.

As has so long been customary, we offer our grateful thanks to those who try to keep us 'on the rails' in territory which is not our own: Prof. D. M. Dunlop for Arabic, Dr Sebastian Brock for Syriac, Dr Charles Sheldon for Japanese, Prof. G. Ledyard for Korean, and Prof. Shackleton Bailey for Sanskrit and Tibetan.

A couple of years ago it became clear that our working library and its operations had grown so much in size and complexity that a full-time Amanuensis (*chêng chen shu tshao*[1]) or Librarian was needed. For this we first recruited a physical chemist, Dr Christine King (Ting Pai-Fu[2]), who gave us much assistance; being succeeded after some time by a valued former associate, the Japanologist Miss Philippa Hawking. Her organising abilities stood us in good stead during the moves of the library mentioned below. The best librarians are born, not made, and she is of that company.

Next comes our high secretariat—Miss Muriel Moyle, who continues to give us impeccable indexes; and Mrs Liang Chung Lien-Chu[3] (wife of another Fellow of Caius, the physicist Dr Liang Wei-Yao[4]), who has inserted many a page of well-written characters and made out many a biographical reference-card, as well as editing the typescripts of collaborators to conform with project conventions. We also offer appreciative thanks for skilled and accurate typewriting by Mrs Diana Brodie and Mrs Evelyn Beebe; and for editorial work by Mrs Janin Hua Chhang-Ming[5], Mrs Margaret Whetham Anderson and Major Frank Townson.

All that has been said in previous volumes (e.g. Vol. 4, pt. 3, p. lvi) about the University Press, our treasured medium of communication with the world, and Gonville and Caius College, that milieu in which we used to live and move and have our being, has become only truer as the years go by—their service and their encouragement continues unabated and so does our heartfelt gratitude. If it were not for the devotion of the typographical—and typocritical—masters, and if one could not count on the understanding, kindness and appreciation of one's academic colleagues, nothing of what these volumes represent could ever have come into existence. We have taken pleasure on previous occasions of paying a tribute to our friend Mr Peter Burbidge of the University Press, and as we do so again we would like to associate with his name all those in that unique organisation who deal so faithfully, accurately and elegantly with our very difficult work.

Down to the summer of 1976 the library which constitutes the engine-room of the project was housed in Caius, but upon my retirement from the Mastership it was moved to a temporary building in Shaftesbury Road just outside the 'compound' (as one would say in Asia) of the University Printing House. Later we were installed in a spacious house in Brooklands Avenue. This building belongs to the Press, and is lent by the Syndics to the Trustees of the East Asian History of Science Library, *pro tem.* We acknowledge with warmest thanks a generous installation grant from the British Museum Library Ancillary Libraries Fund, and a special grant from the Sloane Foundation in America. Particular continuing gratitude is due to the Wellcome Trust of London, whose generous support has upheld us throughout the

[1] 正眞書曹 [2] 丁百馥 [3] 梁鍾連杼 [4] 梁維耀 [5] 華昌明

period of preparation of these chemical volumes. Since the history of medicine is touched upon at so many points in them we feel some sense of justification in accepting their unfailing aid. It can hardly be too much emphasised that in China proto-chemistry was elixir alchemy from the very beginning (as it was not in other civilisations of comparable antiquity), and by the same token alchemists there were very often physicians too (much more so than they tended to be in other cultures). For the basic elixir notion was a pharmaceutical and therapeutic one, even though its optimism regarding the conquest of death reached a height which modern medical science dare not as yet contemplate. All this will be clarified in what follows.

More recently our project received a notable benefaction from the Coca-Cola Company of Atlanta, Georgia, through the kind intermediation of Dr C. A. Shillinglaw, and for this also our grateful thanks are due. The support of their benevolent fund is being continued for the expenses of Dr Li Li-Shêng[1], who has spent some months in Cambridge completing Section 34 on the chemical industries, a first draft for which was made some years ago by Prof. Ho Ping-Yü. To Thames Television we acknowledge a useful grant for the support of our amanuensis, and to the Lee Foundation of Singapore (founded in memory of the late Dato Lee Kong-Chian[2]) several most welcome grants for general project expenses. Help on a lesser scale has also been forthcoming from the American Philosophical Society. Certain private persons, too, have sent us truly notable donations from time to time; and here we cannot forbear from offering our warmest thanks to Mrs Carol Bernstein Ferry and Mr W. H. Ferry of Scarsdale, N.Y., as also to Mr and Mrs P. L. Lamb of Hongkong. Lastly Dr N. Sivin wishes to acknowledge financial assistance from the National Science Foundation in Washington, D.C., and the Department of Humanities at the Massachusetts Institute of Technology.

Let us end with a few words of help to the prospective reader, as on previous occasions, offering some kind of waywiser to guide him through those pages of type not always possible to lighten by some memorable illustration. This is not intended as a substitute for the contents-table, the *mu lu*, or as any enlargement of it; but rather as some useful tips of 'inside information' to tell where the really important paragraphs are, and to distinguish them from the supporting detail secondary in significance though often fascinating in itself.

First, then, we would recommend a reader to study very carefully our introduction (Sect. 33*b*, in Vol. 5, pt. 2) on concepts, terminology and definitions, especially pp. 9–12; because once one has obtained a clear idea of the distinctions between aurification, aurifaction and macrobiotics (already referred to, p. xxxii above), everything that one encounters in the proto-chemistry and alchemy of all the Old World civilisations falls into place. There is a parallel here with the history of time-keeping, for the radical gap between the clepsydra and the mechanical clock was only filled by half-a-dozen centuries of Chinese hydro-mechanical clockwork. So in the same way the radical gap between Hellenistic aurifictive and aurifactive proto-chemistry at one end, and late Latin alchemy and iatro-chemistry at the other, could only be explained by a knowledge of Chinese chemical macrobiotics.

[1] 李勵生 [2] 李公健

After that the argument develops in several directions, among which the reader can take his choice. How could belief in aurifaction ever have arisen when the cupellation test had been known almost since the dawn of the ancient empires? Look at 33*b*, 1–2, and especially p. 44 of pt. 2. What was the position of China in this respect, and what were the ancient Chinese alchemists probably doing experimentally? Read 33*b*, 3–5; and *c*, 1–8. Why were they so much more occupied with the perpetuation of life on earth, even in ethereal forms, than with the faking or making of gold? We try to explain it in 33*b*, 6. Such an induction of material immortality was indeed the specific characteristic of Chinese alchemy, and our conclusion is that the world-view of ancient China was the only milieu capable of crystallising belief in an elixir (*tan*[1]), good against death, as the supreme achievement of the chemist (see esp. pt. 2, pp. 71, 82, 114–15).

This is the nub of the argument, and in the present part (pt. 4, Sect. 33*i*, 2–3) we follow the progress of that great creative dream through Arabic culture and Byzantium into the Latin Baconian and Paracelsian West. Differences of religion, theology and cosmology did not stop its course, but there can be no doubt that it was born within the bosom of the Taoist religion, and hence the reader is invited to participate in a speculation that the alchemist's furnace derived from the liturgical incense-burner no less than from the metallurgical hearth (pt. 2, Sect. 33*b*, 7, see esp. pp. 127, 154). Finally something is said on the physiological background of the ingestion of elixirs (33*d*, 1, see esp. p. 291); why were they so attractive to the consumer initially and why so lethal later? Here belongs also the conservation of the body of the adept after death, important in the Taoist mind in connection with material immortality (pt. 2, Sect. 33*d*, 2, see esp. pp. 106, 207–8).

In the sub-section giving the straight historical account of Chinese alchemy from beginning to end, *chi shih pên mo*,[2] as the phrase was (pt. 3, Sect. 33*e*, 1–8), no part is really more significant than any other. Yet special interest does attach to the oldest firm records of aurifiction and macrobiotics expounded in (1), and to the study of the oldest alchemical books in (2) and (6, i). Now and then the narrative is interrupted by passages of detail, especially in (1), (2), (3, iii) and (6, vii) which readers not avid for minutiae may like to pass over (esp. pt. 3, pp. 42–4, 52–6, 76–8, 111–13, 201–5); such is the wealth of information not previously available in the West. The following sub-sections in the present part on laboratory apparatus, distillation, aqueous reactions, and alchemical theory (pt. 4, sects. 33*f*, *g*, *h*) explain themselves from the contents table, and again no passage stands out as particularly crucial; unless it were the relation of the Chinese alchemist to time (33*h*, 3–4). His was indeed the science (or proto-science) of the Change and Decay Control Department, as one might say, for he could (as he believed) accelerate enormously the natural change whereby gold was formed from other substances in the earth, and conversely he could decelerate asymptotically the rate of decay and dissolution that human bodies, each with their ten 'souls' (*hun*[3] and *pho*[4]), were normally subject to (cf. Fig. 1306). Thus in the words of the ancient Chinese slogan (33*e*, 1) 'gold *can* be made, and salvation *can* be

[1] 丹 [2] 紀事本末 [3] 魂 [4] 魄

attained'. And the macrobiogens were thus essentially time- and rate-controlling substances—a nobly optimistic concept for a nascent science of two thousand years ago.

Lastly, in part 5, we pass from the 'outer elixir' (*wai tan*[1]) to the 'inner elixir' (*nei tan*[2]), from proto-chemistry to proto-biochemistry, from reliance on mineral and inorganic remedies to a faith in the possibility of making a macrobiogen from the juices and substances of the living body. For this new concept we coin a fourth new word, the enchymoma; its synthesis was in practice the training of mortality itself to put on immortality. This 'physiological alchemy' will be explained in the next part of Volume 5 (Sect. 33*j*, 1–8), and the basic ideas will be found in two places, (2) especially (i, ii), and (4). It was not primarily psychological, like the 'mystical alchemy' of the West, though it made much use of meditational techniques, as did the Indian *yogacāra* with which it certainly had connections. Our conclusion is, at the end of (4) and in (8), that most of its procedures were highly conducive to health, both mental and physical, even though its theories embodied much pseudo-science as well as proto-science.

In the end, the iatro-chemistry of the late Middle Ages in China began to apply *wai tan* laboratory techniques to *nei tan* materials, bodily secretions, excretions and tissues. Hence arose some extraordinary successes and anticipations (33*k*, 1–7), but we must not enlarge on them now. And this may suffice for a reader's guide, hoping only that he may fully share with us the excitement and satisfaction of many new insights and discoveries.

[1] 外丹 [2] 內丹

33. ALCHEMY AND CHEMISTRY

(*f*) LABORATORY APPARATUS AND EQUIPMENT

It will readily be allowed that the history of chemical apparatus and equipment must constitute a sector of cardinal importance in any history of alchemy and early chemistry. Was it not after all the foundation of the techniques of modern chemical science? We have already quoted the words of Francis Bacon (pt. 2, p. 32) on the husbandman and his buried gold in Aesop, and later on (in pt. 5) we shall give those of Hermann Boerhaave and Albrecht von Haller, all recognising the immeasurable debt which true chemists owe to their alchemical, iatro-chemical and artisanal ancestors. How far we shall have to accept a special indebtedness to those of them who were Chinese will appear as the following pages pass. The full appreciation of the facts will be assisted by a reference to the contents of Sect. 26*g*, 5 on the history of glass in China (Vol. 4, pt. 1, pp. 101 ff.), and when the Sections on ceramics (35) and metallurgy (36) become available, further light will be thrown on what possibilities were open; for all these practical arts were necessarily laid under contribution by the Taoist alchemists of the Middle Ages in fitting out their elaboratories.

Tshao Yuan-Yü (*1*) was the first to make a study (1933) of Chinese alchemical apparatus. His remarkable paper on the 'Apparatus and Methods of the Ancient Chinese Alchemists' aroused such interest that English abridgements were made by Barnes (1) and Wilson (*2b, c*) in the following years. Li Chhiao-Phing (*1*, 1) also devoted a few pages to alchemical apparatus in his book. Further short descriptions in German and Chinese were later given by Huang Tzu-Chhing (1) and Yuan Han-Chhing (*1*) respectively, and then in 1959 the subject of laboratory equipment was extensively reviewed by Ho Ping-Yü & Needham (3). Since then there has been little save the book of Sivin (1) which has touched illuminatingly on certain special aspects of the subject.[a] In the present sub-section we have drawn materials more exhaustively both from the Taoist patrology and from ethnographical data, designing to treat the matter more thoroughly, and more comparatively, than anyone has so far done. Some of our interpretations, such as that of the East Asian types of still, were already essentially different from previous suggestions, and some techniques, like the method of *destillatio per descensum* using a bamboo tube, had not been mentioned before our first review.

Our main sources here include more than twenty different alchemical texts, all from the *Tao Tsang*, and many of them illustrated. Since they must be referred to very often it will be convenient to tabulate them in a list with the names of their writers (if possible), their approximate dates of composition, and their numbers in the standard catalogues (Table 114).

[a] There are also interesting discussions in Yoshida Mitsukuni (7), pp. 223ff., 249ff., 252ff. His interpretations differ but little from ours, though we cannot quite follow him in his generalisations about the development of early chemical equipment in East and West.

Table 114. *Names and details of 'Tao Tsang' texts useful in the study of chemical apparatus*

Catalogue numbers			Approx. date	Author
Wieger(6) *TT*/	Ong Tu-Chien(1)			
229	232	*Huan Tan Pi Chüeh Yang Chhih-Tzu Shen Fang* 還丹祕訣養赤子神方 (The Wondrous Art of Nourishing the (Divine) Embryo (lit. the Naked Babe) by the use of the secret Formula of the Regenerative Enchymoma)	Sung, late +12th	Hsü Ming-Tao 許明道
874	880	*Thai-Chhing Shih Pi Chi* 太清石壁記 (The Records in the Rock Chamber (lit. Wall); a Thai-Chhing Scripture)[a]	Liang, early +6th, but including material as old as the late +3rd (Chin)	ed. Chhu Tsê 楚澤 orig. writer: Su Yuan-Ming 蘇元明 (Chhing Hsia Tzu) 青霞子
878	884	*Huang Ti Chiu Ting Shen Tan Ching Chüeh* 黃帝九鼎神丹經訣 (The Yellow Emperor's Canon of the Nine-Vessel Spiritual Elixir, with Explanations)	'Thang or Sung, but incorporating some material as old as the +2nd (H/Han)	unknown
884	890	*Ta-Tung Lien Chen Pao Ching, Chiu Huan Chin Tan Miao Chüeh* 大洞鍊眞寶經九還金丹妙訣 (Mysterious Teachings on the Ninefold Cyclically Transformed Gold Elixir, supplementary to the Manual of the Making of the Perfected Treasure; a Ta-Tung Scripture)[b]	Thang, perhaps *c.* +712	Chhen Shao-Wei 陳少微
885	891	*Thai-Shang Wei Ling Shen Hua Chiu Chuan Huan Tan Sha Fa* 太上衛靈神化九轉還丹砂法 (Methods of the Guardian of the Mysteries for the Marvellous Thaumaturgical Transmutation of Ninefold Cyclically Transformed Cinnabar; a Thai-Shang Scripture)[c]	uncertain, probably Sung	unknown
886	892	*Chiu Chuan Ling Sha Ta Tan* 九轉靈砂大丹 (The Great Ninefold Cyclically Transformed Numinous Cinnabar Elixir)	unknown	unknown
889	893	*Yü Tung Ta Shen Tan Sha Chen Yao Chüeh* 玉洞大神丹砂眞要訣 (True and Essential Teachings about the Great Magical Cinnabar of the Jade Heaven)	Thang, early +8th	Chang Kuo 張果
893	899	*Tan Fang Hsü Chih* 丹房須知 (Indispensable Knowledge for the Chymical Elaboratory)	Sung, +1163	Wu Wu 吳懋
894	900	*Shih Yao Erh Ya* 石藥爾雅 (The Literary Expositor of Chemical Physic; or, Synonymic Dictionary of Minerals and Drugs)	Thang, +806	Mei Piao 梅彪

895	901	*Chih-Chhuan Chen-Jen Chiao Chêng Shu* 稚川眞人校證術 (Technical Methods of the Adept (Ko) Chih-Chhuan (i.e. Ko Hung), with Critical Annotations)	Ascr. Chin, *c.* +320, but most of it probably a good deal later	Attrib. Ko Hung 葛洪
902	908	*Lung Hu Huan Tan Chüeh* 龍虎還丹訣 (Explanation of the Dragon-and-Tiger Cyclically Transformed Elixir)	probably Sung	Chin Ling Tzu 金陵子 (ps.)
904	910	*Kan Chhi Shih-liu Chuan Chin Tan* 感氣十六轉金丹 (The Sixteen-fold Cyclically Transformed Gold Elixir preapred by the 'Responding to the Chhi' Method)	Sung	unknown
905	911	*Hsiu Lien Ta Tan Yao Chih* 修鍊大丹要旨 (Essential Instructions for the Preparation of the Great Elixir)	Sung	unknown
907	913	*Chin Hua Chhung Pi Tan Ching Pi Chih* 金華冲碧丹經祕旨 (Confidential Instructions on the Manual of the Heaven-piercing Golden Flower Elixir)	Sung, +1225	Phêng Ssu 彭耜 & Mêng Hsü 孟煦
908	914	*Huan Tan Chou Hou Chüeh* 還丹肘後訣 (Oral Instructions on Handy Formulae for Cyclically Transformed Elixirs)	Ascr. Chin, *c.* +320, but actually by a Thang writer between +874 and +879	Attrib. Ko Hung 葛洪
911	917	*Chu Chia Shen Phin Tan Fa* 諸家神品丹法 (Methods of the Various Schools for Magical Elixir Preparations)	Sung	Mêng Yao-Fu 孟要甫 (Hsüan Chen Tzu) *et al.* 玄眞子
912	918	*Chhien Hung Chia Kêng Chih Pao Chi Chhêng* 鉛汞甲庚至寶集成 (Complete Compendium on the Perfected Treasure of Lead, Mercury, Wood and Metal)	Thang, +808	Chao Nai-An 趙耐菴
935	941	*Thung Hsüan Pi Shu* 通玄秘術 (The Secret Art of Penetrating the Mystery)	Thang, +864	Shen Chih-Yen 沈知言
939	945	*Thai-Chi Chen-Jen Tsa Tan Yao Fang* 太極眞人雜丹藥方 (Tractate of the Supreme-Pole Adept on Miscellaneous Elixir Recipes)	unknown, but probably Sung on account of the philosophical pseudonym in the title	unknown
946	952	*Kêng Tao Chi* 庚道集 (Collection of Procedures on the Golden Art)	Sung or Yuan, date unknown but after +1144	unknown
990	996	*Chou I Tshan Thung Chhi Chu* 周易參同契註 (The *Kinship of the Three and the Book of Changes*, with Commentary)	tradit. date of orig. text, H/Han, +142; this comm. ascr. H/Han, *c.*+160, but more probably Sung.	Attrib. ed. & comm. Yin Chhang-Shêng 陰長生
1020	1026	*Yün Chi Chhi Chhien* (itself a collection) 雲笈七籤 (The Seven Bamboo Tablets of the Cloudy Satchel)	Sung, *c.* +1022	ed. Chang Chün-Fang 張君房
1054	1060	*Chin Tan Ta Yao Thu* 金丹大要圖 (Illustrations for the *Main Essentials of the Metallous Enchymoma: the true Gold Elixir*)[d]	Yuan, +1333 but based on drawings and tables of the Sung, +10th century, onwards by	Chhen Chih-Hsü 陳致虛 (Shang Yang Tzu) 上陽子 Chang Po-Tuan 張伯端 Lin Shen-Fêng *et al.* 林紳鳳

[a] Tr. Ho Ping-Yü (8). [b] Tr. Sivin (4). [c] Tr. Spooner & Wang (1); Sivin (3). [d] Tr. Ho Ping-Yü & Needham (2).

To describe their experiments the medieval Chinese alchemists and proto-chemists employed a host of technical terms.[a] Unfortunately, in contrast with those used in astronomy, definitions of such terms, so far as we know, have not been found in the literature.[b] A study of some of them has been made in recent times by Yuan Han-Chhing (*1*)[c] and Ho Ping-Yü (15, 18). Their results are further elaborated in the following list:

Table 115. *Technical terms of operations*

an[1] (lit. to place)	to set up, to place in position.
chêng[2] (lit. steaming)	to steam grain, food, ferment or any other material in a steamer.
chêng[3] (lit. steaming)	distillation.[d]
chiao[4] (lit. to water)	to pour out a hot liquid and allow it to cool down or solidify slowly.
chieh[5] (lit. to tie up, to form an alliance)	to congeal, or solidify, generally by evaporation. Also used to refer to the formation of crystals.
chien[6] (lit. to fry)	to heat while stirring, either dry or with oil.
chien lien[7] (lit. to fry and refine)	to recrystallise.
chih[8] (lit. to control)	to prevent or delay the process of volatilisation, sublimation or distillation (i.e. fixation); to produce a change (cf. *fu* and *sha*).[e]
chih[9] (lit. to broil, stew, or toast; also to cauterise)[f]	to apply heat locally; to make an aqueous extract by heating; to dry by heating.
ching,[10] *ching hua*[11]	crystal; to crystallise or make to crystallise.
chu[12] (lit. to boil)	to heat a substance in water, to simmer.
chuan[13] (lit. turn)	a cycle of changes, usually several times repeated. Cf. *huan*.
chhou[14] (lit. to draw out or pull up)	to distil, especially of mercury.[g]
fei[15] (lit. to fly)	sublimation; distillation (especially in the case of mercury);[h] vaporisation in general.

[a] Hopkins gave a striking example of the incomprehensibility of technical terms to laymen, (1), p. 91. He took as his text a sample of instructions to a seamstress in 1934: 'Cross-cut bands are the medium turned in even to face and tacked at the edges; holes are used instead of eyes, made with a stiletto, and fan-stitch is used to fix the bones.' He added that not everyone, even at that time, would know the meaning of other terms such as herring-boning, fagotting, shirring, easing, piping, basting, overcasting, coarse-running and tacking out. Furthermore, he said, a foreigner would find the words hard to translate, especially if contemporary literature had disappeared, a thousand years hence. The same applies, of course, to all the arts and trades, so one cannot be surprised that there are still problems in the technical terms of alchemy and chemistry in the different cultures.

[b] There is similar need for a glossary of technical terms in pharmacology and this we propose to provide in Sect. 45 (Vol. 6).

[c] Pp. 207ff. [d] Mod. *chêng liu*.[16]

[e] For example, heating sal ammoniac with tin so as to produce stannous chloride.

[f] By confusion with *chiu*,[17] the correct medical term for moxibustion and other forms of cautery.

[g] Cf. e.g. *TT*893, p. 7*a*, *b*. [h] Cf. again *TT*893, p. 7*a*, *b*.

[1] 安 [2] 烝 [3] 蒸 [4] 澆 [5] 結 [6] 煎 [7] 煎鍊
[8] 制 [9] 炙 [10] 晶 [11] 晶化 [12] 煮 [13] 轉 [14] 抽
[15] 飛 [16] 蒸餾 [17] 灸

Table 115 (*continued*)

fu[1] (lit. rotten, corrupt)	putrefaction; but also certain special fermentations.
fu[2] (lit. to subdue, to make to lie prostrate)	to extract; to separate out from; to purify; esp. to prevent or delay the process of volatilisation, sublimation or distillation (i.e. fixation); to inhibit the potency of some other substance; cf. *chih* and *sha*.
fu chi[3] (lit. cover and bed)	a layer of mineral substance placed below and above the reactants in the vessel.
fu huo[4] (lit. to subdue in the fire)	to heat until the substance is subdued (i.e. fixed).
hua[5] (lit. to change)	to undergo, or make to undergo, chemical change; to melt or to solidify.
hua chhih[6] (lit. radiant or flowery pool)	a bath of strong acetic acid (vinegar, with additions), in which is immersed a substance or substances, sometimes contained within a pared and sealed bamboo tube.[a]
hua khai[7] (lit. to change so as to separate)	fusion; melting; thawing; digestion.
huan[8] (lit. return)	a cyclical operation several times repeated. Cf. *chuan*.
hui chhih[9]	ash-bath (sand-bath)
hsia[10] (lit. down)	to put an ingredient in a vessel; to drive down; precipitation; descensory distillation.
hsiao,[11] *hsiao hua*[12] (lit. to disperse, dissipate)	to dissolve; to digest.
jou[13] (lit. weak, to weaken)	to soften; to macerate; ceration.
jung[14, 15, 16] (lit. to melt)	to smelt; to melt; to fuse; to blend; to dissolve.
kang[17] (lit. hard)	to harden.
Khan kua[18] (*Khan* trigram)[b]	to boil in water; to heat over a water-bath.
kou[19] (lit. to hook)	to extract (e.g. a metallic *chhi* from its ore).
ku chi[20] (lit. firmly enclosed)	sealing the parts of a vessel together, with the aid of a lute, to make it as gas-tight (or water-tight) as possible, so that processes of change, especially those involving ascent and descent (as in sublimation and distillation), can go on in the interior, isolated thus as far as possible from its surroundings.[c]

[a] One must be on the watch for very different meanings of this term, partly in pharmacy and medicine where various drugs might be combined with salts and vinegar, but especially in physiological alchemy, where (as with other *wai tan* terms) the significance is entirely different (cf. pt. 5 below).

[b] Cf. Vol. 5, pt. 5 below, in our discussion of physiological alchemy.

[c] This expression is an obscure one, and has given rise to some misunderstandings. Its second character evokes the hexagrams *Chi Chi* and *Wei Chi* (cf. pp. 68, 70–1); and here implies a perfecting of Yin–Yang relationships in compensation and equilibrium. That this could be done by moving things up and down was mirrored in the origin of these two *kua* themselves from the trigrams *Khan* and *Li* by

[1] 腐 [2] 伏 [3] 覆罐 [4] 伏火 [5] 化 [6] 華池 [7] 化開
[8] 還 [9] 灰池 [10] 下 [11] 消 [12] 消化 [13] 揉 [14] 熔
[15] 鎔 [16] 融 [17] 剛 [18] 坎卦 [19] 勾 [20] 固濟

Table 115 (*continued*)

kuan[1] (lit. portal)	to bury in a container under the ground and allow slow chemical change to proceed without heating.
Li kua[2] (*Li* trigram)[a]	to heat directly in the fire of a stove.
lien[3] (lit. to refine)	to heat a substance (especially a metal) without water; more broadly, to effect any chemical transformation.
lin[4] (lit. to soak)	to dissolve part of a substance (e.g. a mixture of salts) in water; to separate a solution from a precipitate or residue by filtration or decantation.
liu[5] (lit. steamed food)	some preparation submitted to the action of steam.
lo[6] (lit. gauze)	to sift through a sieve of cloth.
lu[7,8] or *lü*[7] (to strain)	filtration; to filter.
mu yü[9] (lit. to bathe)	to grind in the presence of water or some other liquid.
niang[10] (ferment)	to ferment; fermentation.
ning[11] (lit. to congeal)	to solidify; to harden; coagulation.
o[12]	see *wu*.
phu[13] (to spread)	to spread out a bed of mineral material.
san[14] (lit. to scatter)	to separate; to disperse; to comminute; a medicinal powder.
sha[15] (lit. to kill)	to change a substance so that it is no longer volatile (cf. *chih* and *fu*).
shai[16] (lit. to sift)	to sift through a sieve of hair or rattan.
shang[17] (lit. up, above)	to drive up; sublimation; distillation.
shêng[18,19] (lit. to rise or raise)	to sublime; to distil; to evaporate and vaporise in general.
shêng hua[20] (lit. rising flower, ascending floreate essence)	sublimate; distillate; condensate.
shih[21]	see *wei chhi shih*.

changes in the position of their central lines (cf. p. 271). In the simplest *wai tan* usage, therefore, *ku chi* gave the instruction 'seal and sublime' (cf. pp. 47, 79); though in some contexts the first half might perhaps predominate over the second (cf. Tshao Yuan-Yü (*1*), pp. 43, 52 (78, 85); Yuan Han-Chhing (*1*), p. 209; Sivin (1), p. 185).

But the phrase was also adopted in *nei tan* terminology, referring then to the sealing in of secretions normally lost from the body (cf. pt. 5), and to the ascent and descent of *chhi* and secretions within it; hence further to the ultimate retention of the enchymoma when formed. As we read in *Chin Tan Ta Chhêng* (*HCSS*, ch. 10, p. 9*b*): 'Thai-I Chen Jen says: "Seal the container (lit. womb, *thai*[22]) firmly; then the chemical transformations (of the various materials inside) will take place with celerity". He is speaking of "water" and "fire" combining to form the *kua Chi Chi*. Close the doors of the mysterious chamber and let nothing escape.' Later on, the 'hermetic' sealing idea was applied to the sealing out of sense impressions and wandering thoughts (cf. pt. 5). 'Forgetting forms and abandoning desires and memories, that is called *ku chi*' (*HCSS*, ch. 1, p. 3*b*).

Finally, *ku chi* was also used in medical language, again with the nuance of ascent and descent within. Fang I-Chih explains the method that went by that name (*Wu Li Hsiao Shih*, ch. 4, p. 17*b*) as applying drugs which would drive up or down the malign *Yang chhi* according to the illness concerned.

[a] Cf. Vol. 5, pt. 5 below, in our discussion of physiological alchemy.

[1] 關 [2] 離卦 [3] 煉 [4] 淋 [5] 餾 [6] 羅 [7] 濾
[8] 漉 [9] 沐浴 [10] 釀 [11] 凝 [12] 煕 [13] 鋪 [14] 散
[15] 殺 [16] 篩 [17] 上 [18] 升 [19] 昇 [20] 昇華 [21] 使 [22] 胎

Table 115 (*continued*)

shui fa[1] (lit. water method)	solubilisation; bringing substances into aqueous solution.
shui fei[2] (lit. flying on water)	purification of a powdered mineral by flotation on water (cf. *fei*).
shui hai[3] (lit. water sea)	a cooling-water reservoir or condenser vessel.[a]
shui kuan[4] (water pipe)	a cooling-water tube or coil.[a]
ssu[5] (lit. death, to die)	change of a substance so that it loses its original form or properties; to detoxicate; to decompose.
tao[6] (to beat)	to pound (as in a mortar).
tê[7] (lit. to obtain)	'going well with', the synergistic action of substances chemically or pharmacologically; one thing enhancing the action of another (an expression which could have covered cases of what we should now call catalysis). Cf. *wei chhi shih*.
thi ching[8] (to cleanse)	to purify; to separate a metal from an alloy.
thi lien[9]	to refine.
tien[10, 11] (lit. a spot)	a pinch, a speck, a knife-point, 'a spot of'; and to put such a small amount into a larger body of something else; projection.
tien hua[12]	projection; a small quantity of one substance producing change in a much larger quantity of another substance.
tuan[13] (lit. to forge)	to heat at a high temperature.
wei[14]	'to have a fear of', i.e. to be capable of dissolving in, some solvent.[b]
wei chhi shih[15]	'acting as its envoy (or adjutant)',[c] said when one substance enhances or activates the effect of another, chemically or pharmacologically. Cf. *tê*.
wu[16] (lit. to hate)	to inhibit the potency of some other substance.
yang[17] (lit. to nourish)	to apply heat gently over a long period, as by dung fire, charcoal embers, the water-bath, bed of ashes, or sand-bath (athanor).
yen[18] (lit. to grind)	to comminute, to powder.
yü yen[19] (lit. fish eyes)	bubbles appearing on the surface of a heated liquid, like fish eyes.
yü yen fei[20] (fish-eye boiling)	a particular stage in the boiling process (cf. Vol. 4, pt. 1, p. 69).
yung[21, 22, 23]	see *jung*.

[a] On these two expressions see particularly *TT*907, discussed on pp. 35ff.
[b] Said, for example, of gold with respect to mercury, because of the formation of amalgams.
[c] Cf. our account of the most ancient Chinese pharmacological classification system in Sect. 38 (Volume 6).

[1] 水法 [2] 水飛 [3] 水海 [4] 水管(筧) [5] 死 [6] 擣 [7] 得
[8] 提淨 [9] 提煉 [10] 點 [11] 点 [12] 點化 [13] 煆 [14] 畏
[15] 爲其使 [16] 惡 [17] 養 [18] 研 [19] 魚眼 [20] 魚眼沸 [21] 熔
[22] 鎔 [23] 融

From this it can be seen that the armamentarium of technical terms available to the ancient and medieval Chinese alchemists, proto-chemists and pharmacists was quite parallel with those used by the Greeks[a] and Latins[b] in the West. Lists of standard operations are often found in the occidental texts,[c] and it may be worth looking at them for a moment by way of comparison. One can tabulate them as follows, in accordance with the changes of state which they implied:[d]

solid——→solid	
Calcination	G/4
Fixation	G/7
Ceration	G/8
solid——→liquid	
Fusion	G/5
Solution	G/2
Descension	
liquid——→solid	
(Crystallisation)	
Coagulation	G/6
(Precipitation)	
(Filtration)	
solid——→gas	
Fermentation or Putrefaction	
solid——→gas——→solid	
Sublimation	G/1
liquid——→gas	
(Evaporation)	
gas——→liquid	
(Condensation)	
liquid——→gas——→liquid	
Distillation	G/3

In the old lists of definitions the terms occur in a variety of different orders, sometimes with omissions, sometimes with additions, and they do not include all of the modern operational ideas which one would expect. A few words of further explanation will suffice to assist comparisons with the Chinese terms.

By Calcination[e] was meant the reduction of any solid to a powder by chemical means (e.g. a metal to its oxide)—'the pulverisation of a thing by fire'.[f] Fixation,[g] reminiscent of *chih*,[1] was 'the convenient disposing of a fugitive thing to abide and

[a] See Berthelot (2), i.e. Berthelot & Ruelle (1), pp. 263–4.

[b] See e.g. Holmyard (1), pp. 43 ff.

[c] As also in Syriac and Arabic MSS. For such lists of operations see Berthelot & Duval (1), pp. 165 ff.; Stapleton, Azo & Husain (1), pp. 326 ff., 356 ff., 366 ff., 385 ff.

[d] Terms primarily modern, though occasionally used in medieval times, are placed in brackets. The numbers marked G show the order of description in the Geberian *Summa Perfectionis*, *c.* +1290.

[e] *Summ. Perf.*, ch. 51 (like all the other chapters here quoted, in bk. 4).

[f] *Ibid.*, Russell tr., p. 101.

[g] *Summ. Perf.*, ch. 54.

[1] 制

sustain the fire'.[a] Ceration,[b] softening or 'waxifying', was 'the mollification of a hard thing, not fusible unto liquefaction',[c] e.g. the formation of amalgams and sulphides. Fusion applied generally to all smelting and melting; it might have been regarded by the Geberian writer as a form of Solution,[d] 'the reduction of a dry thing into water',[e] as happens when a salt is dissolved. Descension[f] was simply what we shall shortly discuss as *destillatio per descensum*,[g] the liquefying of mercury or an oil by heat and its descent into a receiver below. Coagulation[h] was defined in Geber as 'the reduction of a thing liquid to a solid substance by privation of the humidity',[i] as when mercury is combined with sulphur to form vermilion.[j] Crystallisation, Precipitation and Filtration were processes known, of course, to all the proto-chemists from Hellenistic times onwards, and China also; though not often listed in the Western medieval categories of operations. These do generally include, however, Fermentation or Putrefaction, names referring to the natural changes occurring in dead organic materials under the action of bacteria, yeasts and moulds, often with the evolution of gases; as also the formation of gases from inorganic substances in certain reactions—but the terms were commonly applied as well to any chemical change brought about by long subjection to mild heat. Sublimation,[k] on the other hand, was a term always used in much the same way as we ourselves use it, vaporisation with condensation above in solid form; and this 'elevation of a dry thing by fire, with adherency to its vessel'[l] was the process which occasioned the lengthiest descriptions in the *Summa Perfectionis*. Evaporation and Condensation are terms rather more modern, but Distillation[m] necessarily gave rise also to a long discussion.' The cause why distillation was invented' said the Geberian writer, 'and the general cause of the invention of every distillation, is the purification of liquid matter from its turbulent faeces and the conservation of it from putrefaction'.[n] The term included also a medieval process which has few remains in modern technique, *destillatio per filtrum*, where a siphon is made of a piece of cloth hanging across the edge of a pan to take the solvent over by capillary attraction into a separate receiver.[o] Finally, besides all these we must remember the characteristically alchemical processes of Projection, clearly recognisable in *tien hua*[1] (pt. 3, pp. 38, 88, etc.); as also Separation, Mortification, Ablution, *Nigredo*, *Albedo*, *Citrinitas* and *Rubedo* (pt. 2, p. 23), about which no more need be said here. Thus, all in all, an inspection of the two lists of technical terms will show considerable parallelism in the development of chemical technique in the Far East and the Far West.

We are now in a position to make a tour of the Chinese medieval alchemical and

[a] *Ibid.*, Russell tr., p. 116.
[b] *Summ. Perf.*, ch. 55.
[c] *Ibid.*, Russell tr., p. 119.
[d] *Summ. Perf.*, ch. 52.
[e] *Ibid.*, Russell tr., p. 107.
[f] *Summ. Perf.*, ch. 49.
[g] Pp. 55ff. below.
[h] *Summ. Perf.*, ch. 53.
[i] *Ibid.*, Russell tr., p. 110.
[j] Cf. pp. 262–3 below, and pt. 3, pp. 126, 198.
[k] *Summ. Perf.*, chs. 39 to 48 incl.
[l] *Ibid.*, Russell tr., p. 74.
[m] *Summ. Perf.*, ch. 50.
[n] *Ibid.*, Russell tr., p. 96.
[o] Whether or not this practice was also current in medieval Chinese alchemy we are at present unable to say.

[1] 點化

iatro-chemical laboratory,[a] and to examine systematically the pieces of apparatus that were used there.[b]

(1) The Laboratory Bench

The Chinese alchemist's version of the modern laboratory bench was the *than*[1] (lit. platform or altar). No specific rules were laid down with regard to its dimensions and constructions. *TT*904, a Sung book, gives an illustration of it (Fig. 1374)[c] together with the following explanatory notes:

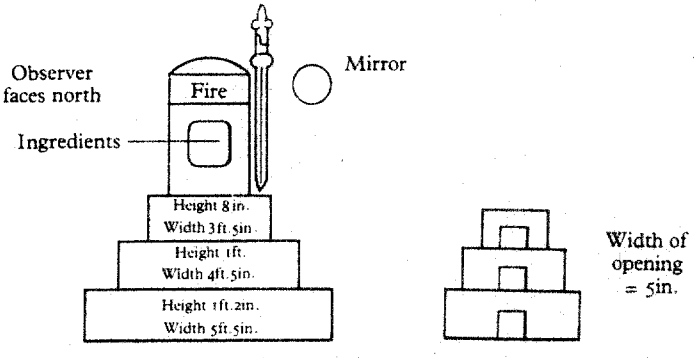


Fig. 1374. Stove platform from *Kan Chhi Shih-liu Chuan Chin Tan* (a Sung text).

The *tsao*[2] (furnace) is the *yao lu*[3] (chemical stove). The *ting*[4] (vessel) is called the *sha ho*[5] (cinnabar enclosure). The *shen shih*[6] (magical reaction-chamber) is the *hun tun*[7] (world of chaos).

The same text describes the diagram, saying:[d]

Build a *than* (platform) of three stages, with a (total) height of 3 ft. 6 in. The platform is square with a perimeter of 10 ft.

One notes that this description does not coincide with the dimensions given in the diagram itself.

[a] Here we are concerned primarily with the 'hardware', but later more will be said about the liturgical and magical aspects of the matter (cf. pp. 289ff. below, and Fig. 1521). The sword, the mirror, the jars of pure water, the peach-wood talismans, all have to be borne in mind along with the aludels, matrasses and stills; cf. Yoshida Mitsukuni (7), pp. 250, 257.

[b] We may be excused from offering any complete guide to the lists of apparatus and instruments used in other culture-areas. For the Hellenistic apparatus Berthelot (1, 2) and Sherwood Taylor (2, 5) are of course indispensable. Arabic apparatus (*tadābīr*) is listed and described, *inter alia*, in Berthelot & Duval (1), pp. 150ff. (Syriac MSS); and in Stapleton, Azo & Husain (1), pp. 324ff., 353ff., 362ff., 378ff.; Stapleton & Azo (1), pp. 60ff. Wiedemann (22) consecrated a special paper to the apparatus of the Arabic chemists such as al-Rāzī (*c.* +900); and names of the parts of apparatus can be found in the dictionary of Siggel (2). Holmyard (18) covers clearly and succinctly the whole range from the Hellenistic proto-chemists through the Arabic writers and the Latin West to the 17th century in Europe.

[c] P. 8*a*. [d] P. 7*b*.

[1] 壇 [2] 竈 [3] 藥鑪 [4] 鼎 [5] 砂合 [6] 神室 [7] 混沌

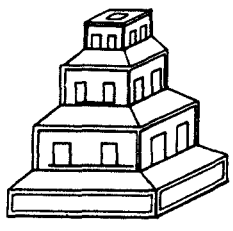
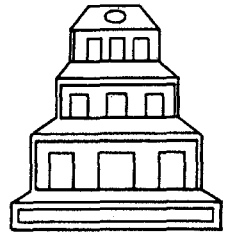


Fig. 1375



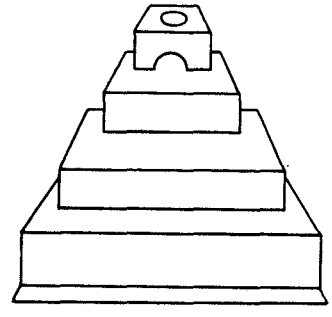


Fig. 1376

Fig. 1375. Stove platforms from *Tan Fang Hsü Chih* (+ 1163).
Fig. 1376. Stove platform from *Yün Chi Chhi Chhien* (+ 1022).

In *TT*893, also a Sung book, we find two illustrations of the *lung hu tan thai*[1] (Dragon-and-Tiger platform), (Fig. 1375) and also the following description:[a]

The *Tshan Thung Lu*[2] (Records of the Kinship of the Three)[b] states: 'below the *lu*[3] (stove) is the *than* (platform), which consists of three stages put one over the other. Each stage faces the eight directions and has eight openings'.

The construction of the *than* was by no means standardised in the Sung as can be seen from another example in Fig. 1376 taken from *TT*1020. The text says, 'The *than* can be so constructed as to suit one's convenience'.[c] This implies that there were no fixed rules in the construction of the *than*, but that it could be made to fit the circumstances, such as the size of the stove and the size of the laboratory.

It is curious to see a stepped stove platform looking very like these in the Syriac alchemical texts of the +10th or +11th century (though the MSS we have were not written till the +16th).[d] It would not be at all unreasonable to take this as suggestive of Chinese influence.

(2) The Stoves *lu*[3] and *tsao*[4]

Although the word *tsao* generally refers to the kitchen stove,[e] the two words *lu* and *tsao* both mean the heating apparatus of the alchemists which took many different forms. As the texts do not employ consistent terminology, in certain cases the heating apparatus may be taken to mean a stove or furnace, while in other cases it must mean an oven or combustion-chamber.

[a] P. 5*b*.
[b] Presumably a reference to the *Tshan Thung Chhi* or some commentary on it.
[c] Ch. 72, p. 12*b*. In these drawings note one on the usual axonometric projection (left) and two in optical perspective (right). Cf. Vol. 4, pt. 3, pp. 113 ff. and Figs. 758, 776, 778.
[d] Berthelot & Duval (1), p. 113.
[e] Pottery tomb-models of stoves with as many as nine or ten openings carrying vessels of various kinds are extremely common in Chinese museums. Some particularly good ones are in the Archaeological and Historical Museum at Canton.

[1] 龍虎丹鼎 [2] 參同錄 [3] 爐 [4] 竈

*TT*1020, a Sung text, describes one form of stove, saying:[a]

The *lu* (stove) forms the walls of defence for the *ting*[1] (reaction-vessel). Without the walls there would be evil influences (coming from outside). From top to bottom it resembles the *phêng hu*[2] pot and from side to side it symbolizes the Five Sacred Mountains (*wu yo*[3]). The platform consists of three stages, while the combustion-chamber has eight openings. The twelve cyclical signs and the months follow the (*Pei-*) *Tou*[4] (the Great Bear).... The *hua chhih lu*[5] (stove for digestion in vinegar) is 4 ft. high, 6 in. thick and has an internal circumference of 3 ft. 5 in. The openings measure 2 in. and they are eight in number.

The same text also tells us about the *thai i lu*[6] stove. It says:[b]

The *thai i lu* is placed over the platform. It is 2 ft. high, 6 in. thick and has an internal circumference of 3 ft. 5 in. Each opening is 2 in. high and half an inch wide. The 12 projections (*chih*[7]) are one inch wide all round. The platform can be made to suit one's convenience. Again, the *hua chhih lu* is 4 ft. high, 6 in. thick and has eight openings. It also has a two-inch rim....

Here is another description from *TT*904:[c]

On the platform is the *tsao*[8] (stove), on which is placed the *ting* (reaction-vessel). Within the *ting* is placed the *shen-shih*[9] (magical reaction-chamber).

A text of the Liang period, *TT*874, gives an account of the construction of the *tan lu*[10] (elixir stove) saying:[d]

Iron rods are fixed at the bottom of the stove. There should be, say, twelve or thirteen of them, each being 1 ft. in length and with a cross-section of 0·4 in. square. They are put in position (so as to form a grate) over the hollow space (*chhien*[11]) at a distance of 0·2 in. from one another. There is an empty space beneath the rods, which are placed two inches above ground (or rather above the base of the stove). The *tan lu* has an opening four and a half inches wide at the centre. The openings in front of and behind (the stove) enable air to pass in and out. The fire is lit above the rods and is fanned by the air current....

Figure 1377 shows the *yen yüeh lu*[12] (inverted-moon stove), taken from *TT*1054, a Yuan work.[e] The stove has a flat top, at the centre of which is an opening for the container or crucible and for the emission of flame. The text says:

The (upper) surface of the *lu* (stove) has a circumference (perhaps it should mean diameter) of approximately 1 ft. 2 in. It has a central opening measuring 1 ft. across. The rim all round is 2 in. wide and 2 in. thick. The opening faces upwards (to hold) the *kuo fu*[13] (pot and crucible) resembling an upturned moon. Hence the name *yen yüeh lu* (inverted-moon stove). In Chang Sui's[14] annotations it is also known by the name *wei kuang ting*[15] (reaction-vessel of intense brightness).[f]

It seems likely that the *yen yüeh lu* was the stove referred to by Wei Po-Yang[16] in the mid +2nd century in *TT*990.[g]

[a] Ch. 72, p. 11*a*. [b] P. 11*b*. [c] P. 7*b*. [d] P. 14*a*.

[e] P. 9*b*. This term had also a special significance in physiological alchemy quite different from the plain meaning here (cf. Vol. 5, pt. 5 below).

[f] We have no further information about this adept. The same description first occurs in the preliminary material of the *Wu Chen Phien* of +1075, but only in the version of this contained in *Hsiu Chen Shih Shu* (*TT*260), ch. 26, p. 7*a*.

[g] Ch. 1, p. 32*b*.

[1] 鼎 [2] 逐鞏 [3] 五岳 [4] 北斗 [5] 華池鼎 [6] 太一鑪
[7] 支 [8] 竈 [9] 神室 [10] 丹鑪 [11] 甑 [12] 偃月鑪
[13] 鍋釜 [14] 張隨 [15] 威光鼎 [16] 魏伯陽

*TT*878 explains how the crucible was placed over a tripod inside the *tsao* (combustion-chamber; oven). It says:[a]

...Within the *tsao* (combustion-chamber) is placed an iron tripod, which is best made of cast iron (*shêng thieh*[1]). The *yao fu*[2] (closed vessel) is placed over the tripod and adjusted until it is in the centre of the chamber. Care should be taken so that it does not incline to one side. The four sides should be about three and a half inches away from the wall of the chamber. The chamber should be two inches higher than the vessel. Rice-husk (fuel) should be regularly placed around the four sides of the crucible and more must be added as heating progresses. This is necessary for fear of uneven heating due to the varying intensity of the fire.

For ordinary heating the containing vessel was simply placed over the stove and fire was applied below. This is shown in Fig. 1378, taken from the Sung text *TT*1020.[b]

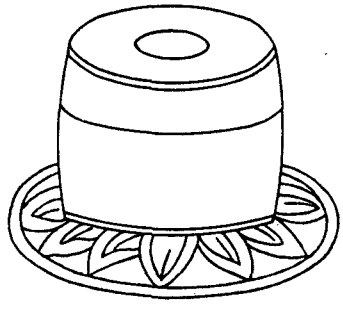


Fig. 1377

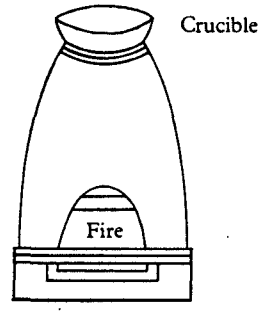


Fig. 1378

Fig. 1377. The 'inverted-moon stove' (*yen yüeh lu*) from *Chin Tan Ta Yao Thu* (+ 1333).
Fig. 1378. Stove depicted in *Yün Chi Chhi Chhien* (+ 1022).

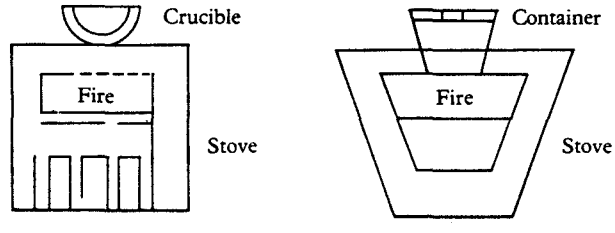


Fig. 1379. Stoves drawn in *Thai-Chi Chen-Jen Tsa Tan Yao Fang* (a text probably of the Sung).

Another example is given in *TT*939.[c] It shows *yang lu*[3] stoves (Fig. 1379), which employed a strong fire (*wu huo*[4]).

Curious stoves which may well have had alchemical use are to be seen in Chinese museums. For example the Archaeological Institute of Academia Sinica in Peking has a flat conical pottery object shaped rather like a hollow mountain having holes for escape of fumes from burning charcoal or other fuel, and four cupped holders to take

[a] Ch. 7, p. 4*a*. [b] Ch. 72, p. 20*b*. [c] P. 5*a*.

[1] 生鐵 [2] 藥釜 [3] 陽爐 [4] 武火

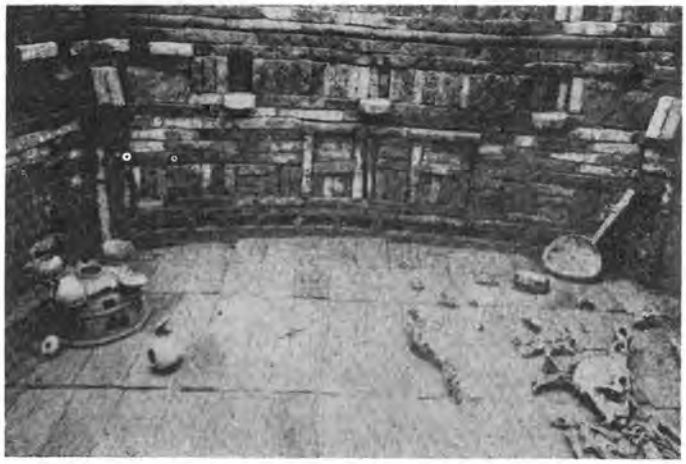


Fig. 1380*a*. Pottery stove designed to heat four containers at one time, in an excavated tomb of the Thang period, *c.* + 760 (Chhen Kung-Jou, *3*).

Fig. 1380*b*. As it was found on the floor of the tomb chamber.

lidded pots, surrounding a chimney at the top of the stove. This apparatus, which was exacavated from a Thang tomb[a] near Yü-hsien[1] in Central Honan,[b] could have served well for continuous slow heating (Figs. 1380*a*, *b*). A very different stove for gentle charcoal heating is the – 11th-century 'hot-plate' comprised in the Tuan-Fang altar set (Fig. 1380*c*).

Over and over again, not only in alchemical texts, but in descriptions of industrial fermentations, tea-making, etc., emphasis is laid on the indispensability of careful temperature regulation—without which everything will fail.[c] Sivin (2) has drawn

[a] Dated by coins in the neighbourhood of +760, not earlier.
[b] It has been figured and described by Chhen Kung-Jou (*1*, *3*).
[c] Cf., for instance, the explanation of the term *wên huo*[2] in *Wei Lüeh*, ch. 11, p. 5*b*.

[1] 禹縣 [2] 文火

Fig. 1380*c*. A bronze 'hot-plate' of the −11th century, for warming sacrificial wine in liturgical vessels (photo. Metropolitan Museum of Art). This is the Tuan-Fang altar set, so named after the enlightened Governor of Shensi in whose time (1899 to 1901) it came to light at Tou-chi-thai in that province. Besides its own vents, the stove platform has a cubical chimney at one side also fitted with slits. The vessels are probably not all of the same date, but were assembled by some early Chou ruler; cf. Li Chi (5).

attention to the concern shown in many of the alchemical writings for the precise control of the intensity and duration of the heat. A quotation from the *Chu Chia Shen Phin Tan Fa* runs as follows:[a]

The amounts of fuel to be weighed out are increased and decreased in cyclical progression according to the phases of *Yin* and *Yang*. They must conform to the (order of the) symbols of the *Book of Changes*,[b] to the threefold concordance,[c] to the (correspondences of the) four, eight, twenty-four and seventy-two seasonal divisions of the year, and to the implicit configuration and proper activity of the year, month, day and hour, without one jot or tittle of divergence.

This quantitative aspect is also seen, as Sivin points out, in the monograph of Chhen Shao-Wei on the careful assessment of the amount of cinnabar to be obtained from cinnabars of different quality. The yield recorded from 'lustrous cinnabar' (14 ozs. from one 1 lb.) comes very close to the theoretical yield from pure cinnabar—13·8 ozs. We shall return to this subject on p. 300.[d]

About the means used to ensure a good draught for the furnace not much is known. The expression *fêng lu*[1] occurs frequently enough, as in the writings of Sun Ssu-Mo,[e] and this is explained in the *Thang Yü Lin* as meaning a stove or brazier pierced with

[a] *TT*911, ch. 4, p. 1*b*; a Sung work by Mêng Yao-Fu and others. Tr. Sivin (2), p. 14*a*.

[b] I.e. the trigrams and the hexagrams. See Sect. 13 in Vol. 2.

[c] Heaven, earth and man? More probably, whatever was implied in the title of the *Tshan Thung Chhi*.

[d] The great importance attached to weights in chemical operations by the Arabs is well known (cf. pp. 393–4). Stapleton & Azo (1), in their study of the treatise of Ibn 'Abdal-Malik al-Kāṭī (+1034) emphasise this point.

[e] E.g. *Tan Ching Yao Chüeh*, pp. 18*a*, *b*. See Sivin (1), pp. 206–7, and also pt. 3, pp. 132 ff. above.

[1] 風鎚

numerous holes like an iron beacon basket so as to catch the wind from whatever quarter it might be blowing.[a] Some processes needing strong and continuous heat called, no doubt, for the use of the cylindrical box-bellows (*fêng hsiang*[1]),[b] and this would have been available throughout the medieval period. *Fêng lu* could also be of this kind, for Sun was able to melt cast-iron in such 'blast'-furnaces.

(3) The Reaction-Vessels *ting* (tripod, container, cauldron) and *kuei* (box, casing, container, aludel)

The word *ting*[2] normally refers to the tripod cauldron, so familiar among the bronzes in Chinese archaeology, but the alchemists' apparatus known by this name included not only pots of this kind but also various other forms of reaction-vessel to which fire was applied externally. Perhaps the best distinction between the *lu*[3] (stove; combustion-chamber) and the *ting* is that the former had fire within it whereas the latter was surrounded by fire. The *ting* itself might contain an inner reaction-chamber in which the ingredients were placed.

The earliest account[c] of the reaction-vessel is found in the +2nd century *Tshan Thung Chhi* of Wei Po-Yang.[4] It says:[d]

> The Song of the *Ting* (reaction-vessel): Its circumference is three-five (i.e. 1 ft. 5 in.) (and its thickness is) one inch and a tenth (i.e. 1·1 in.). The circumference of the mouth is four and eight (i.e. 12 in.). Its lips are 2 in. thick. The total body height is 12 in. (i.e. 1 ft 2 in.), with an even thickness throughout. With its belly set erect it is to be warmed gently (over the stove). (The *chhi* of) Yin (i.e. the reaction-vessel) stays above, while (that of) Yang (i.e. the fire) runs below. Use a strong fire during the end and the beginning of each (lunar) month, but a gentle fire during the middle of it. Begin heating for 70 days, and after the end of another 30 days the contents are to be properly mixed and heated for a further 260 days (making a total of 360 days, i.e. twelve lunar months). . . .[e]

*TT*889 mentions five types of *ting*:[f]

> One is called *chin ting*[5] (gold vessel), the second is called *yin ting*[6] (silver vessel), the third is called *thung ting*[7] (copper vessel), the fourth is called *thieh ting*[8] (iron vessel) and the fifth is called *thu ting*[9] (pottery vessel).

Figure 1381, taken from a Thang or Sung text in *TT*1020, shows a *chin ting* ("gold" vessel).[g] The text gives the following description:

> According to rule the *ting* measures 1 ft. 2 in. in height and weights 72 oz. The number is nine (alternative translation: 'there are nine of them'). The inner circumference is 1 ft. 5 in. The *ting* is supported by legs so that it stands two and a half inches above ground. The base has a thickness of 2 in., while the body is one and a half inches thick. It has a capacity of

[a] Ch. 8, p. 22*a*. [b] Cf. Vol. 4, pt. 2, pp. 135ff. [c] *TT*990, ch. 3, p. 11*b*ff.
[d] We depart here from the translation made formerly by Wu Lu-Chhiang & Davis (1), p. 260.
[e] In interpreting the above measurements it must be remembered that the Chinese foot was one of 10 inches, not 12.
[f] P. 2*b*.
[g] YCCC, ch. 72, p. 10*a*, *b*. Sep. ed. p. 11*a*, *b*.

[1] 風箱 [2] 鼎 [3] 爐 [4] 魏伯陽 [5] 金鼎 [6] 銀鼎
[7] 銅鼎 [8] 鐵鼎 [9] 土鼎

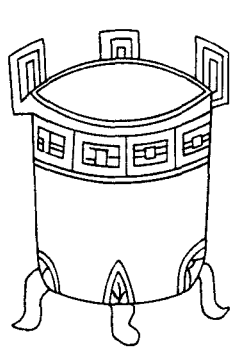


Fig. 1381

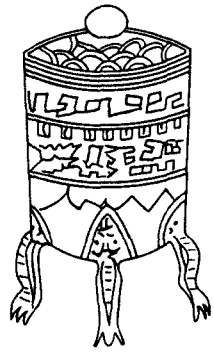


Fig. 1382

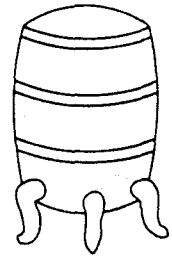


Fig. 1383

Fig. 1381. Gold reaction-vessel, a drawing from *Yün Chi Chhi Chhien* (+ 1022).
Fig. 1382. Covered reaction-vessel, a drawing from the same work.
Fig. 1383. 'Suspended-womb' reaction-vessel, also with three legs (*hsüan thai ting*), from *Chin Tan Ta Yao Thu* (+ 1333).

three and a half *shêng*[1] (approx. 100 cu. in.) when filled to a depth of 6 in. The cover is 1 in. thick and the ears are one and a half inches high.

In the same chapter of this text we find another picture of the *ting* (Fig. 1382).[a] It has a lid and the decorations are more elaborate.[b]

The Yuan text *TT*1054 gives an illustration (Fig. 1383) of the *hsüan thai ting*[2] (suspended-womb vessel) with the following description:[c]

The *ting* has a circumference of 1 ft. 5 in. and is hollow inside for 5 in. It is 1 ft. 2 in. high like a *phêng hu*[3] pot....It also symbolizes the human body. It consists of three layers corresponding to the Three Powers (*san tshai*[4]—Heaven, Earth and Man). The upper and the middle section of the *ting* are connected by the same vertical passage. The upper, middle and lower sections must be evenly set. (The *ting*) is put into a *lu*[5] (stove) to a depth of 8 in. or is suspended inside a *tsao*[6] (combustion-chamber) so that it does not touch the base. Hence the name *hsüan thai* (*ting*) (suspended-womb vessel). It is also called the cinnabar vessel (*chu sha ting*).[7] In Chang Sui's[8] annotations it also receives the name *Thai I shen lu*[9] (magical vessel of the Great Unity).[d]

From the above quotations we can see that sometimes it is difficult to distinguish between a *ting* (reaction-vessel) and a *lu* (stove) as the two terms may refer to the same apparatus.

[a] P. 24*b*. Sep. ed. p. 25*b*.

[b] The title of the tractate is *Ta Huan Tan Chhi Pi Thu*;[10] we discuss it in other contexts elsewhere (pt. 5). One should be warned here that some of these works may really be talking about physiological alchemy (*nei tan*,[11] cf. pt. 5 below); nevertheless their illustrations draw on the equipment of the laboratory alchemists and proto-chemists.

[c] P. 8*b*. The same text first occurs in the preliminary material of the *Wu Chen Phien* of +1075, but only in the version of this contained in *Hsiu Chen Shih Shu* (*TT*260), ch. 26, p. 6*b*.

[d] Tshao Yuan-Yü (*1*) confused the *hsüan thai ting*[2] with the *yen yüeh lu*[12] by calling the former *wei kuang lu*[13] and the latter *Thai I shen lu*.[9]

[1] 升 [2] 懸胎鼎 [3] 蓬盧 [4] 三才 [5] 爐 [6] 竈
[7] 朱砂鼎 [8] 張隨 [9] 太一神鑪 [10] 大還丹契秘圖 [11] 內丹
[12] 偃月鑪 [13] 威光鑪

In all the examples so far mentioned the *ting* has been represented by cauldron-like forms with three legs, i.e. tripods. However, the legs were often omitted, for one may see in Chinese museums (e.g. at Sian and at Chêngchow) large cast-iron cauldrons about 1 ft diameter at the mouth dating from the Han period and almost certainly used for alchemical or technological preparations. Moreover, as we have pointed out, the word *ting* has a wider meaning. For example, no legs are attached to the *hun tun ting*[1] (chaos vessel), taken from the Sung book *TT*904 and shown in Fig. 1384.[a] In fact, it has now become plainly a reaction-chamber.

Fig. 1384

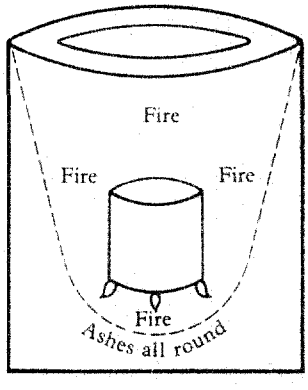


Fig. 1385

Fig. 1384. Aludel from the *Kan Chhi Shih-liu Chuan Chin Tan* (a Sung text).
Fig. 1385. Furnace and reaction-vessel, from *Chhien Hung Chia Kêng*...(+ 808 or later).

In one method of *yang huo*[2] (conserving the glowing fire) we shall see (p. 57) that fire was applied above and around the reaction-chamber, below which was placed a receiver containing water, and that the space inside the combustion-chamber was packed with ashes. In another method described in *TT*912, a Thang text,[b] we find that fire was applied all round the reaction-vessel. Fig. 1385 shows the *lu* (stove) with a *ting* (vessel) and how the glowing fire was conserved with a lagging of ashes.[c] The fuel used in this case was charcoal.

Next we have what was known as the *kuei*[3] (box, casing, container) the function of which was rather similar to that of the *ting* (reaction-vessel), because within the *kuei* was placed the reaction-chamber. Sometimes the *kuei* itself formed the reaction-chamber. Broadly speaking, *kuei* had lids while *ting* were open at the top, though the terms were not consistently used. Several types of *kuei* are illustrated in *TT*939 (Fig. 1386).[d] Some of them appear to have been containers pure and simple. The same text also mentions the following types:[e]

[a] See above, p. 17 note d.
[b] This is the book supposedly of + 808 by Chao Nai-An (see pt. 3, pp. 158–9), but most of which may date rather from Wu Tai or early Sung.
[c] From ch. 1, p. 9*b* of this text.
[d] In Fig. 1386(*a*) is taken from p. 4*b*, (*b*) from p. 5*b*, (*c*) from p. 8*b* and (*d*) from p. 10*b*.
[e] Pp. 14*b* and 15*a*.

[1] 混沌鼎 [2] 養火 [3] 匱

huang ya kuei[1] (yellow sprout casing)
pai hu kuei[2] (white tiger casing)
hei hu kuei[3] (black tiger casing)
huang kuei[4] (yellow casing)
hsüan chen kuei[5] (suspended needle casing)[a]
li chih kuei[6] (immediate fixing casing)
san chih kuei[7] (rice cake casing)
yung chhüan kuei[8] (bubbling spring casing)
thien-shêng huang ya kuei[9] (natural yellow sprout casing).

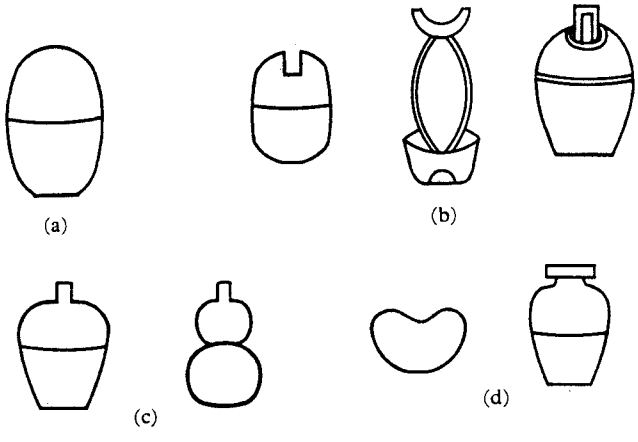


Fig. 1386

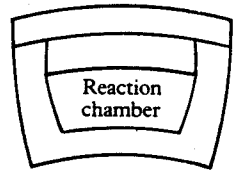


Fig. 1387

Fig. 1386. Types of aludels and reaction-vessels from *Thai-Chi Chen-Jen*...(probably Sung). (*a*) P. 4*b*, (*b*) p. 5*b*, (*c*) p. 8*b*, (*d*) p. 10*b*.
Fig. 1387. Reaction-chamber from the *Kêng Tao Chi* (+ 1144 or later).

Further accounts of other types of *kuei* are given in *TT*946. Fig. 1387 is an example taken from this text.[b] In the same work we also find a description of a *phi kuei*[10] (arsenical lead casing):[c]

Make *tzu ho chhê*[11] (lead) into powder. For every ounce of *phi mo*[12] (arsenic powder) use one and a half oz. of *ho chhê*[13] (lead) powder. After stirring and mixing they are put into a *kan kuo*[14] (crucible).[d] Begin with a gentle fire and gradually increase its intensity. When calcination is over use the residue to make a *kuei* (casing). This is most useful for subliming (*yang*)[15] calomel (*fên shuang*[16]).[e]

[a] This 'suspended needle aludel' we have encountered before, in Vol. 4, pt. 1, p. 275, where its name provided evidence of value from the mid + 11th century for the history of the magnetic compass. Presumably the significance of its figurative appellation here was that it was intended to stand bolt upright in the furnace.

[b] Ch. 1, p. 3*a*.

[c] Ch. 2, p. 15*a*.

[d] Also called *khan kuo*.[17]

[e] Lead and arsenic alloy readily, hardening the metal yet increasing its fluidity when molten. Hence the use of arsenic in spherical lead shot. Cf. Gowland (9), p. 133.

[1] 黃芽匱 [2] 白虎匱 [3] 黑虎匱 [4] 黃匱 [5] 懸針匱 [6] 立制匱
[7] 糍制匱 [8] 湧泉匱 [9] 天生黃芽匱 [10] 砒匱 [11] 紫河車
[12] 砒末 [13] 河車 [14] 甘堝 [15] 汞 [16] 粉霜 [17] 坩堝

In another example mentioned in the same treatise[a] a *kuei* was made from *chhing yen*[1] (blue salt; rock salt), *pai yen*[2] (white salt) and the juice extracted from arrowroot. This recipe must originally have included a refractory clay. It is interesting in this connection that accounts of blast-furnaces in late medieval China generally mention 'salt' as well as clay, lime and sand. The suggestion is elsewhere made that gypsum (calcium sulphate) was really meant in these cases, for among its traditional names are

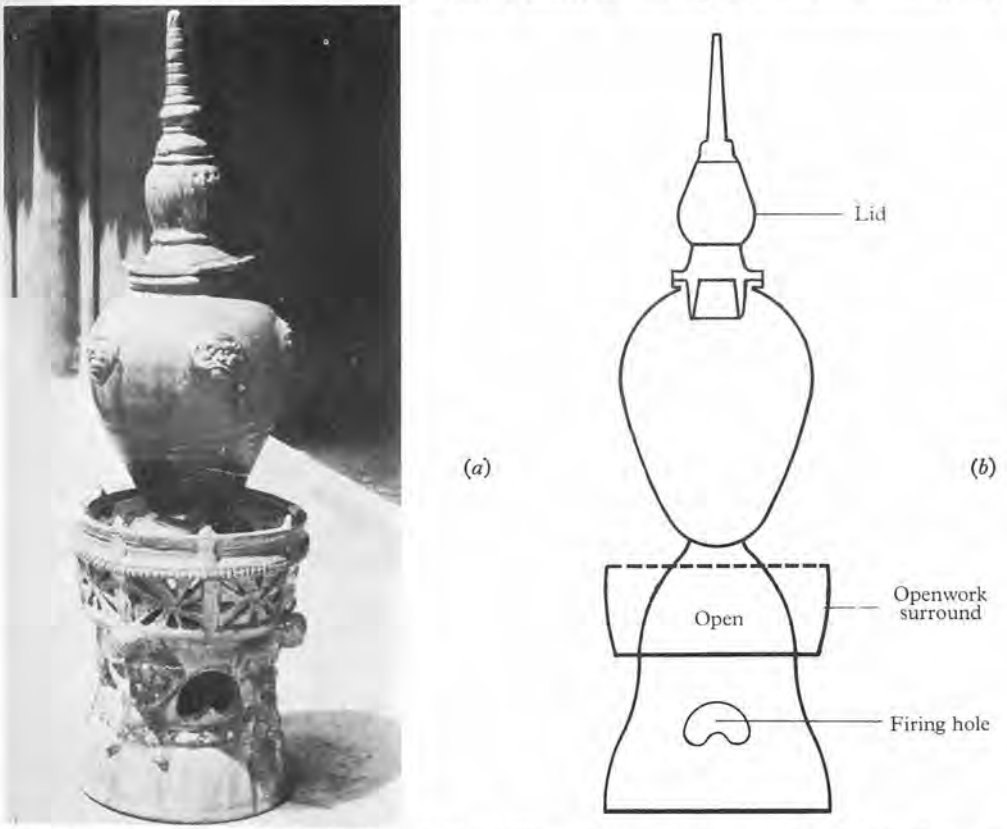


Fig. 1388. 'Precious vase' (*pao phing*), probably of Thang date, in the Provincial Historical Museum, Thaiyuan, Shansi (orig. photo. 1964). Recovered from a tomb excavation at Lin-fei-chhang to the west of the city. As the cross-section line drawing (*b*) shows, it was probably used as a digester with gentle heat.

yen chen[3] ('salt's pillow') and *yen kên*[4] ('salt's root'), both probably derived from stratigraphic relationships.[b] Gypsum is still used in the making of mortar and cement. Unless certain characters have dropped out of the text, the bald statement we have here may have been meant to deceive the uninitiated while being perfectly comprehensible to those with alchemical training. Other examples of *kuei* are given in *TT*912, an important Thang text.

A very different type of reaction-vessel, if that is what it was, is constituted by the *pao phing*[5] or 'precious vases', one example of which, conserved in the Provincial

[a] Ch. 7, p. 11*a*.
[b] Cf. Needham (30), and Vol. 3, pp. 673ff.
[1] 青鹽 [2] 白鹽 [3] 鹽枕 [4] 鹽根 [5] 寶瓶

Fig. 1389. Bronze reaction-vessel (*ting*) with clamp handle mechanism to permit tight sealing (Anon. (*106*), pl. 7). From the tomb of Liu Shêng (d. −113) at Man-chhêng. Ht. 17·8 cms., diameter at opening 17·2 cms. Two of these vessels were found in the tomb.

Historical Museum at Thaiyuan in Shansi, is illustrated in Fig. 1388. Of green and brown glazed pottery, it is considered Thang in date. As can be understood from the cross-section appended, the bottom part is a charcoal stove with firing openings and a solid ceiling, then above that a separable inverted hemisphere bears an egg-shaped reaction-vessel stoppered at the top by a bung in the form of a miniature pagoda. It seems unlikely that Taoist apparatus of this kind could have been employed for operations requiring any great degree of heat, but one could imagine it in use for the slow oxidation of mercury, or still better for the *hua chhih*[1] bath of strong vinegar (perhaps distilled or otherwise concentrated acetic acid) and saltpetre, in which various rather insoluble minerals could be dissolved by the dilute nitric acid (and perhaps also hydrochloric, if salt were present) formed.[a]

Yet another type of bronze vessel was like a *ting* with legs, but provided with a flat cover which could be held down tight with clamp handles. These pieces are rare, but two were found in the tomb of Liu Shêng,[2] Prince Ching of Chung-shan[3] (d. −113), the same that provided the two complete jade-plate body-cases shown in Fig. 1332 (Vol. 5, pt. 2, Pl. CDLII). We reproduce a photograph of one of these pressure vessels here (Fig. 1389).[b]

[a] Cf. pp. 167ff. below.
[b] Anon. (*106*), pl. 7; Hsia Nai, Ku Yen-Wên *et al.* (1), pp. 8ff., 13ff.

[1] 華池 [2] 劉勝 [3] 中山王靖

(4) THE SEALED REACTION-VESSELS *SHEN SHIH* (ALUDEL, LIT. MAGICAL REACTION-CHAMBER) AND *YAO FU* (CHEMICAL PYX)

Besides the more open crucible or bowl-like forms of reaction-vessel, whether with lids or not, many kinds of sealed containers (*shen shih*[1]) were employed. These corresponded also in some degree, no doubt, to the aludels of Arabic-Western alchemy. In some forms, especially when they were made of metal, pressures considerably higher than atmospheric could be generated in them;[a] in other forms they were used for sublimation. Fig. 1390 taken from *TT*907 illustrates one of these reaction-chambers, as used in the Sung.[b]

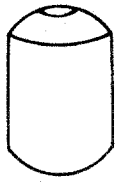


Fig. 1390

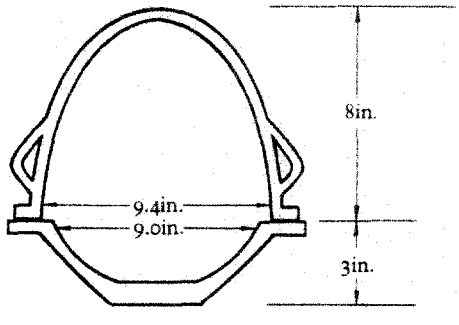


Fig. 1391

Fig. 1390. Reaction-chamber from the *Chin Hua Chhung Pi Tan Ching Pi Chih* (+ 1225).
Fig. 1391. Reconstruction of the *yao-fu* 'bomb' from the *Thai-Chhing Shih Pi Chi* (Liang, + 6th century, or earlier).

Another important closed vessel was the pyx or 'bomb', *yao fu*[2] (a vessel composed of two more or less hemispherical crucible-like bowls with flanges placed mouth to mouth). The following is an account of its construction taken from *TT*874, a text written probably in the Liang period (+ 6th century):[c]

Method of making a *yao fu*:

The lower iron bowl (*thieh fu*[3]) has a capacity of one peck (*tou*[4]), a diameter of 9 in. and a height of 3 in. At the base, which comes in contact with the fire, the thickness is 0·8 in., but around the four sides the thickness is 0·3 in. The upper and lower bowls are of equal thicknesses. The base is flattened. The flange all round is one and a half inches wide and 0·3 in. thick; it is also flattened. The two handles at the side are three inches long and three and a half inches wide; they are situated above the flange. The upper bowl (i.e. the cover) is made of pottery (*shao wa*[5]). It has a diameter of 0·4 in., a height of 8 in. and a thickness of 0·3 in. The cover thus has a greater curvature (than the lower bowl). Its flange is also made flat. The *yao fu* is used for the preliminary treatment of the ingredients and hence its size. After the ingredients have become refined they should be transferred to a *hsiao fu*[6] (small vessel), which measures $2\frac{1}{2}$ inches across at the mouth and 6 inches in height. Apart from

[a] This is certain because of the directions which often occur in the texts to bind the parts of the apparatus together with iron wire. Examples of such directions are given on p. 40.

[b] Ch. 2, p. 2*a*.

[c] P. 14*a*, *b*.

[1] 神室 [2] 藥釜 [3] 鐵釜 [4] 斗 [5] 燒瓦 [6] 小釜

this the shape and other dimensions (of the lower bowl) are the same as (those for the *yao fu*). For the cover the diameter is 6·2 inches and the height 6 inches. Apart from this the shape and other dimensions do not differ from those of the bigger vessel.

A conjectural diagram of the *yao fu* is given in Fig. 1391.

The dimensions of the *yao fu* were by no means standardised. For example different values are given in descriptions of the *yao fu* in the *Yün Chi Chhi Chhien*.[a] Another specification is to be found in Sun Ssu-Mo's *Tan Ching Yao Chüeh*[b] of *c.* +640, studied and reconstructed by Sivin.[c] In general the design is the same, but Sun's has thicker walls, a narrower lip, and a taller upper compartment. Its material is cast iron, as was probably most usual.

Fig. 1392. A bronze *tui*, possibly used as a reaction-vessel, Chou period, *c.* −6th century, from Chia-ko-chuang, near Thangshan in Hopei (National Institute of Archaeology, Peking, cf. Watson & Willetts (1), p. 8). Ht. 21·9 cms.

The description of the *yao fu* suggests the use of close-fitting surfaces by the Chinese alchemists. Iron bowls with smooth lapped edges were produced early in China. Li Kao,[1] a Thang prince (+752 to +820), experimented with bowls and

[a] E.g. ch. 68, p. 27*a*. *TT*1020.
[b] P. 8*a*, *b* (only in the *Tao Tsang* version).
[c] (1), pp. 166–7.

[1] 李皋

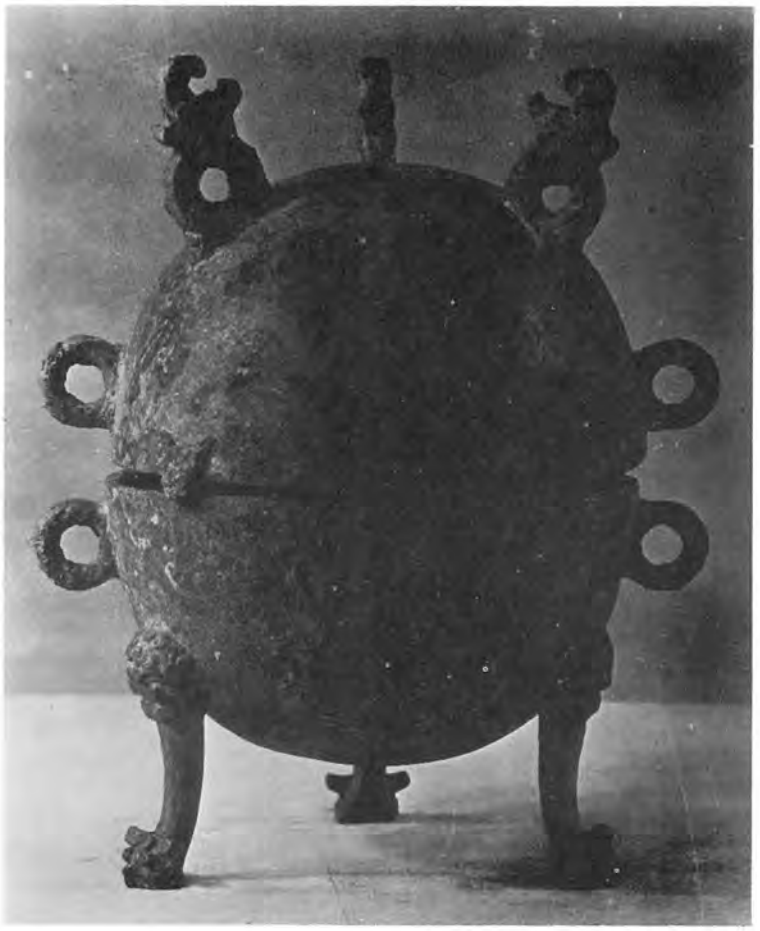


Fig. 1393. Bronze *tui*, usable as a reaction-vessel, Chou period, between −493 and −447, from the tomb of a Marquis of Tshai, near Shou-hsien in Anhui (National Institute of Archaeology, Peking, cf. Watson & Willetts (1), p. 8). Ht. 33 cms.

plates fitting so well that no air could enter and displace liquids contained within them. Li Yuan[1] used iron bowls ground very smooth at the edges. Similar experiments were carried out by Jen Shih-Chün[2] about +780. The context of this was the search for accuracy in tuning musical instruments by filling sets of precisely fashioned vessels with different amounts of water.[a] But in due course a much more sinister development occurred when the first gunpowder bombs were made from these opposed hemispheres or 'coquilles' in the +12th and +13th centuries. The story is told elsewhere in this work.[b]

These close-fitting bipartite vessels go back very much further than the *yao fu* of the medieval alchemists. Spherical or nearly spherical tripod pyxes of bronze from the

[a] Vol. 4, pt. 1, pp. 38, 192, 194.

[b] Sect. 30 in Vol. 5, pt. 1.

[1] 李琬 [2] 任使君

Fig. 1394. Stoppered aludel of silver, from the hoard of the son of Li Shou-Li, buried at Sian in +756 (Anon. (*106*), pl. 63c).

Chou and Han periods with removable enantiomorphic lids are quite common in museums (Figs. 1392, 1393).[a] Apart from other projecting ornaments or feet, they generally have ring handles on both parts, perhaps for lifting off the lid with chains, perhaps for binding the two halves tightly together. The ancient name for these vessels is *tui*[1]. They have mostly been dubbed 'food vessels' by the archaeologists, but they seem curiously armoured for such a purpose. Imitations in pottery for tomb-goods are also common.

Still another type of vessel which may belong to the category of *yao fu* are the little ovoid silver bottles with well-fitting stoppers standing about 4 or 5 ins. high (Fig. 1394).[b] At least three of these were found in the hoard excavated at Hsing-hua Fang[2] in Sian which gave us the named and labelled specimens of chemicals already described in Vol. 5, pt. 2, p. 161, so they must date from the near neighbourhood of +750. These metal bottles would withstand considerable pressure, especially if the stoppers were wired down, and Chinese archaeologists regard them as alchemical in purpose.

[a] See, e.g. Anon. (*11*), pp. 27, 31, 39, 40, pls. 9, 12, 63; Anon. (17), p. 7, pl. 6; O. Fischer (1), p. 303; Willetts (3), pp. 86, 89 and pl. 18.

[b] Anon. (*106*), pl. 63c; Hsia Nai, Ku Yen-Wên *et al.* (1), pp. 3ff.

[1] 敦 [2] 興化坊

(5) Steaming Apparatus, Water-Baths, Cooling Jackets, Condenser Tubes and Temperature Stabilisers

At this point our exposition must commence in prehistoric times when alchemy and chemistry had not yet developed from the techniques of cooking. During neolithic times (before −1500) the Chinese people invented a peculiar type of vessel, the *li*[1],[a] in shape like a substantially built pottery jug, with or without handles but always having the bottom running smoothly into three hollow, bulbous legs, often strikingly resembling breasts. The purpose of this cooking-pot was presumably to bring the food into closer contact with the heat of the fire rather than to be able to cook three

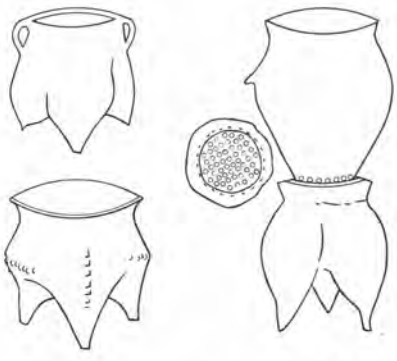


Fig. 1395

Fig. 1396

Fig. 1395. Neolithic pottery vessels connected with the origins of chemical apparatus, all from the −3rd millennium.

a On the left, two types of *li* (from de Tizac, 1). The form of the *li* gave it a large effective heating surface, and of course permitted the cooking of more than one foodstuff at a time, but it must have required great skill on the part of the potter. Moulds for the bulbous legs have survived. The shape was perpetuated in the later bronze tripod cauldrons or reaction-vessels (*ting*), but their legs are usually solid, and as transitional types show, these arose by the collapse of the hollow ones.

b On the right, a *li* surmounted by a pot with perforations in the bottom, as shown in the middle above (from Andersson, 6). The combination of the two vessels was called a *tsêng*, though the term could also be applied to the upper one alone, if separate. Later on, the two vessels were combined into one, having a grating between the two parts, generally removable. Vessels of this type were called *hsien*, and became much more preponderant when bronze replaced pottery. As we shall see later on (p. 97), the *tsêng*, or perhaps rather the *hsien*, generated the characteristically Chinese types of distillation apparatus.

Fig. 1396. Three-lobed spouted jug (*li*) of red pottery, from a neolithic site at Shih-chia-ho in Thien-mên Hsien, Hupei, *c.* −2000 (National Institute of Archaeology, Peking, cf. Watson & Willetts (1), p. 3). Ht. 18·4 cms.

[a] K855. The ancient pictograph has already been given in Vol. 1, p. 81.

[1] 鬲

Fig. 1397. A *li* vessel of grey pottery, in the style of the Hsiao-thun culture, excavated from neolithic levels at Erh-li-kang, near Chêngchow in Honan, dating from the −23rd to the −20th century (National Institute of Archaeology, Peking, cf. Watson & Willetts (1), p. 5). An early stage in the solidification of the legs to give the *ting* form. Ht. 23 cms.

different foods separately at the same time. Fig. 1395*a* shows two characteristic *li* of pottery (after de Tizac, 1); abundant specimens are preserved in museums all over the world. The shape continued into the Shang and Chou periods made in bronze instead of pottery. Sometimes the vessel may have a fixed cover with a hole for filling and a spout for pouring out (Fig. 1396). There is reason for believing that the tripod cauldron (*ting*) originated by the collapsing of the bulbous legs of the *li* (Figs. 1397, 1398).

As is well known, the typically Chinese method of making bread from cereals throughout the ages was steaming, not baking. And so the *li* generated a form of double vessel in which it was surmounted by a simple pot having holes in the bottom through which the steam could mount to cook the dough. While we must not here go too far into the typology of these vessels, it should be said that they are distinguished by whether the top vessel is separable from the bottom one or not.[a] Steamers of the former type are known as *tsêng*,[1] those of the latter type as *hsien*[2] or *yen*[3].[b] Again the early crude pottery forms were perpetuated in much more elegant bronze, and with

[a] See e.g. Tzu Chhi (*1*) and Willetts (1), vol. 1, pp. 125ff., (3), pp. 85–6, 87–8.

[b] K252. The ancient pictograph has already been given in Vol. 1, p. 81. Hopkins (25), p. 475, gives other forms, with an ingenious explanation of the ancient scribal mistake by which the 'tiger' radical came to be incorporated in the left-hand component of the character.

[1] 甑 [2,3] 鬳

free ring handles, during the Shang and Chou periods. In the pottery stage the *tsêng* are much more common than the *hsien*; Andersson (6) in 1947 found upper vessels with perforated bottoms obviously intended for placing over *li* with flanged mouths (see Fig. 1395*b*). Examples of these are to be seen today in Chinese museums; one for instance is in the Archaeological Laboratory of Academia Sinica at Sian.

A Shang example of a bronze *hsien* from about −1300 is seen in Fig. 1399, and an early Chou type in Fig. 1400.[a] By the Warring States period the ornamentation

Fig. 1398

Fig. 1399

Fig. 1398. Tripod vessel (*ting*) of coarse dark grey pottery, from a neolithic site at Shih-chia-ho in Thien-mên Hsien, Hupei (National Institute of Archaeology, Peking, cf. Watson & Willetts (1), p. 3). Its date may be as early as −2000. Ht. 28·5 cms.

Fig. 1399. Bronze *hsien* of the Shang period, *c.* −1300 (Bushell (2), vol. 1, p. 67; cf. Chêng Tê-Khun (9), vol. 2, pl. 44a).

becomes less florid and the vessel looks more and more like a piece of apparatus (cf. Fig. 1401). Whether the bottom of the upper vessel is perforated (like a colander) or whether there is a removable plate (when the whole vessel is in one piece) the grating takes a wide variety of forms, with round holes, slits, crosses, etc. in multifarious patterns.[b]

[a] The former from Bushell (2), vol. 1, fig. 45; the latter from White (3), pl. 65, following Mizuno Seiichi (3), pl. 11, fig. 5.

[b] A very good Warring States bronze example with radiating slots was on view in the Chhêngtu Archaeological and Historical Museum in the summer of 1972.

Fig. 1400

Fig. 1401

Fig. 1400. Early Chou bronze *hsien*, *c.* −1100, photographed to show the grating. Now in the Royal Ontario Museum, Toronto. Mizuno Seiichi (3), pl. 11, no. 5; White (3), p. 131, pl. 65.

Fig. 1401. Bronze *tsêng*, i.e. an apparatus of two separate vessels with a grating between them, and fitting well together. From a tomb of the −4th or −3rd century at Chao-ku near Hui-hsien in Honan (National Institute of Archaeology, Peking, cf. Watson & Willetts (1), p. 8). Ht. 60 cms.

One example of a bronze *ting* which might have been the bottom of a *tsêng*, from about − 500 (in the Shantung Provincial Museum at Chinan), has a very well moulded water-seal rim round the top of the lower bulbous-legged vessel (Fig. 1402). This was probably an ancestral form of one that is still common in Chinese kitchens today, the *chi tshai kuan*[1] (colloquially *phao tshai kuan*[2]). A simple round vessel of red pottery is provided with an annular rim round its mouth which acts as a water-seal, supporting an outer domical cover under which there is an inner flat stopper which just covers the hole (Fig. 1403). This is used for making pickled vegetables. Chinese cabbage, carrots, celery, cucumber, turnips, peppers, etc. are first sun-dried, then cut up and allowed to turn pleasantly sour by natural fermentation in half-saturated salt solution. The quasi-anerobic conditions prevent the growth of moulds which otherwise give the mass a white frothy scum and a disagreeable taste and smell.[a] These annular troughs

[a] We shall discuss traditional fermentation techniques at length in Sect. 40 (Vol. 6).

[1] 漬菜罐 [2] 泡菜罐

are of much cultural and evolutionary interest in connection with what we shall have to say presently about the ancient history of distillation, though that technique in China developed quite different apparatus. Indeed we shall show (p. 97) that the characteristic Chinese still form was derived from the *tsêng* and the *hsien* surmounted by a bowl of cooling water and with a smaller receiver bowl placed on the grating. Though the annular trough went no further in China it generated on the other hand the characteristic Hellenistic still form at the Western end of the Old World. As for the

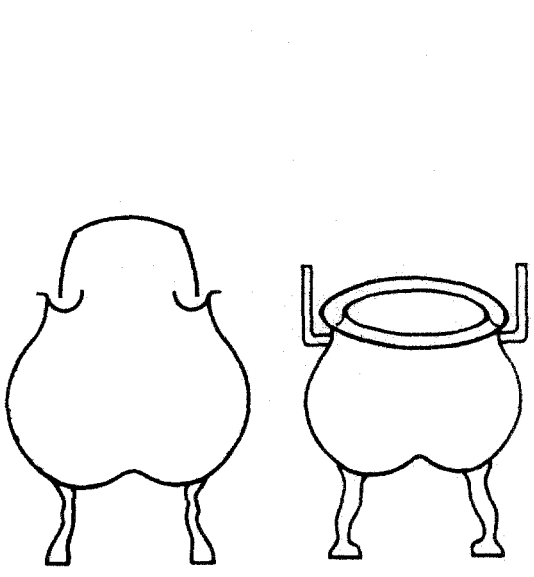


Fig. 1402

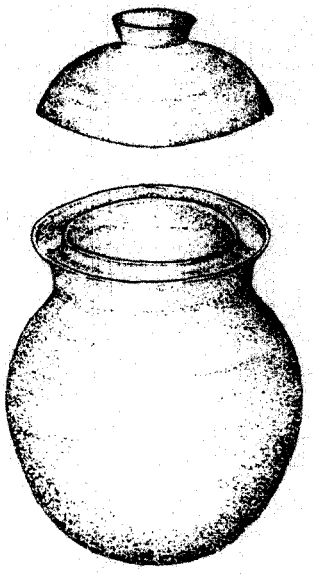


Fig. 1403

Fig. 1402. Bronze *ting* with well moulded water-seal rim, *c.* −500, from Huang-hsien (in the Chinan Provincial Museum, Shantung; orig. drawing).

Fig. 1403. Characteristic pickling pot in common use in China, usually in red pottery, with annular water-seal for maintaining almost anaerobic conditions (*phao tshai kuan* or *chi tshai kuan*; orig. drawing).

developed *phao tshai* pot, it cannot be later than the +3rd century, for the Nanking Museum has one taken from a tomb of the Western Chin dynasty (+265 to +316).

By the Chhin and Han there are plenty of literary references to the steamer vessels. For example, in the *Chou Li*[1] (Record of Institutions of the Chou Dynasty), a text of perhaps the −4th, certainly of the −2nd century, the *tsêng* is mentioned together with its close relation the *hsien* steamer.[a] Many of these bronze vessels dating back to the Shang, Chou and Han periods still exist today in museums and private collections.

Han funerary stoves of pottery or bronze frequently have a special hole in the top designed to take the lower vessel of a *hsien* or *tsêng* resting upon a flange around its middle. One of these in the Archaeological Institute of Academia Sinica at Sian has a set of three top vessels, one with coarse holes for steaming, another with fine holes, and

[a] Ch. 12, p. 7*a*; Biot's translation vol. 2, p. 537.

[1] 周禮

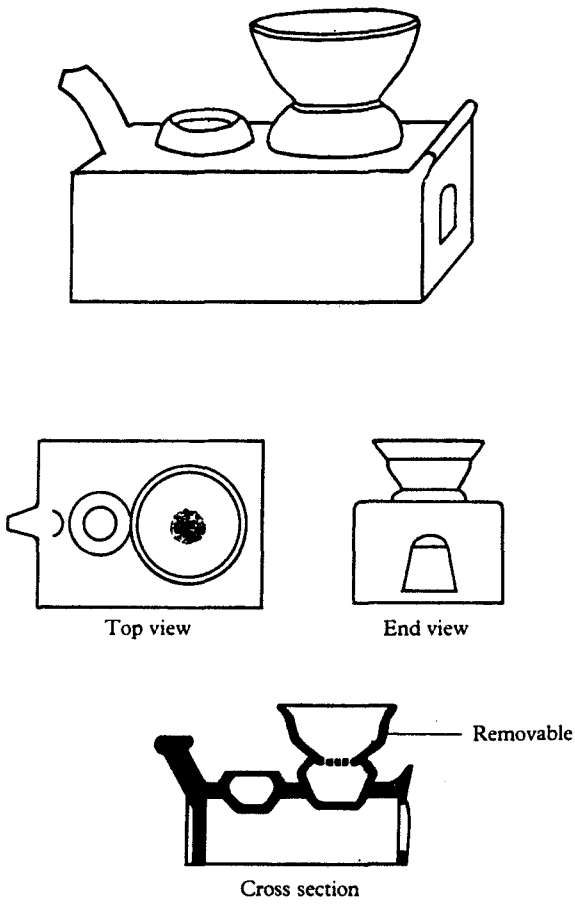


Fig. 1404. Tomb-model of stove and steamer from Chhangsha; Earlier Han period, −2nd or −1st century. These are very common in Han tombs, and usually of rough pottery or terra cotta.

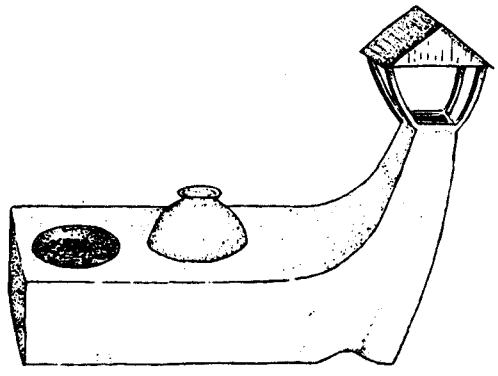


Fig. 1405. Tomb-model of stove, and chimney with roof, from a Later Han grave at Chhangchow. The pot, which could be the lower part of a *tsêng*, is a miniature in bronze (Chiangsu Provincial Museum, Nanking; orig. drawing).

a third with no holes at all for water-bath heating.[a] Since these date from between the −2nd and the +2nd century they parallel the literary references of early times to the water-bath (the 'bain-marie') in the Mediterranean region.[b] Another example, in the Kansu Provincial Museum at Lanchow, has a slit-perforated steaming basin on three legs to fit into a larger basin on a stove, and above that again a smaller basin on three legs with a solid bottom for pure steam heating. The close connection between all these cooking utensils and the equipment of the alchemists' laboratory is obvious.

Fig. 1406. Elaborately ornamented water-bath, with grate underneath, in bronze, of middle or late Chou date (*c.* −6th century). No inscription. Supplement to the Catalogue of the Sumitomo Collection at Kyoto; Umehara Sueji (*3*), no. 245, pl. 6 and fig. 5, descr. pp. 5–6.

[a] Other examples from the −1st century are illustrated in Anon. (*11*), pp. 100, 101, pl. 53. We give one as Fig. 1404. Cf. also the photograph in Graham (4). In others again (Fig. 1405), a roofed chimney is prominent, as in a model of Han date exhibited in the Chiangsu Provincial Museum at Nanking.

[b] This topic was the subject of a special paper by von Lippmann (19). In spite of the common name of the water-bath there are unfortunately no grounds for attributing the invention to the Alexandrian proto-chemist Mary the Jewess, who belongs to the +1st century. As von Lippmann pointed out, the earliest Western mentions occur in the Hippocratic Corpus (*De Morbis*, III), *c.* −350, and in the fragmentary book of Theophrastus on perfumes (V, 22), *c.* −300; then in Cato (*De Re Rustica*, ch. 81), *c.* −170, and many other writers. Oil-baths are mentioned by Galen (*De Sanitate Tuenda*, IV, 8), *c.* +170. Ash-baths and sand-baths as well as water-baths were of course used by the Alexandrians. But drawings in MS. Marc. 299 which Berthelot (2), pp. 146–7 labelled as forms of the 'bain-marie' seem much more like perforated stoves under the *kerotakis*. On the other hand, an enigmatic diagram (*op. cit.*, p. 141) also from this MS., with no accompanying explanation in the text, has a cup on the right labelled *pontos* (πόντος), 'the sea', but it seems rather to be the receiver of a still, possibly a basin supported in a bath of cold water. Nevertheless this gave von Lippmann the clue for his alternative explanation that the name 'bain-marie' derives from *mare*, the sea, and its Graeco-Egyptian goddess Isis-Cypris or Pelagia-Marina, the Aphrodite of the sailors. Subsequent confusions between this Marina, Miriam the sister of Moses, and the B.V.M., need not detain us.

A rather unusual but striking water-bath in bronze from the Chou period, some five hundred years before the Alexandrians, is illustrated in Fig. 1406. In the Sumitomo Collection at Kyoto,[a] it is rectangular in shape, with an elaborate fire-grate underneath, and large enough to take quite a number of pots, flasks or other containers.

There can be no doubt that the *tsêng* and the *hsien* were of cardinal importance for the invention of distillation in its East Asian form. But the *tsêng* found a fiercer use in metallurgy (especially non-ferrous) when it took the form of two superimposed crucibles, the upper one having a perforated bottom.[b] From the ingredients placed above, the molten metals descended below when the heating was sufficient, leaving the less fusible oxide scoriae and slag in the upper vessel.[c] The whole was known in Syriac as the *bot-bar-bot* ('the crucible and the son of the crucible') a term which got into Latin as the unintelligible *botus barbatus*.[d] It was used for preparing alloys of copper, lead, iron, tin, arsenic, etc., some of which closely resembled silver.[e] More than a hint as to the origin of this apparatus is contained in the untitled +9th to +11th-century Arabic–Syriac alchemical treatise translated by Berthelot & Duval, which says, 'it will come down to form an ingot like Chinese iron'. This *khār-ṣīnī* was probably not metallic zinc but rather the famous alloy paktong (*pai thung*[1]), a mixture of copper, zinc and nickel which had been made in China for many centuries before it became known in the West.[f] What is probably one of the earliest references to it is in the *Kuang Ya*[2] dictionary by Chang I[3] *c.* +230. Its appearance in the Arabic Jābirian corpus of the +9th and +10th centuries is one of the pieces of evidence pointing to Chinese influence at that time. But this may have been exerted still earlier, as another, purely Syriac, treatise, also translated by Berthelot & Duval, dating from the +7th to +9th centuries and closely related to the earlier Greek texts, speaks of taking 'two amphorae, one being pierced with holes'.

The texts classify *ting* into two types—*huo ting*[4] (heating reaction-vessel) and *shui ting*[5] (cooling vessel). For *huo ting* heat was applied externally, sometimes all round, sometimes only underneath. This is in effect the *ting* already described. But the *shui ting* vessel was a condenser full of cold water for use in conjunction with a *huo ting*. According to its position, it brought about local cooling within or above the *huo ting* to facilitate sublimation and condensation; or it prevented the rise of the temperature of the reactants above boiling water and steam level. Fig. 1407, taken from *TT*908, a work perhaps of the Chin period (+256 to +420) but more probably of the late +9th century,[g] indicates diagrammatically the position of the *shui ting* as a condenser

[a] Supplementary Catalogue, Umehara (3), no. 245, pl. VI.
[b] Thus the ancestor of the Gooch crucible.
[c] The process was obviously a special case of *destillatio per descensum*, on which we shall have more to say presently (p. 55).
[d] Berthelot & Duval (1), pp. 58, 149–50; Wiedemann (15).
[e] On aurifictive and argentifictive metallurgy in ancient and medieval China cf. our extended discussion, pt. 2, pp. 188ff.
[f] On the history of cupro-nickel see pt. 2, pp. 225ff. and on *khārṣīnī* pp. 428 ff. below.
[g] Ch. 1, p. 25*a*.

[1] 白銅 [2] 廣雅 [3] 張揖 [4] 火鼎 [5] 水鼎

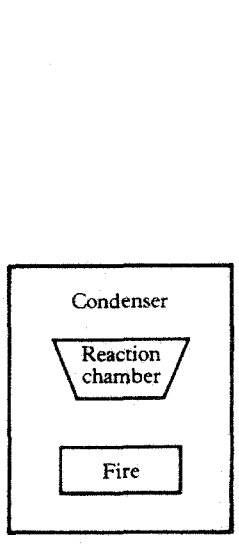


Fig. 1407

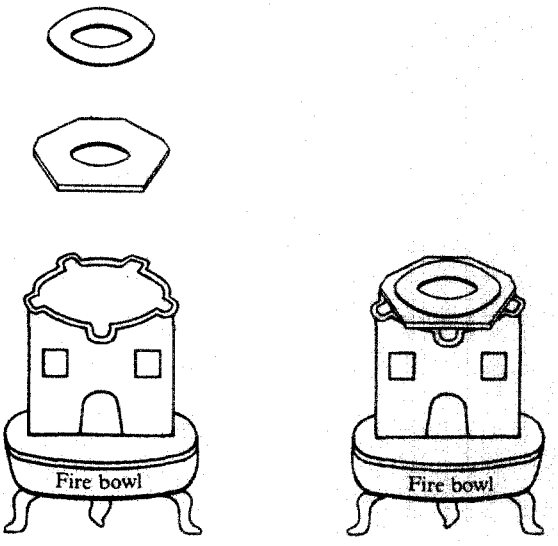


Fig. 1408

Fig. 1407. Diagram of furnace with condenser, from the *Huan Tan Chou Hou Chüeh*, a Thang text of the + 9th century. The *shui ting* above, the fire (*huo mên*) below, and the reaction-chamber in the middle, marked *chin hung* (gold and mercury).

Fig. 1408. Stove and steamer-support, from *Chin Hua Chhung Pi Tan Ching*..., a Sung text, + 1225. The picture shows only the bowl for the fuel, and the chimney, on the top of which there are rings giving openings of different sizes to accommodate vessels, steamers or water-baths large or small.

in one of the alchemical processes. The adjacent text gives no explanation. This arrangement brings us very near to the beginnings of distillation in its Chinese form.[a]

*TT*907 describes the water-bath as used by Sung alchemists under the name *huo phên*[1] (fire bowl), though this was simply a basin with a three-legged support containing charcoal or other fuel. Fig. 1408, copied from this text,[b] purports to show a fire-bowl together with what is called a *tsêng*, though actually the stove and chimney only are shown, and the water-bath or steamer is left to the imagination. The text describes the apparatus as follows:

Below (the steamer-chimney) is placed a *huo phên* (fire-bowl). Bricks are laid until level as a support. On top (of the fire-bowl) is built a *tsêng* (steamer-chimney) 1 ft. 5 in. high and 1 ft. 2 in. in diameter. Four openings are made in the middle facing north, south, east and west (*tzu*,[2] *wu*,[3] *mao*,[4] *yu*[5]) and in communication with the mouth of the steamer-chimney at the top. These five openings enable fire to be emitted. (The walls) should be quite thick. The mouth for the steamer is circular, 5 inches in diameter. A piece of tile is cut into two and

[a] In fact if it was a bowl of water continually renewed with cold supplies, the apparatus was indeed engaged in reflux distillation. It might even suggest the presence of a central catch-bowl or a catch-bowl with side-tube already at the early Chin date. This piece of evidence should be remembered when considering the antiquity of the Chinese still type.

[b] Ch. 1, p. 4*a*. The picture shows at the top of the chimney a couple of rings giving openings of different sizes so as to accommodate water-baths large or small—just the same device as we find in all chemical laboratories today.

[1] 火盆 [2] 子 [3] 午 [4] 卯 [5] 酉

placed squarely on the heater, while a second piece with side measuring 1 ft. 2 in. is put over the top. (The apparatus) uses both water and fire. The *tan ting*[1] (reaction-vessel) is suspended at the centre (presumably in the steam).

In the alchemical books of the Sung period very peculiar and complicated combinations of condensers and water-jackets are described. How the different parts of the apparatus were assembled for these more complicated experiments can be seen most conveniently from *TT*907. Here Phêng Ssu wrote:[a]

Method of constructing the *shen shih*[2] (magical reaction-chamber):

Eight ounces of pure gold (lit. full-coloured gold) are cast into a *hun-tun thai-yuan ho-tzu*[3] (chaos womb-shaped closed vessel; reaction-chamber), which is shaped like an egg or a round ball. Then take another ounce of pure gold to make a tube (*chhi kuan*[4]) with a bore the size of the hole in a coin. The length of the tube should project beyond the reaction-chamber by about half an inch. (The capacity of) the reaction-chamber should be just sufficient for holding the *tan phi*[5] (elixir embryo, i.e. the ingredients),[b] and should be neither too big nor too small. After the ingredients have been introduced the joints are sealed by means of *chhih shih chih*[6] (red bole clay) mixed with *chin thu*[7] (earth) and vinegar and left to dry.

Eight ounces of silver (*pai chin*[8]) are used to make a *shui hai*[9] (funnel-shaped reservoir). The lower end is set on the opening of the *ting* (reaction-vessel) and goes down to a depth of about 2 in. When the two are found to fit, the lower end of the *shui hai* reservoir is connected to the gold tube (*chhi kuan*) so that water can flow (down into the latter). The joint is firmly sealed by means of *chhih ni*[10] (a lute or sealing mixture, possibly of red bole clay and mud) and left to dry before water is poured in.

The *wai ting*[11] (outer vessel):

This is made of pottery. Its capacity should be just sufficient for inserting the reaction-chamber and 2 lb. of silver (*pai chin*[12]) and must be neither too spacious nor too narrow. If it is too large the space can be filled in, using yellow earth mixed with vinegar and left to dry. Then half a handful of silver is put in and adjusted until it is packed and level before the gold reaction-chamber is inserted. Silver is again put over the top until (the reaction-chamber) is covered up. A paper ring is put over the reaction-chamber to mark the position for the *shui hai* reservoir. After filling up (the *ting*) with silver, the silver *shui hai* reservoir is put in position through the hole as marked by the ring. (The *ting*) is then shaken up until everything is properly packed. The outside has to be tightly sealed before (the vessel) is suspended inside the combustion chamber.

Fig. 1409, taken from this text,[c] illustrates the reaction-chamber (*b*) and the *shui hai* reservoir (*a*), and also how they were assembled inside the *huo ting*[13] (heating vessel, *c*). The description of the diagrams is rather similar to what we have just read. It says:

Eight ounces of pure gold are cast into a *hun-tun chi-tzu shen shih*[14] (magical chaos egg-shaped reaction-chamber). Again one ounce of gold is used to make a water-tube (*shui kuan tzu*[15]), the lower end of which is closed and does not allow water to pass through.[d] It is about

[a] Ch. 1, p. 1*a*.

[b] On this very ancient appellation, which goes back, perhaps, to Babylonian antecedents, cf. pp. 293, 296.

[c] Ch. 2, p. 2*a*.

[d] This is curiously evocative of the 'cold-finger' still types in modern organic chemistry which we shall mention in connection with the principle of the Chinese still, pp. 100 ff. below.

[1] 丹鼎 [2] 神室 [3] 混沌胎元合子 [4] 氣管 [5] 丹胚
[6] 赤石脂 [7] 金土 [8] 白金 [9] 水海 [10] 赤泥 [11] 外鼎
[12] 白金 [13] 火鼎 [14] 混沌雞子神室 [15] 水管子

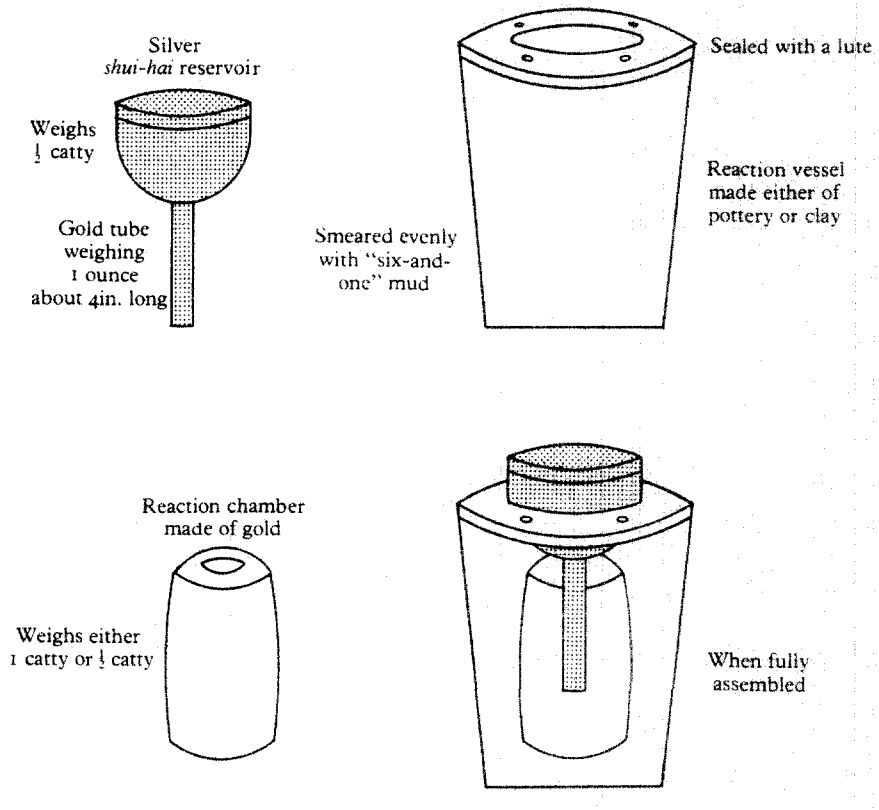


Fig. 1409. Water-cooled reaction-vessel from the *Chin Hua Chhung Pi Tan Ching*..., + 1225. The upper reservoir is prolonged into a blind finger below, so that the cold water can moderate the temperature of the reaction proceeding in the chamber.

4 inches long and is inserted down to the base of the *hun-tun ho*[1] (closed chaos-vessel; reaction-chamber). The top end is attached to the *shui hai* reservoir, which is made of eight ounces of silver. The joints are all tightly sealed with (*chhih shih*) *chih*[2] (red bole clay) and *fan* (*-shih*)[3] (alum) and allowed to dry. The portion (of the tube) inside the reaction-chamber is filled with water.[a]

The text then describes the process that followed after the ingredients were introduced:

The joints (of the reaction-chamber) are tightly sealed. It is then put into a pottery vessel (*thu ting*[4]) and the space inside filled with silver beads (*yin chu*[5]) so that no gap is left. After the silver *shui hai* reservoir is set on top the outside is smeared (with a lute) to a thickness of a finger's width. After drying for half a day (the vessel) is suspended inside the combustion chamber. Fire is applied below and round all sides (of the vessel). At first 5 lbs of charcoal are used, and when more than half that amount is burnt another 5 lbs of charcoal are needed. These are to be added twice or thrice within the period of one day and night...

[a] P. 2*b*. Some of these statements can be seen in the original captions of Fig. 1409.

[1] 混沌合 [2] 赤石脂 [3] 礬石 [4] 土鼎 [5] 銀珠

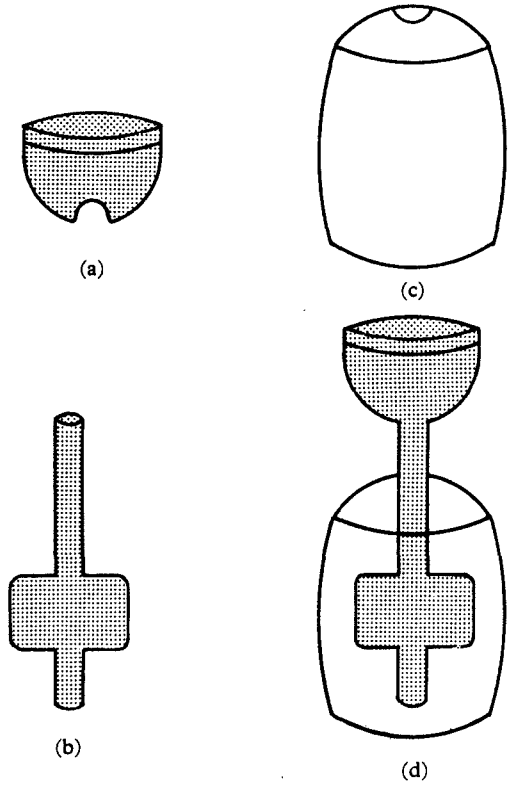


Fig. 1410. Water-cooled reaction-vessel, from the same work (+ 1225). The central tube descending from the cooling reservoir is enlarged into a single bulb. (*a*) Cooling reservoir, (*b*) blind finger with bulb, (*c*) reaction-chamber, (*d*) full assembly.

Another device of closely similar character is illustrated in the same text,[a] but while the former is called a *chi-chi*[1] apparatus (cf. p. 68), the latter is not. What is particularly noteworthy about these pieces of apparatus is the large vessel of water at the top of the system, for it corresponds closely with the position of the main condenser basin in the characteristic East Asian type of still.[b]

The purpose of the reservoir (*shui hai*[2]) and the attached tubes (*shui kuan*[3,4]) must have been to exert a thermostatic control by ensuring the presence of water at boiling temperature isolated from the reactants. The insertion of a blind tube into the centre of the reaction-chamber meant that the reactants would be cooled centrally. We find many other approximations to constant-temperature technique in the same text. The first elaboration was to introduce a bulb in the central cooling columns, as in Fig. 1410.[c] The next thing was to introduce two bulbs as shown in Fig. 1411.[d] Still more complicated is the system given in the same chapter where the central tube connects the upper reservoir or condenser with a water space below built in to the side-walls of the reaction-chamber (Fig. 1412).[e]

[a] Ch. 2, p. 18*a*. [b] Cf. p. 63 below. [c] Ch. 2, p. 16*b*. [d] Ch. 2, p. 10*a*.

[e] Pp. 5*b* and 6*a*. It is not quite clear from this and some of the following illustrations whether cross-sectional elevations are intended, so one cannot always be sure whether the coolers were tubes in the plane of the paper or all-round water-jackets with concentric walls.

[1] 既濟 [2] 水海 [3] 水管 [4] 水筦

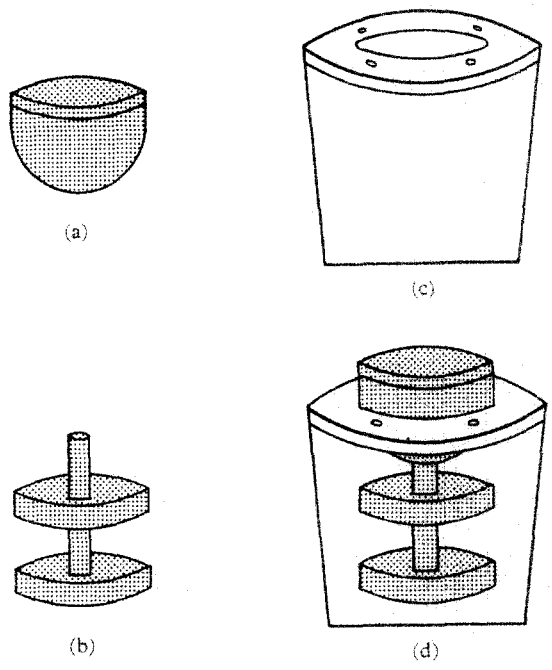


Fig. 1411. Water-cooled reaction-vessel, from the same work (+ 1225). The central tube has two bulbs flattened like radiator fins. (*a*) Cooling reservoir, (*b*) blind finger with two flattened bulbs, (*c*) reaction-vessel, (*d*) full assembly.

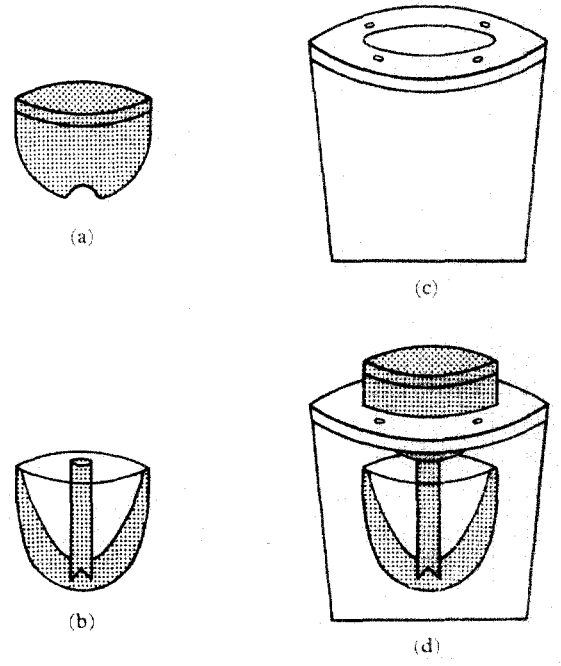


Fig. 1412. Water-cooled reaction-vessel, from the same work (+ 1225). The central tube connects the cooling reservoir with a peripheral water-jacket in the wall of the reaction-chamber. (*a*) Cooling reservoir, (*b*) tube connecting with jacket, (*c*) reaction vessel, (*d*) full assembly.

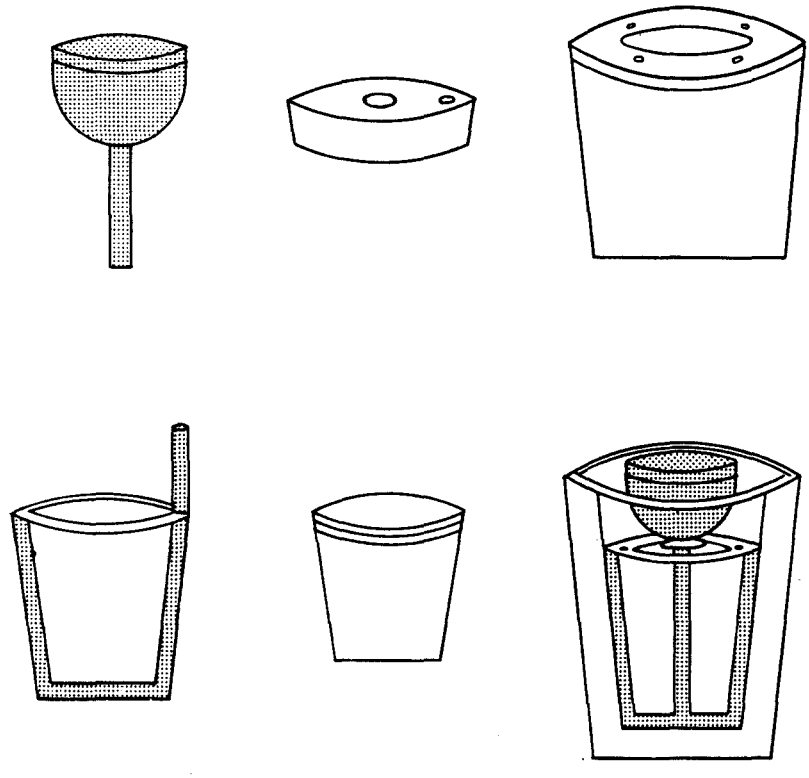


Fig. 1413. Water-cooled reaction-vessel, from the same work (+ 1225). Here the peripheral water-jacket is provided with a filling tube at one side as well as the connection with the cooling reservoir through the central tube. The assembly can be understood in the light of the preceding drawings.

Several other types of cooling system related to those already described and taking the form of veritable water-jackets are given in the same text and are shown in Figs. 1413 to 1417. One sees how the aim of Mêng Hsü and his friends was to increase the cooling surface. It was evidently a prime concern of the + 13th-century alchemists to control the temperature of their reactants and prevent it from rising too high. By varying the extent of the water-jacketing they could choose a wide variety of temperatures for their reactions. Fig. 1413 shows a water-jacket with an upper filling tube at one side.[a] Fig. 1414 shows another version of the external water-jacket.[b] A double water-jacketed hood is seen in Fig. 1415 forming a more complicated type of condenser.[c] Fig. 1416 shows a complete water-jacket.[d] Finally, in the *san shui-kuan*[1] (triple water-tube) reaction vessel, water-cooling was applied externally by means of three meridional tubes.[e] This is shown in Fig. 1417.

In this account we have followed an ascending order of apparent complexity natural

[a] Ch. 2, pp. 8*b*, 9*a*.
[b] Ch. 2, p. 7*a*.
[c] Ch. 2, pp. 11*b*, 12*a*.
[d] Ch. 2, p. 13*b*. Or possibly two tubes connected at the bottom as well as the top.
[e] Ch. 2, pp. 3*b*, 4*a*.
[1] 三水筦

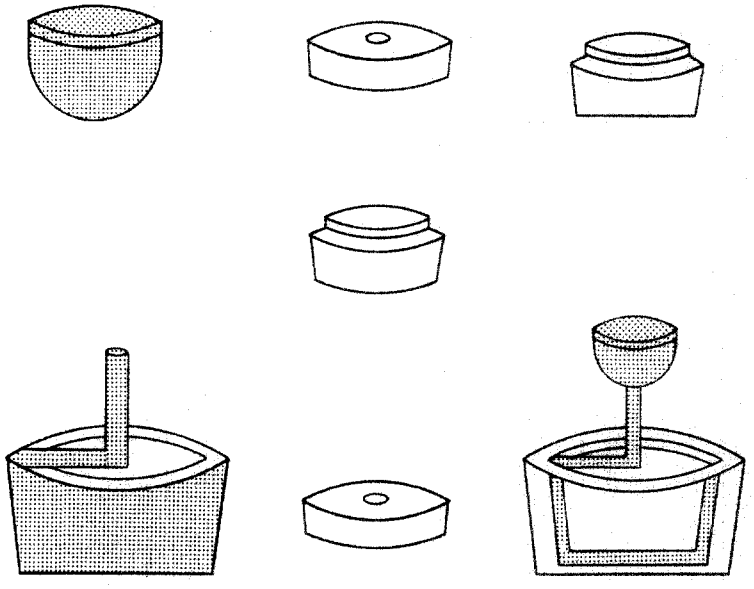


Fig. 1414. Water-cooled reaction-vessel, from the same work (+ 1225). There is no central tube, and the cooling reservoir connects directly with the peripheral water-jacket at one point on its circumference above.

to us with our hindsight knowledge of modern chemical apparatus. But in Mêng Hsü's time (+1220) there was no thought of any such order. The pieces of apparatus just described were all used at appropriate stages in a long gold-elixir preparation consisting of nine 'turns' (*chuan*[1]) or chemical transformations, plus two preliminary processes, most of which employed each a different system of reservoir cooling with its tubes or jackets. The order of use of the apparatus is shown in the accompanying Table 116.[a] Exactly what was happening at each stage and what the end-product was will only be elucidated in the course of further research, which could be quite rewarding; all we can say at present is that gold and silver, lead, cinnabar, sulphur, mercury, vinegar, alums and the arsenic sulphides were all involved at one phase or another. It may also be relevant to add that there are numerous mentions of binding the parts of the apparatus together with iron wire (*thieh hsien*[2]), just as one used to do with modern pressure-tubing connections;[b] this must mean that considerable pressures were liable to be generated during the reactions.[c]

The exact place of these extraordinary developments in the history of chemical apparatus technology as a whole, whether in relation to water-tube and fire-tube boilers,[d] or to heating and refrigerating and condensing coils in chemical industry,

[a] A similar analysis of the text has been made by Yoshida Mitsukuni (7), pp. 252ff.

[b] E.g. ch. 2, pp. 6*b*, 15*b*, 17*a*. In other books the same is found, as, for example, in *TT*912, ch. 1, pp. 5*b*, 7*b*.

[c] This is not without significance in connection with the earliest proto-gunpowder mixtures, on which see pt. 3, p. 159 above.

[d] Cf. Needham (48), and (64), p. 153.

[1] 轉 [2] 鐵線

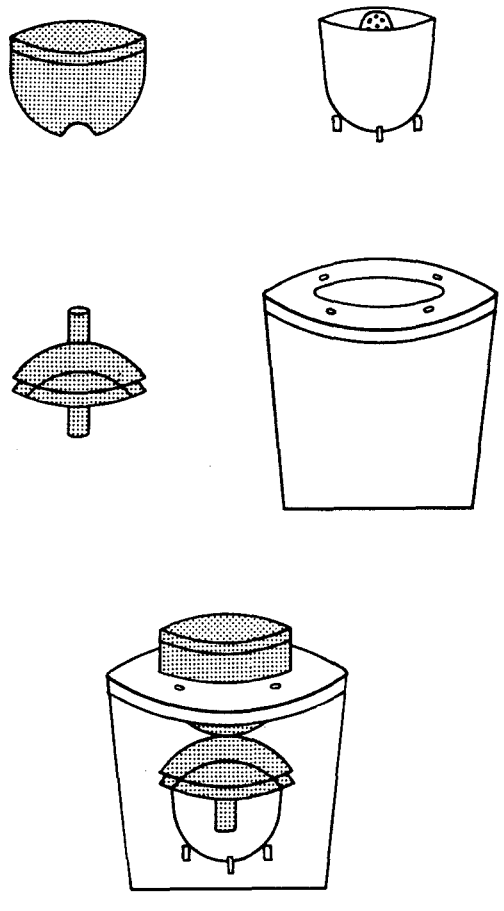


Fig. 1415. Water-cooled reaction-vessel, from the same work (+ 1225). Cooling reservoir, central tube, and two water-jackets in the form of hoods, but no peripheral cold-water walls.

remains to be determined in future historical studies, but it would seem highly unlikely that they constituted a unique phenomenon without antecedents or later repercussions in the history of techniques. There is much room for thought in considering what may have derived from these strange circulatory systems.

One fairly clear descendant could be descried in the Japanese *daki*[1] temperature stabiliser used in the fermentation industry. As Shinoda Osamu (*1*) has shown, this takes the form of containers, now of pottery, formerly of wood, which are suspended in the saccharification vats and filled with water of a temperature appropriate to the season, cold in summer and hot in winter. Such a temperature stabilisation helps the moulds to break down the polysaccharides, and discourages the yeasts at this stage.[a]

Again, later on (pp. 124, 127), when studying the limiting factors for the discovery of

[a] At a visit to the Ōkura Sake Brewery in Kyoto in 1964 this technique was seen by us in operation.

[1] 暖氣

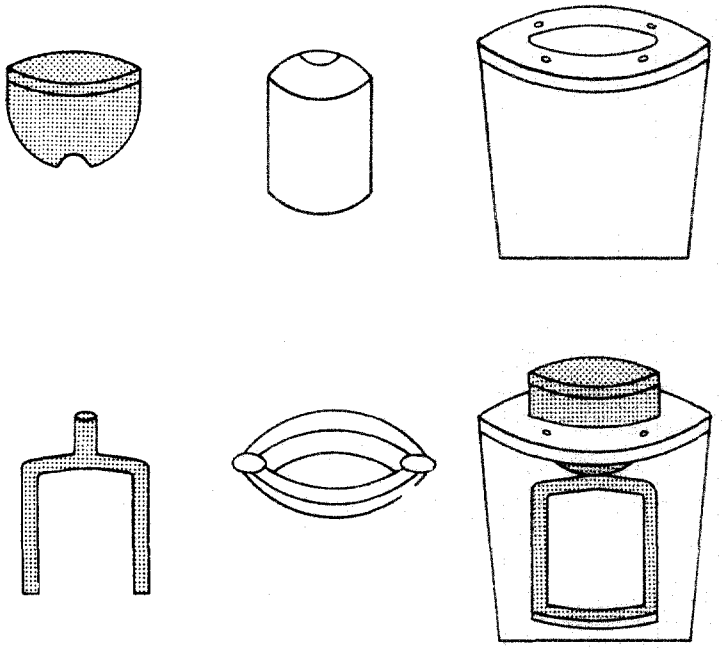


Fig. 1416. Water-cooled reaction-vessel, from the same work (+ 1225). Cooling reservoir with complete water-jacket horseshoe-shaped in cross-section but continuing under the floor of the chamber.

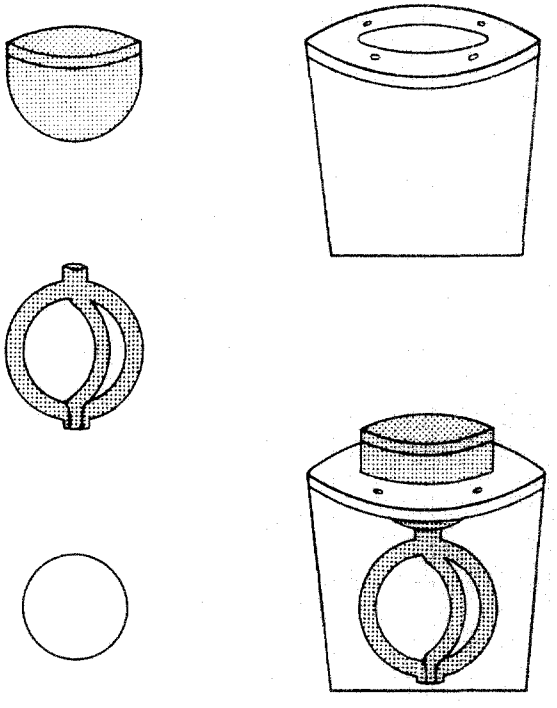


Fig. 1417. Water-cooled reaction-vessel, from the same work (+ 1225). Cooling reservoir prolonged below into three meridional tubes passing around the chamber and meeting at the bottom.

Table 116. *Order of operations in the elixir preparation of the 'Chin Hua Chhung Pi Tan Ching Pi Chih', ch. 2 (TT907)*

Turn (*chuan*)	Ch./page	Apparatus used	Fig.	Ho Ping-Yü & Needham(3), fig.
—	1/4*a*	stove, steamer-chimney and rings for giving openings of different sizes.	1408	19
prelim. process (*a*)	2/1*b*, 2*a*	*chi-chi*[1] app. (cf. p. 68); cooling reservoir and central tube.	1409	20
prelim. process (*b*)	2/3*b*, 4*a*	*ting chhi*[2] app. (a term also applied to all the rest); cooling reservoir and three meridional tubes below meeting at the bottom.	1417	29
1	2/5*b*, 6*a*	cooling reservoir, central tube and peripheral jacket below.	1412	24
2	2/7*a*	cooling reservoir and peripheral jacket below.	1414	26
3	2/8*b*, 9*a*	cooling reservoir, central tube and jacket with additional filling tube at one side.	1413	25
4	2/10*a*	cooling reservoir and central tube with two bulbs shaped like radiator fins.	1411	23
5	2/11*b*, 12*a*	cooling reservoir and double water-jacketed hood.	1415	27
6	2/13*b*	cooling reservoir and complete water-jacket horseshoe-shaped in cross-section.	1416	28
7	2/14*b*, 15*a*	cooling reservoir and central tube in connection with some kind of sublimation or distillation apparatus (cf. p. 72).	1448	49
8	2/16*b*	cooling reservoir and central tube with one bulb.	1410	22
9	2/18*a*	cooling reservoir and central tube; similar to prelim. process (*a*).	1409	21
ancillary process	2/4*a*, *b*	ambix and *lopas* for the descensory distillation of mercury	1433	37

alcohol in the West, we shall find that adequate cooling by water was probably the essential thing, and since there seem no antecedents for this among the chemists of Islam the Chinese still with its water-cooled head may have been influential. The oldest cooler in the West, however, seems to have been a serpentine side-tube rising through a barrel of cold water, and the question may therefore be posed whether this could have been stimulated (even as a matter of hearsay) by the tubes, bulbs, and

[1] 既濟 [2] 鼎器

layers which had developed in China. The time when Mêng Hsü was working was just half a century before that of Taddeo Alderotti (cf. pp. 92, 122) and the first indubitable condenser coil in the West. Figs. 1414, 1416, and especially 1417, show apparatus which could conceivably have exerted some influence. Mêng, to be sure, was active half a century later than the Salernitan Masters and the writer of the recipe in the *Mappae Clavicula* (cf. p. 123), but what apparatus they used is not known, and the complexity of the devices described by Mêng points to a longish previous development, going back to the Northern Sung (+11th century) if not indeed to the Thang. Moreover, the +13th century was a time of intensified intercourse between East and West, marked not only by Marco Polo and other merchants, but also by the Franciscan friars in Mongolia and China;[a] nor do we lack outstanding examples of other westward transmissions in the +12th century (cf. p. 403).

These speculations are strengthened perhaps by the fact that the *daki* temperature stabiliser is described already in the text of the *Pei Shan Chiu Ching*[1] (Northern Mountain Wine Manual), written by Chu I-Chung[2] in +1117, where it has the name of *chui hun*,[3] or 'recovering the soul' (which otherwise was chilled and lost, or driven away by over-heating).[b] This was a whole century before Mêng Hsü's descriptions, and half a century before the Masters of Salerno.

Lastly, it is obvious that the principle of increase of surface which these devices embodied is constantly used in modern scientific apparatus. Fractionation-columns and scrubbing-towers come at once to mind.[c] As another instance Ratledge (1) recently described flasks with deep finger-like indentations designed to cool bacterial suspensions more effectively during the ultrasonic disruption of the cells, when immersed in brine at −20 °C.

(6) Sublimation Apparatus

The simplest form of vessel for this purpose was nothing but a pot inverted and suspended over a glowing fire. Substances were cast in small quantities on to the red charcoal or hot ashes, and the sublimate caught in the receiver above. This procedure is little mentioned in histories of chemical technology, but it was used a great deal, even in the +17th century by J. R. Glauber, though by then there was much refinement of superimposed receivers.[d] With this system he could make many things commercially including not only flowers of antimony but hydrochloric acid. If simplicity is an adequate criterion of age, the inverted pot must be considered very old, and it would be surprising if the alchemists in ancient China made no use of it. The next simplest thing was a pot with a removable lid placed on the first mouth upward, heating being applied locally at the bottom so as to allow for the condensation of the volatile substance on the under surface of the lid, whence it could be easily removed.

The first Western description of the process of obtaining metallic mercury from

[a] Cf. Vol. 1, pp. 188 ff. and Needham (64), pp. 61, 201, 300.
[b] Ch. 2, p. 11*b*.
[c] Cf. Morton (1), pp. 75 ff., 91 ff.
[d] See Greenaway (5).

[1] 北山酒經 [2] 朱翼中 [3] 追魂

cinnabar by the method of sublimation is generally attributed to Dioscorides (*c.* +50), who said that cinnabar was heated on an iron saucer contained in a pot and covered by another pot.[a] Throughout history mercuric sulphide in the form of natural cinnabar was perhaps the single most important raw material used by the Chinese alchemists, its name (*tan*[1]) being identical indeed with the very word for elixir itself. Although we do not know exactly when they first began converting cinnabar to mercury,[b] it must have been at least as early as the Warring States period, and the first textual mentions come from the beginning of the Former Han (−2nd century). The *Shen Nung Pên*

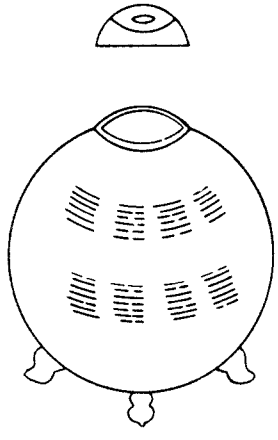


Fig. 1418

Fig. 1419

Fig. 1418. A sublimatory vessel in the shape of a narrow-mouthed *ting*, from the *Hsiu Lien Ta Tan Yao Chih* (Sung).

Fig. 1419. Traditional Thaiwanese sublimatories for camphor (Davidson). A, fireboxes; B, pans of water for the steam; C, containers for the wood chips piled on a grating; D, inverted jars to collect the sublimed crystals.

Tshao Ching[2] (Pharmacopoeia of the Heavenly Husbandman) states clearly that cinnabar can be converted into mercury, taking it indeed as a matter of course.[c] Then the same statement is found in the *Huai Nan Wan Pi Shu*[3] (Ten Thousand Infallible Arts of the Prince of Huai-Nan), first compiled about −120 or very little later.[d] A variety of vessels, made of pottery or metal, and having removable lids, are illustrated in Chinese alchemical books. Fig. 1418 shows what is called a 'mercury vessel'—*hung ting*[4]— in *TT*905, a Sung book.[e] It was certainly used for sublimation.[f] The sublimate adhering

[a] *Mat. Med.* v, 110; Gunther tr. p. 638. See Sherwood Taylor (4), p. 52; Forbes (9), p. 17. The method was mentioned by Agricola in +1556 (Hoover & Hoover tr. p. 427).

[b] We give a discussion of the history of mercury in China elsewhere (pt. 3, pp. 4 ff.).

[c] Mori Tateyuki's ed. (1845), p. 22; Miu Hsi-Yung's (+1625), ch. 3, p. 1*b*. The text is also quoted by Liu Wên-Thai in *Pên Tshao Phin Hui Ching Yao*[5] (Essentials of the Pharmacopoeia classified according to Nature and Efficacity), +1505, ch. 1, p. 1*a*, and by nearly all the other writers of pharmaceutical natural histories.

[d] *TPYL*, ch. 988, p. 6*a*; Yeh Tê-Hui's reconstruction, no. 83. [e] Ch. 2, p. 3*b*.

[f] Vermilion from mercury and sulphur (pt. 3, p. 74) is almost as old; cf. Gettens, Feller & Chase (1).

[1] 丹 [2] 神農本草經 [3] 淮南萬畢術 [4] 汞鼎 [5] 本草品彙精要

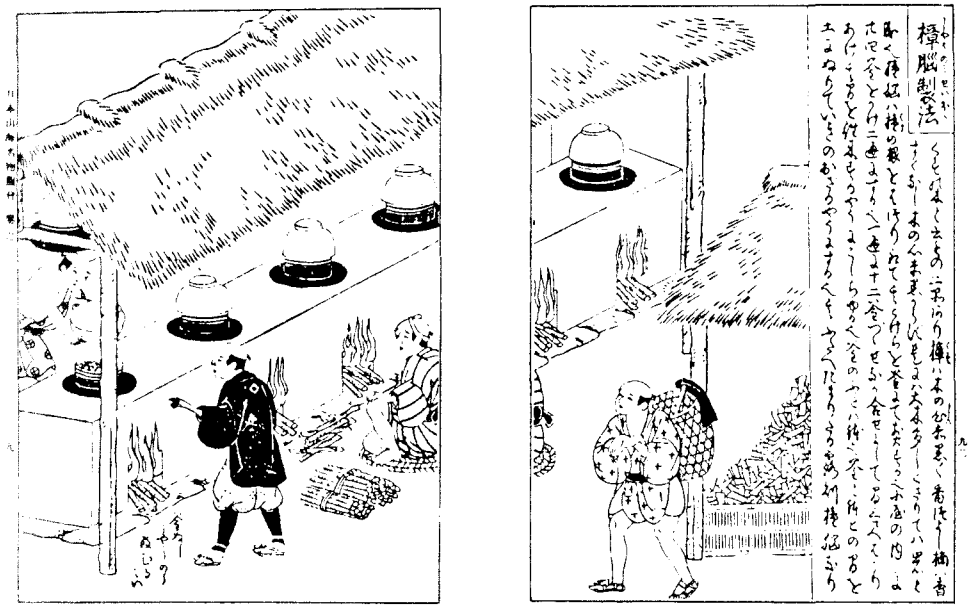


Fig. 1420. Camphor sublimation with steam as carried out in Japan, from the *Nihon Sankai Meibutsu Zue* (+ 1754).

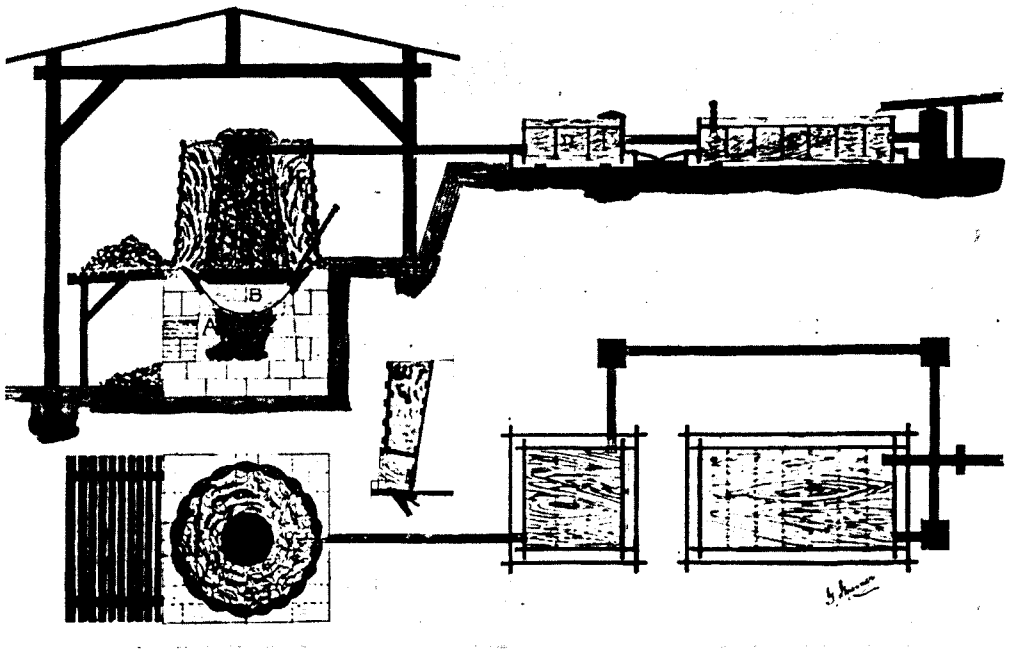


Fig. 1421. Camphor still of Japanese type as used in Thaiwan (Davidson). The wood chips are steam-distilled, and the vapours pass over into long shallow boxes fitted with partitions and covered by a long trough-like lid within which the cooling water is made to flow. The oil and the camphor both condense in the box receiver, but the oil floats below on the water from the steam while the camphor crystals gather on the sides and under-surface of the cooling trough. A, firebox; B, pan of water; C, the chip 'retort'; D, cooling box; E, crystallisation box.

to the cover—the *yin kai*[1]—was collected at the end of the process by scraping with a feather. It would seem that the *yao fu*[2] types of vessel (see p. 22 above) were commonly used for this operation. But in descriptions one may encounter almost any term applicable to an aludel-like vessel capable of being hermetically sealed, e.g. *kuan*[3] (cf. p. 58), and the phrase *ku chi*[4] often occurs in connection with it (cf. pp. 5, 6, 79).

Another sublimation widely practised in China for centuries, indeed on a commercial scale, at least since the times of Thao Hung-Ching and Sun Ssu-Mo, was that of the chlorides of mercury.[a] We were able to illustrate this in Fig. 1357, taken from a rare MS. of the *Pên Tshao Phin Hui Ching Yao* (+1505) with pictures in colour,[b] which shows the age-old pharmaceutical preparation of calomel.

One substance early obtained by sublimation was camphor, an indigenous aromatic of great antiquity in Chinese culture.[c] We have not found any drawings in traditional style of the apparatus used, but in 1903 Davidson (1) gave a sketch of the traditional Chinese sublimatory stoves then working in Thaiwan (Formosa). This is reproduced in Fig. 1419. The chips of camphor-tree wood were renewed twice daily, and the camphor was carried upwards in the steam to condense like snow in the inverted earthenware jars above, whence it was collected by hand every ten days. This was very like the procedure (Fig. 1420) which the Jesuit F. X. d'Entrecolles had described[d] in +1736. Davidson also studied a composite process of sublimation and distillation which produced not only solid camphor crystals but also camphor oil floating on the condensed water. He gave an interesting drawing of a 'Japanese' still, in use on the island in his time, for the preparation of both the solid and the liquid products (Fig. 1421).[e] Steam generated below a perforated plate on which the chips are piled extracts the aromatic substances from them and fills the space above, then passing out through a long bamboo tube from the top of the 'retort' reaches a long shallow box fitted with partitions and covered by a trough-like lid within which cooling water is made to flow. The oil and the camphor crystals condense in the box, the oil floating on the aqueous phase, the camphor crystals gathering mainly on the sides and under the top of the box.

Bryant (1), writing in 1925, described a similar sublimation-distillation apparatus used in Chiangsi, Kuangtung and Hainan (Fig. 1422).[f] This arrangement differs from

[a] On this important chemical discovery see Vol. 5, pt. 3, pp. 123ff. above.

[b] This was on sale in the market at Hongkong in 1959, and we owe our knowledge of it to Dr S. D. Sturton, who kindly supplied some photographs. The same illustration, from another MS. copy, has been reproduced by Bertuccioli (2).

[c] This we discuss elsewhere (pt. 2, pp. 135ff.) in relation to liturgy and alchemy. The typical Chinese camphor was 'chang camphor', from *Cinnamomum Camphora*. Later, other camphors were imported, and some other camphor-producing species acclimatised. A glimpse of the camphor industry in late Ming times is found in Fernaõ Mendes Pinto (1), p. 118, (ch. 30, sect. 3). He was in China about +1543 and his book was first printed in +1614.

[d] (2), pp. 232ff. The only difference was that the chips were then first submitted to extraction with boiling water, and the cooled aqueous mass piled in layers with earth before subliming. This purification process was still in use in 1867 (Julien & Champion (1), p. 229).

[e] His elaborate chapter on the Thaiwan camphor industry is well worth reading. Cf. Schelenz (2), fig. 119. An earlier description (1895) was given by Grassmann (1).

[f] A brief recent account of camphor sublimation-distillation among the Thai people of the Hsi-shuang-bana autonomous region in Yunnan has been given by Alley (9).

[1] 銀蓋 [2] 藥釜 [3] 罐 [4] 固濟

Fig. 1422. Traditional sublimation-distillation apparatus for camphor used in South China (Bryant; photo. Brisker).

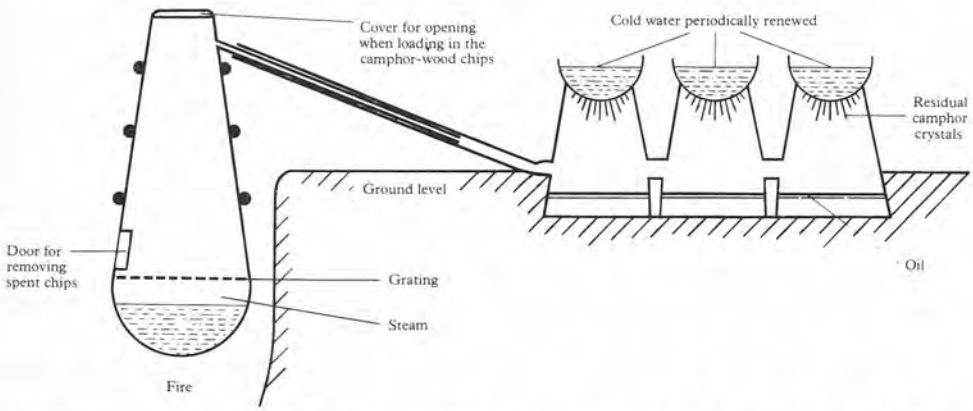


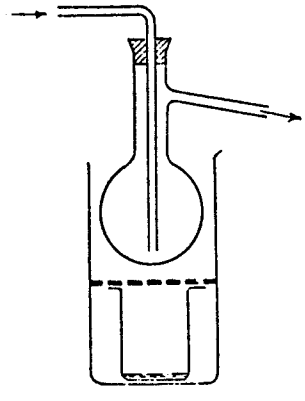
Fig. 1423. Diagram to illustrate the operation of this apparatus. On the left, the 'retort' with grating separating the wood chips from the source of steam; on the right, a succession of chambers each like a Mongolian still (cf. p. 62) with a cooling reservoir above, acting as a receiver into which the side-tube delivers. The camphor oil floats on the condensed water below, the camphor itself sublimes as crystals round the bottoms of the coolers and on the sides of the chambers.

that shown in the previous illustration because the condensing box and trough is replaced by a series of three tubs forming a continuation of the bamboo side-tube and each capped by a 'Mongolian'[a] water-basin still-head cooler.[b] This description

[a] The terms 'Mongol' and 'Chinese' as applied to stills are explained in the course of the following pages.

[b] Sublimation technique just like this is current in modern organic chemistry, e.g. for anthracene, when a flask with circulating cold water is suspended above a perforated plate over a beaker (Robinson & Deakers (1); Morton (1), fig. 116, p. 215). See inset diagram on p. 49. The crystals accumulate on the lower surface of the flask.

will be understood from Fig. 1423 but better appreciated from p. 62 below, whence it will be seen that this camphor apparatus is likely to be much older than the trough-and-box system. The ingenuity of both lies in the fact that they solved the problem of handling vapour liable to deposit a solid which could clog narrow condenser tubes and develop a dangerous pressure in the 'still'. The train of tubs attached here to each side-tube is reminiscent of the trains of three to six mercury-condensing aludels at the famous works of Almadén in Spain. Since the Arabic world once stretched from Cadiz to Canton there might even be a genetic connection. Bryant also gave details of a complicated process for purifying the commercially valuable camphor oil (containing more than twenty important compounds such as pinene, limonene, cineol and terpineol) nd obtaining considerable amounts of solid camphor (up to 40 %) from what had been regarded as the waste material of the method. In this further operation, said to be of Japanese origin, the oil is placed in simple pot stills connected to long coiled brass condenser tubes cooled by flowing water. The various fractions coming out of this are carefully examined, filtered, redistilled, etc. Such an apparatus seems to be of essentially modern type with a Western background (cf. p. 93 below).



Sublimation of camphor was also carried out in India, Southeast Asia, and by the Arabs. The +9th-century text of al-Kindī, translated and discussed by Garbers (1), though mainly devoted to distillation, contains several recipes for the purification of camphor by sublimation. Garbers gives redrawings of some of the original illustrations.[a]

If we are right in our interpretation, one of the most interesting of all ancient pieces of Chinese chemical apparatus was used for sublimation. During the second world war (in 1943) the Institute of Cultural Studies of the University of Nanking (then located at Chhêngtu in Szechuan) exhibited a remarkable bronze self-named from its inscription as a 'rainbow vessel' (*kung têng*[1]).[b] We reproduce it in Fig. 1424.[c] Above a round tripod vessel in the form of a flattened sphere there is a cylindrical compartment with sliding walls capped by a hemispherical dome. Two tubes of ample lumen arise one on each side from the lower vessel and join at the top at the crown of the dome. The upper halves of the tubes and the dome are removable, after which the central cylinder, which has no direct communication with the bottom, can be lifted off by the side handle. The inscription says *Yen Ong Chu thung kung têng i chü*,[2] i.e. 'One rainbow

[a] (1), pp. 19–21, 95.

[b] Normally the word for rainbow (*hung*[3]) has the 'insect' radical (K 1172*j*), and the lexicographers' meanings for *kung*[4] are the iron bearing of a chariot-hub or an ornament worn by women at their belts. But the present context is unique. Similarly *têng*[5] is the word later used for a stirrup, not a lamp or vessel.

[c] By the kindness of Dr Li Hsiao-Yuan. It was President Hsiang Hsien-Chiao who identified it as a piece of chemical apparatus, thinking it might have been one of the instruments obscurely referred to in the *Huai Nan Tzu* book.

[1] 虹鐙 [2] 閻翁主銅虹鐙一具 [3] 虹 [4] 虹 [5] 鐙

Fig. 1424. Bronze 'rainbow *têng*' of Later Han date (+ 1st or + 2nd century) (photo. Nanking University Museum, 1943). A tripod *ting* below is connected by two side-tubes of ample lumen to the top of a cylindrical space with sliding walls situated on top of the 'boiler' below but having no connection with it. Probably apparatus of this type was used for subliming volatile substances such as camphor.

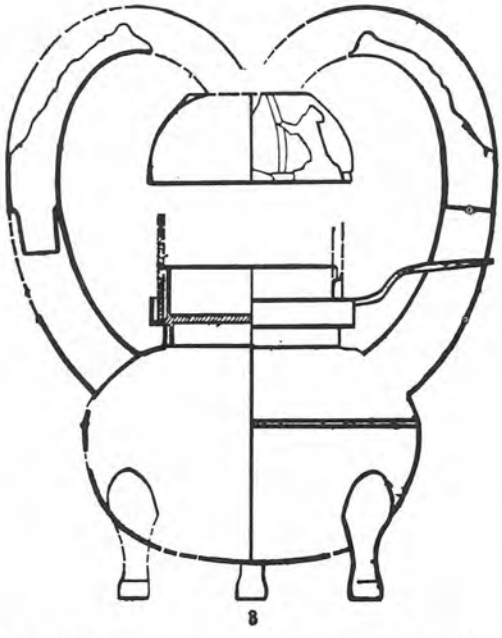


Fig. 1425. Cross-section of another example of this apparatus, found at Chhangsha and dating from the Early Han period, *c.* −1st century (Anon. (*11*), p. 115, fig. 94).

vessel belonging to Old Master Yen'. The object, which was found in a tomb at Chhangsha in Hunan, is considered to be of Hou Han date (+1st or +2nd century).

More recently, further excavations at Chhangsha have brought to light another example (see Fig. 1425), in dimensions closely similar to the former (e.g. height about 34 cm.), but in date somewhat earlier (−1st century).[a] It has no inscription. The authors of the report regarded the object as some kind of lamp, but this is hard to believe since no space exists from which light could be irradiated. We much prefer the view that substances to be volatilised were placed in the lower part of the vessel, so that on heating the vapour would ascend through the tubes and condense in the upper compartment, perhaps with the assistance of a sponge or cold wet rags outside. The fact that according to the writers of the report some waxy material was found in the upper compartment when the vessel was excavated must surely suggest that volatile organic substances had been treated in it.

Other examples were illustrated long ago in archaeological works. The Sung imperial collection possessed one, with an inscription saying: *Wang shih thung hung chu ting*[1] (Mr Wang's bronze rainbow lamp heater), but we do not know the date of it.[b] Two others were in the Chhing imperial collection, as we see in the *Hsi Chhing Ku Chien*[2] (Catalogue of Ancient Mirrors (and Bronzes of the Imperial Collection in the Library of) Western Serenity), compiled by Liang Shih-Chêng.[3] One occurs in the original work (+1751),[c] the other in the second supplement (+1793).[d] The latter had lost its central cylindrical walls. The editors called the first a *têng*,[4] but this one a *ting*,[5] i.e. a hot-plate.[e]

There has been some argument among philologists about *ting* and *têng*; the question at issue being the identification of one of the pictographs on the Shang oracle-bones—a semi-circular amphisbaema or two-headed dragon. Takada Tadasuke believed that it meant *hung ting*, the 'rainbow heater' or sublimatory vessel itself (afterwards shortened to *ting* alone), but Hopkins (26) preferred to see in it the word for rainbow as such,[f] and on this view he could make sense of certain bone  inscriptions otherwise difficult to translate. While it would certainly be interesting if our sublimatory design were as old as the −2nd millennium there is as yet no archaeological evidence in support of that, and it is more likely that the rainbow vessel with its over-arching side-tubes got its quite appropriate name in Warring States or Early Han times.[g]

[a] Anon. (*11*), p. 115.

[b] *Hsüan-Ho Po Ku Thu Lu*[6] (+1111 to +1125), ch. 18, p. 41*a*. On the stormy career of the curator who made this catalogue, Wang Fu,[7] cf. Vol. 4, pt. 2, p. 500.

[c] Ch. 30, p. 27*a*. [d] Ch. 13, pp. 33*b*, 34*a*.

[e] This was one of the most ancient meanings of the word, which later on came to signify an ingot (cf. pt. 2, pp. 67–8, pt. 3, p. 102) and eventually an anchor (cf. Vol. 4, pt. 3, p. 657).

[f] Cf. Vol. 3, p. 473, where we gave a cut of the ancient graph.

[g] Figurines of serpent-like creatures arching their backs with a human head at each end are not uncommon in archaeological collections; the Royal Ontario Museum at Toronto has one dating from the Wei dynasty made of grey pottery and painted white, light green and red (Fig. 1426). Doubtless they personified the rainbow.

[1] 王氏銅虹燭鋌 [2] 西清古鑑 [3] 梁詩正 [4] 鐙 [5] 鋌
[6] 宣和博古圖錄 [7] 王黼

Fig. 1426. Figurine of an amphisbaena or two-headed serpent, probably personifying the rainbow and representing a visible rain-bringing dragon, generally beneficent (photo. Royal Ontario Museum, Toronto). Of grey pottery, painted white, light green and red, in stripes; date Wei. Such representations, not uncommon, throw light on the naming of the apparatus with its double over-arching side-tubes.

Fig. 1427. Rainbow *têng* with only one side-tube, Sung in date, but the bronze inlaid in Chhin or Han style (photo. British Museum, 1960).

Fig. 1428. Modern still for the purification of mercury in high vacuum, lined with glass and porcelain to prevent contact with the metal (photo. Multhauf, 1961, Smithsonian Museum, Washington). Although the heating chamber is above and the receiver below, the design with double side-tubes perpetuates the ancient Chinese sublimatory system.

Two further variations of vessels of this type are now known. In one, from another tomb at Chhangsha, described by Kao Chih-Hsi (*1*), the boiler below is in the form of an ox; the walls of the upper chamber or receiver have been lost, but there are two tubes rising up as continuations of the backward-curving horns.[a] An inscription says: 'Made for the Imperial Temple (*chhih miao*[1]) by the Chief Intendant of the Four Ceremonials', and accompanying objects were dated as from Chhangsha 'in the first year'. This cannot be further identified but is considered to have been some time during the Former Han period (−2nd or −1st century). The other vessel, different in having only one rising tube, is in the British Museum; it is the latest of all, dating from the Sung period, but its bronze is inlaid in Chhin and Han style, and it has gilded feet in the shape of bears after the Han fashion (Fig. 1427). The general ornamentation is

[a] Kao's own interpretation does not commend itself to us; he suggested that the lost enclosing walls were to protect a lamp flame from draught, and that the tubes were to convey its smoke down into the interior, thus keeping the room clean.

[1] 敕廟

Fig. 1429. Single-tube rainbow *têng* in the form of a serving-maid holding a lamp, from the tomb of Liu Shêng, Prince Ching of Chung-shan, d. −113 (photo. Hsinhua Thung-hsün Shih, 1971).

much more elaborate than that of the ancient examples, but like some of them it has lost the walls of the central chamber.[a]

This last object was catalogued by the curators as a 'perfume still',[b] and that raises the interesting problem of what they were all used for. In personal correspondence Dr R. P. Multhauf has discussed with us the possible uses of the apparatus. First he brought to our attention a modern still for purifying mercury (made about 1925) which has a strange structural resemblance to the ancient 'rainbow *têng*' (Fig. 1428), only in reverse, the electrically heated chamber being above and the receiver for the distillate below.[c] It is a vacuum still, lined with glass and porcelain, so mercury and metal do not come in contact. Cinnabar mixed with fuel (and possibly with metal filings or lime to release the mercury better) could of course have been heated in the lower chamber of the rainbow vessels, but the likelihood of attack on the bronze walls by the mercuric vapour with the formation of amalgam,[d] seems to all of us to suggest that this was not their use. Multhauf inclined to the view that they were used in some distillation process, perhaps of essential oils in connection with drug and perfume preparations. But even more attractive is the possibility that they were sublimatories for some substance which would condense in crystals on the inside surface of the dome

[a] We know now that the design with one rising tube only was also current in the Han, for an example of this, with its sliding side-walls complete was found in the tomb of Tou Wan alongside that of Liu Shêng at Manchhêng (−113). A photograph is reproduced in Watson (5), no. 165, p. 107; Capon & McQuitty (1), p. 17.

[b] Anon. (94), no. 237.

[c] This morphological identity with physiological or functional inversion reminds one of the parallel case of the 'water-powered reciprocator' and the steam-engine (Vol. 4, pt. 2, p. 387, also Needham (64), p. 200).

[d] Apart from the obvious danger of clogging the tubes in any sublimation process.

and upper parts of the walls kept cool by a wet sponge. It may therefore be suggested that the purification of camphor by sublimation is the clue to the problem.[a]

Before leaving the subject of these interesting pieces of apparatus a word should be said about a remarkable 'lamp' of gilt bronze excavated in China in 1968 and since then depicted in several exhibitions.[b] It shows a serving-maid holding up an object which closely resembles the 'rainbow *têng*' in several ways, the cylindrical central compartment with place for a sliding door, the hemispherical dome, and one side-tube of ample lumen, disguised as the maid's right arm and sleeve, entering into its crown (Fig. 1429).[c] This object is precisely datable, for it was found in the tomb of Liu Shêng,[1] Prince Ching of Chung-shan,[2] who died in −113.[d] The words *chhang hsin*,[3] inscribed on the maid's left sleeve, indicate that the apparatus was part of the dowry given by the Empress Dowager Tou (imperial concubine of Han Wên Ti) to her grand-niece Tou Wan[4] (wife of Liu Shêng), and came from the Chhang-Hsin Palace, royal residence of empresses. Could the designation 'lamp' perhaps be wrong? Might it not be an ornamental one-tube rainbow *têng*?

(7) Distillation and Extraction Apparatus

(i) *Destillatio per descensum*

We have spoken above of the sublimation of mercury formed in a closed space from its sulphide, cinnabar. The other ancient and early medieval method of preparing it was known as *destillatio per descensum*. A number of flask-shaped pots were filled with cinnabar ore, plugged loosely with moss, and inverted over a second series of pots buried in the earth. Under the influence of strong heat from above, the mercury liberated by oxidation dropped down into the lower receivers while the sulphur dioxide escaped through the porous plugs and walls of the 'retorts'. We do not know when this process was first used in Europe.[e] However, it clearly appears in *TT*884, a text of the Thang period. Writing about +690, Chhen Shao-Wei says:[f]

[a] The inscription just given points rather clearly to a connection with temple incense. On this see pt. 2, pp. 134 ff.

[b] We saw it first in Hongkong in Sept. 1971, and are much indebted to Mr Li Tsung-Ying for the photograph here reproduced. It was soon afterwards published in Hsia Nai (6). The tomb of Liu Shêng and Tou Wan, at Manchhêng in Hopei, contained rich finds including certain objects previously unknown in Chinese archaeology. Cf. Anon. (*106*), pl. 1.

[c] The 'lantern' and the head of the maid of honour holding it can be taken apart.

[d] He had thus been a contemporary of Liu An, Prince of Huai-nan.

[e] It must surely have some connection with the age-old winning of tar and pyroligneous acid from the kilns of charcoal-burners. In the form of the *bot-bar-bot* (p. 33 above) it is in al-Rāzī (+9th century). It is seen again in the apparatus called *koṣṭhi-yantra* and *adhaspātana-yantra* described in the *Rasaratna-samucchaya*, and it figures also in Geber, both works being of +1300 or a little before. For the former see Ray (1), 2nd ed., fig. 30*a* ii and p. 172; fig. 30*b* ii and p. 189. For the latter see Darmstädter (1), pp. 50–1, 115 and pl. IX, from *Summa Perfectionis*, ch. 48 and *Liber Fornacum*, ch. 5. Conrad of Megenburg in the +14th century describes the use of descensory distillation for the preparation of juniper oil. On the whole subject see Schelenz (2), pp. 14, 29, and fig. 5. Could it not be that the perforation of the middle septum of Chhen Shao-Wei's bamboo was done in direct analogy from the ancient steamer vessels (p. 27 above)?

[f] P. 1*b*, tr. auct. The passage is also quoted in *YCCC*, ch. 68, p. 9*a*, from a tractate with the title (probably abbreviated) *Chiu Huan Chin Tan*.[5]

[1] 劉勝 [2] 中山靖王 [3] 長信 [4] 竇綰 [5] 九還金丹

From 1 catty (16 ozs.) of *kuang ming sha*[1] (a high-grade cinnabar) 14 ozs. of mercury can be extracted.[a] The method is to make a tube from a stem of young bamboo so that it has three septa in all. Pellet-sized perforations are made (in the uppermost septum), and small holes about the size of the thick end of a chopstick in the middle one, to enable the mercury to flow downwards. First two layers of waxed paper are placed over the middle septum. Then the finely ground cinnabar is introduced into the (upper section of the) tube.[b] The whole is next wrapped round with hempen cloth and steamed for one day before being plastered over with yellow clay to a thickness of about 3 ins. It is buried underground so that its upper end comes level with the surface. The tube must be tightly sealed all round to prevent leakage. Firewood is then piled on top and burnt for one day and one night until the heat has thoroughly penetrated the upper section (of the tube). Mercury will flow into the lower section without any loss.

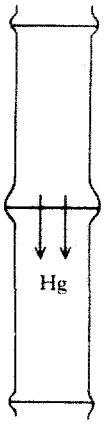
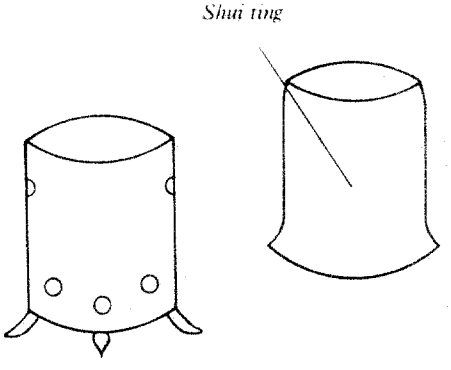


Fig. 1430



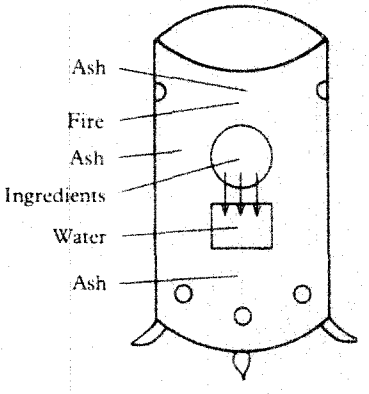


Fig. 1431

Fig. 1430. Bamboo tube for descensory distillation of mercury, from *Ta-Tung Lien Chen Pao Ching*... (Thang).

Fig. 1431. Stove arranged for descensory distillation; drawings from the *Kan Chhi Shih-liu Chuan Chin Tan*, a Sung work.

A very similar method appears in *TT*902, most probably a Sung text.[c] A conjectural diagram of the apparatus is seen in Fig. 1430.

This bamboo method is so evidently ancient and rustic that it invites a reconsideration of the antiquity of the knowledge and applications of mercury in China,[d]

[a] Note the quantitative figures, not at all uncommon in medieval Chinese texts on alchemy and chemical technology; cf. pp. 300ff. and the discussion in Sivin (2). The theoretical value is 13·8.

[b] Presumably the uppermost septum was replaced as a lid, its holes permitting the entry of air and the escape of SO_2.

[c] We should like to draw particular attention to this ingenious use of the ever-helpful bamboo in technology (cf. Vol. 4, pt. 2, pp. 61ff.). We shall refer again shortly (p. 164) to the value of bamboo tubing for the Chinese alchemists and chemical technologists. As a natural tube its availability doubtless led to the widespread and characteristic employment of the sighting-tube in Chinese astronomy (Vol. 3, p. 352), and it was also responsible for the first 'barrel-guns' in the shape of 'fire-lances' which developed in the Wu Tai and Sung periods (see Sect. 30 in Vol. 5, pt. 1).

[d] See Vol. 5, pt. 3, pp. 4ff.

[1] 光明砂

especially in amalgamation gilding and silvering.[a] All the evidence we have presented in previous volumes points to the beginning of this art about the −4th century, the late Chou period and the time of Tsou Yen; concrete chemical-archaeological results now available support this. Lins & Oddy (1), applying emission spectrography to gilded metal objects of known date in the British Museum, have found mercury traces on Chinese belt-hooks and ornaments from the −3rd century onwards, but none on Greek and Roman articles before the +2nd.[b] Andersson has reported amalgamation gilding on a bronze as early as the Shang period in date,[c] but this has not yet been chemically confirmed. Amalgamation silvering on mirrors may be accepted fairly safely for the Chhin and early Han, however.[d] It seems that at present other culture-areas do not compete; Sassanian Persia starts only in the +3rd. Thus the simple bamboo descensory still, so pure and primitive, may be a kind of relict witness of the capabilities of China's early chemical craftsmen.[e]

In *TT*904, another Sung text,[f] we find an illustration of a *lu*[1] (stove) with a three-legged support, and a second diagram to show how fire was conserved in the apparatus, presumably to produce a low but uniform and sustained heat. The same set of drawings, reproduced in Fig. 1431, also includes the diagram of a *shui ting*,[2] which in this case was probably a receiver partly filled with water. The text explains:[g]

> The *lu*[1] (stove) is made of earth or baked clay, hollow inside, and measures 2 ft. 2 in. high and 1 ft. 2 in. in diameter. There are two openings near the top and three openings near the base. The *shui ting*[2] (water-receiver) is made of porcelain with a capacity of about 3 pints, and the mouth fits exactly that of the reaction-vessel. Whenever the *shui ting* (water-receiver) is used it should be filled to 6/10th or 7/10th of its capacity with boiling water. The ash inside the combustion chamber is obtained from burnt paper.

All this is clearly another method of *destillatio per descensum*. Incidentally it may also give further evidence of the close-fitting surfaces or flanges which we referred to above.[h]

In *TT*912, a text which may be of +808, we find another illustration[i] showing the method of *yang huo*[3] (conserving the fire); cf. Fig. 1432. Here the reaction-chamber is

[a] See Vol. 4, pt. 1, p. 91; Vol. 5, pt. 2, pp. 62, 67, 206, 232–3, 243–4, 246–9, 274ff.; Vol. 5, pt. 3, pp. 123, 207.

[b] They therefore throw a little doubt on the passages from Pliny and Vitruvius which we accepted in Vol. 5, pt. 2, p. 248.

[c] (8), p. 37.

[d] Here Lins & Oddy were right, but for the wrong reason. They cited the Khao Kung Chi chapter of the *Chou Li* (ch. 11, p. 20*b*, probably of the −2nd century), which they knew from a quotation in the text of the *Thien Kung Khai Wu* (ch. 8, p. 4*b*, +1637), translated by Sun & Sun, p. 165, but they did not notice where the quotation ended. In fact there is nothing about mercury gilding or silvering in the *Chou Li* here (cf. Biot's tr. (1), vol. 2, pp. 491ff.). But another work of similar date, the *Huai Nan Tzu* (*c.* −120), has a passage (ch. 19, p. 7*b*) which has always been interpreted as referring to amalgamation silvering (cf. Morgan's tr. (1), p. 231). Tinning, however, cannot be excluded; cf. Vol. 5, pt. 2, pp. 232–3. It would be extremely interesting to apply the technique of Lins & Oddy to the numerous Chou and Han mirrors available in museums.

[e] On the history of the winning of gold and silver by amalgamation see Teich (3). The question of evidence for the use of the process in the Roman Empire, or in the Hellenistic proto-chemical Corpus, or in ancient China, needs a good deal more study.

[f] P. 2*a*, *b*. [g] Tr. auct. [h] P. 24. [i] Ch. 1, p. 10*b*.

[1] 爐 [2] 水鼎 [3] 養火

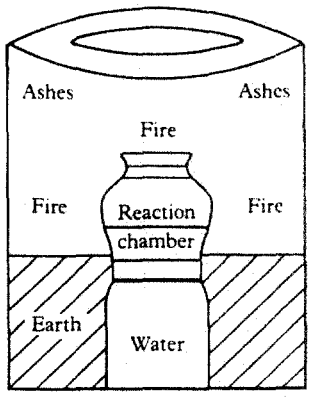


Fig. 1432

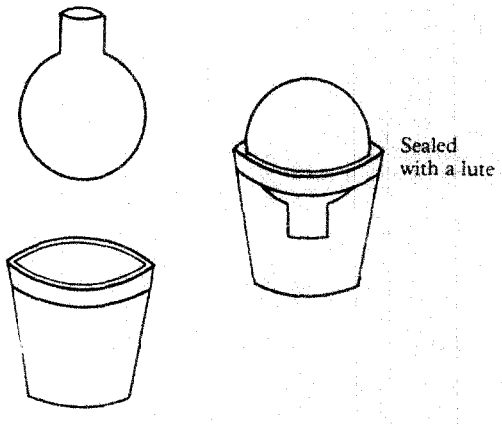


Fig. 1433

Fig. 1432. Furnace arranged for descensory distillation, from the *Chhien Hung Chia Kêng*... of + 808 (Thang).

Fig. 1433. 'Pomegranate' flask (an ambix) used in descensory distillation, from *Chin Hua Chhung Pi Tan Ching Pi Chih* of + 1225 (Sung).

surrounded on all sides, except the base, by fire and ashes, while the bottom is in contact with a buried receiver containing water.

In *TT*907, the Sung text so often quoted here, we can see a further example[a] of *destillatio per descensum* closely similar to the classical description in Agricola.[b] It shows a diagram of a *tzhu shih-liu kuan*[1] (pomegranate-shaped porcelain vessel); see Fig. 1433. This was simply a porcelain flask (in fact an *ambix*, ἄμβιξ) with a porous plug, used for converting cinnabar to mercury by downward distillation. The flask containing cinnabar was inverted over a *kan kuo tzu*[2] ('crucible'), analogous to the *lopas* (λοπάς), which contained some vinegar. The joint was made air-tight using a lute (equivalent to the *pēlos*, πηλός).[c] Fire was then applied above. The mercury formed passed through the porous plug and fell into the crucible.[d]

To end our discussion of descensory distillation we may give two further examples from the Sung period. First, in the *Pên Tshao Thu Ching*[3] of + 1062 the following passed the keen scrutiny of Su Sung's editorial eye:[e]

Take a jar made at Yang-chhêng[4] and fill it with cinnabar mixed with small pieces of hard charcoal. Cover the mouth of the jar with a piece of iron sheet that has been perforated with small holes. Hold the iron sheet in position by fixing a length of iron wire around the jar.

[a] Ch. 2, p. 4*a*, *b*. [b] Hoover & Hoover tr., pp. 426ff.

[c] For the background of the Greek terms see Sherwood Taylor (5), p. 188. They were equally applicable to the Dioscoridean sublimation process.

[d] The whole apparatus was called a *wei-chi*[5] (cf. p. 68).

[e] Tr. auct., from the quotation given in *Pên Tshao Phin Hui Ching Yao*, ch. 3, (p. 155). This seems a better text than that in *PTKM*, ch. 9, (p. 56) or in *CLPT*, ch. 4, (p. 107. 1), though the latter adds an illustration (Fig. 1434).

[1] 磁石榴罐 [2] 甘堝子 [3] 本草圖經 [4] 陽城 [5] 未濟

Then invert the jar and place it over another similar jar containing water in such a way that the two come into contact mouth to mouth. Apply a lute composed of salt, clay and pig's hair all over the upper jar, and especially round the rim where the two jars meet. After the lute has dried bury the lower jar in the ground so that the rim appears about an inch above the earth. Then build a stove surrounding the upper jar so that fire can be applied all about it to heat the contents. Let four openings be made, one on each side of the stove, to supply air for the burning. After heating for two hours the mercury will trickle down into the lower jar.

Fig. 1434. Mercury distillation *per descensum* depicted in the *Chêng Lei Pên Tshao* of + 1249 (Sung), ch. 4, p. 14*b*. The text on the right describes various uses of edible salt.

Secondly, we have an account in *Ling Wai Tai Ta*[1] (Information on What is Beyond the Passes), a book on the products and practices of the southern provinces and the South Seas by Chou Chhü-Fei[2] in + 1178. He says:[a]

The people of Yung(-chou)[3] (in Kuangsi) turn cinnabar into mercury as follows. Iron is used to make an upper and a lower bowl-like vessel (*fu*[4]). The upper vessel holds the cinnabar, which is separated (from the lower one) by an iron plate with small perforations. The lower vessel contains water and is buried in the ground. The two are joined mouth to mouth and sealed together just at ground level. A strong fire is then applied. On being heated the cinnabar changes into vapour, and on coming into contact with water it condenses, descending thus in the form of (liquid) mercury.

[a] Ch. 7, p. 11*a*, *b*, tr. auct. Very likely the apposed iron bowls were flanged (cf. p. 24 above).

[1] 嶺外代答 [2] 周去非 [3] 邕州 [4] 釜

Thus by this time it had become customary to make both vessels of iron. A still later description seems to imply the same thing, i.e. that of Hu Yen[1] in his *Tan Yao Pi Chüeh*[2] (Confidential Oral Instructions on Elixirs and Drugs), a pharmaceutical and chemical work ascribable to the Yuan or the early Ming.[a]

(ii) *The distillation of sea-water*

Perhaps the oldest thoughts of ascending distillation arose in connection with the question of obtaining fresh water from sea-water. This was a subject much discussed through many centuries.[b] Thales of Miletus in the −6th century recorded his belief that fresh water resulted from the filtration of sea-water through the earth, and the same view was among those mooted by Aristotle. In the *Meteorologica* he notes that when the vapour from salt water condenses it does not give salt water again.[c] The idea, expressed for example by Hippocrates, that liquids including sea-water could be made sweet by boiling,[d] may have arisen from some misunderstanding of a primitive distillation. Aristotle also believed that a closed wax bottle left in the sea would be found to contain fresh water,[e] and this idea of the efficiency of filtration through wax persisted down even to the late +18th century, though many times experimentally disproved.

We are brought nearer to ideas of true distillation by the observation of Pliny in the +1st century that fleeces spread out round a ship became moist with evaporated water, and that fresh water might be wrung out of them.[f] St Basil on his travels in the +4th century reported that sailors boiled sea-water in a vessel over a fire, suspending sponges above to catch the condensing vapour.[g] The method long endured, discussed by Abū al-Qāsim al-Zahrāwī (Abulcasis) in the +10th century, and illustrated by Conrad Gesner in +1555 (Fig. 1435).[h]

The first description of sea-water distillation seems to be due to Alexander of Aphrodisias in the +3rd century, in his commentary on Aristotle's *Meteorologica*.[i] He writes of 'condensing and collecting the vapour in appropriate covers'. The +10th-century Persian physician Abū Manṣūr al-Harawī indicated distillation as a method for water desalinisation,[j] and in the +14th century John of Gaddesden wrote in his *Rosa Anglica* of four available methods: filtration of sea-water through earth, boiling and condensation of the vapour on linen, distillation with alembics, and filtration

[a] Quoted in *PTKM*, ch. 9, (p. 56). One would like to know more about this work and its author. An account of the industrial production of mercury by descensory distillation as traditionally practised at Ise in Japan will be found in Yoshida Mitsukuni (7), p. 251.

[b] A good account is given by Nebbia & Nebbia-Menozzi (1).

[c] 358*b* 15, Lee tr., p. 157.

[d] *Airs, Waters and Places*, 8.

[e] 358*b* 34, 359*a*, Lee tr., p. 159.

[f] *Hist. Nat.*, XXXI, 70.

[g] *Homilies*, IV. This is repeated elsewhere, as by Olympiodorus, the commentator of Aristotle, in the +6th century.

[h] In the *Thesaurus Euonymus Philiatri*; Forbes (9), fig. 48; Underwood (1), fig. 29; Schelenz (2), fig. 6.

[i] 384*a* 3; Venice ed. of +1527, p. 97. Cf. Düring (1), p. 45.

[j] See Sarton (1), vol. 1, p. 678. Further references will be found in Nebbia & Nebbia-Menozzi (1), p. 135.

[1] 胡演　　[2] 丹藥祕訣

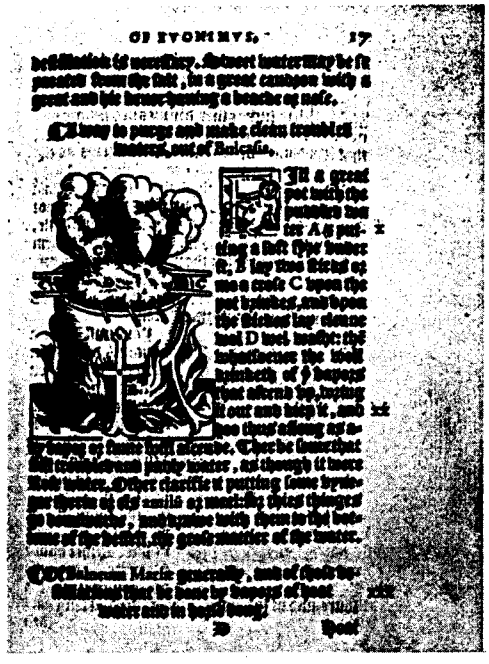


Fig. 1435. Condensing the distillate from sea-water in a suspended fleece, an ancient method illustrated by Conrad Gesner in his *Thesaurus Euonymus Philiatri* (+1555); from the English edition of +1559. He had it, he says, from Abū al-Qāsim al-Zahrawī (d. *c.* +1013), the great Moorish medical encyclopaedist.

through a wax vessel.[a] Two hundred years later the Spanish physician Andrés Laguna listed the same four methods.[b] During the +16th, +17th and +18th centuries many descriptions of stills for the production of fresh from sea-water on board ship or in states of siege were written. One difficulty often remarked upon was the unpleasant bitter taste of the distillate. Attempts to overcome this, sometimes successful, were made by adding to the sea-water ingredients (perhaps of an alkaline nature) the composition of which was often kept secret. Stephen Hales in +1739 described a fractional distillation, finding that only the first fractions coming over really tasted good. He therefore advised drinking only a part of the water.

So far we have not encountered any descriptions of the desalinisation of sea-water by distillation in the Chinese literature, but very possibly it was done during the great voyages of the fleets of Chêng Ho during the +15th century[c] if not at other times. Paradoxically nevertheless the old technique of the fleeces and sponges may have been relevant to the development of the characteristically Chinese and Mongol types of still, as will shortly appear.

While on the subject of distilled water, it is worth mentioning, perhaps, that this universal desideratum of every modern laboratory bench has appeared in most of the Chinese pharmaceutical natural histories since the beginning of the +8th century.

[a] Sarton (1), vol. 3, pp. 880ff.
[b] Dubler (1), vol. 3, p. 514.
[c] Vol. 4, pt. 3, pp. 487ff.

First introduced in the *Pên Tshao Shih I* of +725, it occupies a modest place in the *Pên Tshao Kang Mu*,[a] where it is recommended for use in various children's diseases. It hides under the name of *tsêng chhi shui*,[1] water condensed in the upper parts of culinary steamers, but it was recognised long ago by Geerts.[b] Of course the chemical significance of using pure water in laboratory reactions and experiments was not understood until the period of modern chemistry.

(iii) *East Asian types of still*

The process of distillation today is unambiguously called *chêng liu*.[2] But in traditional usage[c] here was no one word for it, since *chêng*[3, 4] alone meant also 'to steam', as in cooking, and the name of the apparatus, *tsêng*[5],[c] so often used for a still, could also mean any kind of 'steamer' (cf. p. 26 above). The difficulties which this vagueness can create for the study of the history of the chemical arts will make themselves sufficiently apparent later on (pp. 179 ff.), but fortunately there are ways of getting round them.

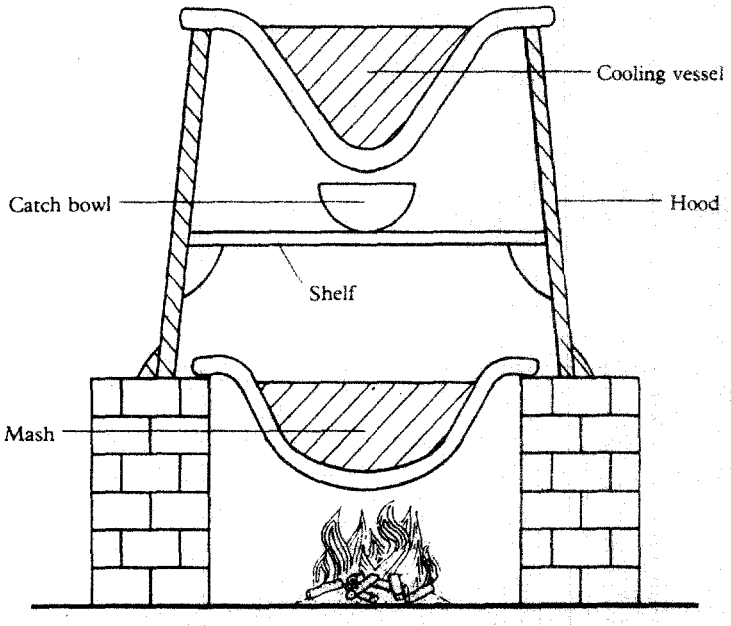


Fig. 1436. The 'Mongolian' still (after Hommel). The condensing surface is convex and the distillate drops centrally into a receiver within the still body; there is no side-tube. The shelf is of course perforated. The appellation originated ethnologically, but the assumption is natural that this was the most primitive and ancient of the East Asian types.

We must now describe the two most characteristic types of East Asian stills as found in traditional use down to the present day. The simplest form, known as the

[a] Ch. 7 (p. 54). [b] (1), no. 33, p. 155.

[c] The lexicographers give *ching* or *chêng* as a special alternative pronunciation of this word when it is used for a distillation apparatus, but we have not felt sufficiently sure of the general validity of this usage to adopt it here.

[1] 甑氣水 [2] 蒸餾 [3] 蒸 [4] 烝 [5] 甑

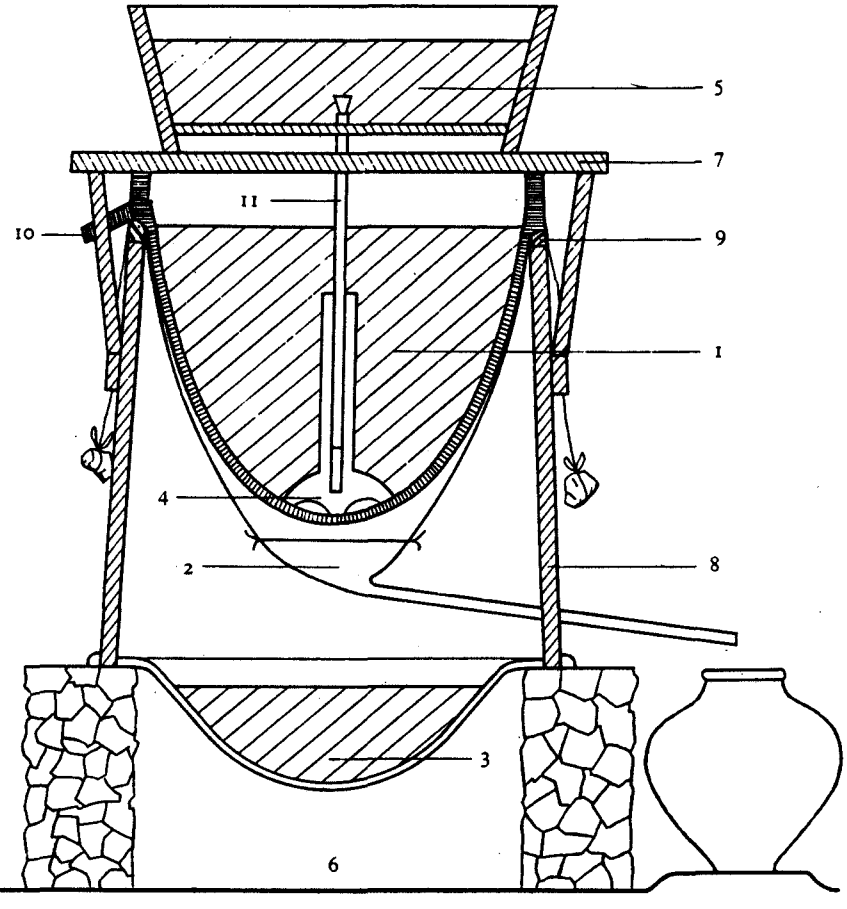


Fig. 1437. The 'Chinese' still (after Hommel). The principle is the same as that in the previous diagram, but the receiver is provided with a side-tube which draws off the distillate into a cool, or cooled, vessel outside the still body.

1. Pewter cooling reservoir.
2. Pewter catch-bowl and side-tube, suspended by cords.
3. Cast-iron bowl forming the bottom of the still and containing the mash to be distilled.
4. Inverted funnel of pewter to guide the cold water to the bottom of the cooling reservoir.
5. Wooden reservoir of cold water, a shallow tub.
6. Fire and grate.
7. Wooden frame to support the tub.
8. Wooden barrel-work forming the side of the still.
9. Tube-like ring of sewn cloth filled with sand and serving as a gasket.
10. Overflow pipe for heated water.
11. Wooden pipe with wooden stopper for letting cold water flow down into the cooling reservoir or condenser at the still-head.

Again the appellation originated ethnologically, but this type must surely be regarded as the more developed, and hence the later, of the two.

Mongol still, is seen in Fig. 1436, taken from Hommel (1). The vapours from a boiling liquid in a pan (*fu*[1]) below are condensed on the under surface of a similar pan of cold water placed above, and caught in a bowl resting on a shelf in the middle of the space formed by a wooden cylindrical barrel-like wall (*thung*[2]). Such stills are used for preparing the spirit distilled from fermented mare's milk. The more developed form

Fig. 1438. Alcohol still at Tung-chêng in Anhui (photo. Hommel), showing the external appearance of a traditional Chinese distillation apparatus. The overflow pipe for the warmed water is on the far side of the still, but the bamboo gutter into which it discharges can be seen on the right. On the left is the pewter side-tube for the distillate, prolonged by a wooden pipe which is suspended in position by a cord.

Fig. 1439. Pewter cooling reservoir or condenser vessel of a traditional liquor still, photographed upside down, at Lin-chiang in Chiangsi (Hommel). Two handles project, one on each side; that on the left is hollow and serves as an overflow pipe for conveying away the warmed water.

(Fig. 1437), known throughout China and used for making vodka-like spirits from fermented glutinous rice, kao-liang, millet or other cereals, is essentially the same except that the pewter catch-bowl is provided with a side-tube (*lou tou*[3]) forming something like an old-fashioned 'churchwarden' clay tobacco pipe, and conveying away the distillate through the wooden wall into a receiver. A wooden pipe (*mu thung*[4]) may guide the distillate into a pottery vessel standing in a small tub of cold

[1] 釜 [2] 桶 [3] 漏斗 [4] 木筒

Fig. 1440. Pewter catch-bowl and side-tube of a traditional liquor still, photographed upside down, at Lin-chiang in Chiangsi (Hommel).

Fig. 1441. Traditional Chinese liquor still at Chia-chia-chuang Commune, Shansi (orig. photo. 1964). The side-tube delivering *pai-kan-erh* spirits from kao-liang grain is pointing towards the camera, and the distillery worker is holding another catch-bowl and side-tube with one hand while stirring the cooling water reservoir with the other.

water. This we shall refer to as the Chinese still. Both types are of course seated on a stove (*tsao*[1]). Fig. 1438 shows a Chinese still photographed near Tung-chêng in Anhui province; the delivery tube is seen on the left, and an overflow pipe from the water-cooler, assuring a constant level of cooling water, is seen on the right.[a] Fig. 1439 from Lin-chiang in Chiangsi province shows the condenser vessel upside down, with its two handles, one of which is hollow and serves as the overflow pipe. Fig. 1440 from the same place shows the catch-bowl and side-tube upside down. A more recent

[a] On the matter of overflow pipes to secure constant-level conditions in reservoirs, see Vol. 3, pp. 316ff., 324, for the great importance of this development in China with regard to water-clock (clepsydra) technology.

[1] 灶

photograph of a still and a spare catch-bowl held by one of the workers (Fig. 1441) was taken at the Chia-chia-chuang Commune near Thaiyuan in Shansi in 1964. It was producing *pai-kan-erh* spirits (cf. p. 142) of 55 % alcohol content from kao-liang grain.

Representations of these stills in literature appear to be rare. The only Chinese-style illustration of a Chinese still which we have found is contained in the *Nung Hsüeh Tsuan Yao*[1] (Essentials of Agricultural Technology) written as late as 1900 by Fu Tsêng-Hsiang[2] but rather traditional in character.[a] We reproduce this in Fig. 1442. Here it is shown in connection with the making of the essential oil of peppermint (cf. p. 117). It is unfortunate that ch. 17 of the famous *Thien Kung Khai Wu*[3] (Exploitation of the Works of Nature) written by Sung Ying-Hsing[4] in + 1637, which deals with wine-making, does not include a picture of a Chinese-type still.

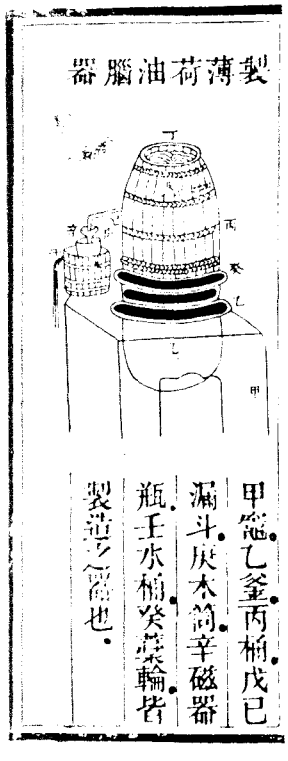


Fig. 1442

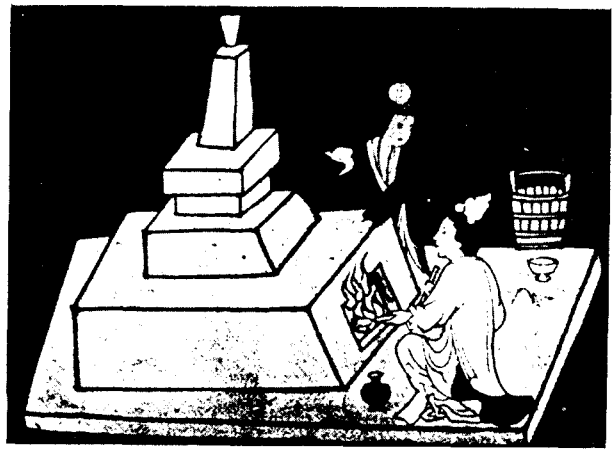


Fig. 1443

Fig. 1442. Traditional still from the *Nung Hsüeh Tsuan Yao* (1901) by Fu Tsêng-Hsiang; one of the rare Chinese-style illustrations of the apparatus. The dotted lines which show the side-tube within the still body are in the original. The drawing occurs in connection with the distillation of the essential oils of peppermint, *Mentha arvensis* and other species. The text below describes the parts; the catch-bowl and side-tube being called *lou-tou*.

Fig. 1443. A wine-distilling scene from the frescoes at the cave-temples of Wan-fo-hsia (Yü-lin-khu) in Kansu, dating from the Hsi-Hsia period (+ 1032 to + 1227). Copy-painting by Tuan Wên-Chieh. If there is no side-tube in the original, the still must be of the Mongolian type.

[a] Ch. 2, p. 31*b*.

[1] 農學纂要 [2] 傅增湘 [3] 天工開物 [4] 宋應星

Apart from the drawings in the alchemical books in the *Tao Tsang*,[1] which we shall study presently, we know of no other medieval Chinese literary representations of stills. But it is to be hoped that further studies of the frescoes depicting daily life on the walls of temples and cave-temples in various parts of China may bring to light some paintings of distilling apparatus. We can here offer but one (Fig. 1443), a scene of wine-making from the frescoes of the cave-temples at Wan-fo-hsia[2] (Yü-lin-khu[3]), in Kansu province.[a] This dates from the Hsi-Hsia[4] period (+1032 to +1227). We suspect that a closer study of the painting would show a side-tube leading to the cooling bucket on the right; if not, it is a painting of a Mongol rather than a Chinese still and has a catch-bowl set centrally.

Fig. 1444. A late + 18th-century coloured MS. drawing of a Chinese wine still (Victoria and Albert Museum). Side-tube on the left, filling-tube with bung on the right.

Pictures of what are presumably Chinese stills drawn by Europeans, or in European style by Chinese, during the past two hundred years, are not uncommon. Usually one sees only the side-tube and the large bowl of cooling water at the top of the apparatus. Fig. 1444 shows a late +18th-century coloured MS. drawing in the Victoria and Albert Museum[b] which was undoubtedly the original for the coloured print embodied in the book of G. H. Mason (1800).[c] The vessels on the left bear the characters *chhang li*[5] [d] (ordinary spirits for formal occasions).[e]

[a] From the booklet of reproductions issued by the Tunhuang Research Institute in 1957, ed. Tuan Wên-Chieh (1).

[b] Print Room II-20; no. 31, D 83–1898. [c] (1), pl. xxiv.

[d] This *li* properly means a sacrificial vessel.

[e] A small picture in exactly the same iconographic tradition, but cruder, will be found (in the English edition but not in either of the Chinese editions) of Li Chhiao-Phing (1), p. 199. Such representations, with varying degrees of artistry, are quite common; e.g. Gray (1), vol. 2, p. 140 (Fig. 1445). No sources

[1] 道藏 [2] 萬佛峽 [3] 榆林窟 [4] 西夏 [5] 常醴

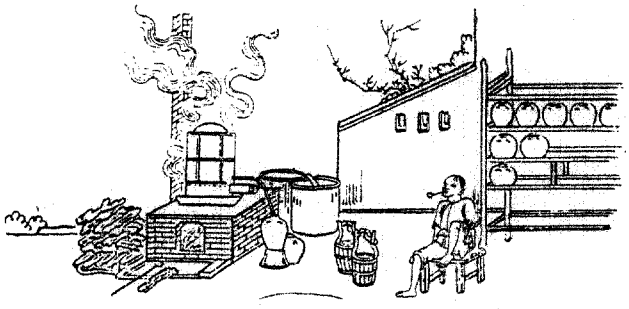


Fig. 1445. Traditional-style drawing of a Chinese liquor distillery, from Gray (1878).

We have not made any great search to establish the customary alcohol-content of distilled Chinese spirits, but Deniel in Vietnam found as much as 54%,[a] while Li Chhiao-Phing gives 65% as a usual figure for North China kao-liang spirit.[b] About alcohol and its history we shall have a good deal more to say later on (pp. 121 ff.).

(iv) *The stills of the Chinese alchemists*

We are now in a position to examine the distillation apparatus described and figured in the medieval Chinese alchemical texts. In general we have two widely-mentioned forms of equipment, the *wei-chi lu*[1] (imperfect accomplishment stove) and the *chi-chi lu*[2] (perfect accomplishment stove).[c] Fig. 1446 (*a*) and (*b*) are taken from *TT*893, a work of the +12th century.[d] Unfortunately, the text, as it has come down to us, does not describe the function of these two complicated pieces of apparatus. According to Tshao Yuan-Yü (*1*), Li Chhiao-Phing (*1*) and Huang Tzu-Chhing (1), however, in the *wei-chi lu* (*a*) the ingredients were contained in A, cold water was contained in B, and the left-hand object C served as an inlet for water and also as an outlet for steam. The upper section where they think fire was applied has indeed a perforated top. Heating would thus have occurred around A while the space surrounding B was filled with ashes. These interpretations were those of the three modern authors and do not arise directly from anything in the accompanying text, while no explanation for the right-hand object was forthcoming from either. The nature of an operation carried on in this way would thus remain extremely puzzling. On the other hand, the second apparatus, the *chi-chi lu* (*b*), occasions little uncertainty. In the *chi-chi lu* the ingredients were contained in B and cold water in A, while fire, they think (we believe rightly), was

are ever stated. The fact that the side-tube generally comes off at what may seem a very low position is not inconsistent with the Chinese still pattern, as witness Fig. 1437.

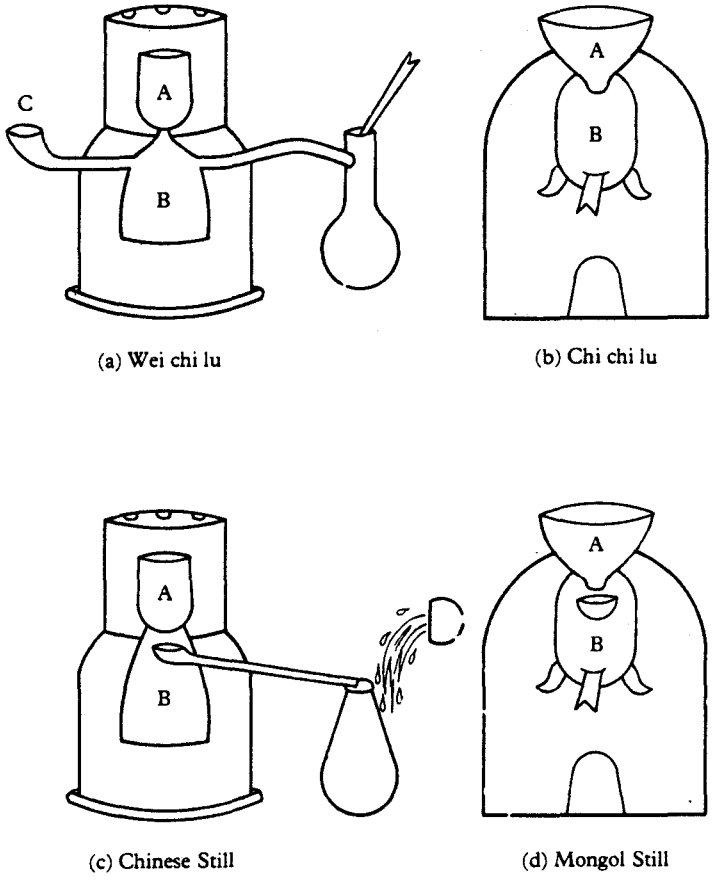
[a] (1), p. 86. This figure is about that for ordinary brandy, whisky and rum. The wines which he analysed gave very variable results, and it is not clear whether all of them were in fact distilled. Some had only about 20% alcohol, equivalent to the 'fortified' wines of Europe.

[b] (1), p. 208. This would approach vodka in alcohol-content. Useful information on the strengths of wines and spirits in general can be found in Ure (1), vol. 1, p. 59, and in the book of Ribereau-Gayon & Peynard (1).

[c] We shall return in a moment to the significance of these strange names.

[d] P. 9*a*.

[1] 未濟爐 [2] 既濟爐



(a) Wei chi lu (b) Chi chi lu

(c) Chinese Still (d) Mongol Still

Fig. 1446. East Asian stills (*a*, *b*) from the *Tan Fang Hsü Chih* of +1163 (Sung). Below (*c*, *d*) re-drawn in interpreted form (see text).

applied underneath B. All these forms of apparatus were sealed by using a lute or sealing-compound.

Although it might seem strange to do a great deal of heating from above, there can be no doubt from a general survey of these texts that the Thang and Sung alchemists did practise alternate heating from above and below, thus inverting (as they believed they had to do) the positions of Yin and Yang in their apparatus. They might even be told to alternate the procedure each day for two months.[a] The two arrangements certainly derived from the ancient techniques of descensory distillation on the one hand, and of sublimation to a cold surface (later, distillation) on the other. It may at the outset be admitted that not every procedure carried out by the medieval Chinese alchemists will necessarily make sense in modern terms when all the results are in, because many of their ideas and presuppositions were not the same as those legitimated by modern science; but nevertheless it is our duty in the meantime to interpret them as reasonably as possible. By a kind of extension from William of Ockham one

[a] Cf. *TT*907, p. 15*b* and pp. 74, 283 below.

should always assume science until proto-science is inescapably proven. We have to allow also for some distortion and misunderstanding in the transmission of the illustrations, and some corruptions in the texts. We may also be able to descry, through the apparatus depicted by the alchemists, techniques perhaps more practical used by the brewers, food industry workers, pharmacists and physicians contemporary with them. Their designs, in a word, did not come out of the blue.

From the explanation of Tshao, Li and Huang it is difficult to see what purpose was served by the vessel shown so clearly on the right-hand side of Fig. 1446 (*a*). It must surely have been the receiver of a still. Moreover, the unexplained slanting lines on the right which at first light look like a tapering tube are plausibly to be interpreted as a stream of water poured on to the receiver to cool it.[a] One of the Indian pictures referred to below (p. 104) has exactly this.[b] Our Chinese diagram may well have become distorted by draughtsmen who did not quite understand what they were drawing or copying. On the other hand the 'inlet' C may have been drawn projecting outwards and the horizontal tube shown as continuous with the body of the still not so much for the purpose of 'deceiving the experts' (as practised by the Greek metallurgical artisans), but to 'discourage the layman'. To quote from the preface of *TT*894 (a text of +806):[c]

> Whereupon I realised that the sages do not desire their subtle and efficacious methods to be understood by the common people who happen to come across them by chance. They have intentionally made their processes involved so that the wise would diligently pursue them, while the average person would leave them alone and indeed scorn them.

Alternatively, again, the catch-bowl and side-tube was hung up outside and in front of the still when the draughtsman uncomprehendingly drew it. If our guess is correct then, we obtain immediately the two types of East Asian still, as shown in the two conjectural diagrams in Fig. 1446 (*c*) and (*d*). A would then be the water-condenser vessel in both cases and B would be the body of the still. The *chi-chi lu* would then be in effect the Mongol still, with a simple catch-bowl at the centre, while the *wei-chi lu* would be the more developed type or Chinese still in which the distillate is conducted away from the catch-bowl by a side-tube.[d]

To understand these names better it is necessary to turn to our discussion of the *I Ching* (Book of Changes) in Vol. 2. There it will be seen that Chi-Chi and Wei-Chi are the last two of all the *kua* (the hexagrams),[e] bringing up the rear like St Sylvester in the calendar of the Western Church, and not without some of the associations that tend to gather round his name. Chi-Chi signifies consummation or perfect order,

[a] Another possibility which has been suggested is that they represent a feather such as was used by the alchemists for collecting sublimates from the surfaces on which they had condensed. This seems much less convincing.

[b] The *tiryakpātana yantra* (Ray (1), 2nd ed., fig. 30*e* i, and p. 190).

[c] Tr. auct.

[d] The only other conceivable possibility which has occurred to us for the interpretation of Fig. 1446(*a*) is that the central part could be a two-armed dephlegmator vessel like that in Fig. 1473(*a*), with the still itself invisibly on the left and the final receiver shown on the right. But this is negatived by many things, the absence of any other reference to such a device in China, and the stated presence of fire within the stove-like container.

[e] See Table 14 at Vol. 2, p. 320, as also, for the relations with alchemy, p. 331.

completion, equalisation and successful accomplishment, but in a figure full of symbolism it cedes the final place to Wei-Chi, the *kua* which signifies disorder capable of consummation, order, equalisation and perfection, the position, in fact, when all has not yet quite been successfully accomplished. Why then should the 'Mongol' still have been called a *chi-chi lu*? Perhaps because it formed a unitary and perfect whole, like the philosophers' egg,[a] the distillate condensing at the very heart of the system. When the catch-bowl was provided with a side-tube (as in the 'Chinese' still), chemical efficiency was assuredly multiplied, but the pattern lost its symmetrical perfection, the distillate being conveyed away to a receiver outside the microcosmos. Perhaps the name *wei-chi lu* thus betrays a certain disapproval on the part of the Taoist mutationists and symbolists, even though their alchemical colleagues were not thereby deterred from accepting a radical technical improvement. But it would be premature to accept this interpretation, and one must leave open the possibility of some alternative connection, not so far clear, with the relative positions of the heat source and the cooling system. Certainly in *TT*907 one of the systems with upper cooling, where the fire must clearly have been applied below, was called a *chi-chi* (see pp. 37, 43 and Fig. 1409), while the simple apparatus for descensory distillation (see p. 58 and Fig. 1433) was called a *wei-chi*.[b] It remains to be seen whether these terms were invariably used in this way or not; they certainly do not always appear where (on this view) they might be expected.[c] In any case, whatever the explanation of the names may be, the drawings with the long side-tubes do, we believe, betray the existence of the Chinese still at the time when the texts were written.

In another book (*TT*895), we find a further diagram of what seems to be a *wei-chi lu*, reproduced in Fig. 1447(*a*).[d] This work is ascribed to the +4th century (Chin), the time of Ko Hung and Zosimus, though presumably it must be somewhat later.[e] The name *wei-chi lu* does not actually appear in the text, and we use it only by analogy. Now if we reconstruct this drawing on the assumption that the Chinese still was what was being depicted, we get Fig. 1447(*b*) showing the side-tube in place. Thus one might suppose (as in the case of Fig. 1446) that the churchwarden-pipe-like bowl and side-tube had been hung up in front of the apparatus before the artist drew it, no doubt in the elaboratory of some Taoist temple. Unfortunately no help whatever is

[a] Cf. Cheppard (2, 7), and pp. 17 ff. above. Actual egg-shells were sometimes used as containers or reaction-vessels by the Chinese alchemists (cf. pp. 292 ff.).

[b] Perhaps it was considered more high and philosophical to make things go up rather than persuading them to flow down.

[c] The Chi-Chi and Wei-Chi hexagrams will be encountered again in our presentation of the theory of physiological alchemy (Vol. 5, pt. 5 below) where they play an important part. One feels also that there must have been some connection between the alternation of the positions of water and fire (Yin and Yang), above and below, in these physical apparatuses, and the principle of inversion (*tien tao*) so fundamental in physiological alchemy (see pt. 5).

[d] P. 1*b*. On the fire-water theory the name would imply that the heating should be from above, but the apparatus is then quite incomprehensible.

[e] There might be philological justification for considering it of the Liu Chhao period or at least Thang, rather than Sung or Yuan. Further study of the text could perhaps date it more closely by internal evidence. The question is of much importance because of the obscurity which veils the historical origins of the Chinese still (cf. pp. 78–9, 155), and the strong probability arising from textual evidence that alcohol was being regularly distilled from the +7th century onwards (cf. p. 162).

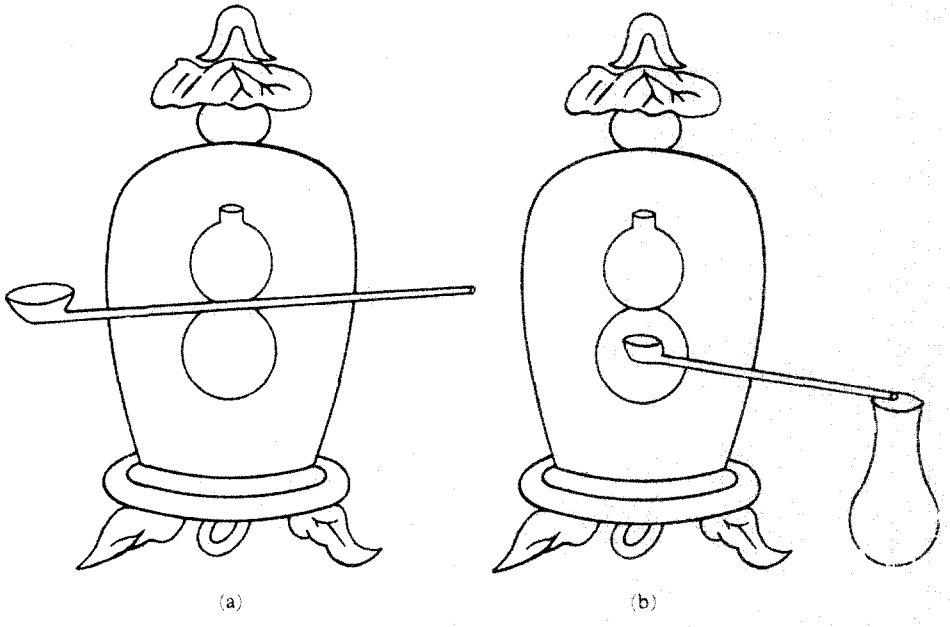


Fig. 1447. Another Chinese apparatus (*a*) from *Chih-Chhuan Chen-Jen Chiao Chêng Shu*, ascribed to the Chin period (+3rd or +4th century), but more probably Thang (+8th or +9th). Redrawn in (*b*) interpreted as a still of 'Chinese' type.

forthcoming from the accompanying text, which is concerned only with generalities and poetical cover-names for certain substances and processes.

Yet another example occurs in *TT*907, a text definitely of the Sung (+13th cent.), the very same from which we drew above so many examples of cooling-'coils' and water-jackets. Here we find two diagrams, reproduced in Fig. 1448(*a*) and (*b*).[a] They look like *wei-chi lu* and *chi-chi lu* respectively, though these names are not used in text or captions; and they represent the apparatus to be used in Turn 7 of the elixir preparation (cf. Table 116 above). Together they constitute perhaps the hardest nut to crack in the study of medieval Chinese alchemical apparatus. One could of course argue, in the case of (*a*), that it was a variant of the Chinese still in which the central collecting-bowl had two side-tubes (as in the reconstruction of Fig. 1448*c*); or alternatively that two separate catch-bowls and side-tubes had been hung up in front of the apparatus before the artist drew it. If the former interpretation were to be admitted there would be a remarkable parallel with the apparatus of the Hellenistic protochemists, for among them one repeatedly encounters a still having two side-tubes, the *dibikos* (διβίκος).[b] This occurs in fact in one of the oldest texts, the *Chrysopoia* of Cleopatra, now consisting of only one page of diagrams.[c] The arrangement was presumably adopted with the object of removing distillate as quickly as possible from the hot atmosphere of the interior of the still.[d] But since the *dibikos* lacked all future

[a] Pp. 14*b*, 15*a*.
[b] Berthelot (2), pp. 132, 138; Sherwood Taylor (2), pp. 117, 136, 137.
[c] Berthelot (1), pl 1, (2), fig. 11.
[d] Sometimes indeed three side-tubes are shown (Berthelot (2), pp. 141, 161, 163).

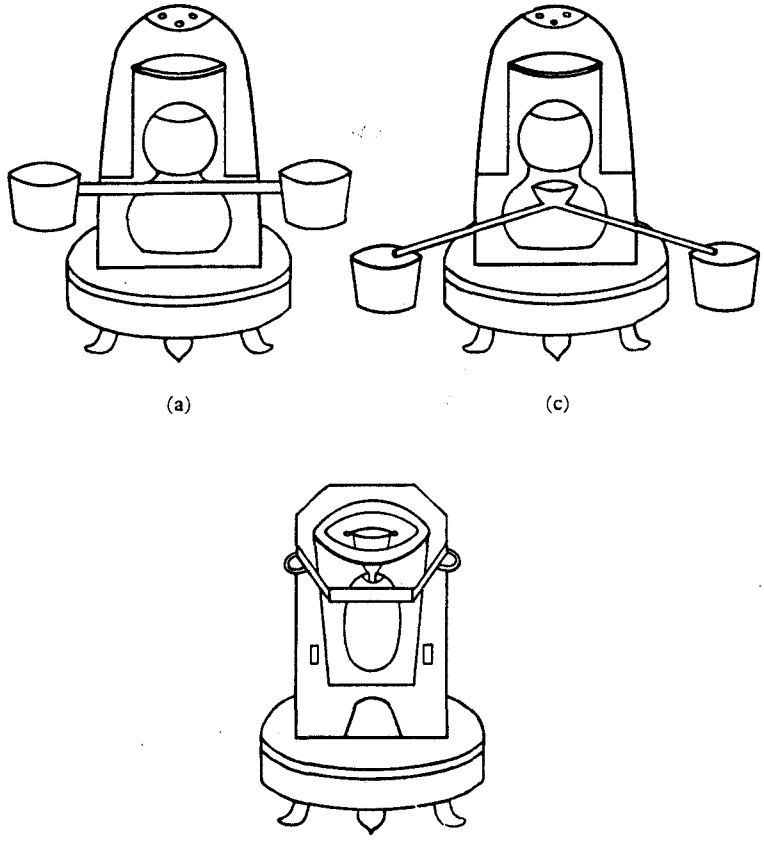


Fig. 1448. East Asian stills (*a*, *b*) from *Chin Hua Chhung Pi Tan Ching Pi Chih* of + 1225 (Sung). The latter presumably depicts the 'Mongolian' type; the former is redrawn in (*c*) interpreted as a *dibikos* with two side-tubes and two receivers.

in the West,[a] and since no other example of a *dibikos* in the Chinese style of still is known, either alchemical or technological, and since furthermore a dozen centuries separated the two devices, such an interpretation would imply a possible rapprochement between Hellenistic and Chinese chemical technique as fascinating as it would seem unlikely.

No, there is much that we do not yet understand about this apparatus. First, the caption for the '*wei-chi lu*' with the assumed double catch-bowls, Fig. 1448(*a*), distinctly says that the fire is to be applied above and that there is to be water below.[b] Secondly, it is clear from the accompanying diagrams that in the '*chi-chi lu*' the furnace contains an arrangement of upper water-reservoir (*shui hai*[1]) and central

[a] A badly drawn one has been illustrated from late (+ 16th), but archaic, Armenian alchemical MSS (see Kazanchian, 1). Curiously enough, as we shall see (pp. 103, 105–6), there are echoes of it in Mongolia, and several in India.

[b] And one can see furnace holes for the escape of fuel vapours at the top.

[1] 水海

cooling-tube closely analogous (with fire below) to those already shown in Figs. 1409 and 1413, and used for Preliminary Process (*a*) and Turn 9 of the elixir preparation (cf. Table 116). It therefore cannot be a Mongol still in the usual sense, though it could of course have permitted the condensation of a sublimate on the water-reservoir and its tube. This is in fact mentioned in the accompanying text, which prescribes that it should be collected and used for subsequent stages in the whole preparation. Once again, unfortunately, it gives us very little other help beyond prescribing alternate heating in the two types of apparatus each day for two months. It also makes clear

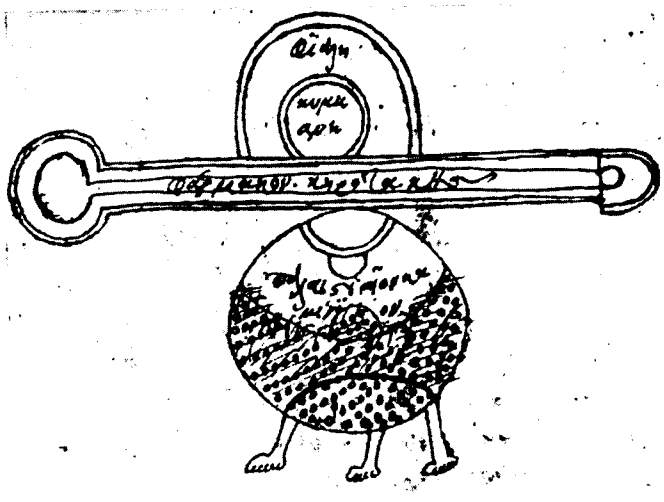


Fig. 1449. One of the forms of the *kērotakis* (reflux distillation) apparatus of the Greek proto-chemists (Marc. 299, fol. 195*v*). See discussion in text.

that the starting material is the product of Turn 6, and that the end-result of the present stage (7) is an elixir one ounce of which will convert by projection (*tien*[1]) five ounces of ordinary silver into yellow gold. One has to conclude that what exactly was going on here will not be elucidated until the book of Phêng Ssu & Mêng Hsü has been studied at leisure and translated in full.

Our assumption that the drawings of Figs. 1446(*a*), 1447(*a*) and perhaps 1448(*a*) represent (or were derived from) Chinese stills not assembled for operation seems in the context not unjustifiable. But there remains a disturbing resemblance between them and one of the Greek drawings of the *kērotakis* (κηροτακίς) apparatus (Fig. 1449).[a] As is well known, the primary form of this was a long cylindrical vessel having boiling mercury below and a palette (*kērotakis*) at the top on which was placed small pieces of copper or copper alloys; then acting as a reflux extractor the apparatus served for the preparation of the golden-coloured alloy or amalgam of copper with 13 per cent of mercury (Fig. 1450).[b] Globular forms of this vessel occur in various places in the

[a] Marc. 299; Berthelot (2), p. 146; Sherwood Taylor (2), p. 134.

[b] Berthelot (2), p. 143; Sherwood Taylor (2), p. 132. The above interpretation was one of Sherwood Taylor's; in later writings (e.g. (3), pp. 46ff.) he joined with others, notably E. J. Holmyard (esp. (1),

[1] 點

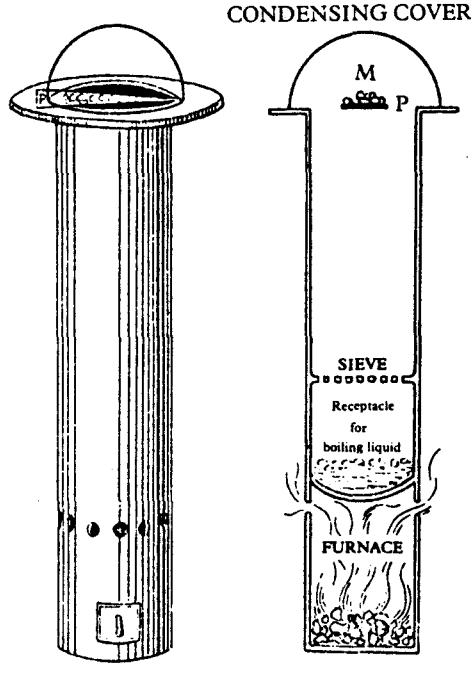


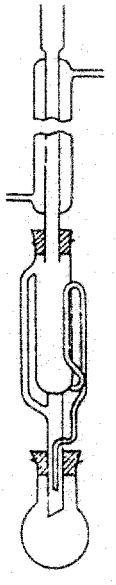
Fig. 1450. Sherwood Taylor's conjectural reconstruction of the long type of *kērotakis* apparatus. P, the 'palette'; M, the metal or other material to be acted upon by the vapours.

MSS[a] but only in one drawing does the 'palette' appear as the very elongated object bisecting the two round ones which we see in Fig. 1449. The legends in this drawing are also a little different from those on the others. The uppermost circle is labelled *phialē* (φιάλη), the standard term for a still-head, and the lowest *palaistiaion kaminion* (παλαιστιαῖον καμίνιον), heater 'a hand's length in diameter'. Below this space a fire-holder in the lowest part of the vessel, pierced with holes for ash, may be assumed. Then the 'palette' bears the words *pharmakon kērotakēs* (φαρμακον κηροτακης), 'the *kērotakis* of the drug', and immediately above it the small inner circle is labelled *kumbanē* (κυμβάνη), the cup. The thought arises therefore that this 'cup' might be the same thing as the rounded left-hand end of the long horizontal component itself, in which case the drawing of the apparatus could be considered very similar to those of the Chinese stills which we have been examining. That the word *kērotakis* could be very loosely used by the Greek proto-chemists is suggested by other places, e.g. the dialogue of Synesius (+4th century) where he directs that the still shall be placed on a hot ash bath 'which is a *kērotakis*';[b] there the word can only mean a platform like a modern

p. 47), in supposing that boiling sulphur rather than mercury was the substance at the bottom of the reflux apparatus. It is noteworthy that the analogous Indian *dhūpa yantra* is distinctly stated to have sulphur and the sulphides of arsenic as the 'solvent' (Ray (1), 2nd ed., fig. 30*a* i; and p. 191).

[a] Berthelot (2), pp. 148, 149; Sherwood Taylor (2), p. 134
[b] Berthelot (2), p. 164; Sherwood Taylor (5), p. 197.

sand-bath.[a] Thus we have the possibility at any rate that the horizontal component was really a catch-bowl and side-tube (or even for part of its length a side-trough), and that the Chinese form of the still was known to the Greek proto-chemists. If so, it did not develop in later Greek or Latin tradition,[b] and it would certainly be simpler to assume two quite separate lines of evolution as suggested in Fig. 1454 below. Perhaps those who are more familiar with the Greek proto-chemical texts than we are may be able to settle this point.



Alternatively, there is the remote possibility that the Chinese pictures are representations of reflux *kērotakis* extractors intended for preparing golden-coloured Cu–Hg alloys. There is no doubt that this amalgam was known to the Chinese alchemists from an early time (cf. pt. 2, p. 243). The drawing of the Chinese apparatus, however, in all cases so clearly tubular, and also in some, e.g. Fig. 1447(*a*), showing the catch-bowl so clearly, seems to us to make it even less likely that the stills in the Chinese drawings were reflux extractors than that the special form of the Greek *kērtoakis* was a Chinese still.

Here one perceives a certain morphological similarity, however, between the *kērotakis* and the East Asian still. Both have a boiling liquid below (the 'Hades'), and an object held in the upper central part of the vapour zone. In the *kērotakis* the purpose of the arrangement is the effecting of chemical alteration in the object's substance or contents by the action of the vapour, as in the formation of a coloured surface-film, with the possibility also of gradual extraction of the product formed and its accumulation in the solvent at the bottom, or simply indeed the extraction of any extractable component. The *kērotakis* might therefore be considered the ancestor of the Soxhlet siphon and all other modern reflux extractors (see inset). The East Asian still on the other hand uses the central object to collect the drops that fall from the uppermost ('heavenly') condenser like rain in the meteorological water-cycle, and even to remove them from the system. It is thus the ancestor of many molecular stills of today.[c] But whether this morphological similarity of arrangement could mean anything in terms of intercultural borrowing (cf. Fig.1454*h*) it would be very hard to say. As we shall see (p. 331) there is a certain Chinese priority in the first beginnings of alchemy and chemical technology as compared with the Hellenistic world, and mutual influences remain possible. As a focal date we would only recall here the opening of the Old Silk Road in −110 and the facilitation of cultural and intellectual interchange so permitted. But as yet there is no positive evidence that the Mongol or Chinese still was in use as early as the Chhin and Han, nor is it obvious how the *kērotakis* apparatus, with its total absence of water-cooling, could have been stimulated by it.

Among later drawings of chemical apparatus from the Mediterranean region we have come across one which could conceivably be analogous to the drawings of

[a] It is true that Berthelot & Ruelle (vol. 3, p. 65), translated differently, 'such as is used for a *kērotakis*', *Corp. Alchem. Gr.* II, iii, 6.

[b] But cf. the surmise on p. 77.

[c] Cf. p. 101 below.

Chinese stills not assembled for operation which we have been discussing. It occurs in the *Liber Florum Geberti*, that curious Arabic–Byzantine MS. in Latin, the text of which seems to be earlier than the +14th century (cf. p. 94). As Fig. 1451 shows,[a] the object seems to be a still on a tripod base, and the S-shaped tube looking like the arms of a flag-signaller might possibly be the catch-bowl and tube of a Chinese still hung up in front of it. However, it would seem very unlikely that draughtsmen would have been confronted with just such an arrangement in Europe as well as in China, and besides, there is no other evidence for the appearance of the Chinese still in the Mediterranean culture-zone.[b]

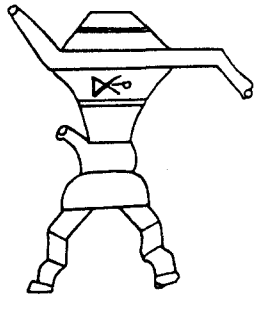


Fig. 1451

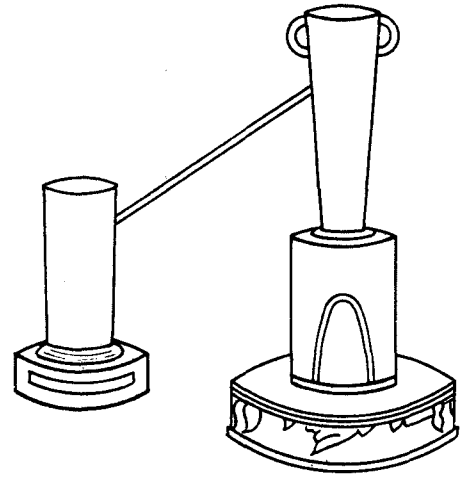


Fig. 1452

Fig. 1451. A drawing from the *Liber Florum Geberti*, a pre-Geberian Arabic-Byzantine MS. in Latin, probably of the + 13th century (München Staatsbib. Cod. Lat. 25, 110, from Ganzenmüller, 3). The apparatus could possibly be a still of Chinese type, on a tripod or four-footed base, with the catch-bowl and side-tube strung up in front of the still body, as suggested for the Chinese drawings in the preceding Figures. The cooling reservoir with its convex bottom would then be the uppermost component, and the short tube on the left would have been for replenishing the liquid to be distilled. But Ganzenmüller himself could not decide the true purpose of the apparatus, and the significance of the alchemical symbol marked on it is obscure as this does not occur elsewhere.

Fig. 1452. Mercury still from the *Tan Fang Hsü Chih* of + 1163 (Sung). The catch-bowl at the top of the side-tube is not seen, but the shape of the still-head indicates fairly clearly a cooling water reservoir or basin. Indeed, this is actually referred to in the accompanying text, which purports to be of the + 3rd century (San Kuo period), but could well be of Thang date (+ 7th to + 9th century).

The only distillation apparatus depicted in the *Tao Tsang* as set up ready for use occurs in *TT*893, a +12th-century text (see Fig. 1452). The following explanation is given:[c]

Ko the Immortal Elder (*hsien ong*[1]), (i.e. Ko Hsüan,[2] *fl.* +238 to +250, the great-uncle of Ko Hung) says: 'For the distillation of mercury the stove has a wooden frame (*chhuang*[3])

[a] Ganzenmüller (1), p. 293, fig. 19, no. 9, repr. from (3).
[b] Except the haunting conjecture referred to on p. 74.
[c] P. 7*a*, *b*, tr. auct.

[1] 仙翁 [2] 葛玄 [3] 床

measuring 4 ft. (in circumference, i.e. a base). The wooden legs supporting the stove are more than 1 ft. high so as to avoid the dampness of the ground. A hollow space is cut out (at the top, for the still to sit on). The closed vessel (or still, *fu*[1]) has a capacity of two pecks. Fire must be kept up at a distance of not less than 8 ins. from the vessel. The stove on the frame base should be made in accordance with the size of the closed vessel.' The commentary says: 'The uppermost part of the vessel is well covered with clay (as a lute) and rendered leak-proof. A tube for the vapours (*chhi kuan*[2]) is attached to the cover as usual. Water is filled in to the water reservoir at the top. This prevents the escape and loss of mercury'.

Fig. 1453. A retort still for mercury, from *Thien Kung Khai Wu* (+ 1637) by Sung Ying-Hsing.

These words thus imply that Ko Hsüan was familiar with the distillation of mercury in the +3rd century. They could thus be extremely important for the history of the still in China, and their veracity is not necessarily impugned by the relatively late date of the text in which they occur because of the marked tendency of alchemical writers to copy from one another century after century. Even a cautious estimate, however, could place the text in the Thang, and that alone would be highly significant (along with Figs. 1407 and 1447) in the context of the literary evidence for the distillation of alcohol during the +7th, +8th and +9th centuries (cf. pp. 141 ff. below). All indications justify the Liu Chhao period as the time when we can first be reasonably

[1] 釜 [2] 氣管

sure of distillation in China; doubt only remains concerning the Chhin and Han. Although the still-head end of the side-tube is not shown in the drawing (Fig. 1452). the fact that a water-container is clearly mentioned indicates that there must have been a central catch-bowl underneath it.[a]

We come lastly to types of still depicted in Chinese books which have no catch-bowl and depend upon the withdrawal of the vapour for condensation in a separate recipient. The mercury 'retort' in the *Thien Kung Khai Wu*[1] of +1637 (Exploitation of the Works of Nature) is perhaps the best example of this.[b] As Fig. 1453 shows, no water-cooling is provided at the still-head, and the shape of the side-tube precludes the presence of any catch-bowl, but cooling water in, and perhaps around, the receiver is vouched for by the caption adjacent in the picture. The caption on the still itself, *ku chi*,[2] means 'solidly fitted together'. It is a term often found in the alchemical and chemical literature,[c] and implies that optimal fit of adjoined edges, often but not necessarily secured with the aid of lute (*liu i ni*[3]), which we have spoken of already when discussing the flanges of the apposed halves of reaction-vessels (pp. 22, 35–6). The word *chi* clearly has a connection with the *kua* which gave their names to the two types of East Asian still (pp. 5, 6, 68, 70–1 above), signifying that the Yin and the Yang were 'completely' compensated or equalised, fitting together like a tally without a hairs-breadth of inaccuracy. As for the caption on the side-tube, it simply says 'empty bow-shaped iron tube'.

A perfect description of the apparatus is given in a much older text, from the Sung, the *Ling Wai Tai Ta*[4] of +1178. This demonstrates that the retort type of still was then employed for the purification of mercury, and therefore presumably also for its preparation from the sulphide ore. It runs as follows:[d]

> The people of Kuei(-chou), (modern Kuangsi province) heat mercury to make vermilion (*yin chu*[5]). They use an upper and a lower vessel made of iron. The lower vessel is like a bowl and holds the mercury. The upper vessel acts as the cover and has a hole at the top through which a tube passes. The tube bends over and curves downwards away from the vessels. The two vessels are closely and tightly fitted together (*ku chi*[6]). The open end of the tube is made to dip into water (in a receiver). The fire is applied below the lower vessel. Under the influence of the heat, the mercury distils (lit. flies up, *fei*[7])[e] but on coming into contact with the water (the process) is arrested (i.e. it condenses)...

Chou Chhü-Fei then goes on to speak of the two grades of vermilion on the market, omitting the later sublimation of the sulphide from the purified mercury.[f] Perhaps

[a] Since mercury boils at 357 °C. this water-cooled head was quite unnecessary and the water in it would have been boiling fiercely all the time. Its retention here, if by inertia, would show the fixity of pattern of the Chinese still, in which cooling by water had been an essential element from the beginning. But is it not more probable that the still in question was in fact used for quite different things, such as wine, vinegar or essential oils, and that the drawing became associated with the text by mistake?

[b] Ch. 16, p. 5*b*, text p. 2*a*, tr. Sun & Sun (1), p. 280.

[c] Cf. Tshao Yuan-Yü (1), pp. 43, 52 (pp. 78, 85); Sivin (1), p. 185.

[d] Ch. 7, p. 12*a*, tr. auct. Cf. p. 59 above.

[e] This term was almost always reserved for sublimation processes (cf. pp. 4, 134–5), but perhaps mercury was an exception. If we allow this, then the distillation of mercury was certainly known to Ko Hung, *c.* +300, as we shall see. Cf. pt. 2, p. 65, pt. 3, p. 103.

[f] This is clearly described in *TKKW*, ch. 16, pp. 2*b*, 6*a* (Sun & Sun tr., pp. 280, 283, 285).

[1] 天工開物 [2] 固濟 [3] 六一泥 [4] 嶺外代答 [5] 銀朱 [6] 固濟 [7] 飛

a sentence or two fell out. All this may not necessarily mean that Western still-types had reached China by the +12th century, for there is no trace of the characteristic peripheral rim (cf. p. 84), but it does recall the much older Indian, Gandhāran, still-type (cf. p. 86 and Fig. 1460), which had probably had water-cooling at the receiver only. It looks, therefore, as if some time between the +7th and the +12th centuries this was recognised in China as more practical for the purpose than the stills of Mongol-Chinese type, and adopted accordingly.

As a pendant to the foregoing vistas of the industrial preparation and purification of mercury in the middle ages,[a] we may quote the words of one of the alchemical works of the Thang. In *TT*878 we read that according to the *Hu Kang Tzu*[1] book:[b]

> People who make mercury by roasting (and distilling) eat much pork and drink much wine. If they did not eat this the *chhi* of the mercury would enter their stomachs and their five viscera would become stopped up. They would become unable to take food and drink, and after a long period they would suffer serious injury. Great care should be taken in these matters.

It is interesting to read this ancient warning of an industrial hazard, an occupational disease dangerous for artisans and alchemists alike.[c] The pork was doubtless prescribed on account of the fat, for mercury tends to form compounds with fatty acids, and this is the probable method of its normal absorption.[d]

(v) *The evolution of the still*

How do all these facts fit in with what is known about the general history of distillation apparatus? It is curious that the two East Asian types have never been taken into consideration in the classical theories of the evolution of the still, such as those of Berthelot[e] and Sherwood Taylor.[f] As will be remembered, they took as their starting-point the process of sublimation of mercury described by Dioscorides, where a flask-shaped vessel, the *ambix* (ἄμβιξ), was inverted over an iron saucer of cinnabar resting inside an earthenware pot, the *lopas* (λοπάς); cf. Fig. 1454(*b*). This stage itself would have derived from the simplest possible combination of heated pot and lid; cf. Fig. 1454(*a*). The next development was the better fitting together of the mouths of the two vessels, and the turning-in of the rim of the upper one so as to form an annular channel for the reception of the condensate; this might be considered the

[a] On the traditional technology cf. Geerts (5).

[b] *TT*878, ch. 11, p. 4*a*, tr. auct. We have already met with the obscure personality of Hu Kang Tzu, whoever he was; cf. pp. 188, 302 and also Vol. 4, pt. 1, p. 308. The oldest work bearing his name is in the Sui bibliography, but none of them have survived.

[c] We shall have more to say of industrial diseases and their recognition in medieval China in Sect. 45 in Vol. 6.

[d] Cf. Clark (1), p. 611. Milk has always been the classical antidote for oral poisoning by mercury, which causes, too, fatty degeneration in many viscera; cf. Sollmann (1), 1st ed., p. 634.

[e] (2), p. 165. See also Berthelot (10); Berthelot & Houdas (1), *passim*.

[f] (5). It is indeed the case, broadly speaking, that nothing resembling either of the East Asian stills has made its appearance so far in Greek, Syriac or Latin alchemical or proto-chemical texts and diagrams, nor (so far as we can see) in Arabic sources either.

[1] 狐剛子

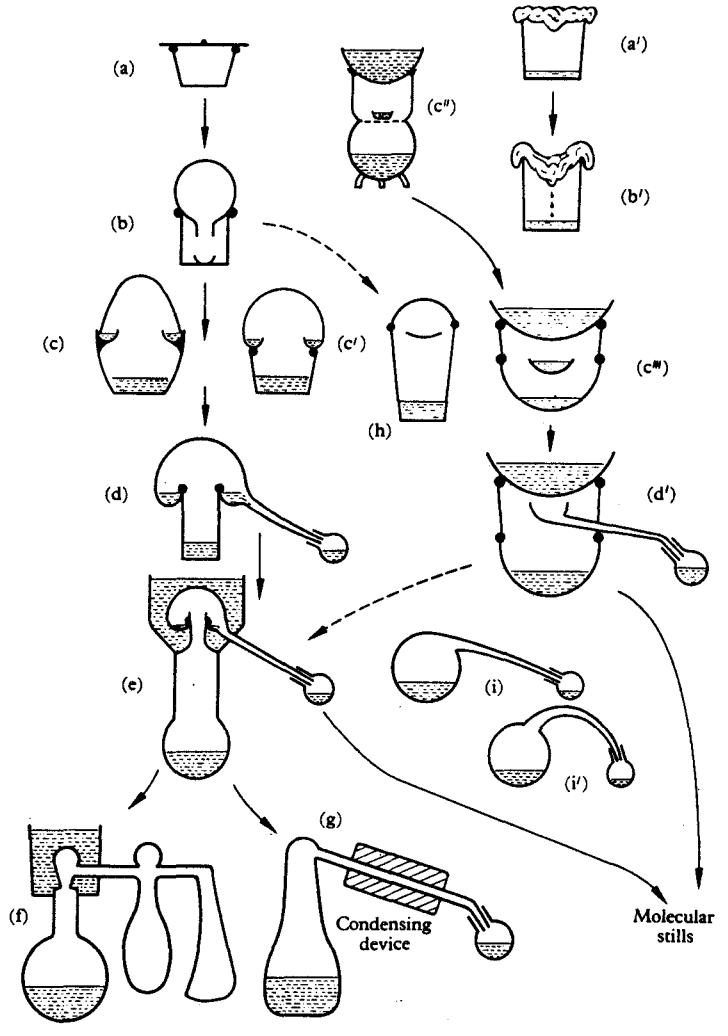


Fig. 1454. Chart to illustrate the evolution of the still (see text).

(*a*) Simplest combination of heated pot and lid, for sublimation.

(*b*) Flask-shaped vessel (*ambix*) inverted over an earthenware pot (*lopas*) containing a saucer with the substance to be heated for sublimation.

(*c*) Ancient Mesopotamian pot with annular rim surmounted by an inverted pot. The distillate running down is collected in the channel.

(*c′*) A more developed form in which the edges of the still-head are turned inward to form an annular gutter.

(*d*) Typical Hellenistic still in which the gutter is provided at one point with a side-tube leading off to a receiver.

(*a′*) Collection of distillate in a fleece or ball of floss above the liquid to be distilled.

(*b′*) Conjectural central drip of distillate from such a fleece.

(*c″*) Reconstruction of the most ancient Chinese (Mongolian) still-type; a small bowl placed on the grating of a *tsêng* or *hsien* (cf. pp. 27, 97) receives the distillate condensed on the convex bottom of a basin of cooling water placed over the mouth.

(*c‴*) The Mongol still, with the catch-bowl held centrally within the still body in a variety of ways.

(*d′*) The Chinese still, with catch-bowl, side-tube and receiver.

(*e*) The 'Moor's Head' helm or still-top, in which cooling water surrounds the Hellenistic annular rim and side-tube.

(*f*) Dephlegmator of medieval Europe; a second vessel intervenes between the cooled still-head and the receiver so as to condense the less volatile fractions and separate components of the distillate.

(*g*) Cooling condenser applied to the side-tube of the still, with no cooling at the head.

(*h*) The Hellenistic *kērotakis*, a reflux distillation apparatus with concave head and no cooling.

(*i*) Retort with cooled receiver deriving from the Gandhāran tradition.

(*i′*) Retort with cooled receiver used in China in the Ming period.

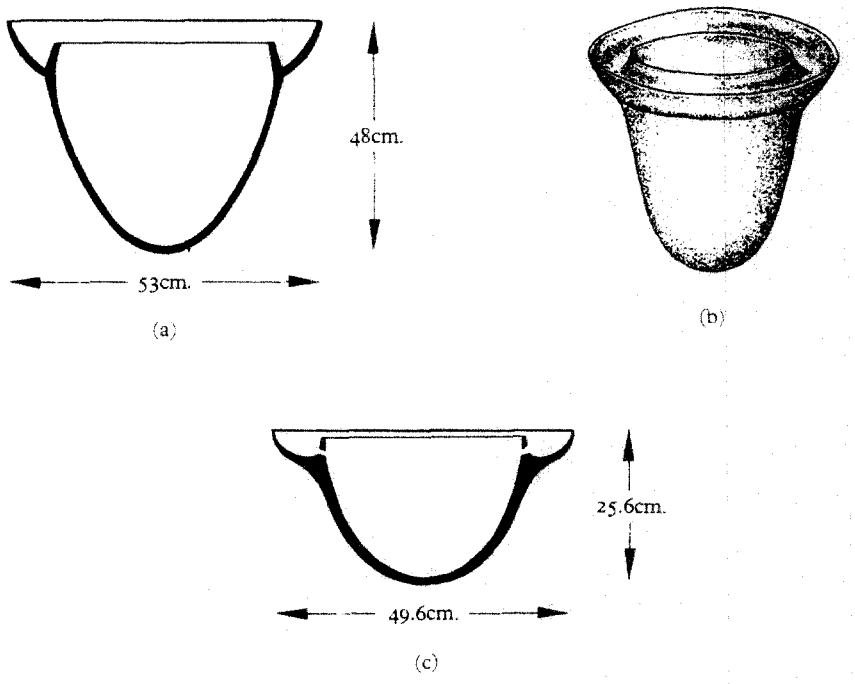


Fig. 1455. Distillation and extraction apparatus from pre-Akkadian times in Northern Mesopotamia, *c.* −4th and −3rd millennia (Levey).

(*a*) Still body of brown earthenware with annular rim for the collection of the distillate from the inside surface of another pot inverted above it. The gutter shown in the cross-section contains about 2 litres in comparison with the body capacity of 37 litres.

(*b*) Drawing of such a still body and its rim.

(*c*) Cross-section of a similar pot having holes which connect the rim with the still body. This would have been used as a continuous extractor, vegetable or animal substances being placed in the rim, and the solvent returning to the pot for re-circulation until the extraction was completed.

ancestor of Western still-heads; Fig. 1454(*c'*). Although we have shown it thus arranged, the same objective was in fact probably first achieved by giving the lower vessel an annular rim into which a domical cover would direct the condensate on all sides (*c*). Mesopotamian 'stills' of this type (Fig. 1455*a*, *b*), dating as far back as −3500, have indeed been recovered by Speiser (1) and Tobler (1) from Tepe Gawra,[a] and studied by Levey (1–4). It may possibly be that the Chou bronze tripod container with an annular rim (from about −500) already mentioned[b] was an apparatus of this kind, though, like the Tepe Gawra pots, it has lost its original cover. These Assyriologists also describe companion pieces having holes connecting the annular gutter with the body of the pot (Fig. 1455*c*); such vessels were doubtless used as extractors, the plant material to be extracted being placed in the rim.

Levey has discussed[c] the interpretation of Ebeling's translation of a group of Akkadian cuneiform tablets dating from the later half of the −13th century and around −1100, and dealing with the preparation of perfumes. It seems that myrrh,

[a] A mound site, some 15 miles NE of Mosul in Iraq.

[b] P. 30 above.

[c] (2), pp. 36 ff., 132 ff. (4).

sweet grasses, incense gums and balsams were among the materials treated with steam and hot oils. Emphasis is laid on the repeated wiping out of the inside of the pot with a handcloth and the replacement of the cover. It is suggested that this refers not to the main walls of the pot but to the upper built-in annular receiving channel.[a] If the channel had holes, soluble constituents would of course gradually accumulate in the solvent. Doubtless the type of vessel without holes was the ancestor of all those aludels with 'shelves (*itrīz*)', used as sublimatories or 'stills' by the Arabic alchemists.

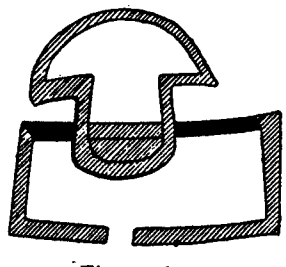
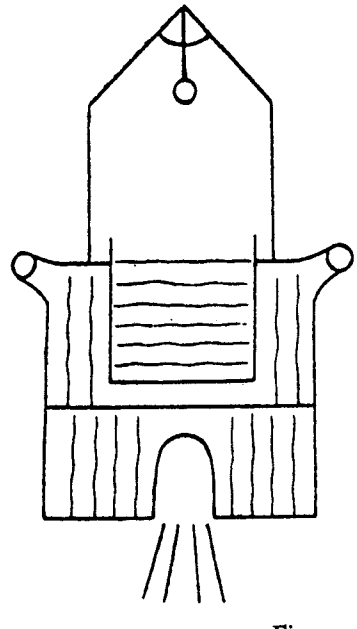


Fig. 1456



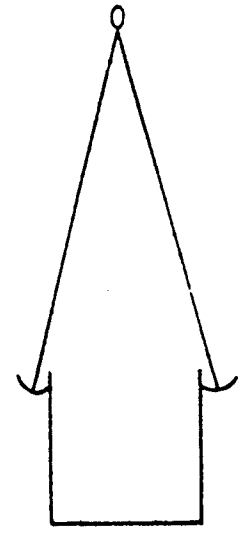


Fig. 1457

Fig. 1456. Aludel with annular shelf used by the Arabic alchemists as a sublimatory or 'still', from a text of al-Kāṭī (+ 1034) reproduced by Stapleton & Azo (1).

Fig. 1457. Aludels with annular shelves or gutters, from a late + 13th-century MS. of Geber, *Summa Perfectionis Magisterii* (Bib. Nat. Paris, Cod. Lat. 6514; reproduced by Stapleton & Azo).

There is a drawing of one of these in the treatise of Ibn 'Abd al-Malik al-Kāṭī, written in + 1034. Fig. 1456 is taken from this work.[b] Much is made of the good fit of the cover achieved by careful polishing as well as by luting the edges with clay.[c] The 'shelf' is mentioned also about + 900 by al-Rāzī,[d] and diagrams of aludels with a similar gutter occur in late + 13th-century MSS of Geber (Fig. 1457).[e]

[a] In view of the prominence of women in Hellenistic proto-chemistry (Mary the Jewess, Cleopatra, Paphnutia, Theosebeia), and in Chinese alchemy (cf. pt. 3, pp. 38, 42, 169, 191), it is interesting that these texts sometimes give women perfume-craft mistresses as their authorities; for example Tapputi-Bēlatekallim of the − 13th century.

[b] A translation of the accompanying text is given by Stapleton & Azo (1).

[c] Cf. p. 23.

[d] Stapleton, Azo & Husain (1), p. 386.

[e] Stapleton & Azo (1), p. 49; Berthelot (10), pp. 149, 150. Cf. Ahmad & Datta (1). Another is depicted in the late Armenian MSS discussed by Kazanchian (1).

Next came the addition of one or more side-tubes to convey away the distillate from the annular channel into cooler surroundings (Fig. 1454*d*); or from a cup in which it was caught (Fig. 1454*d'*). Perhaps the art of distillation may be said to have really begun at this point, when it was realised that by withdrawing the condensate as quickly as possible from the heated vapour the process could be made to run con-

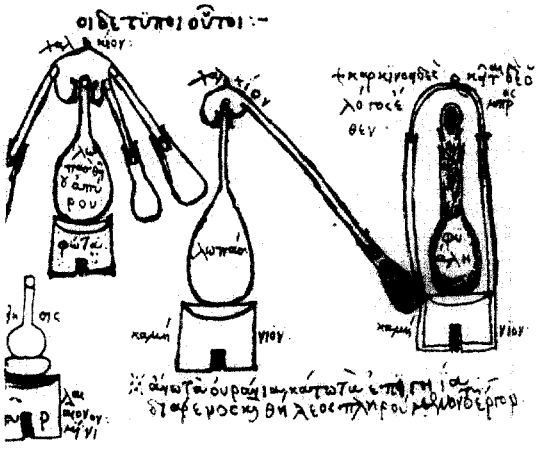


Fig. 1458. Illustration of Hellenistic apparatus from MS. Paris 2327, a copy made in + 1478 of the proto-chemical Corpus in Greek compiled by Michael Psellus in the + 11th century, and containing material from the ± 1st century onwards (cf. Vol. 5, pt. 2, pp. 16–17 and pp. 324 ff., 501 below). In the centre, a characteristic still, with its flask or still-body (*lopas*) and still-head (*chalkion*), heated on a stove (*kamēnion*). On the left, a similar still, but provided with three side-tubes leading off from the annular gutter, hence called a *tribikos*. Under this alembic, fire (*phōta*) is marked. On the right a flask (*phialē*) for digestion or reflux distillation, derivative from the *kērotakis*. For further explanation of the inscriptions see Berthelot (2), pp. 160 ff. Fol. 81 v.

tinuously until completion. By the time of the first group of Hellenistic proto-chemists such as Mary the Jewess, Cleopatra, Pammenes and pseudo-Democritus (+ 1st century), the technique had already developed as far as this (Fig. 1458).[a] Similar designs continued in use essentially unchanged until the + 18th century,[b]

[a] See Sherwood Taylor (2, 5); Berthelot (2), pp. 127 ff., esp. pp. 132, 136, 161, 163.

[b] This is well seen in a page from a + 14th-century MS. in the Library of Caius College, Cambridge (181/214), p. 441, where the drawings of still-heads with annular gutters are strongly reminiscent of the Greek proto-chemical tradition (Fig. 1459). It may be desirable to recall here that we have no illustrations of these pieces of apparatus earlier than the + 11th century, the date of the most important Greek proto-chemical MS. (Marc. 299). Next in importance are the two Paris MSS (2325 and 2327) of the + 13th and + 15th centuries respectively. It is of course recognised that the apparatus they depict corresponds well with the texts of the Hellenistic proto-chemists themselves. By contrast in China we have printed illustrations going back to a *printed text* of the early + 12th century, though none of the early editions has survived. These too correspond well with texts which derive in some cases from as far back as the Later Han (+ 2nd century). Of chemists contemporary with Mary and pseudo-Democritus, and even rather earlier, we have no lack in China, as we point out in more detail elsewhere (p. 330), e.g. Li Shao-Chün, Liu An, Liu Hsiang, Mao Ying, etc., but before Wei Po-Yang in the + 2nd century and Ko Hung in the + 4th, they did not leave proto-chemical or alchemical writings which have come down to us. There is however a certain parallelism between the metallurgical material in the *Khao Kung Chi* (Artificers' Record), originally of the − 4th century, though based on traditions of much earlier times, and incorporated into the *Chou Li* in the − 2nd or − 1st; and the material on alloys in the + 3rd-century Leiden and Stockholm papyri (cf. pt. 2, pp. 15 ff.).

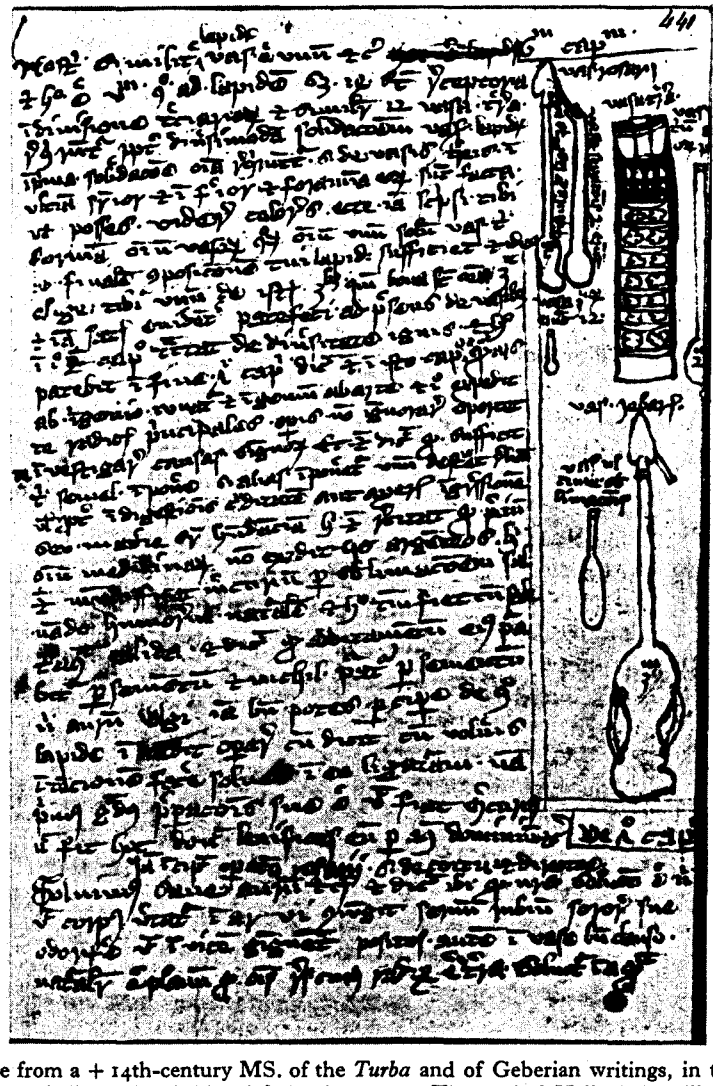


Fig. 1459. Page from a + 14th-century MS. of the *Turba* and of Geberian writings, in the library of Gonville & Caius College, Cambridge (181/214), p. 441. The typical Hellenistic still-head with its annular gutter and side-tube surmounting the long-necked flask and receiver can be seen in the side-drawings. The lower flask has re-entrant tubes which were probably intended to have a dephlegmator effect, returning heavier fractions to the liquid being distilled.

and the basic pattern, with a thousand modifications, permeates all chemistry and chemical industry at the present day.[a]

The only developed form of still (i.e. with a side-tube) which has come down to us as an object anything like contemporary with the Hellenistic proto-chemists is that deduced from the pottery pieces found in the excavations at Taxila in Northern India, about 1930, and described by Marshall as a 'water-condenser'.[b] The constituent

[a] Actual fragments of alembics or still-heads in glass and pottery from a number of sites in England and datable in the +15th century have been described by Moorhouse, Greenaway *et al.* (1).

[b] (1), vol. 1, pp. 149, 180, 193, 402–1 and pl. 125, nos. 127, 128, 129 and 129*a*. We are indebted to Mr John Dearlove for our first knowledge of this still, and to Dr M. Sharif, Custodian of the Taxila Museum (Pakistan Government Department of Archaeology) for correspondence on the subject.

still-heads and receivers, made of baked clay, were unearthed at Sirkap, the site on the north-west frontier of the Punjab to which the city of Taxila was transferred in the −2nd century, and which remained in occupation for three hundred years. The still belongs to levels of Śaka times, *c.* −90 to +25. Fig. 1460 shows the characteristic receiver-bottle and the helm or alembic, intended for fitting over the mouth of a *haṇḍī* pot, with the suggested assembly.[a] If Marshall is right and water-cooling of the receiver was actually practised, this was a set-up much in advance of its time, as will emerge shortly. The tapered character of the side-tube has also a strangely modern air.

Some twenty years later Ghosh reported a further example from Taxila,[b] and since that time several others have come to light. Then, in his recent excavations at Shaikhān Dherī, Allchin (1) has found one more, together with no less than 130 receiver-bottles, and many pots with soot on them which could have served as still-bodies. The receivers are quite capacious, holding just under 8 litres each. There were also many basins of a size which would have been suitable for cooling the receiver-bottles, and one pottery tube, ribbed as if to imitate bamboo, which would have connected a receiver with an alembic.[c] This site is at Charsada in the vale of Peshawar, and corresponds with the ancient city of Pushkalāvatī, one of the two capitals of Gandhāra, Taxila being the other. Stratigraphic and other evidence points to a date between −150 and +350. It can be seen at a glance that these stills, which may be called Gandhāran, are closely related to the Western or Hellenistic stills in that they have a concave roof at the still-head, but they lack the built-in annular peripheral rim or gutter. True, the alembic has a lower bevelled edge, and some distillate might collect between that and the mouth of the pot, but the position of the side-tube shows that there was no intention of drawing it off. The space thus served the purpose of a dephlegmator (cf. pp. 81, 93), conserving the heavier fractions. Condensation in the still-head itself was not envisaged in this design; only the vapour passed through the side-tube to condense in the receiver. The Gandhāran stills were thus essentially 'retorts', and they may well be the origin of all such forms of still.[d]

Greater cooling and the collection of more distillate would come about of itself if the side-tube were made sufficiently long. Thus we find that the still-head was dropped as a separate entity in certain cases very early among the Greek proto-chemists, for an apparatus appears in which the neck of the still is greatly elongated, and turning at a

[a] The still-head component looks remarkably like an inverted bed-pan, a fact which might invite the curious to embark upon a comparative history of bed-pans, were it not for their radical incompatibility with all Indian ideas of hygiene and nursing. Another possibility is that what we take to be a side-tube could have been intended for the wedging-in of a wooden handle. But the 'alembic' cannot be considered in isolation from the receiver-bottles, which would be incomprehensible if not still-parts.

[b] (1), p. 63.

[c] Occasionally the side-tubes of the alembics are fitted with studs, which would have been convenient for binding on the longer tube and the receiver-bottle; Dani (1), fig. 34.3.

[d] Wheeler (8) has described (pp. 224, 226, 228–9) similar pottery still-heads from a Mysore culture; the Brahmagiri neolithic. This means a date in the −2nd millennium, though coming down to as late as the −2nd century. At first sight it would violate one's sense of historical perspective to imagine distillation in India as far back as that, yet we must remember the Babylonian pots with annular rims (p. 82), ancestors of the Hellenistic still, as also the grated steamers of the Chinese neolithic (p. 27), in which we descry the origins of the Mongol and Chinese stills.

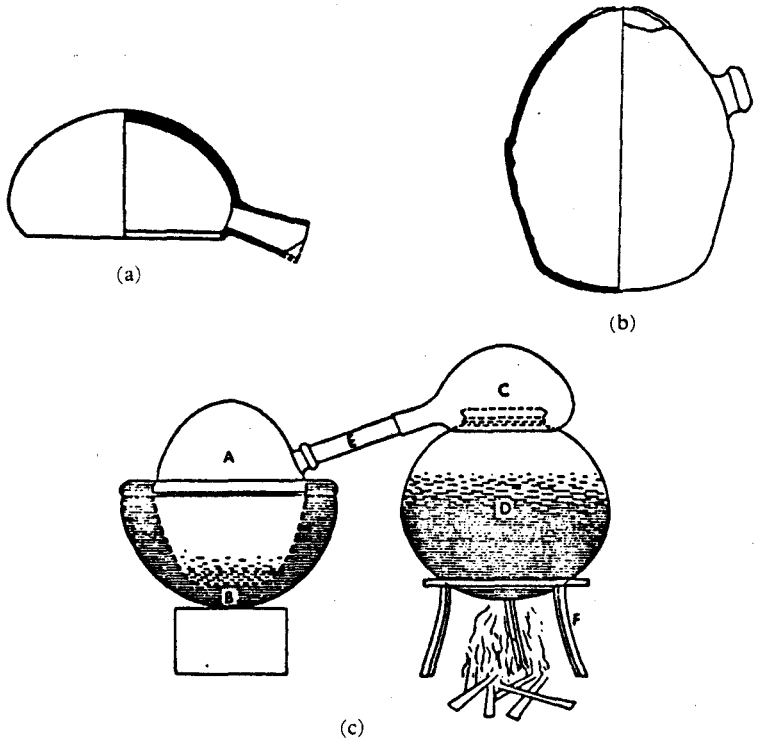


Fig. 1460. Distillation equipment found at Taxila in the Punjab, India, and dating from the ± 1st century (Marshall (1), vol. 1, pl. 125). All in pottery, the pieces consist of a helm or alembic (*a*, C) fitting over the mouth of a *haṇḍī* pot (D), and delivering into a receiver-bottle with only one opening (*b*, A). The connecting tube may well have been of bamboo. The water-bath cooling (B) of the receiver was a conjectural addition of Marshall's, but stills of the same type used traditionally in India today have it.

right angle is prolonged into a tube at the end of which is a receiver (Fig. 1461).[a] Such an arrangement, however, would have favoured the deposition of distillation-products in the side-tube, whence it would be difficult to remove them. Nevertheless it must have aided the development of the type of distillation apparatus classically known in chemistry as the retort, also called 'pelican' or 'cucurbit' because of its bird- or gourd-like shape (Fig. 1454 *i*, *i'*). Many figures in the herbal of Lonicerus and the books of Brunschwyk show retorts of this kind.[b] At what date it reached its most typical one-piece form in the West is not clear, but that probably started among the Arabs.[c] There is a good drawing of it in one of the Syriac MSS studied by Berthelot &

[a] See Berthelot (2), pp. 140, 163; Sherwood Taylor (5), p. 192.

[b] Cf. Forbes (9), figs. 31, 67.

[c] Cf. Schelenz (2), figs. 14, 15; Forbes (9), figs. 13, 16, 17, 18. But some of these were certainly in two parts (like Indian, Gandhāran, stills), the body (*qar'a*) and the helm (*anbīq*), as well as the receiver (*qawābil*). Retorts occur among the very Moorish illustrations in the late + 15th-century MS. *Liber Florum Geberti* studied by Ganzenmüller (1), figs. 21, 24, nos. 29, 60. This text itself seems to be Byzantine in origin with much Arabic influence, and internal evidence suggests that it dates from some time before the + 14th century (+ 1000 to + 1300). There is much on retorts also in the *Kitāb Nukhbat al-Dahr* of al-Dimashqī, written about + 1320 (cf. the translation of Mehren). Drawings of them occur, too, in late Armenian MSS (Kazanchian, 1).

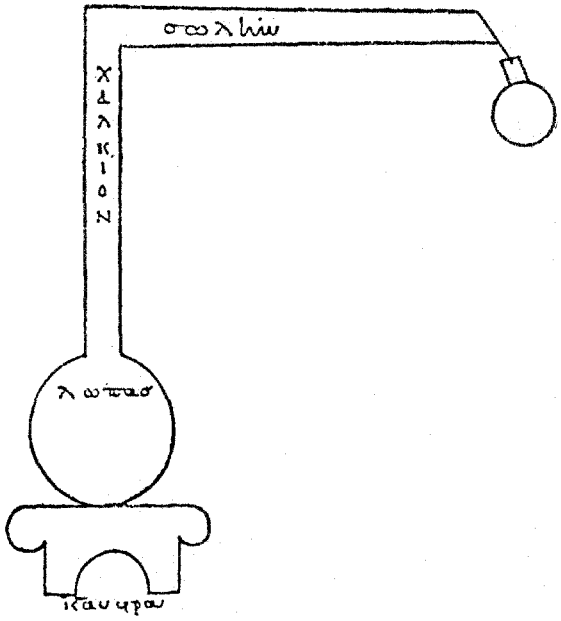


Fig. 1461. Hellenistic still with no guttered still-head but a single side-tube of large diameter leading to a receiver—the first of all Western 'retorts'. The ascending neck is still called *chalkion*, however, and the side-tube *solēn* as usual. From a description by Mary the Jewess, in Cod. Marcianus 299, fol. 194v; cf. Berthelot (2), p. 140; Sherwood Taylor (5), p. 192.

Fig. 1462. Drawing of a retort in a Syriac MS. copied in the + 16th century but containing material going back to the + 1st century, and much from the + 2nd to the + 6th (BM Egerton 709; from Berthelot & Duval (1), p. 120). The inscription says 'curved like a bow', and on the receiver (not shown here) is written 'place where it stops'.

Duval.[a] Unfortunately, although these codices date from about the + 10th century and contain some old Hellenistic material, the MS. concerned is not older than the + 16th, so that the picture in question (Fig. 1462) may be as late as that time, and indeed seems to be drawn in a rather different style from the majority of the illustrations. We know of no Chinese drawing of the retort in its typical Western shape, but the mercury still of Fig. 1453 is essentially the same thing.[b]

[a] (1), p. 120. By some remarkable inadvertence this was illustrated as Chinese by Huard & Huang Kuang-Ming (2), pl. opp. p. 24, but of course the slip was evident. It may be of interest to record that retorts of the classical form were always held among the glassware stores of biochemical and chemical laboratories in my young days, but no-one ever used them.

[b] Further research will be required to determine whether the retort in China (Fig. 1454 *i'*) was an introduction from the Hellenistic, the Arabic, or the Indian chemical traditions, or whether it arose independently from the East Asian still type as an abandonment of water-cooling for specific purposes.

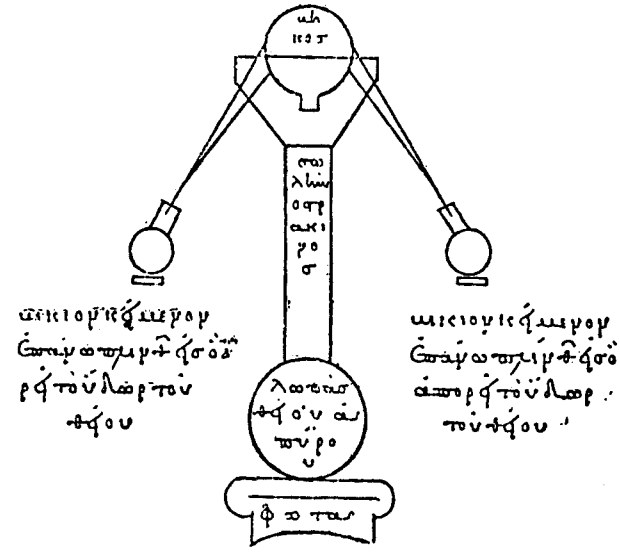


Fig. 1463. A *dibikos* or Hellenistic still with two side-tubes, from Cod. Marcianus 299, fol. 193v. For the translation of the inscriptions see Berthelot (2), pp. 137, 139.

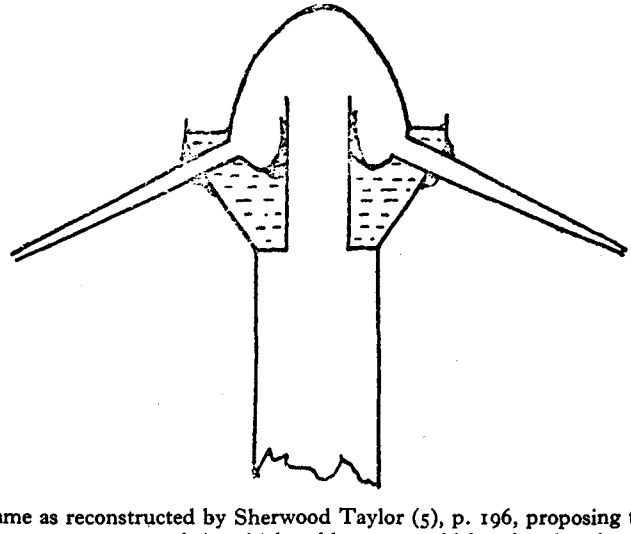


Fig. 1464. The same as reconstructed by Sherwood Taylor (5), p. 196, proposing that the uppermost funnel-shaped structure was a trough in which cold water could be placed and renewed. The Greek text, however, makes no mention of water-cooling at the still-head, and Berthelot did not assume it.

The greatest secret of the art of the still may thus be said to lie in the withdrawal of the cooled distillate as rapidly as possible from the hot vapours in its body. We have seen something of how this was achieved by the Chinese, but for the moment must continue the consideration of the course of development in the West. There are three points at which arrangements for the application of cooling water may be incorporated in the apparatus—the receiver, the side-tube or the still-head itself. The presence of

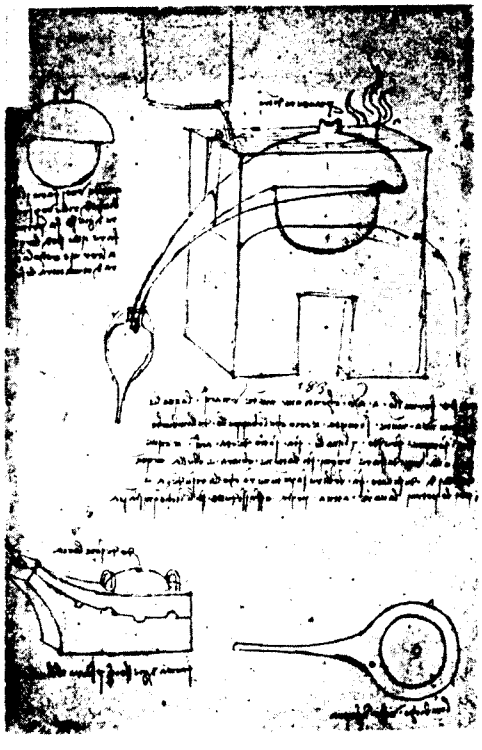
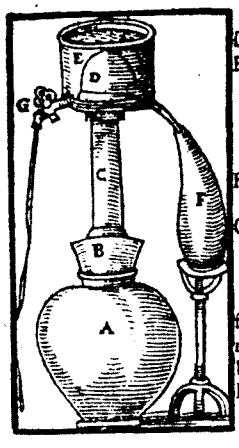


Fig. 1465

EVONYMI



ſcat capitellum
D. Capitellum.
E. Vas circundis capitellum, in quod continuè aqua frigida illabitur.
F. Recipiens oblongum.
G. Epiſtomium, aquam calefactam educens.
Hanc fornacis figuram, accepi nuper à D. Felici Platero Medico Baſilienſi.

DE OLEORVM EXTRACTIO-
ne per deſtillationem aquæ bullientis.

ACcipe ollam ex cupro factam, decem aut quindecim menſuras capientem, eã imple vino aut aqua, aut mixto ex vtroq; vt tertia tantum pars vacua relinquatur. Aquæ impone rem tuam, extrahendis oleis aptam, craſſiuſculè puluerisatam, & ſtet in infuſione horis tribus, quatuor, aut etiam ſex. Deinde ollæ ſuppone alembicum, perlute-
tur

Fig. 1466

Fig. 1465. The earliest representation of a Moor's head cooling bath, a drawing by Leonardo da Vinci, *c.* + 1485 (Codex Atlanticus, fol. 400v).

Fig. 1466. The Moor's head condenser as depicted by Conrad Gesner (*De Remediis Secretis*, + 1569). A tap at the base allows for replenishment with cold water.

a water-cooled receiver in the Taxila still was conjectural.[a] There has also been much uncertainty about the structure of some of the still-heads of the Alexandrian protochemists. Apparatus of the type of the *dibikos* in Fig. 1463[b] was first interpreted by Sherwood Taylor[c] in 1930 as meaning that the globular still-head was luted into a funnel-shaped enlargment of the still flask itself, but fifteen years later he proposed[d] that it might represent a built-in cooling bath at the head of the still (Fig. 1464; cf. Fig. 1454*e*). The only passage in the Corpus which he could adduce to justify this is in one of the Zosimus texts[e] which says that 'one should have a cup full of water at the top (or, in general), and wipe the vessel all round with a sponge'. Obviously this does

[a] But stills of just this type, with the receiver cooled in water, have been common in modern India; Mahdihassan (56), fig. 42. And those in the Tantric alchemical books are the same.

[b] Berthelot (2), p. 138. It is interesting that this feature only appears in one of the two iconographic traditions of the Greek chemical MSS, and that the annular rim only occurs in the other, the still-head in the first being always represented as a simple globe.

[c] (2), p. 137. [d] (5), pp. 195–6.

[e] *Corp. Alchem. Gr.* III, xlvii, 2; tr. Berthelot & Ruelle (1), vol. 3, pp. 216–17

not imply a proper water-cooled jacket, but there may possibly have been some enclosure there to prevent the sponge water from running down the hot still into the furnace.

It is not until we come to the time of Geber that effective devices for cooling the parts of stills were definitively introduced in Latin Europe. In the + 14th and + 15th centuries two methods of cooling were used; first to condense the whole of the distillate, and secondly to divide it into fractions of higher and lower boiling-point. The

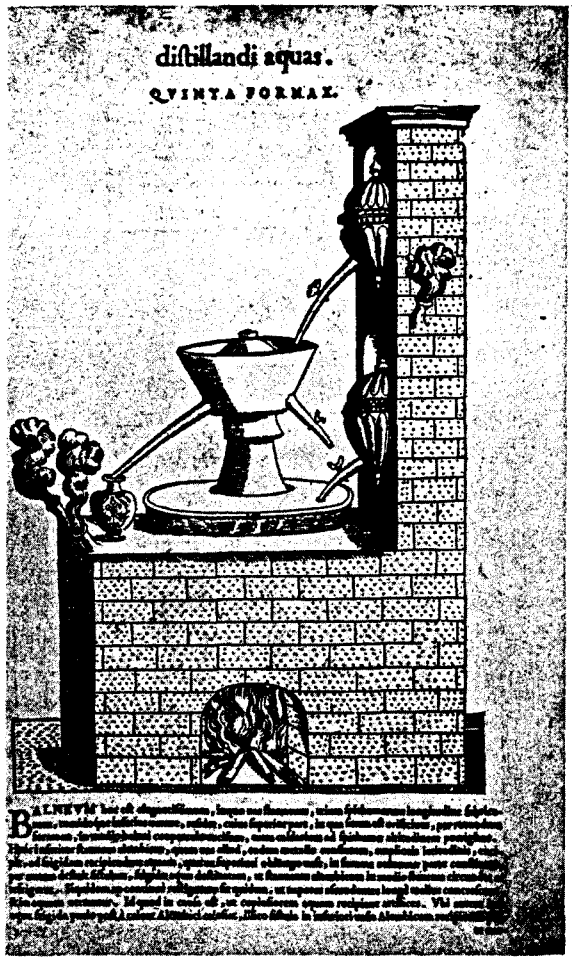
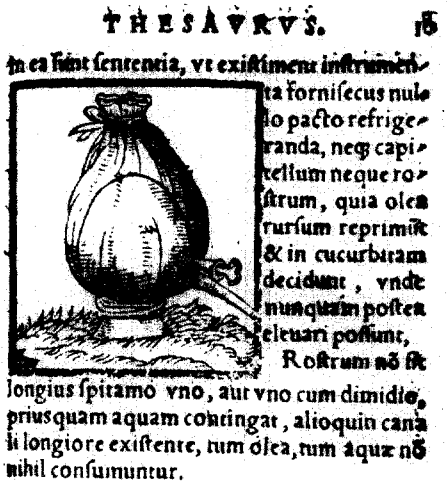


Fig. 1467. The elegant picture of the Moor's head in Mattioli's *De Ratione Distillandi*, + 1570.

so-called 'Moor's head' was a cooling-bath so fashioned as to embrace the whole of the upper part of the still, allowing all fractions to run into the internal annular channel on condensation, and thence out into a receiver (Fig. 1454 *e*). The 'dephlegmator' was a variable arrangement in which the distilled vapours were carried through air- or water-cooled tubes or vessels which detained the heavier fractions or returned them to the still, only the lighter ones passing on into the receiver (Fig. 1454 *f*). The earliest


THESAVRVS. 15

in ea ſint ſententia, vt exiſtimem inſtrumenti-
ta forniſecus nullo pacto refrige-
randa, neq; capi-
tellum neque ro-
ſtrum, quia olea
rurſum reprimit
& in cucurbitam
decidunt, vnde
nunquam poſtea
eleuari poſſunt,
Roſtrum nõ ſit
longius ſpitamõ vno, aut vno cum dimidio,
priusquam aquam contingat, alioquin cana
li longiore exiſtente, tum olea, tum aquæ nõ
nihil conſumuntur.

Fig. 1468. Bladder still-head cooler, from Gesner's *De Remediis Secretis*, + 1569.

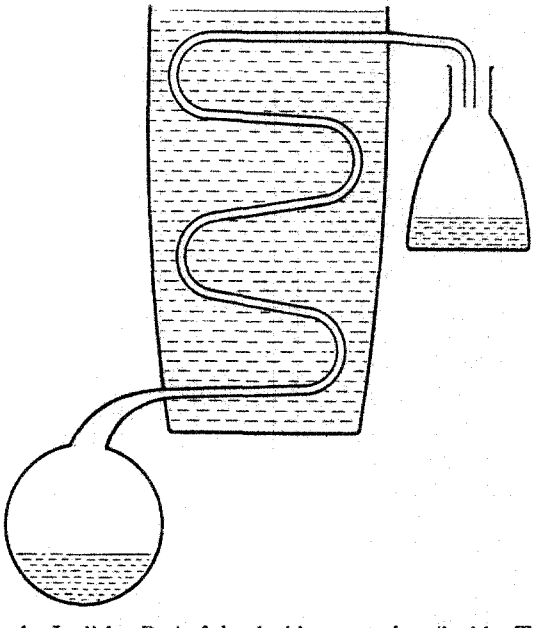


Fig. 1469. Reconstruction by Ladislao Reti of the dephlegmator described by Taddeo Alderotti in his *Consilia Medicinalia* (late + 13th century). It is simply a rising water-cooled serpentine coil connecting the still-body with the receiver.

extant representation of the Moor's head can be seen in Leonardo da Vinci's drawing, *c.* + 1485 (Fig. 1465);[a] and from the + 16th century come those of Gesner (Fig. 1466), Mattioli (Fig. 1467) and others.[b] Intermediate between Zosimus' sponge and the

[a] *Codex Atlanticus*, 400 v, *c.* See Reti (7), figs. 4, 5, 6, (10), fig. 5.

[b] Forbes (9), figs. 52, 60; Geisler (1), fig. 2. For later examples see Ferchl & Süssenguth (1), figs. 86*a*, *b*, 96, 140 (57), 143, 145.

Moor's head comes the wrapping of linen sheets periodically moistened with cold water round the top of the still, as described by Michele Savonarola, *c.* +1440.[a] Theoretically intermediate too in its simplicity (though not exactly so in time) was the system of surrounding the still-head with a large tightly-fitting bladder in which cold water was renewed as distillation proceeded. This was mentioned by Lonicerus in +1555 and illustrated by Gesner in +1583 (Fig. 1468).[b]

The earliest account of a dephlegmator (without any drawing) appears to be that of Taddeo Alderotti[c] in the late +13th century.[d] The description in his *Consilia Medicinalia* is interpreted by Reti as shown in Fig. 1469, a water-cooled serpentine side-tube rising above the still, so that all the heavy fractions would be returned into the still body.[e] A dephlegmator of this kind[f] must not be confused with the simple cooling of a descending side-tube, where all fractions will pass into the collecting vessel (Fig. 1454 *g*). The earliest extant European illustration of such a side-tube cooled by a water-jacket seems to be that of Johannes Wenod de Veteri Castro in a MS. of +1420, showing the distillation of alcohol from beer (Fig. 1470).[g] The arrangement of Brunschwyk (soon after +1500, Fig. 1471),[h] however, has the same effect as that of Alderotti; the water-cooling is applied at the upper part of the still in Moor's head style, but since there is no annular channel, the heavy fractions fall back, only the lighter going on.

The dephlegmation method was soon applied to fractionation. An early drawing of a set-up with an intermediate vessel for this purpose occurs in a Bavarian MS. of +1519 in the Jagellonian Library at Cracow, recently studied by Ameisenova.[i] As

[a] MS. entitled *Ad Divum Leonellum Marchionem Estensem Libellus de Aqua Ardenti*, not printed till +1484.

[b] *Ander Theil des Schatzes Euonymi*, pp. 14–15. The turban-like shape of this bladder and the hat-like forms of the Moor's heads suggested to the late Dr Reti an origin for the latter expression—'oriental headgear'. But to admit an 'oriental' influence is to open the door to the possibility of a deeper form of it (cf. p. 120). His impression is that the term arose later in Europe than the invention, as it seems not to occur in Gesner, della Porta, Besson, Mattioli or Lonicerus. On the other hand it may have been considered 'lab. slang' and so excluded from books.

[c] +1223 to +1303, one of the Papal physicians.

[d] Text in von Lippmann & Sudhoff (1); partial translation in von Lippmann (13), p. 1359. Cf. Mieli (3), p. 132.

[e] Personal communication in correspondence. Dr Ladislao Reti told us that he could obtain experimentally 90% alcohol in a single run with an apparatus of this kind. Yet Alderotti, as we shall see (p. 123), redistilled, taking off $\frac{5}{7}$ at each rectification. Cf. Reti (8); Forbes (9), pp. 60–1. It is puzzling to speculate on what inspired Alderotti to use a rising serpentine. He may have observed, as Dr Reti wrote to us, the partial reflux of the condensed vapours in a glass still, and felt that a longer path would offer opportunity to the 'lighter spirits' to escape from the slow and heavy 'phlegm'. But we suggest elsewhere (p. 44) influences of a more concrete kind as well.

[f] Subsequent use of rising serpentine coils is seen in the Oldanis MS. (+15th century but probably recording practices of the +14th) described by Carbonelli (1), p. 136; in Ulstadt (+1526) and the later editions of Brunschwyk (Forbes (9), fig. 56), an apparatus often misunderstood but correctly interpreted by Sudhoff (3) and Egloff & Lowry (1). Cf. also Lonicerus' set-up (+1578) in Forbes (9), fig. 67), and the account in Biringuccio (Smith & Gnudi tr., p. 348, fig. 65).

[g] Sudhoff (3), often afterwards reproduced, as in Ferchl & Süssenguth (1), fig. 30; Forbes (9), fig. 31.

[h] Ferchl & Süssenguth (1), fig. 32; Forbes (9), fig. 30; Underwood (1), fig. 13; Schelenz (2), fig. 27. But Fester (1), p. 101, and Reti (8) have alone correctly explained its purpose.

[i] Personal communication from the late Dr Zofia Ameisenova, recorded with gratitude here. The MS. (35/64) is a universal encyclopaedia, something like the *Liber Floridus*, containing coloured illustrations of many scientific and technical subjects (our picture is on fol. 52v). Fol. 82v has a remarkable mining painting with diagrammatic plans of underground workings and of a geodetic compass used

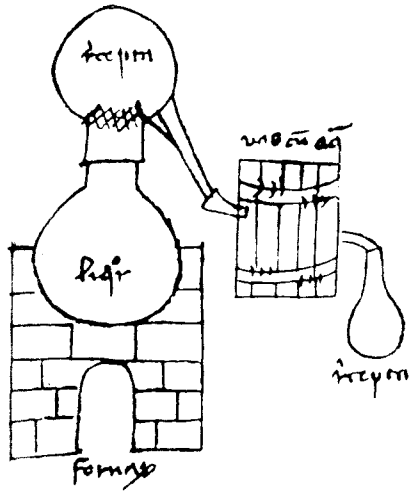


Fig. 1470

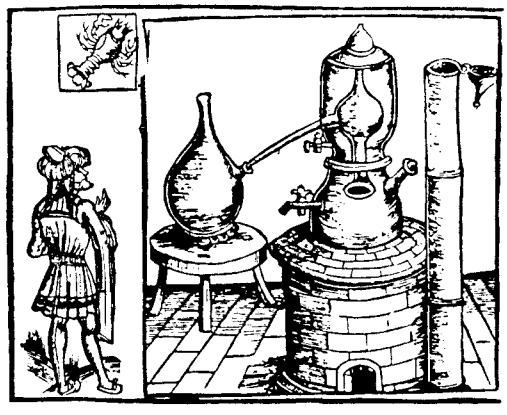


Fig. 1471

Fig. 1470. The oldest representation of a water-cooling condenser surrounding the side-tube between the still and the receiver, in a MS. of + 1420 by Johannes Wenod de Veteri Castro.

Fig. 1471. A form of Moor's head described by Hieronymus Brunschwyk soon after + 1500 in *Liber de Arte Distillandi de Compositis* (1st ed., + 1512). Here the water-cooling is applied at the still-head rather than the side-tube, but as there is no peripheral channel, the heavy fractions fall back and only the more volatile ones go on. Note the cylindrical automatic stoker on the right ('Slow Harry').

will be seen from Fig. 1472, it incorporated a rimless Moor's head cooler, which presumably restored the heaviest fractions to the still, allowing intermediate ones to be caught in the intermediate vessel. Perhaps the earliest attempt was the set of flasks along an extended side-tube drawn in a + 14th-century MS. on potable gold attributable to the court physician Albini di Moncalieri.[a] Later examples are those described by Gesner in the middle of the century (+ 1552, Fig. 1473 *a*),[b] by Lonicerus in + 1578 (Fig. 1473 *b*),[c] and by della Porta (+ 1609).[d] Vessels which might perhaps be intermediate dephlegmators of this kind occur also in the rather enigmatic *Liber Florum Geberti*, apparently an Arab–Byzantine work of the + 13th century, the time of Alderotti himself.[e]

Most of this sequence of developmental stages (quite acceptable as far as it goes), which we have diagrammatically depicted in Fig. 1454, presupposes that the cover which gave rise to the still-head was originally concave to the distillation space. The condensing distillate would then necessarily run down in all directions to the periphery, stimulating the invention of the annular gutter—something very ancient indeed, if we are to judge from the Babylonian rim-pots (p. 82). But if the original cover had been convex to the distillation space the condensing distillate would have

in them. The publication of this MS. in facsimile was planned by the late Dr Ameisenova, and will still be eagerly awaited.

[a] Sudhoff (4). [b] Cf. Forbes (9), fig. 54. [c] Cf. Forbes (9), fig. 68; Schelenz (2), fig. 51.
[d] Cf. Forbes (9), fig. 41, and from Libavius, fig. 83. For other and later examples see Ferchl & Süssenguth (1), figs. 55 (8*a*, *b*), 65, 82 (4), 140 (61), as also Geisler (1), fig. 3.
[e] See Ganzenmüller (1), figs. 18, 25, nos. 7, 69.

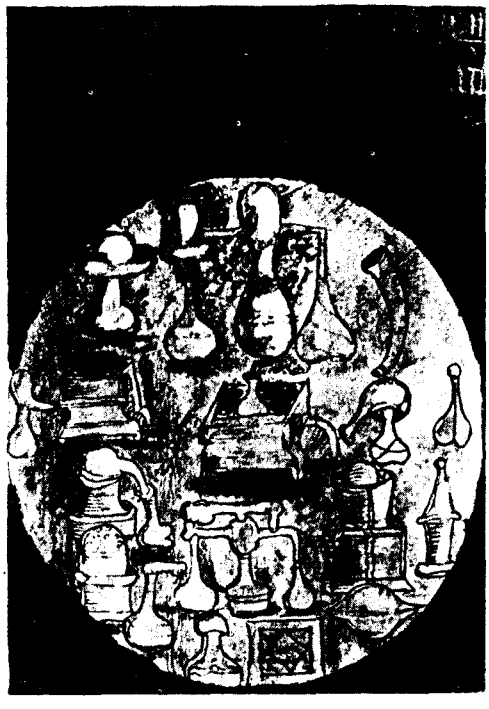


Fig. 1472. An early drawing of a dephlegmator arranged for fractionation, from a MS. (35/64) in the Jagellonian Library at Cracow. Bavarian, dated + 1519, it is a universal encyclopaedia of the sciences. In this picture (fol. 52v) there can be seen at the top a rimless Moor's head cooler, the side-tube from which enters the top of an intermediate vessel before passing on to the receiver (cf. Fig. 1454*f*). In such an apparatus the heaviest fractions would return to the still-body, intermediate ones would condense in the second vessel, and only the lightest would collect in the third. Apart from retorts and aludels, the lower part of the picture shows a curious reticulate arrangement of dephlegmator type but the text has no explanation.

been seen running down to the central and lowest point before dropping back into the still body, so that there would have been a stimulus to provide first a catch-bowl (Fig. 1454 *c'''*), i.e. the Mongol still; and then a catch-bowl with a side-tube (Fig. 1454 *d'*), i.e. the Chinese still. That the convex roof was traditionally a bowl (*kuo*[1]) of cold water we know, but what could have been the origin of such a device?

Perhaps the answer was that already suggested by Sherwood Taylor (5) when he referred to the technique of obtaining *pisselaion* (πισσέλαιον), oil of pitch, mentioned by Dioscorides.[a] This consisted of stretching a clean fleece over the heated pitch and recovering the distilled oil by squeezing (Fig. 1454 *a'*). We have also noted already the collection of the condensate of sea-water in fleeces and sponges mentioned by Pliny and St Basil.[b] Such a method could have been known in ancient times throughout the

[a] *Mat. Med.* I, 95; Gunther tr., p. 51. The same method was used for cedarwood oil, see I, 105; Gunther tr. p. 57. Pliny discusses oil of pitch and its collection by fleeces in *Hist. Nat.* XV, vii, 28, 31; cf. his *picea resina stillaticia* in XVI, xxii, 54. Cf. Schelenz (2), p. 15.

[b] P. 60 and Fig. 1435 above. Alexander of Aphrodisias also mentions this.

[1] 鍋

Fig. 1473*a*. A complex dephlegmator of five vessels depicted by Conrad Gesner in + 1552, from *De Remediis Secretis* (+ 1569). Three of the 'vases of separation' being heated on sand-baths, opportunity is afforded for the heavier fractions to condense in the successive vessels, and only the lightest fractions to accumulate in the receiver, though no still-head cooling is shown at any point. The bulbous objects on the left represent smoke from the stove underneath.

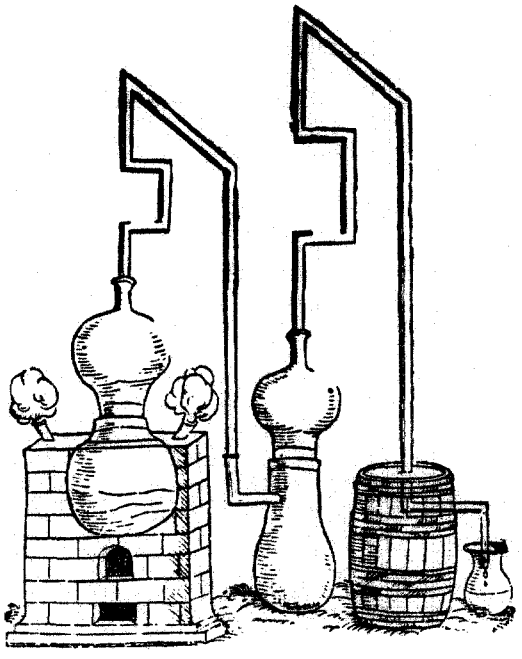


Fig. 1473*b*

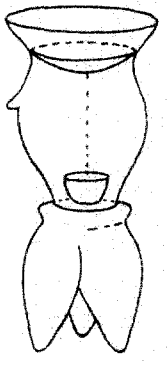


Fig. 1473*c*

Fig. 1473*b*. Dephlegmator from the *Kräuterbuch* of Adam Lonicerus (+ 1578).

Fig. 1473*c*. Conjectural design of the most ancient Mongolian-Chinese still type. A bowl of cooling-water caps the upper vessel (*tsêng*) and a collecting-bowl stands upon its perforated bottom (or of course on the grating of a *hsien* when the two vessels were combined into one); cf. Fig. 1395. The *li* below provides the vapours, and the distillate collects in the bowl, equipped subsequently with a side-tube. An earlier sketch of this by us has been reproduced in Thurm (1), p. 18.

length and breadth of the Old World. An arrangement of this sort could easily have led to the convex surface for which we are looking, and it is not difficult to imagine the observation of the dropping back of the distillate from the central part of such a large plug of fleece, felt or floss silk (Fig. 1454*b'*). From this the characteristic East Asian still forms (Fig. 1454*c'''*, *d'*) could have derived. To support this argument one might adduce a piece of concrete evidence from that culture-area, namely the use of silk floss for plugging bamboo tubes used in solubilisation reactions. This is described in the *San-shih-liu Shui Fa*[1] (Thirty-six Methods for bringing Solids into Aqueous Solution), a text of approximately Liang date (early +6th century) which we shall discuss more fully in the next sub-section (p. 167). Silk floss, therefore, could have been the Chinese equivalent of fleeces and sponges.

But this idea does not throw any light on the nature of the oldest East Asian still bodies (or barrels), and it is not necessary to invoke fleeces or flosses as the ancestors of all Mongol and Chinese still-head condensers, for they could have been basins filled with cold water from the very beginning. At an earlier stage (pp. 26 ff.) we described the 'steamers' (*tsêng*[2] and *hsien*[3]), with their perforated gratings,[a] which were so characteristic of the cuisine of the Shang and Chou periods,[b] and we hinted that they may have had much importance in the beginnings of Chinese chemical technique. Now Mahdihassan (56) drew attention to the colanders (pottery basins with holes pierced in the bottom)[c] which are common in India, and which form the middle vessel of the Mongol still as used by the forest-dwelling tribal people in Bihar. These perforated bowls must be quite ancient, since examples have been found in the excavations at Hastināpura near Meerut.[d] As we knew already in Vol. 1,[e] forms of this kind were at least as ancient in China, going back to Neolithic times and the Shang period (– 2nd millennium).[f] Consequently it becomes evident that if a small catch-bowl was set on the grating of a *tsêng* or *hsien*, and a bowl of cold water then placed over the mouth, the pattern of the Mongol still would immediately appear (Fig. 1454, *c''*). What more natural and convenient support for the catch-bowl could there be than the grating at the waist of the *hsien* or the perforated bottom of the colander half of the *tsêng*? Vapours could rise readily past the receiver. That this must be the origin of the Mongol and Chinese stills becomes almost certain when one remembers[g] that the perennial term for distillation is *chêng liu*,[4] i.e. 'steaming', and nothing more. But at what date this simple and elegant invention was made (cf. Fig. 1473*c*) remains at present beyond conjecture.

The final stage of development of the Moor's head (Fig. 1454 *g*) where the con-

[a] Detachable in the former, built in as part of the body in the latter. See Tzu Chhi (1). For the bone and bronze forms of the characters *hsien* and *li* see K252 and 855.

[b] Cf. Figs. 1398 to 1401 above.

[c] From Fr. *couler*, to flow, and Prov. *couladour*, a vessel for straining.

[d] Lal (1) pp. 58–9. A –6th-century date would be reasonable, according to Bose, Sen & Subbarayappa (1).

[e] Fig. 9, p. 82.

[f] Their antiquity is indicated by the fact that the characters always kept the pottery radical (Rad. no. 98) even when the object was made of bronze or other metal. There are characters with these phonetics and the metal radical (Rad. no. 167), but they were used for quite different words and meanings—the clashing sound of metal, or parts of horse-bits.

[g] Cf. pp. 132 ff. below.

[1] 三十六水法 [2] 甑 [3] 甗 [4] 蒸餾

denser device is applied wholly to the side-tube, would have arisen naturally enough. This is the principle seen in the still of Joh. Wenod (Fig. 1470), and the predecessor of the familiar Liebig condenser. It would not be likely to have sprung from the Chinese still, because there the water-cooling of the head above the catch-bowl or cup was a *sine qua non* from the very beginning. The coiled or serpentine side-tube descending within a barrel of cold water would also seem to have been a development of the +15th century, though not commonly illustrated until the following one, as in the works of Biringuccio (+1540),[a] Gesner (Fig. 1474),[b] Hermann (+1552)[c] and Lonicerus (+1578).[d] The modern counter-current condenser came towards the end of the +18th century,[e] due among others to Poissonnier for shipboard fresh water supplies (+1779)[f] and to C. E. von Weigel for laboratory use (+1773).[g]

Thus it would seem that there were three entirely different lines of development of the still, each starting from a different kind of primitive apparatus (Fig. 1454). One cannot but agree with Hommel's conclusion that the Mongolian and the Chinese types[h] 'are distinctly different from the Mediterranean types and cannot by any stretch of the imagination be explained as related to or derived from them'.[i] He went on to say that the former were an indigenous 'development of inner Asia, and may be closely linked with the discovery of alcohol'. To what extent this could be true will depend on data to be examined in the sequel.

The filiation of modern chemical apparatus with its medieval antecedents back to the equipment of the Alexandrian proto-chemists has been traced by many writers. But it would be quite a misapprehension to think that the East Asian still types play no part in modern chemical technique, and that all stills are descendants of those of the Greeks. An interesting application of the principle of the Mongol still is seen in the method introduced by Jackson & van Bavel (1) for the collection of water from soil and plant materials as a means of survival under semi-desert conditions. The convex cover is here represented (Fig. 1475) by a sheet of plastic and the heat is supplied by the sun-warmed earth. The apparatus devised by Brailsford Robertson & Ray (1) in 1924 for the continuous extraction of solids at the boiling temperature of the solvent (Fig. 1476) was identical with the Mongol still except that the distillate was allowed to drip back into the still body after extracting the solid held centrally in a Buchner funnel.[j] And the same idea has been applied on a minute scale to micro-Soxhlet siphon extractors by Wasitzky (1).[k]

[a] Schelenz (2), fig. 37; Forbes (9), fig. 57. [b] Forbes (9), fig. 49. [c] Forbes (9), fig. 87.

[d] Underwood (1), figs. 24, 25; Forbes (9), figs. 65, 66.

[e] Though Leonardo da Vinci had in his youth proposed something very similar investing both the side-tube and the head of a still (*Cod. Atl.* 400v, *c*; Reti (7), p. 656).

[f] Underwood (1), fig. 50; Forbes (9), fig. 133.

[g] Forbes (9), fig. 134. Was not the beautiful shrub *Weigelia* named after him?

[h] It is interesting that both of their most characteristic forms gave perfect equilibrium vapour-pressure between the two phases, no 'bottle-neck' creating slight pressure in the still-body. But the disadvantage was that with irregular boiling some splashings would come over; this is better avoided in the traditional flask and Liebig condenser of modern times.

[i] (1), pp. 146–7. Dr Ladislao Reti also expressed to us (in private correspondence) his conviction of the originality of the Mongol and Chinese stills.

[j] These workers might have been surprised at the similarity of their device to some of the traditional essential-oil stills of East Asia (cf. pp. 116ff. below). [k] Fig. 1477*a*; cf. Morton (1), p. 202.

Fig. 1474. Coiled serpentine side-tube descending through a reservoir of cold water, from Gesner's *De Remediis Secretis* (+ 1569). It was probably used, though not illustrated, in the previous century.

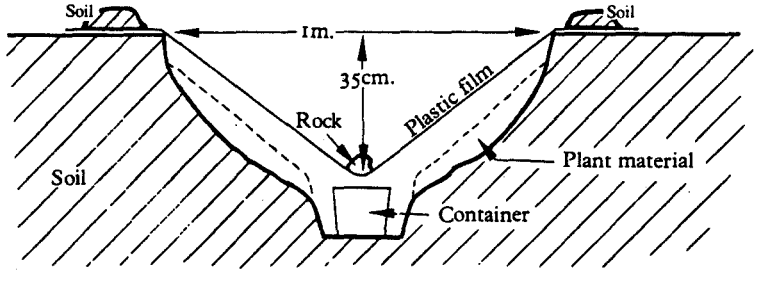


Fig. 1475. Solar still for purifying water described by Jackson & van Bavel (1). A direct derivate from the Mongolian still.

The principle of the Chinese still, moreover, is the basis of many interesting modern high-vacuum molecular stills. A molecular still may be defined as a still in which the distance between evaporating surface and condenser surface is less than the mean free path of the molecule.[a] Hence no re-condensation can occur on the evaporating

[a] Morton (1), p. 118.

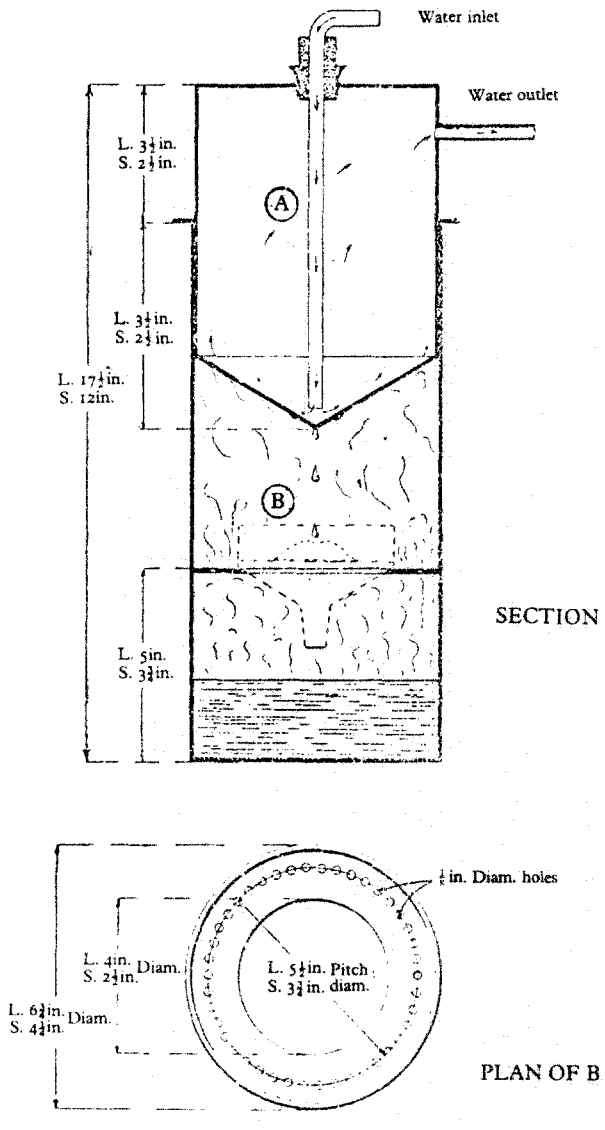


Fig. 1476. Apparatus for the continuous extraction of plant or other material at the boiling temperature of the solvent described by Brailsford Robertson & Ray (1). This is again a direct derivate from the principle of the Mongol still.

surface. Under such conditions the fractional distillation of organic compounds in non-aqueous or nearly non-aqueous medium can be accomplished because the molecules of each substance have their own characteristic mean free path. By adjusting the distance between the donator and receptor surfaces very delicate separations can be carried out. Such stills are often called 'cold-finger stills', and may employ liquid nitrogen as the coolant. In one of the simplest, the Washburn still (Fig. 1477 *b*), the substance sublimes on to the convex bottom of a cooling tube; this can distil paraffin

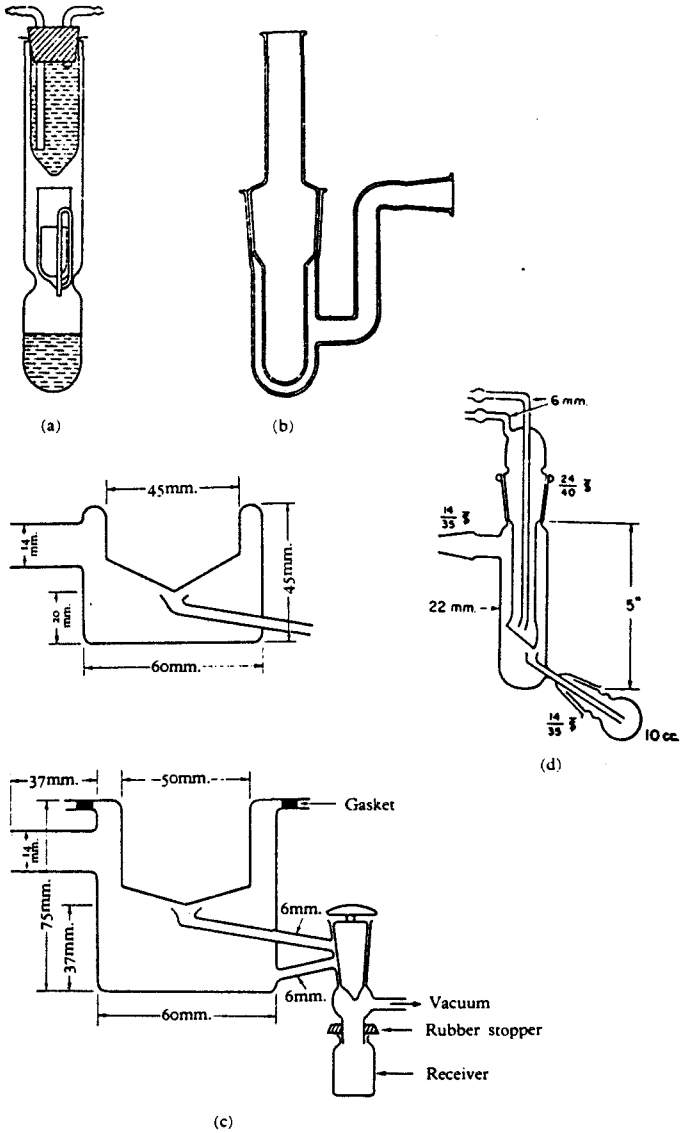


Fig. 1477. The Mongolian and Chinese stills in modern chemical practice.

(*a*) Wasitzky's apparatus for the continuous extraction of micro-quantities of material. Here the Soxhlet system is combined with central drip from a cooling finger. Morton (1), p. 202.

(*b*) Molecular still for use with high vacua; the Washburn type. The disti-sublimate collects on the convex surface of the cooling tube. Morton (1), p. 119.

(*c*) Molecular stills; the Hickman all-glass pot type, with exchangeable receivers. Perry & Hecker (1), p. 528. Dimensions in millimetres.

(*d*) Molecular stills; a Riegel pot still embodying, like the preceding one, a Chinese catch-bowl and side-tube. Perry & Hecker (1), p. 530.

wax at 55 °C. and sucrose at 120°. Tetrasaccharides have been separated and purified by distillation at about 280°.[a] On the other hand, at these very low pressures (e.g. 2 to 6×10^{-5} mm. Hg), a substance like α-bromo-naphthalene, normally boiling at 281°, will distil at 19°.[b] In the Hickman still (Fig. 1477 *c*), called by him a 'vacuum alembic with collecting arm', a catch-bowl and pipe exactly in the Chinese style is used to remove the 'disti-sublimate' condensing on the upper cooler and running down to its central point.[c] The Riegel pot still, on an even smaller scale, is similarly conceived

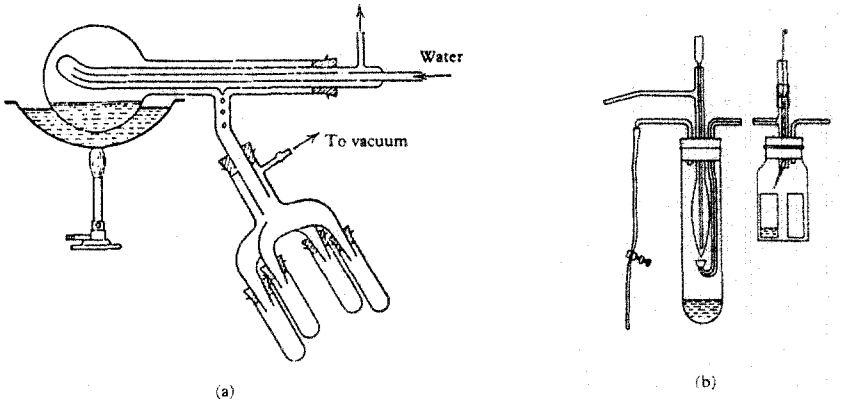


Fig. 1478. Mongolian and Chinese principles in molecular stills.
(*a*) Horizontal-flask molecular still with bent-finger condenser, drip point and four-fold rotating receiver (Morton (1), p. 120).
(*b*) Still of Ellis, in which the catch-bowl transmits to a capillary tube connected to a simple apparatus delivering as rotated to a series of receivers (Morton (1), p. 111).

(Fig. 1477 *d*).[d] Or the distillate may drip off a nipple on a horizontal cold-finger[e] (Fig. 1478 *a*); or be made to pass out of a micro-still by a capillary tube for collection in a series of receivers (Fig. 1478 *b*).[f] General descriptions and further diagrams of these stills are easy to find,[g] and we have noticed a good photograph of a high-vacuum still of 'Chinese' type in Morrison & Morrison (1).[h]

[a] Freudenberg, Friedich & Burmann (1). [b] Watermann & Elsbach (1).
[c] See Hickman (1, 3); Hickman & Sanford (1, 2). In some forms, the collecting tube passes vertically down through the still centrally and ends in a set of several fraction-collecting flasks. In others a central glass rod built in acts as a strut strengthening against implosion, and as a guide to carry the distillate down. It is also interesting (as Reti (8) has pointed out) that yet other types of molecular stills revive the ancient peripheral rim gutter of the West; cf. Hickman (1, 2, 3); Hickman & Trevoy (1); Hickman & Weyerts (1). Some, moreover, have a 'hot finger' instead of a cold one. It would be interesting to know whether any of the pioneers of the modern technique of molecular distillation were aware of the age-old Chinese precedents. [d] Riegel, Beiswanger & Lanzl (1). [e] Morton (1), p. 120. [f] Ellis (1).
[g] E.g. Perry & Hecker (1), pp. 527 ff.; Morton (1), pp. 118ff.; Fieser & Fieser (1), p. 34.
[h] We are indebted to Dr W. E. van Heyningen for first pointing out the extent to which the principle of the Chinese still has been incorporated in the modern practice of organic chemistry.

(vi) *The geographical distribution of still types*

A special investigation should be devoted to the history and geographical distribution of all the possible forms of distillation and extraction apparatus. Of these the East Asian types constitute one branch of considerable interest, not hitherto adequately taken into account by historians of chemistry. We have now given some description of their traditional use in modern times (pp. 62 ff. above), and we have traced them back into the past so far as is at present feasible (pp. 68 ff.).[a] Here we intend to sketch very briefly the extent of their geographical spread.[b]

On distillation among the Mongol peoples perhaps the best paper is that of Montell (2), who describes three types of stills (*burchur*), the Mongol one proper with the central catch-bowl, the Chinese one with the side-tube originating from a flat cup or shallow grooved rectangular wooden plate,[c] and lastly one of retort type in which the heated pot is simply connected by an arched wooden leather-covered tube with an iron receiver jug standing in a basin of cold water.[d] Notable is the use of clay-daubed felt for making joints steam-tight, since felt was one of the most characteristic Mongol inventions.[e] All these types were and are used for obtaining spirits (*arihai*, *airiki*) or twice or thrice distilled spirit (*arsa*, *chorsa*) from fermented mare's milk (*kumys*, *airak*, *arik*) containing only some two per cent of alcohol.[f]

For the Mongol still proper we need not adduce further sources, except the milk-can-like example (filled at the top with snow and ice), reported by Krünitz in +1781 (Fig. 1479).[g] But it is interesting that Pallas, in his famous travel book of +1776, figured two sorts of stills for making spirits from fermented milk.[h] The Kalmuk one, lacking still-head and catch-bowl, simply had two 'kettles' connected by a tube

[a] On various occasions in the past we have referred to what we call the Department of Face-Saving Re-definitions (Vol. 4, pt. 2, p. 545, pt. 3, pp. 564, 651). Here is another: Arntz (1), p. 203, describing briefly the Mongol still, says that it should not make us undervalue 'Destilliergeräten im echten Sinn'. But why should Western-type stills be regarded as any more 'genuine' than Mongol and Chinese stills?

[b] If we are right in our explanation of the origin of the Mongol and Chinese stills (p. 97), all their forms everywhere must have derived from ancient China, since it was only in that culture that the steamers (*tsêng* and *hsien*) existed.

[c] Rather like a butter-pat board, but scooped out and with grooves, the handle constituting the runnel which takes the distillate away.

[d] A similar apparatus is shown in the photograph from Hoernes (1), vol. 2, p. 24, fig. 9, reproduced by Schelenz (2), fig. 114, of an arrack still with two side-tubes used by the Sagai Turks in Southern Siberia. It is apparently non-cooled save that the two receivers are set in a trough which was presumably filled with cold water. Schelenz dubs it 'äusserst urwüchsig', but sees a connection with the Hellenistic style; presumably he had in mind the *dibikos* with its two side-tubes (cr. Berthelot (2), pp. 132, 138, 141; Sherwood Taylor (2), p. 137). Apart from the fact that the tubes come out near the top of the still, showing that it cannot have any internal rim or gutter, this strange survival really does seem a descendant of the *dibikos*, transmitted presumably through the Asian descendants of the Bactrian Greeks. A closely similar drawing given in Wiberg (1), fig. 4, from Maurizio (1), is ascribed to 'K. Stalywho, 1913' and its exact provenance not stated, but it must be also from Turkic Siberia. Presently we shall see other eastward penetrations of Hellenistic and later European still designs (p. 113).

[e] Cf. Olschki (7).

[f] References to this are legion. We may simply add: Buckland (1), p. 263; Maurizio (1), pp. 217ff.; Gmelin (1), vol. 2, pp. 126ff.; Wiberg (1), pp. 74ff. and figs. 4, 5, 6. These refer to Kalmuks, Kirghiz, Baschkirs and Astrakhan Tartars.

[g] (1), figs. 470, 471. From Schelenz (2), fig. 113.

[h] It is unfortunate that although the great Alexander von Humboldt personally saw distillation going on among the Kalmuks in 1829, it did not occur to him to give in his long discussion on the history of distillation (3), a precise account of the apparatus used.

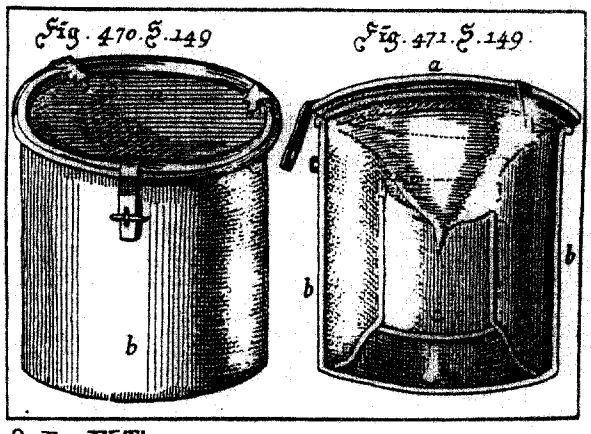


Fig. 1479. The Mongol still in folk use; the can of the Crimean Cossacks for distilling *arak* from *kumiss* (Krünitz, +1781). (*a*) Cavity for coolant, (*b*) still body.

(Fig. 1480 *a*),[a] but that shown as in use among the Mongols, Buriats and Tungus was clearly provided with the upper bowl of cooling water and the side-tube with catch-bowl (Fig. 1480 *b*); it was in fact a 'Chinese' still.[b] A larger one of the same kind appears in a more recent book resulting from the travels of Maenchen-Helfen in Tannu-Tuva (Fig. 1480 *c*).[c] Hermanns has extended its range in his account of the Tibetan nomads, whose economy is quite similar to that of the Mongols.[d] We have not been able to find much information on other marginal zones of the Chinese culture-area such as Korea or the lands of the Thais.

For India the information is complicated. As regards the Tantric alchemical literature, Ray gives excerpts from the *Rasaratna-samucchaya*, probably compiled soon after +1300, which apparently copied its section on apparatus largely from the +12th- or +13th-century *Rasendra-chūḍāmaṇi* of Somadeva. The descriptions and illustrations[e] show only two regular stills (the *dheki-yantra* and the *tiryakpātana-yantra*) with side-tubes and receivers but no peripheral gutters and no cooling at the still-head, certainly no evidence of catch-bowls.[f] They are in fact retorts, like the Gandhāran

[a] (1), p. 3 and pp. 205ff. A Gandhāran type.

[b] (1), pl. 7 and p. 272. The description was carefully considered by Huber (1), who drew attention to the presence of a perforated board above the boiling water at the bottom of the still, and the suspension of the fermented curds on a thick hempen cloth above this and below the position of the catch-bowl and side-tube. He also noted how in travellers' descriptions the Greek type of still tended to predominate west of the longitude of Lake Baikal (*c.* 105°) and the Chinese type east of it. Some of the peoples, according to Pallas, measured the strength of their 'Milchschnaps' in terms of the number of times the condenser bowl was renewed with cold water during the distillation.

[c] (4), opp. p. 53; cf. also p. 57.

[d] (1), pp. 66ff.

[e] (1), 2nd ed., pp. 151, 158ff., 189 ff. and fig. 30*d*, *e*. The drawings are often copied, as in Schelenz (2), figs. 19, 20, 21; Ferchl & Süssenguth (1), figs. 8, 9. In Ray's 1st ed. the titles of the *tiryakpātana-yantra* and the *vidyādhara-yantra* are inadvertently interchanged.

[f] The second of these is the one that has the cooling of the receiver by a stream of water poured from a jug (pp. 69–70 above). A photograph of just this being done during the distillation of palm wine or toddy in South India will be found in Hemneter (1).

stills (p. 87), and therefore allied with the early Greek still-types (p. 84). Hellenistic influence, as might be expected,[a] appears strikingly in the *dhūpa-yantra*, a remarkably precise echo of Mary's *kērotakis*.[b] And, as we shall see in a moment, the *dibikos* appears in India. A link of some interest with the Mediterranean area is the fact that stills of closely similar proportions and dimensions to these were used in the early decades of the present century for the distillation of *araq* among the Arabs of Palestine, where they were studied by Dalman.[c] More in accordance with expectation are the stills of Gandhāran and Tantric type used to this day at Pabna and other places in Bangladesh for illicit spirit distillation.[d] Moreover, in Grierson's description of arts

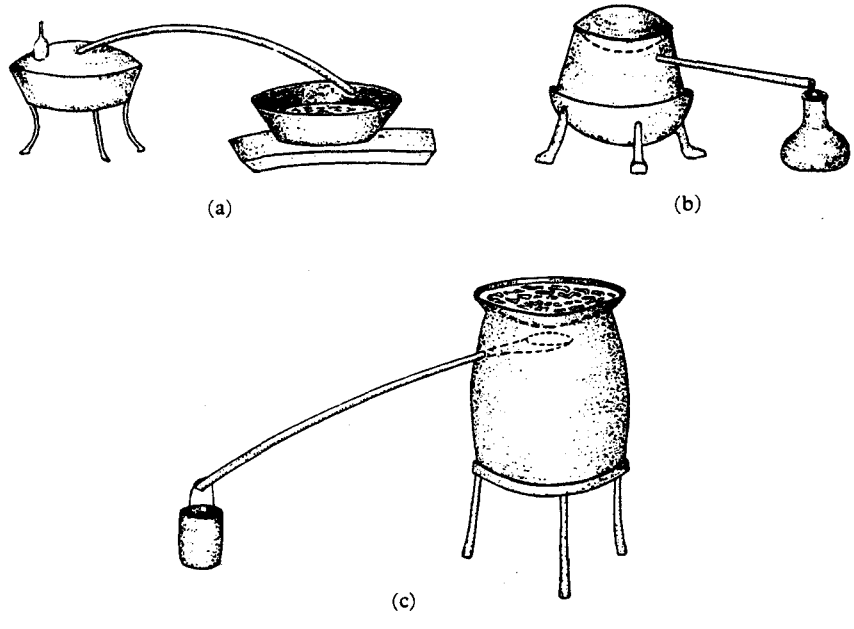


Fig. 1480. Forms of still in use among Siberian peoples for *arak*.
(*a*) Two vessels connected by an arching side-tube.
(*b*) Chinese still with catch-bowl and side-tube used by Mongols, Buriats and Tungus.
(*c*) Larger Chinese still employed by the people of Tannu-Tuva.

and crafts in Bihar, which gives the technical terms for all the parts of the traditional spirit still,[e] the apparatus is clearly of Western or Gandhāran type. A similar single side-tube alcohol still is customary among the Chenchu jungle people of Andhra Pradesh in Eastern India;[f] but much more extraordinary we find a veritable *dibikos* (with two side-tubes though no annular gutters) in use among the Baiga in Central

[a] From the parallel dissemination of Hellenistic mathematics and astronomy, so well known (cf. Vol. 3, pp. 146 and 176).

[b] There are also four sand-baths, two sublimatories, two extractors, and (as we have seen, p. 55) two arrangements for descensory distillation.

[c] (1), vol. 4, p. 368 and fig. 112. The side-tube, however, was usually passed through an amphora pierced with two holes and filled with cold water.

[d] Mahdihassan (56), fig. 42.

[e] (1), pp. 77 ff., but unfortunately no drawing.

[f] Von Fürer-Haimendorf (1), fig. 61.

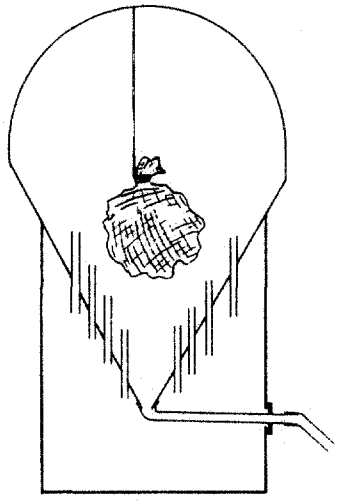


Fig. 1481

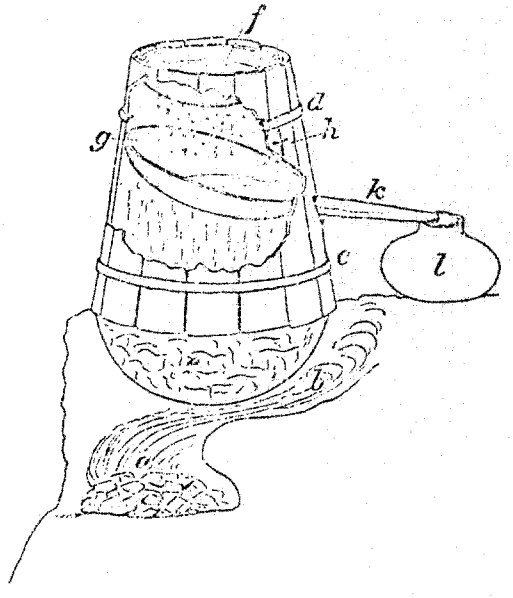


Fig. 1482

Fig. 1481. A combination of Chinese and Western designs: the extraction apparatus for materia medica used among the Algerians (Hilton-Simpson (1), p. 21). The head is convex like a Hellenistic helm, but the extract is collected in a Chinese catch-bowl with side-tube, penetrated by tubes to conduct the ascending vaporised solvent.

Fig. 1482. A Tarasco still from the Lake Patzcuaro region in Mexico (Bourke (1), p. 67). Of pure Chinese type, the catch-bowl is particularly large. (*a*) fire, (*b*) chimney, (*c*, *d*) hoops confining the barrel forming the still body, (*e*) maguey mash in a large earthenware bowl, (*f*) cooling reservoir replenished with cold water, (*g*) catch-bowl of metal, (*h*) barrel walls, (*k*) side-tube, (*l*), receiver.

India.[a] Thus so far nothing of East Asian style is to be seen.[b] On the other hand, among certain primitive peoples, such as the Bhīls, who distil from fermented *mahua* flowers[c] a spirit greatly used in all their ceremonies, the only ritually correct type of still is the Mongol one with the catch-bowl.[d] How did this technique reach Rajputana, Gujarat and Malwa? And why do the Bhīls honour it above the *dibikos*, which they also possess and use?[e] Finally, the Mongol still is commonly employed by the Newars of the Nepal valley, though that is less surprising.[f]

For Mogul India we have an important source in the *Ā'īn-ī Akbarī* (The Administration of the Emperor Akbar) written about +1590 by the great historian Abū'l-Faẓl 'Allāmī. In his account of the imperial still-room, he describes three types of stills, the Mongol suspended catch-bowl type, the Chinese type having a 'large spoon

[a] Verrier Elwin (1), pp. 44–5.

[b] With the partial exception of the *vidyādhara-yantra*, a sublimatory for mercury which has a basin of cold water set above the space in which the metal sublimes; see Ray (1), 2nd. ed., pp. 190–1 and fig. 30*e*; Roy & Subbarayappa (1), pp. 7, 68.

[c] These are the flowers of *Madhuca* (or *Bassia*) *latifolia* (Burkill (1), vol. 2, pp. 1387ff.). The collecting cup or catch-bowl (*dōī*) hangs inside a *haṇḍī* pot surmounted by the bowl of cold water (*vāṭkā*).

[d] See Pertold (1); and Mahdihassan (56), fig. 41, for the forest tribes of Bihar.

[e] Doshi (1), p. 107.

[f] Regmi (1), pp. 787–8.

with a hollow handle leading into a jar', and the Greek still-head with two pipes and two receivers, in fact the *dibikos*.[a] At such a late date, of course, it is difficult to trace anything of technical inter-change in earlier times.[b]

From the close commercial contacts of Arabic and Chinese merchants all through the Middle Ages one would expect to find the East Asian still types in the Islamic culture-area. At present, however (apart from the instance just given), we cannot prove this. But we should like to call attention to the Algerian pharmaceutical distil-

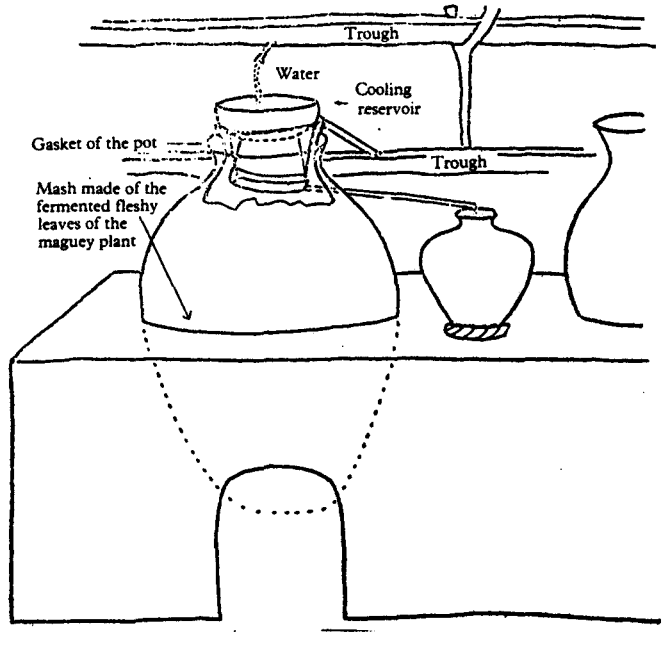


Fig. 1483. Zapotec still, also from Mexico, one of a series set along a bench-like stove (de la Fuente (1), p. 97). Again of pure Chinese type, but with an arrangement for a constant current of cold water through the upper reservoir. For alcohol from maguey mash.

lation and extraction apparatus described by Hilton-Simpson (Fig. 1481).[c] This is a curious combination of Western and Eastern designs in that it has a concave roof but a central collecting point for the condensed extract, surrounded by tubes permitting the rise of the vapour into the upper space. Such an arrangement is reminiscent of the pipes that sometimes rise through the Chinese catch-bowl in curious intermediate forms of apparatus which we shall examine in a moment (p. 119), but it lacks all water-cooling at the top. Hilton-Simpson did not actually see one of these stills, but his Shawiya medical friend approved the drawing of it.

[a] Blochmann (1), vol. 1, p. 69. It is rather remarkable that the only reference to the Chinese still in Forbes' substantial treatise on the history of distillation should be to Abū'l-Faẓl, (9), p. 54. And then he did not recognise it for what it was.

[b] Certain authors, e.g. Wiberg (1), have been inclined to look upon India as the original home of all stills, but without much positive evidence. It now looks rather as if there were three foci for the invention of distillation—the Babylonian-Hellenistic, the Gandhāran, and the Mongol-Chinese.

[c] (1), p. 21.

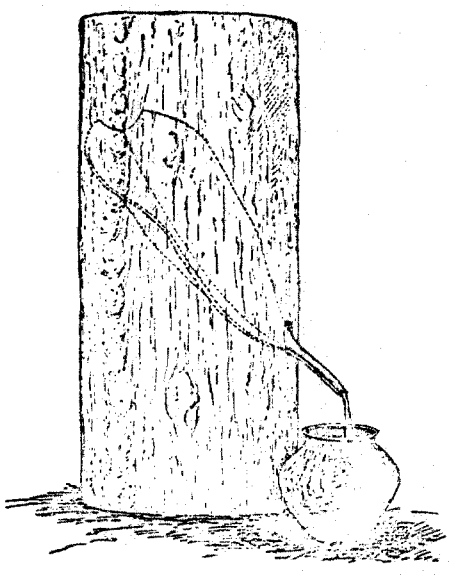


Fig. 1484. Part of a Chinese still used by the Cora and Tarasco Indians in Mexico. A roll of mountain-cedar bark, over a yard tall, forms the sides of the still, its edges being jointed with glue. The catch-bowl is a maguey leaf cut into the shape of a spoon (hence its name, *cuchara*), and its stem, passing outside through a hole, forms the side-tube. From Lumholtz (1), vol. 2, p. 186.

The typical Chinese still turns up in a rather unexpected place, namely Mexico, where the characteristic apparatus for distilling *mezcal* spirit from fermented maguey juice is provided with an upper cooling water-basin and a catch-bowl and side-tube underneath it. This was seen by Bourke (1) in 1893 on the island of Tzintzontzin in Lake Patzcuaro (Fig. 1482).[a] Further descriptions have been given by de la Fuente (1) for the Zapotecs;[b] and Lumholtz (1)[c] for the Cora Indians, who use a roll of mountain-cedar bark as the still sides, with a maguey-leaf cut in the shape of a spoon for the catch-bowl, its stem forming the side-tube (Fig. 1484). Besides this, Lumholtz added evidence that the true Mongol still also is found in Mexico, among the Huichol Indians (Fig. 1485 *a*).[d] It would seem at first sight that the only route by which these could have arrived there was through Muslim influence in Spain. One would hesitate

[a] He called the spirits *mescal*, but it is better to spell it *mezcal*, as the Mexicans do, distinguishing it thus from the 'mescal buttons' derived from the famous *peyotl* cactus *Lophophora Williamsii*. These contain psychotropic active principles (cf. la Barre, 1), especially the alkaloid mescaline, long used in certain Amerindian religious cults, and perhaps the first hallucinogen which received modern scientific study. The similarity of terms no doubt arose because of a confusion between different forms of intoxication. As de Barrios (1) points out, it is not quite true to say that *mezcal* (and the well known *tequila*, a particular regional form of it) is distilled from *pulque*. *Pulque* is the beer fermented from the sap or *aguamiel* of the maguey plant, *Agave atrovirens* (and several other species), in a natural process (i.e. without added sugar) wherein the yeasts are supplemented by an unusual alcohol-producer, *Thermobacterium mobile*. *Mezcal*, on the other hand, is distilled from the press-juice of the hearts of *Agave tequilana* (and several other species), with the addition of sugar, and primarily by yeasts; it is always rectified by double distillation. The agaves belong to the Amaryllidaceae, and are also grown for their valuable sisal fibre.

I cannot refrain from recalling here my first introduction to the excellent *tequila* of Mexico by my late friend Miguel Covarrubias.

[b] His fig. 11, p. 97, is here reproduced (Fig. 1483).

[c] In his vol. 2, p. 186.

[d] (1), vol. 2, p. 184. His diagram seems to have been redrawn erroneously in Wiberg (1), fig. 7.

perhaps in a case like this to assume a direct trans-Pacific pre-Columbian passage from Asia.[a] Yet Lumholtz was much inclined to regard the Huichol method as pre-Columbian because of its simplicity,[b] and Bourke (2) was able to add one positive argument in favour of such a belief. He drew attention to an edict of +1529 by Charles V against the use of distilled *pulque* by the Indians of New Spain.[c] The key word was specifically used—*que destilan los magueyes*—but the complaint was largely

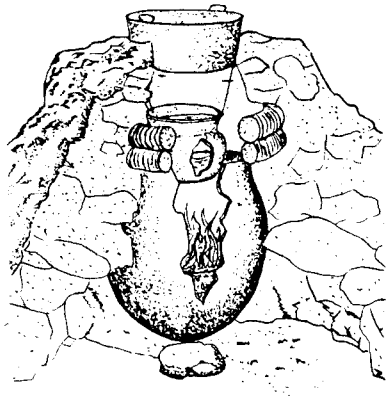


Fig. 1485*a*

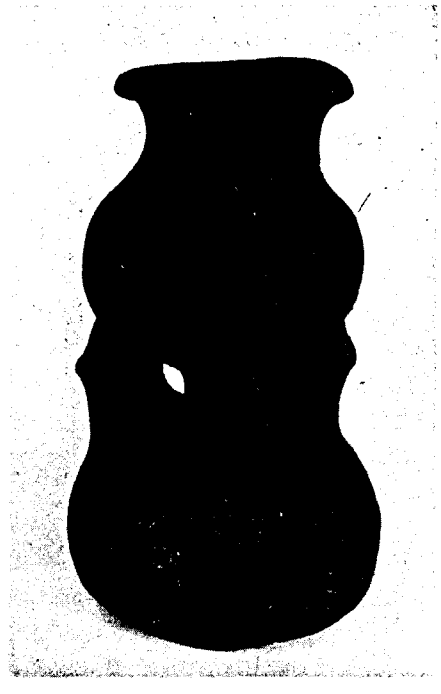


Fig. 1485*b*

Fig. 1485*a*. A Mongol still used by the Huichol Indians in Mexico. A mound of stone and earth is built as an oven around a large pottery jar or boiler, thick rings of grass making tight the space above it. The funnel formed by the top of the mound supports a copper cooling-basin, and a central pottery catch-bowl is suspended underneath by two cords of yucca fibre. From Lumholtz (1), vol. 2, p. 184.

Fig. 1485*b*. 'Trifid' pottery vessel from the Colima culture of north-western Mexico, *c.* −1450 (after Isabel Kelly, 1, 2). With a cooling-water basin above and a catch-cup inside, such pots could have been used for alcohol distillation in pre-Columbian times.

against substances added to the liquor from roots and berries with stupefying, excitatory or hallucinogenic effects, customary in 'heathen' ceremonies. The strongest measures were to be taken against such practices.[d] Now this was less than ten years after the conquest, a remarkably short time if knowledge of distillation had been brought only by the Spaniards. An imported drink-preparation would hardly have been adopted so quickly into the service of gods and ancestors. Supposing therefore

[a] This difficult subject has been looked into already in Vol. 4, pt. 3, pp. 540ff. Cf. Needham & Lu (12).

[b] (1), vol. 2, pp. 183, 185. Diguet (1), p. 610, supported him in this, but Seler (1) preferred to think of a borrowing from Spanish-American mestizo sources.

[c] Statute xxxvii in de Paredes (1). Cf. Wiberg (1), pp. 109ff.

[d] But in fact they still continue to this day.

that the words of the edict mean just what they say, the question of a possible pre-Columbian origin of distillation in Central America remains quite open.[a] The fact that the two methods used were distinctively Asian and not European must give some pause for thought.[b]

An intermediate alternative would be that the stills were indeed Asian but not pre-conquest, and this is the view put forward by Bruman (1, 3) who also visited the Huichol people himself, and found that their name for the fermented must before distillation was *tuba*. Since this same Tagalog word is used for palm toddy in the Philippines, Bruman proposed that the Asian stills were brought by the Filipino sailors who worked the Manila galleons, the first voyage of which took place in +1565. As would be expected, both the Mongol and the Chinese still-types have long been common in the Philippines.[c] Coconut culture later became an important industry on the littoral of Western Mexico, and Filipino influence certainly had much to do with its development.[d] But the Huichol distilled the fermented mash of the *sotol* plant[e] to make their *tuchi*, not palm toddy; and landfalls of Chinese sailors on rafts or dismasted junks during previous centuries cannot be ruled out. So judgment should perhaps be reserved for a while yet.

The Mongol still has also appeared, believe it or not, among the Irish peasantry. Because of economic depression and heavy taxes, illicit distillation has been a prominent feature of that countryside ever since the end of the +17th century,[f] as we can learn in the interesting survey of Connell[g] and the colourful descriptions of Hanna Bell.[h] Though generally a cooled coil or worm is used for the condenser, all kinds of tar-barrels, milk-churns, oil-drums and potato-pots being pressed into service, the poteen or *usquebeatha* ('water of life', the original Erse form of the word whisky) has

[a] Maize beer could also have been distilled. Was this perhaps the *yolatl* or 'heart-water' with which the Aztec captains of Axayácatl consoled themselves after their defeat by the Tarascans in +1478? See Davies (1), pp. 147, 331; Durán (1), vol. 2, p. 283 (xxxvii, 13), Heyden & Horcasitas tr., p. 167. Durán called it a *caldo esforzado*, which could mean 'strength-giving wine'. Today spirits (*chicha*) made from maize are common in many parts of Mexico.

[b] In her excavations of the Capacha phase of the Colima culture of the north-western coast of Mexico, Isabel Kelly (1, 2) found many double gourd-shaped pottery vessels like 'steamers', the two parts, upper and lower, being connected not by a grating but by two or three tubes (Fig. 1485*b* illustrates a typical 'trifid'). The date of these would be about −1450. They are mostly small, with a diameter of some 7 cms. at the mouth, but if surmounted by a cooling bowl and provided with a little catch-cup inside, alcohol could certainly have been distilled in them. We are much indebted to Dr Kelly for knowledge of these pots and discussions concerning them.

[c] See Feliciano (1). [d] Bruman (2). [e] *Dasylirion* spp. (Liliaceae).

[f] There has long been a persistent claim that the people of Ireland were able to distil spirits at a very early date. The most reasonable statement of the case is that when the army of Henry II invaded Ireland in +1172, they found the Irish using some kind of distilled wine or beer. Older works, such as that of Scarisbrick (1), p. 44, tend to accept the story; but more recent studies, e.g. McGuire (1), p. 91, are sceptical, though not completely dismissive. As we shall shortly see (p. 123), the earliest certain alcohol distillation in Europe was carried out by the Salernitan Masters in Italy in the neighbourhood of +1160, so that if the process was known in Ireland only some twelve years later it must have travelled thither with bizarre speed. Wandering Irish monks could have made that just possible, but it remains very improbable. Moreover, no mention of spirits has been found in any primary source or basic authority for Henry II's invasion of Ireland (priv. comm. Dr Roger Lovatt). Of course, if the distillation of alcohol was really known in late +12th-century Ireland it would presumably have been done with stills of Greek, not Mongolian, type. But judgment is best suspended until further evidence appears.

[g] (1), pp. 1–50. [h] (1), pp. 50ff.

also been distilled in simple kettles.[a] A kettle was partly filled with the fermented liquor and a pint mug placed inside it (presumably on some support to lift it from the bottom); the spout of the kettle was then sealed or corked and its lid turned upside down so that the knob hung above the mug and cold water could be added to the hollow of the lid. Thus the vapours condensed on the under surface of the lid and the concentrated alcohol dripped into the mug.[b] Did some Irishman think this up on his own, or had he been travelling among the Mongolians?

Actually, he need not have wandered so far, since the Mongol still design exists to this day all over Russia, Poland, Hungary, Rumania, Czechoslovakia and other parts of Eastern Europe. The fact that distillation by the peasants has generally been illegal has rendered this fact less well known than it might be.[c] *Pálinka* (the 'mountain dew' again) is made by setting a bowl of cold water atop a large tin pail, and supporting a catch-bowl below it by means of pieces of stone or a wooden frame or iron tripod. The must (*cefre*) is usually derived from cheap pure sugar and yeast with flavourings subsequently added. The ubiquity of the arrangement throughout the Eastern European countries may well have had something to do with that persistence of Mongol and Chinese still designs into the sophisticated apparatus of modern chemistry which we discussed above (pp. 99 ff.).

Conversely, clear derivatives from the Hellenistic or Gandhāran still, mostly rimless, and if possessed of water-cooling only round the receiver, have penetrated widely over the world, including parts of Asia. In traditional Ethiopia a still of this kind was used for beer and mead,[d] while that for palm toddy in South-east Asia often had a long bamboo side-tube,[e] and as for Africa, the Anyanja of Nyasaland used a simple 'pot and gun-barrel'.[f] Typical Hellenistic stills with annular gutters are seen in Armenian documents of the +16th century.[g] More advanced types with side-tubes passing through a condenser trough or barrel analogous to Liebig's, are reported for the Ostjaks,[h] the Wotjaks (cf. Fig. 1486),[i] the Palestinian Arabs[j] and the Madagascans, who distilled from fermented sugar-cane, mead, the berries of *Buddleia madagascarensis* and other musts.[k] Some of these forms are irresistibly reminiscent of the picture of Johann Wenod de Veteri Castro (p. 94), and presumably there was plenty of time for them to spread outwards from Europe since the early +15th century.

That the Hellenistic or Indian still-type penetrated far to the east rather earlier

[a] E.g. in Co. Longford.

[b] Irish Folklore Commission MS. 1458, pp. 457–8. At least one such apparatus can be seen in the collection of H. M. Customs and Excise at King's Beam House in the City of London, and a label says that it was seized at Edinburgh about 1950. We are indebted to Mr Arthur Slater for a knowledge of this museum, and to Mr T. Graham Smith the Librarian, with his colleague Mr Trevor Machin, for their kindness in showing it to us.

[c] We ourselves gained this valuable information from our friend Prof. Horváth Árpád of Budapest (Aug. 1970).

[d] See Huber (2); Maurizio (1), reprod. in Wiberg (1), fig. 2. Cf. Ratzel (1), vol. 3, p. 228.

[e] See Weule (1); Maurizio (1), reprod. in Wiberg (1), fig. 3.

[f] Stannus (1).

[g] Figured in Kazanchian (1).

[h] Maurizio (1), reprod. in Wiberg (1), fig. 5.

[i] From Buch (1), p. 505, an account of 1883. There is a bad redrawing in Wiberg (1), fig. 6.

[j] Dalman (1), vol. 4, fig. 112 and p. 368.

[k] See Ellis (1), vol. 1, p. 211; cit. Crawley (1), pp. 185 ff.

than that is indicated by an interesting passage in a Chinese encyclopaedia compiled about +1301. The *Chü Chia Pi Yung Shih Lei Chhüan Chi*[1] (Collection of Certain Sorts of Techniques necessary for Households),[a] probably put together by Hsiung Tsung-Li,[2] contains the following passage on 'The Burnt-wine Method of the Southern Tribesfolk' (*Nan fan shao chiu fa*)[3] which they used to make *a-li-chhi*,[4] i.e. *araqi*. The rather detailed description can be followed more easily by the aid of the drawing (Fig. 1487 *a*). Hsiung Tsung-Li says:[b]

For this item you can use all sorts of wine, sour or sweet, weak or insipid, or wine that doesn't have a proper taste.[c] (Pour the wine into) a pot so that it is eight-tenths full, and place another pot above it so that the two mouths correspond but the upper one slants to one

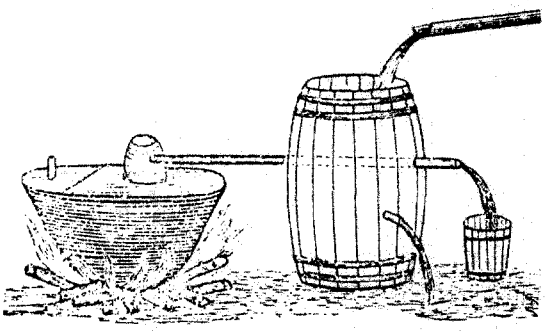


Fig. 1486. Western-type still with cooling-barrel condenser on the side-tube used for the distillation of *arak* by the Wotjaks in Siberia (Buch (1), p. 505).

side. Have a hole at the side of the upper empty vessel, with a bamboo tube coming out of it, and under the end (lit. the beak) of this tube place another empty pot (as receiver). Opposite the side where the rims of the two pots come close and the bamboo tube projects, fill the gap with one or more pieces of white porcelain from a broken basin, or else of pottery or tile, so that (the still) will be air-tight when cemented with the lute. Make the lute by pounding paper to a pulp and mixing it with lime, then seal all chinks carefully as thick as four fingers. Then put (the still) into a large new earthenware vat, embedding its base firmly in a mass of the same paper-lime lute, and heat it all around with two or three catties of hardwood charcoal, but not above (the level of the wine in) the still. When the wine boils the vapours mount up into the empty pot, and from this (still-head) they flow down through the bamboo tube into the pot below (the receiver). The colour (of the spirit) is quite white, no different from that of pure water. Sour wine will give an acrid (distillate), but that from sweet and insipid wine will be agreeable; in any case, one part of good spirits is obtained from three parts of wine. This technique can be used with winter-sacrifice wine, or heated wine;[d] in fact all wines can be 'burnt' (i.e. distilled) in this way.

So here was a 'pot and gun-barrel' still of simple construction, and its southern environment indicates that it had come from the Indian culture-area.

[a] *SKCS/TMTY*, ch. 130, p. 75*a*.
[b] Ch. 12, pp. 42*b*, 43*a*, reproduced in Shinoda & Tanaka (1), p. 345.
[c] Cf. p. 135, note e.
[d] Cf. p. 67.

[1] 居家必用事類全集 [2] 熊宗立 [3] 南番燒酒法 [4] 阿里乞

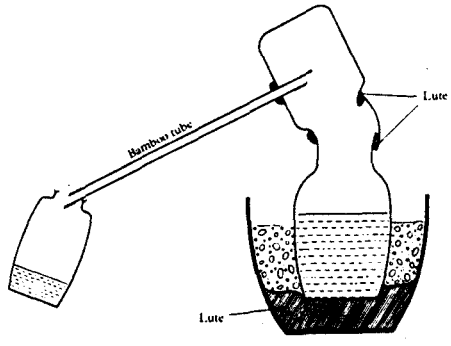


Fig. 1487*a*. Reconstruction of the 'pot and gun-barrel' still described in the *Chü Chia Pi Yung Shih Lei Chhüan Chi* of + 1301. An Indian or Western design with no cooling for either the helm or the side-tube.

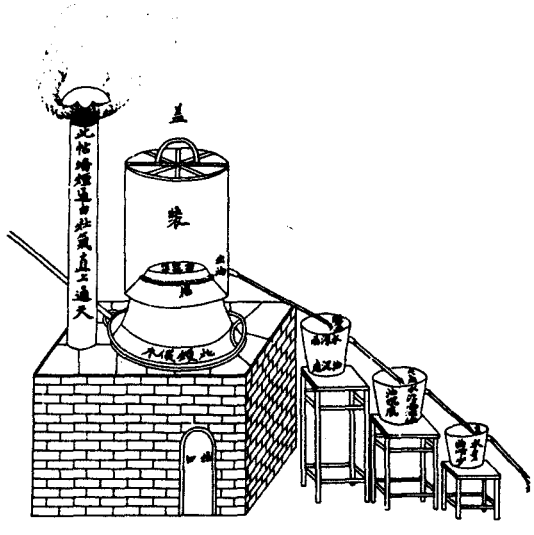


Fig. 1487*b*. Still of Hellenistic type used in China for the industrial preparation of essential oil of cassia, from the leaves and flowers of *Cinnamomum Cassia* (Schelenz). As the inscriptions say, the oil sinks to the bottom in the successive decantation receivers, an emulsified distillate having been drawn off from the peripheral gutter. The chimney is on the left, not to be confused with the automatic fuel stoker shown in Fig. 1471.

Furthermore, stills of Western or Hellenistic type, especially for preparing essential oils, are found in modern China. Or so we must assume from the illustration of a cassia oil still with annular rim, no water-cooling at the head or for the side-tube, and three successive automatic decantation buckets as receivers beyond,[a] presented by Li Chhiao-Phing.[b] We give the better version of Schelenz in Fig. 1487 *b*.[c] It is clear that

[a] The heavy oil sinks in the successive decantations, as the Chinese captions say.

[b] (1), fig. 73, opp p. 148; again this is in the English edition only, and again without statement of source.

[c] (2), fig. 116. The drawing appears again in Forbes (9), p. 7, where it is credited to the Indian Institute at Amsterdam. The probable source is a commercial report of 1893 (Anon. 95), whence it also got into Gildemeister & Hoffmann (1).

this would not work well for a low boiling-point liquid such as alcohol, where some form of water-cooling is desirable. Yet Guppy's description (1) of the distillation of 'samshu' (*san shao*,[1] cf. p. 149 below), thrice-distilled spirits, in North China in the eighties of the last century might be thought to point to the same thing, as he speaks of a gutter. 'The fermented millet', he wrote, 'is placed in a large wooden vat or tub, the bottom of which is made of a kind of grating, and beneath the vat there is a large boiler of water heated by an adjacent furnace. The steam ascending through the grating and passing through the fermented millet finally comes in contact with a cylinder

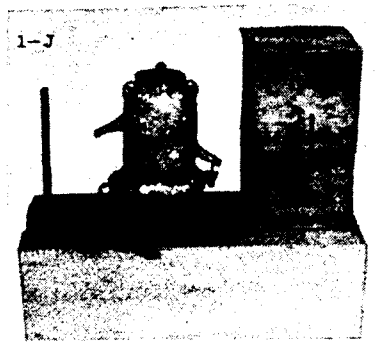


Fig. 1488*a*

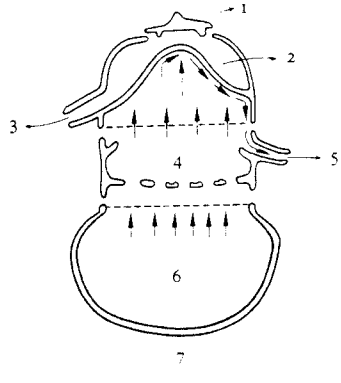


Fig. 1488*b*

Fig. 1488*a*. Japanese *rangaku* or + 18th-century pharmaceutical extractor still (Elm), a very compact device.

Fig. 1488*b*. Cross-section of the same (Elm). 1, lid; 2, cooling water reservoir; 3, outlet for renewing the water; 4, still body, with the plant or other material to be extracted supported on a grating; 5, side-tube from annular gutter delivering the extract in the condensed solvent; 6, solvent to be distilled; 7, source of heat, a charcoal fire.

of cold water; it is there condensed and trickling off into a little gutter, finds its way out through a long spout in a clear stream of veritable *samshu*.' But it is perhaps more likely that by 'cylinder' he meant the cooling-bowl top of a Chinese still rather than any kind of Western Moor's head, and by 'gutter' he referred to the catch-bowl, very possibly elongated, at the end of its side-tube.[a]

A more certain example of the penetration of the annular rim Western still-type into the Chinese culture-area can be seen in the pottery extractor-still used until recently by Japanese pharmacists and physicians. Fig. 1488 *a* shows one of these, and from the sectional diagram (Fig. 1488 *b*) it is clear that the cooled head has a concave roof and that the distillate is carried away by a true peripheral gutter.[b] Similar stills

[a] According to Guppy, the *samshu* produced had an alcohol-content of 48–54 %.

[b] The object here shown belonged to a family which had practised medicine since the + 15th century in Yamato province near Nara. Starting as physicians of the Chinese school, they took up Rangaku learning towards the end of the Tokugawa period, hence the Western influence. A complete collection of their instruments and appliances was described by Messrs. Elm & Co. of Osaka in their Catalogue MB 1967. We are much indebted to this firm for kindly providing us with the cross-section diagram. In 1964 we had been able to examine personally a similar still in the Museum of the Takeda Chemical Company's factory at Osaka, for which we also record thanks to our kind hosts, Dr K. Watanabe and Dr Miyashita Saburo. These compact pottery stills are hard to date, but the famous firm of Wedgwood

[1] 三燒

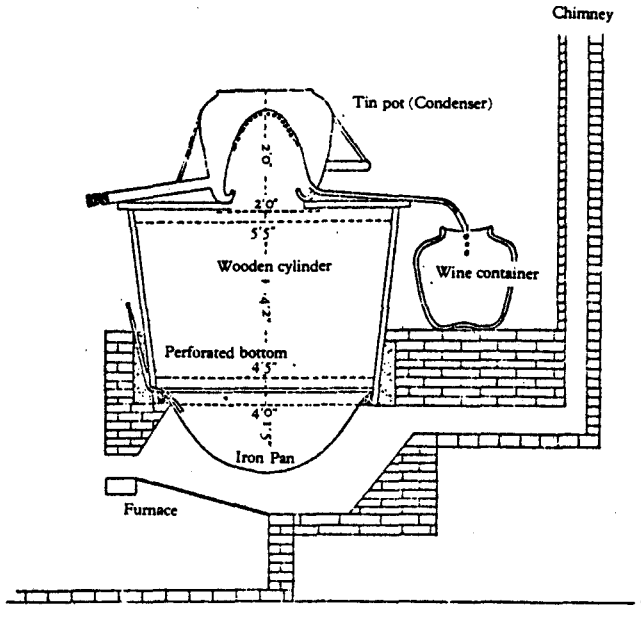


Fig. 1489. Chinese industrial still of Western type for the distillation of kao-liang wine. From Li Chhiao-Phing (1), p. 209.

on a much larger scale came into use in modern times for distilling kao-liang spirits in North China (Fig. 1489).[a] It is not necessary for us here to expatiate on the spread of the Western still-type to other cultures, but it may be worth recording that stills not unlike those of the Japanese and Moroccan pharmacists (cf. p. 130) occur in Mexico made of earthenware, doubtless introduced by Jesuit rather than by Dutch or Arabic influence, while in Brazil such Moor's head stills are carved entire from the local soapstone.[b]

Another possible penetration of the Western annular rim or gutter concept into the Chinese culture-area is to be found in the realm of the kitchen (that foster-home of so much chemical technology),[c] and in the province of Yunnan—though somewhat distorted topologically. Those who have had the good fortune to tread the streets of Kunming, Tali or Kochiu may have enjoyed in restaurants a special dish in which

was making similar types as late as 1802, when one is depicted in the firm's 'Shape Book' or 'Drawing Book', no. 814. The Dutch virtuoso and physicist Martinus van Marum bought a couple of them from Wedgwood in 1790 and these are still in the Museum founded by Pieter Teyler van der Hulst at Haarlem (see Turner & Levere (1), vol. 4, p. 350, no. 346, fig. 309). For this information we are indebted to Mr John Chaldecott of the Science Museum Library and the Curators of the Wedgwood Museum at Barlaston. At what time these distillation devices in pottery or porcelain reached Japan remains obscure, but doubtless it was through Dutch intermediation.

[a] Li Chhiao-Phing (1), fig. 83, p. 209. Not in the 2nd (illustrated) Chinese ed. (1). The description of 1867 for a Hankow distillery, in Julien & Champion (1), pp. 201–2, corresponds in all particulars with this diagram. So does that of Yang Tzu-Chiu (1) for Canton establishments which in 1919 were producing thrice-distilled rice spirits of *c.* 45% alcohol content. In Kuangtung at this time the still-head was sometimes made of pottery rather than of metal.

[b] Dr L. Reti (private comm.).

[c] Cf. here what has been said above (p. 30) on annular rim-trough water-seals.

chicken, ham, meat balls and the like have been cooked in water just condensed from steam.[a] This is done by means of an apparatus called *chhi kuo*[1] (or formerly *yang li kuo*[2]),[b] made especially at Chien-shui[3] near Kochiu. It consists simply of a red earthenware pot with a domical cover, the bottom of the pot being pierced by a tapering chimney so formed as to leave on all sides an annular trough (Fig. 1490). The *chhi kuo* once placed on a saucepan of boiling water, steam enters from below and

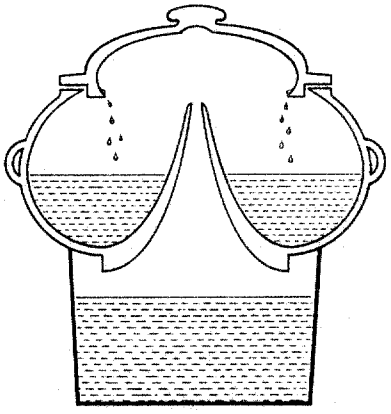


Fig. 1490

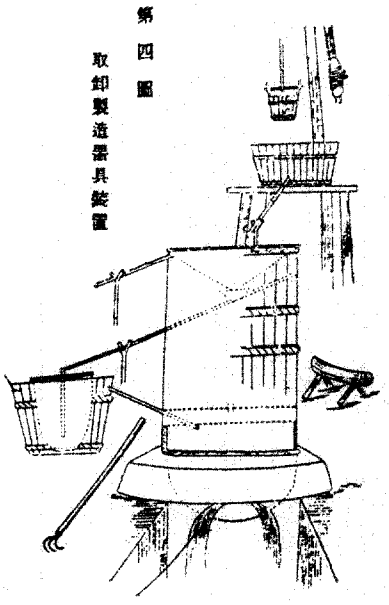


Fig. 1491

Fig. 1490. Cross-section of a *chhi kuo*, for cooking foods in water just condensed from steam, without loss of volatile flavouring substances. The edges of the domical lid direct the distillate inwards, and the food lies in a large annular space surrounding a central chimney with a narrow mouth. A topological relationship with the rim-pot stills of ancient Mesopotamia is clear (cf. Fig. 1455). Vessels of similar shape, but with a spout instead of a lid, are known from classical antiquity (Kenny (1), p. 252); their purpose is uncertain.

Fig. 1491. Japanese industrial still for peppermint oil (from Schelenz (2), p. 129, after Tanaka Setsusaburo and Schimmel). Fully Chinese in type, it has an arrangement for renewing the cooling water at the top, and for returning (by means of a siphon, not seen) the imperfectly separated emulsion of oil and water to the still body for re-distillation.

is condensed so as to fall upon and cook the viands in the trough, resulting thus after due process in something much better than either a soup or a stew in the ordinary sense. Since the chimney tapers to a small hole at its tip no natural volatile substances are lost from the food, hence the name of the object and the purpose of the exercise. The *chhi kuo* must claim to be regarded as a distant descendant of the Babylonian rim-pots (for it has and needs no Hellenistic side-tube) with the ancient rim expanded

[a] In recent times this technique has become known all over China. It is fully described, with photographs, in Anon. (*101*), vol. 11, p. 6.

[b] From the dripping down of the steam condensate infused with fiery Yang.

[1] 汽鍋 [2] 陽燧鍋 [3] 建水

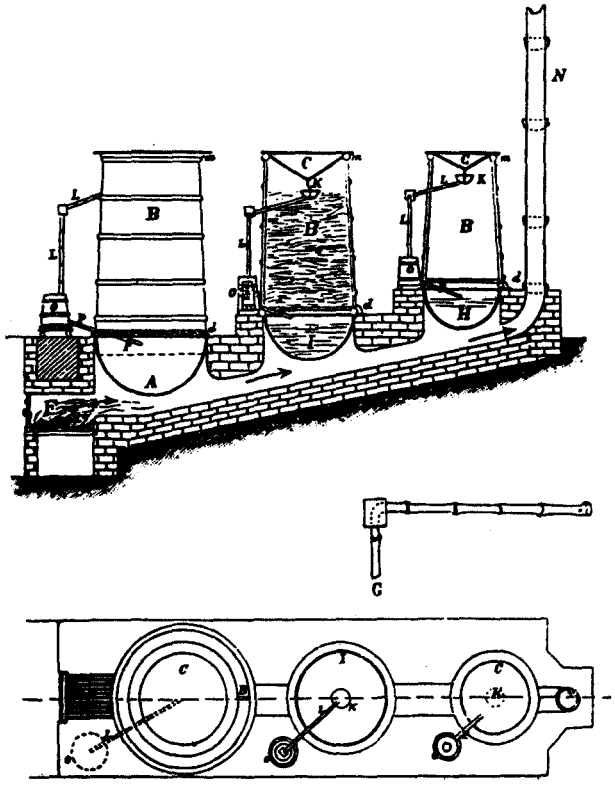


Fig. 1492. Triple still for peppermint oil, also from a Japanese source (Schelenz (2), p. 128). The three stills are set up in a row above a rising flue like a 'hillside' pottery kiln, and all have the return pipes from the receivers, in this case low so as not to disturb the supernatant oil. A, H, I, water for the steam distillation; *d, d, d,* gratings for the vegetable material; B, B, B, still bodies; C, C, cooling reservoirs; F, fire; G, manner of jointing bamboo pipes so as to negotiate corners; K, catch-bowls; L, side-tubes; N, chimney; O, receivers; P, return-pipes.

to form a trough, compressing the 'still'-body to a narrow chimney. But how the idea found its way down through the ages, and from Mesopotamia to Yunnan, might admit of a wide conjecture.

The further pursuit of the Chinese still and its variations by means of eye-witness accounts of traditional technology leads to some very remarkable transitional forms.[a] Two Japanese illustrations of stills for peppermint oil are given by Schelenz (2); see Figs. 1491,[b] 1492.[c] In both of these the wooden tub- or barrel-like towers are

[a] Certain of those reported seem to need further investigation. Deniel (1) in 1954 gave drawings of stills of Chinese type used in Vietnam for the preparation of alcohol from fermented rice, sorghum or kao-liang. But they raise some doubts about their accuracy. In one case (Fig. 1494 *a*), the catch-bowl is very large, almost as large as the still-body, while the side-tube extends uselessly beyond its apex to the opposite side of the still. There are other examples of very large catch-bowls (cf. Figs. 1482, 1484), but the point of the latter arrangement is not obvious unless it was a way of fixing the side-tube more firmly. It occurs also in Fig. 1491. Then in another case (Fig. 1494 *b*), the side-tube descends as a spiral tube through the hot vapours before leaving. This seems incomprehensible, unless the coil was really a cooling-coil outside the still, misplaced by a misunderstanding.

[b] His fig. 112. This also appears in the book of Gildemeister & Hoffmann (1), vol. 3, p. 533, where it is attributed to E. Marx (2).

[c] His fig. 111. Schelenz appears to attribute this to an 'excellent report' made by Tanaka Setsusaburo to Messrs. Schimmel & Co. of Miltitz in 1908.

strengthened with hoops and have at the bottom gratings above the steam boiling pan on which the peppermint plants are piled up, filling most of the still body. This is reminiscent of the set of sieves piled one upon another in which the familiar *pao-tzu*[1] (filled dumplings) are steamed; and of course of the 'steamers' of the Chou and Han (p. 27 above). In both of the stills depicted in Figs. 1491 and 1492 a bamboo tube leading from the receiver back into the still under the grating returns the aqueous phase for re-distillation. The apparatus in Fig. 1492, however, has the further interest

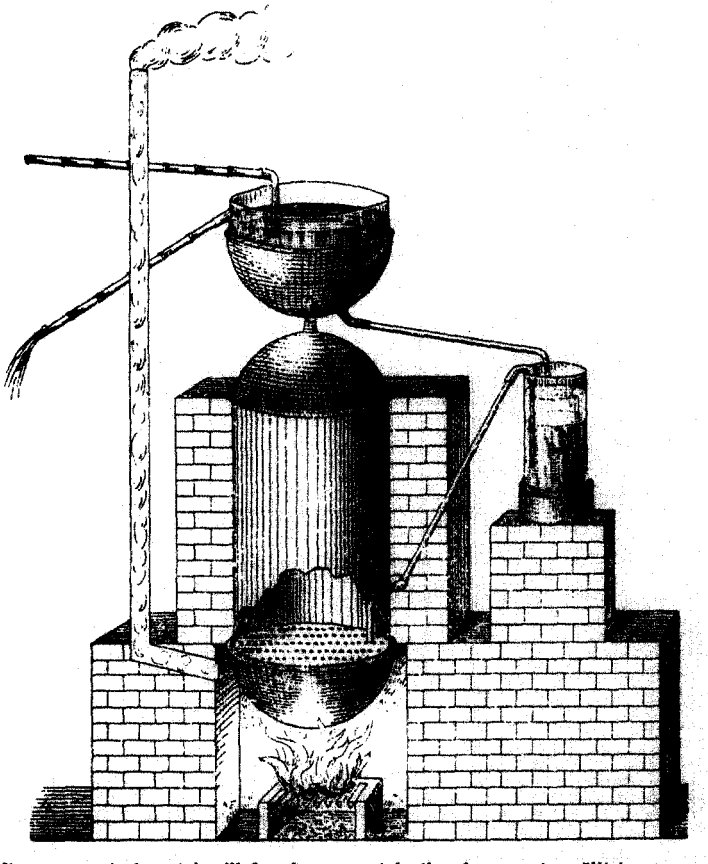


Fig. 1493. Vietnamese industrial still for the essential oils of star anise, *Illicium verum* (from Schelenz (2), p. 134, after Gildemeister & Hoffmann). This is a form transitional between the Chinese and the Western systems; for the steam and the distilled oil rise from a concave-headed still through a short pipe penetrating what is essentially a Chinese catch-bowl, so that the distillate is taken off through the side-tube from an annular channel. The cooling reservoir at the top is typically Chinese. There is also the siphon to return the oil–water mixture for re-distillation.

that a succession of stills is arranged one behind the other upon a rising flue closely reminiscent of the 'hillside' kilns of the pottery and porcelain industry.[a] So far, these forms are of the standard Chinese pattern.

[a] Cf. Sect. 35.

[1] 包子

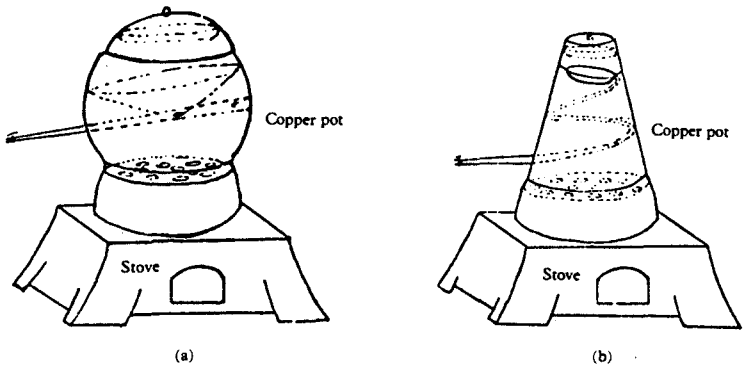


Fig. 1494*a*. Vietnamese alcohol still (from Deniel (1), p. 43). A wholly Chinese design, with a particularly large catch-bowl (*mai rua*); cf. Figs. 1482, 1484.

Fig. 1494*b*. Another Vietnamese alcohol still (from Deniel (1), p. 43). Here the side-tube is depicted as circulating in a coil through the still body (see text, p. 117).

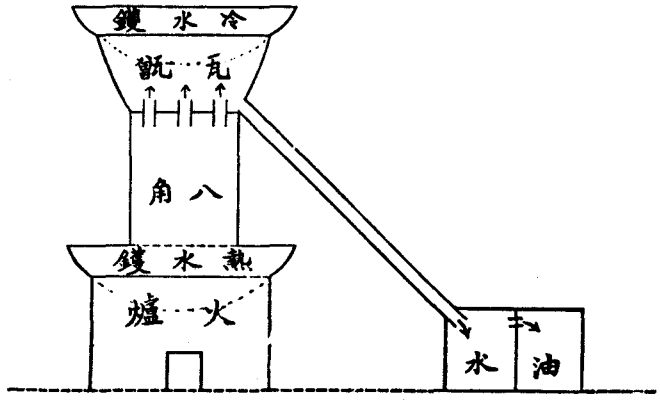


Fig. 1495. Chinese industrial still for star anise oil (*pai chio yu*), from Schelenz (2), p. 135. It is similar to that shown in Fig. 1493, but there are three rising pipes through the 'catch-bowl', and instead of a return tube from the receiver there is a decantation arrangement which separates off the supernatant oil.

But Schelenz (2) also gives pictures of two very strange developments of this type of still. Fig. 1493 shows a Vietnamese one used in Tongking for star anise oil.[a] Here the plant material is placed upon a grating as usual, but the distillation vapour rises through a short tube which passes into a bowl-shaped space surmounted by the characteristically Chinese convex still roof, above which cooling water circulates in a higher bowl. This then is as if a rising vapour tube were to pass through the bottom of a Chinese catch-cup. Thus there is here a remarkable mixture of the Chinese and Western still types, for the cooling is done by a bowl at the still-head, yet the distillate is removed by a side-tube leading off from an annular channel. But since this trough

[a] His fig. 117, from Gildemeister & Hoffmann (1), vol. 2, pp. 379ff., based on Anon. (97), p. 659 and (96), p. 85. On star anise, *Illicium verum*, see pt. 2, pp. 136–7. The 'badiana oil' got from it is an important raw material providing most of the anethol used extensively in the liqueur and cosmetic industry.

space is much larger than the entry pipe it is almost as if the Yunnanese *chhi kuo* had been provided with a side-tube as well as the usual convex water-cooled head. Fig. 1495 gives a further variation,[a] the bottom of the Chinese 'spoon' or catch-cup and side-tube, under the bowl cooler, being pierced by tubes in three places to allow the entry of the vapour.[b] This type was apparently in use in Kuangtung and Kuangsi during the last century. We are here very close to the Moorish (Algerian) extractor still of Fig. 1481, with the difference that the take-off is peripheral rather than central, and the head is a convex water-cooled one rather than a concave one with no special cooling. The receiver of the Chinese apparatus is compartmented to allow the automatic decantation of the oil which floats on the water.[c] In these arrangements, as in other extractor systems which we have already mentioned (pp. 113 ff.), it is worth noting that they all depend on steam distillation; it must have been found out very early that attempting to distil essential oils at temperatures near their boiling-points would only decompose them and lose their fragrance as well as giving a poor yield.

The two pieces of apparatus just described constitute remarkable transitional forms between the Chinese and Western types of still. After all, if a pipe is led up through the bowl of the Chinese catch-cup or spoon collector on its long arm, the structure becomes topologically similar to the ancient Western annular rim channel. Is it conceivable, perhaps, that these types of still were invented by people who had been brought up in the Chinese tradition and then came to know of the Western peripheral gutter? Conversely, could the Moor's head still top of the West have arisen because a knowledge (or even a rumour) of the Chinese cooling-bowl reached the occidental world some time between the +12th and the +15th centuries? This surmise will acquire particular significance in the light of facts recorded in the ensuing sub-section.

It is thus evident that much further research will be needed before we can hope to translate the theoretical diagram of Fig. 1454 into terms of the concrete appearance and development of the different forms among the various peoples in successive ages. But the task will be a truly fascinating one. Here we have only touched the surface layers.

Nevertheless, it does begin to look as if the two polar types of still, the Western and the Eastern, started out from two entirely different instruments of the simplest description, the pot-lid with turned-up edges and the steamer with its grating. The former led to the concave still roof and annular rim collection, the latter to the convex still roof and central collection. Neither of these types could easily affect the other because of their complementary logic, yet (as we have just seen) inter-specific 'crossing' did eventually occur. The most important transmission seems to have come (so far as we can see at present) from the 'Moors' of the East as an idea only, skipping the Arabic culture-area and generating a necessarily different form of still-head cooling in the

[a] Schelenz (2), fig. 118, from Gildemeister & Hoffmann (1), vol. 2, pp. 379ff., based on Anon. (97), p. 659 and (96), p. 85. This still also was used for star anise oil.

[b] Both these still types seem open to the criticism that some of the condensate would drop directly into the tube or tubes and so back into the still, but this may have been obviated in practice by a short right-angle turn at their tops, like the cowled ventilators of ships.

[c] A 'verbluffend einfache und zweckmässige Vorlage', remarked Schelenz.

West. But there was another source from which the principle of water-cooling for condensation could have come, namely the third tradition, geographically intermediate, Indian or Gandhāran. This still-type, the probable ancestor of all retorts, was allied with the Western still because of its concave still-head, but also with the Mongol-Chinese because of the water-cooling which its receiver probably had from an early date. Eventually of course all three traditions have been incorporated among the myriad devices of modern chemistry.

(8) The Coming of Ardent Water

Of all the evocative names in the history of alchemy and chemistry none can be considered more striking than *aqua ardens*—the water that burns—for burning is an attribute of fire, not water. No one can fully appreciate the strangeness of what this meant to medieval people unless he is aware that the work of the alchemist and protochemist, almost from Hellenistic times onwards, and certainly also in China, had concerned the *conjunctio oppositorum*,[a] the hierogamic union of sun and moon, the Tao of the synthesis of Yang and Yin, indeed the 'marriage of fire and water'.[b] True, the light fractions of petroleum had been distilled into 'Greek Fire' by Callinicus at Byzantium about +670, but the petrol- or gasoline-like liquids which he and his successors produced never got the name of 'waters', either in West or East, presumably because although whitish and fairly transparent they smelt so differently and were immiscible with water. They were in fact thought of more as oils, quite rightly; and actually received in China that designation from the time of the first knowledge of them.[c] It is therefore a matter of great interest to discover, if we can, who first became familiar with the taste and smell of strong distilled alcohol,[d] and where this was.[e]

With the praises of the drug indited by European writers we can well dispense, yet the words on *aqua vitae* written by Conrad Gesner of Zürich, the great naturalist and chemist, and a personal friend of John Caius, are too seductive to omit.

> The taste of it [saith he] excedeth all other tastes and the smel all other smelles. It comforteth the natural heat more than any other remedye; it is most holsom for the stomake, the

[a] Cf. pt. 3, pp. 69, 70, 149.

[b] A fascinating account of the 'submarine mare' in the mythology of Śiva has been given by O'Flaherty (1). The fire-breathing mare, *Aurva vaḍavā*, at the bottom of the sea, is like the Yang within the Yin (cf. Vol. 5, pt. 5), and symbolises Śiva and his *shakti Pārvatī*. He is essentially fire and she is water, but they are eternally one. 'He is the ascetic fire which rages against the erotic power, but also the fire of passion that cannot be controlled by asceticism.' She is the giver of the energy of both, and together they image the balance of forces in the universe, flame that can never be quenched, oceans that can never dry. Psychologically it would be hard to go deeper, with the dynamism of the id expressing itself in inwardly-directed mortido and outwardly-directed libido. On the symbolism of the mare and the dragon cf. Rousselle (8).

[c] Cf. pp. 158 ff.

[d] The term originated, as is well known, from the *al-kuḥl* of Arabic authors, antimony sulphide in very finely comminuted form, an impalpable powder used as a kind of mascara by girls and women in the Middle East (cf. Vol. 5, pt. 2, pp. 267–8). Paracelsus applied it about +1535 to the distillate of wine because alcohol was such an extremely subtle thing, so there was *alcool vini* as well as *alcool antimonii* (cf. Partington (7), vol. 2, p. 149).

[e] The best history of alcohol-distillation, perhaps, is that of Arntz (1), but it is lamentably deficient on the Chinese (and indeed the Indian) evidence. There is a short general account of alcohol and its history in a lecture by a distinguished chemist; Armstrong (1).

harte and the liver, it norysceth blud, it agreeth mervelously and most with mans nature, it openeth and purgeth ye mouthes and entrances of the membres, vaines and poores of the body every one, it avoydeth all obstruction and comforteth them—yea, it changeth the affections of the minde, it taketh away sadnes and pensivenes, it maketh men meri, witty, and encreaseth audacitie... It avoydeth and kepeth a man from gray heares, ...it encreaseth the ability of accompanying with wemen, ...it maketh women apt to conceive but anoyeth them that be greate with childe...[a]

And so on. Who were really the first to prepare this stuff?

(i) *The Salernitan quintessence*

Any definitive picture of the development of the means of distillation of volatile substances in the West in the period between the +2nd century and the late +13th century, the time of Taddeo Alderotti, will have to include evidence which may be gleaned about the idea of a 'Quintessence' derived from wine.[b] This appellation, designating ethyl alcohol as of a quasi-spiritual nature,[c] and adding a fifth (*quinta essentia*) to Aristotle's four elements, is fully present in the writings of the followers of Raymond Lull[d] in the mid or late +14th century.[e] Already before this time alcohol (*aqua ardens* or *aqua vitae*, the 'burning water' or 'water of life') had become important in medicine,[f] and in techniques for the preservation of organic substances; for example John of Rupescissa welcomed it as a quintessential stabiliser which would defend the body from corruption until the last day.[g] Alderotti, in his *Consilia*

[a] *Treasure of Euonymus* (+1559), p. 85.

[b] Here the article of Sherwood Taylor (6) is an indispensable aid. In the Jābirian Corpus there is a *Kitāb al-Ṭabṭ'a al-Khāmisa* (Book of the Fifth Nature) Kr/396, and while this is mostly explained as a basic materia prima, the word *rūḥ* (pneuma) is occasionally applied to it. There may therefore have been Arabic influence on the Lullian Corpus.

[c] The whole thought-complex here is extremely suspicious of East Asian ideology. Not only were there always five elements in Chinese natural philosophy, unlike the four of the Greeks (cf. Vol. 2, *passim*), but as we have frequently pointed out, Chinese thinkers were averse to any such sharp distinctions between matter and spirit as were customary in European thought from the beginning (cf. here, pt. 2, pp. 86, 92–3, pt. 3, p. 149). If the idea of the quintessence was really in earlier Arabic texts, we should have yet another reason for suspecting Chinese influence on the Jābirian Corpus.

[d] Himself +1235 to +1315, but probably never a practising alchemist.

[e] Especially the treatise entitled *De Secretis Naturae seu de Quinta Essentia*, which describes the distillation of alcohol as well as the theory, and gives pictures of stills. The receivers are cooled.

[f] In the late +13th century Vitalis du Four (cf. p. 196) and Taddeo Alderotti himself used it therapeutically. In +1288 stills were banned from Dominican friaries, pharmacy being considered a secular calling. About +1250 the physician Gilbertus Anglicus recommended *aqua vitae* for travellers (Sarton (1), vol. 2, p. 658)—very reasonably, if one considers the rigours of winter journeys in those days.

[g] *De Consideratione Quintae Essentiae*, written in the first half of the +14th century. This idea was quite a legitimate one; it may well have derived from actual observations of the preservation of perishable plant and animal matter in alcohol. Thence the road lay straight to the use of alcohol and other liquid organic compounds as fixatives, first noted by Robert Boyle, who in +1666 described 'a way of preserving birds taken out of the egge, and other small faetuses' (cf. Needham (2), p. 137). John of Rupescissa quenched gold leaf in his alcohol 'to fix Sol in it', and the numerous complex liqueurs which the religious orders developed in the +16th century were really examples of microcosmic 'philosophical heavens' in which the stellar influences generating the virtues of many plants had been, as it were, captured on earth and 'fixed' for human benefit. On John of Rupescissa himself see Multhauf (1). On ideas of the permanent preservation of the body in relation to material immortality in China, see pt. 2, pp. 294ff.

Medicinalia[a] about +1280 described how he used the four times re-distilled wine for medical purposes. The ten times distilled, obtained only in small quantities, he called *perfectissima*;[b] it would burn completely away when ignited, and moreover any cloth soaked in it would burn also. Von Lippmann quotes Alderotti's detailed description of his procedure and calculated that at least 90% alcohol could be obtained by his method.[c]

Going back, we find accounts of the distillation of wine in the +13th-century text of Marcus Graecus,[d] as also in Salernitan texts[e] and the +12th-century version of the *Mappae Clavicula*.[f] The latter description is in the form of a cryptogram which was solved without difficulty by Berthelot (10).[g] Little is said about the distillation apparatus, and there is no clear mention of cooling in any text. The distillate, 'burning water', caught fire when a flame was applied, but combustible things dipped in it would not themselves burn.[h] The same observation, using a linen cloth, is made in Marcus Graecus.[i] Berthelot[j] and Diels (3) both emphasised the great similarity in style and content of these two treatises to that of the Alexandrian and Byzantine

[a] Now published in full by Nardi (1). Cf. Siraisi (1).

[b] It is not clear why Alderotti redistilled, since his cooled rising coil will give 80% or 90% alcohol in one operation (Reti). It would seem that his text may be corrupt, perhaps containing insertions made by his students who were used to having to re-distil. Without dephlegmatory or fractionation devices multiple distillation is mandatory, with or without water-cooling. The Chinese certainly did it, as is evident from traditional phrases like *san shao*,[1] 'thrice burnt'. About five distillations would be required for 80% alcohol; it is unlikely that in traditional China anyone ever went beyond this level towards absolute, and probably not usually beyond 70%.

[c] (13), p. 1359. Cf. p. 93 above. Reti's reconstruction of the apparatus Alderotti used has been given in Fig. 1469. Cf. Arntz (1), pp. 227ff.

[d] The famous *Liber Ignium ad Comburendos Hostes*, so important for Greek fire, and the beginnings of gunpowder in the West (cf. Leicester (1), pp. 78–9; Berthelot (10), vol. 1, pp. 89ff., tr. pp. 100ff., alcohol recipes, pp. 117, 122, 134, 136ff., 142; Multhauf (5), p. 205; Arntz (1), pp. 218ff.). The present view is that the text as we have it now is of the late +13th century, with much Arabic influence. No Greek version has been found, in spite of the writer's ethnikon; and the background of the text, from internal evidence, is Spanish rather than Byzantine. The earliest entries may go back to the +8th century (cf. Partington (5), p. 60), but both alcohol and gunpowder belong to the last versions.

[e] The writings of the physicians of the School of Salerno (see Multhauf (5), p. 205–6; Leicester (1), p. 76; Forbes (9), pp. 57–8; von Lippmann (15) and (1), vol. 3, p. 32). They fix the discovery not long before +1170, possibly as early as +1155. The Salernitan Corpus from the first half of the century (ed. Sudhoff) has much to say on the distillation of essential oils, but does not mention alcohol. A MS. copy of *c.* +1200, *Aqua ardens sic fit*, in the Library of Gonville & Caius College (451 (392), 15*c*) has been reproduced and translated by Arntz (1), pp. 223, 225.

[f] 'Little Key to Painting', one of the Latin practical compendia of metallurgy, dyeing and other chemical arts, probably first begun about +820, but now available only in MSS. of the +10th and +12th centuries (cf. Leicester (1), p. 76; Berthelot (10), vol. 1, pp. 23ff., tr. pp. 31ff., alcohol recipe, p. 61; Multhauf (5), p. 205; Smith & Hawthorne (1), p. 59; Arntz (1), pp. 214ff.). The alcohol recipe (a cryptogram) is not in the +10th-century version.

[g] This is not, of course, the only instance of that kind of discreet self-protection by the 'subtile clerkes' and craftsmen of those centuries. Cf. Vol. 5, pt. 1.

[h] This was clearly on account of the relatively large percentage of water present. Beckmann did an experiment for Degering (1) in which he showed that alcohol–water mixtures containing less than 35% alcohol would quench burning sulphur. Such tests as these, made in medieval times no doubt, would have been the origin of the 'proof-spirit' system, a little gunpowder being placed in a spoon with the alcohol, and set off, or not, as the case might be, when the alcohol burnt down. The technique remained in use until comparatively recent times, and the name lingers still in the excise and commercial worlds, though nowadays differently defined. Cf. Sherwood Taylor (4), p. 156.

[i] Berthelot (10), p. 142.

[j] *Op. cit.*, pp. 89ff.

[1] 三燒

manuscripts,[a] some passages even reproducing the Greek text in translation. This is perhaps truer of the *Mappae* than of the *Liber Ignium*, but it is not untrue of the latter, which also draws, however, on military writers such as Julius Africanus of the +2nd century.[b] Berthelot and Diels were thus inclined to see a great influence of the earlier Greek proto-chemical writings on the *Mappae Clavicula* authors,[c] as indeed on other early medieval Latin recipe-books also.

Diels alone, however, went on to maintain (3) that alcohol had been known to the Hellenistic or Byzantine proto-chemists. As Diels remarked, Aristotle knew that the vapours of wine would ignite, though according to his theory wine, like all other aqueous substances, would only give off water.[d] Diels attached much importance to the recipe mentioned by Hippolytus (*d.* +235) in which sweet wine was heated with 'sea-foam' and sulphur, producing in some way a lambent nimbus of flame when sprinkled on the head in temple rites.[e] Hippolytus was concerned to unmask the arts of the magicians and thaumaturgic priests, as in Egypt; and Diels suggested that a distillate of weak alcohol, facilitated by the additions to the wine, would have been very suitable for their purpose. He found it significant that two points of the Hippolytus recipe—the additions to the wine, and the failure of the alcohol to burn away completely, igniting material in contact with it—appear in the *Liber Ignium* of Marcus Graecus.[f] Von Lippmann, on the other hand, in a series of papers (13, 14, 15, 16, 17, 18), argued strongly that the discovery of alcohol occurred in Italy and did not antedate the +12th century, i.e. the time just before the last version of the *Mappae Clavicula*, emphasising especially the dependence of the discovery on improvement in the methods of cooling.[g] He pointed out that Hippolytus made no mention of alcohol under any name or of distillation in any form, and that the nimbus effects could have been obtained by sprinkling the hot wine itself, its readiness to evolve alcohol being increased by its salt content. In a letter to Diels, von Lippmann described his quite negative results on attempting to obtain alcohol by means of the Alexandrian still (*ambix* or *dibikos*).[h] There was no trace of alcohol in the distillate.

Since alcohol boils at a temperature more than 20° lower than water it is indeed

[a] Both the papyri and the Corpus.

[b] Whose *Kestoi* contains much on incendiary compositions (cf. Partington, 5). The phosphorescence recipes in Marcus are clearly Hellenistic.

[c] Whom Diels from philological evidence was inclined to locate in Carolingian France. The more usual view is that they were Italians.

[d] *Meteorologica*, 387*b* 9; Didot ed., vol. 3, p. 622. So also Theophrastus *De Igne*, 67, Wimmer ed., vol. 2, p. 70.

[e] *Refutatio Omnium Haeresium*, IV, 31; McMahon & Salmond tr., vol. 1, p. 98; Legge tr., vol. 1, p. 96. The sea-foam was probably crude salt, which raised the boiling-point of the wine and reduced the proportion of water in the evaporate. Arntz (1), p. 207, describes experiments which demonstrate the effect. De Rochas d'Aiglun (1) was one of the first to call attention to the passage.

[f] In Berthelot (10), pp. 117, 142. Diels' belief in the distillation of alcohol by the later Alexandrian proto-chemists was supported to some extent by Degering (1) who urged (on philological grounds) that an alcohol recipe in one of the *Mappae Clavicula* MSS should be placed in the +8th century. This was strongly contested by von Lippmann (9), vol. 1, and has not won general assent. Cf. Forbes (9), pp. 88–9.

[g] Especially the introduction of water-cooling. Ruska (17); Sudhoff (2) and Sherwood Taylor (4), p. 156, concurred in these views of von Lippmann. So at one time did Reti (7), p. 656. With some reservations (p. 127) we still do, and so does Arntz (1), pp. 205, 211.

[h] In Diels (3), pp. 30–1. In spite of this, Diels never gave up his point of view; cf. (1), p. 153.

easily lost. Nevertheless the dependence of alcohol-production on still-head, condenser or receiver cooling must not be stated in too extreme a way. Much depends on the exact technique used. Suppose wine is distilled in an Alexandrian still with peripheral catch-rim, cooled by air alone. As long as the rising vapours are rich in alcohol the still-head warms up only slowly, and the condensate is collected reasonably well, but as the alcohol-content of the wine in the still falls the temperature at the roof starts to climb, and much of the vapour escapes uncondensed. This results from the specific heat of alcohol, which is only 58 % of that of water, and from its heat of vaporisation,

Fig. 1496. 'Rosenhut' still for alcohol distillation, from Puff von Schrick's book, first published in + 1478. When there is no still-head cooling, as here, the design and dimensions of the still have to be rather special, and particular conditions have to be fulfilled.

only 37 % of that of water. Hence it will come off while the solution is still relatively cool, and it will not heat the still-head too much when it gets there. The still top also has to be large relatively to the size of the bottom containing the wine (cf. p. 126), the room temperature has to be cool, and moreover the operation has to be carried out gently and slowly, never letting the still-contents boil—as indeed many of the old distillation manuals recommend.[a] All this probably explains why the metal 'Rosenhut' still with a high conical un-cooled head is so often depicted during the +15th and +16th centuries in use for the distillation of strong spirits.[b]

This last still seems rather similar to one of those described in the Greek proto-chemical Corpus.[c] In the +4th century Zosimus (Ko Hung's contemporary) added to the other forms a still with a body of large diameter so as to give a greater evaporating surface suitable for distillation at relatively low temperatures, as on a water-

[a] Dr L. Reti told us that he had confirmed in personal experiments the feasibility of the method if carefully handled.

[b] E.g. by Puff von Schrick (Fig. 1496), Brunschwyk, Biringuccio, etc., cf. Forbes (9), figs. 29, 40, 57.

[c] Here Dr Reti dissented, as he felt that the height and conical shape of the Rosenhut were particularly important, though with sufficient care alcohol can be got off from any still.

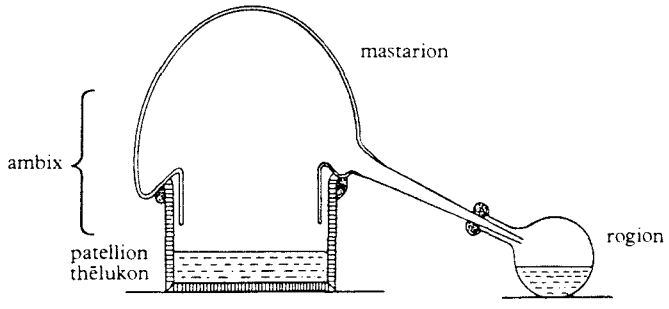


Fig. 1497. The *mastarion* or 'cold-still' of Zosimus (reconstructed by Sherwood Taylor (5), pp. 199 ff.). The *mastarion* is the breast-shaped still-head; and the pan which formed the still body was called the *patellion thēlukon* or female dish, presumably because the still-head was inserted into it. The two together formed an *ambix*. This apparatus was used at low temperatures on a water-bath or dung-bed, and its form permitted a rapid diffusion of vapour to the still-head, as is necessary for distillation in such conditions.

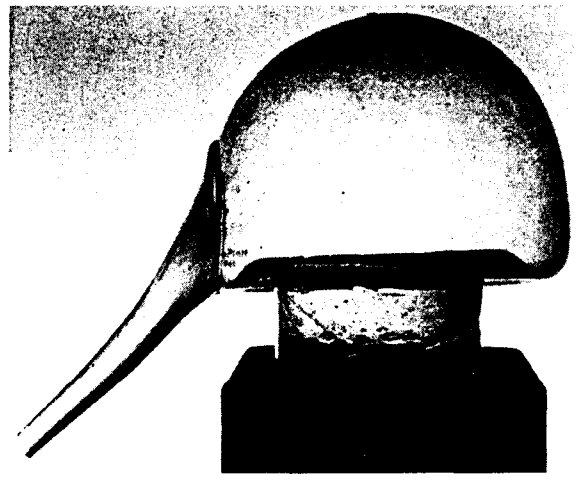


Fig. 1498. Glass still-head of *mastarion* type from Egypt, datable from the + 5th to the + 8th century (photo. Royal Ontario Museum, Toronto).

bath (Fig. 1497).[a] The conical or breast-shaped cowl was called *mastarion* (μαστάριον), and the whole still (*ambix*, ἄμβιξ) with its two parts 'hermaphrodite' (*arsenothēlu*, ἀρσενόθηλυ).[b] The process described was the destructive distillation of eggs to get ammonium sulphide and calcium polysulphides;[c] and the passage seems to be the oldest in the West in which the 'bain-Marie' or water-bath is mentioned. Actual examples of glass still-heads apparently of this type, dating from the + 5th to the + 8th centuries, have been recovered in Egypt and Syria (Fig. 1498).[d] In later times, such pieces of apparatus were known as 'cold-stills'.[e]

[a] *Corp. Alchem. Gr.* III, viii, 1, tr. Berthelot & Ruelle (1), vol. 3. p. 143.
[b] Sherwood Taylor (5), pp. 198ff. [c] Cf. Vol. 5, pt. 2, pp. 252, 271, pt. 3, p. 103.
[d] Cf. Erman & Ranke (1); Sherwood Taylor (4), p. 155 and pl. 10*a* opp. p. 161; Davies (3). Another example is in the Victoria and Albert Museum, London; see Moorhouse, Greenaway *et al.* (1), p. 101.
[e] As, e.g. in French (1), p. 17, reproduced by Sherwood Taylor (5), fig. 12 (cf. Fig. 1496).

These important considerations, however, do not necessarily invalidate von Lippmann's view that still-head water-cooling was historically the basic limiting factor for the discovery of alcohol. The Salernitan Masters and the writer of the recipe in the last version of the *Mappae* may conceivably have used no water-cooling—though after all a wet sponge had been mentioned by Zosimus—but the working hypothesis remains open that efficient still-head cooling was the trigger for the discovery of alcohol in the West. Moreover there was a part of the Eastern world where the practice was traditional and where the idea could have come from.[a] Otherwise one has to explain why eleven centuries elapsed between the first stills of the Alexandrians and the first successes in wine distillation by the Salernitan Masters.[b]

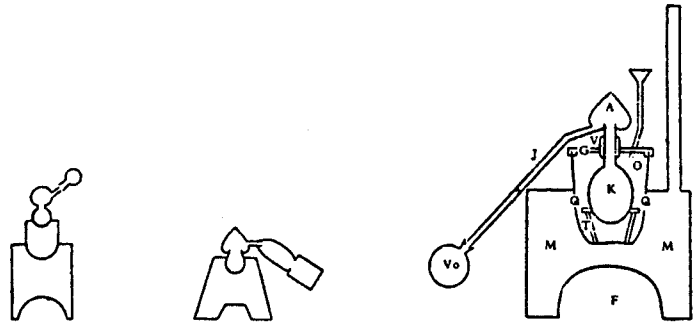


Fig. 1499. Drawings of stills in al-Kindī's *Kitāb Kīmiyā' al-'Iṭr wa'l-Taṣ'īdāt* (Book of Perfume Chemistry and Distillations).

(*a*) Still of retort type, with no annular rim but set upon a water-bath above the stove (from Garbers (1), p. 94).

(*b*) Still of Hellenistic type with annular rim, set in a stove gently heated with charcoal or coal (from Garbers (1), p. 95).

(*c*) Reconstruction of the latter drawing by Garbers (1), p. 19. F, the fire-place (*maudi' al-wuqūd*); M, the stove (*mustauqad*); Q, tall basin of pottery or stoneware (*qidr birām au fakhkhār*); T, ring support of wood (*ṭauq*); K, still body. V, lute and bands connecting it with A, the still-head, of Hellenistic type, delivering to J, the side-tube (*iḥlīl*), and Vo, the receiver (*qābila*); G, a wooden cover to keep in the heat (*ghiṭā'*); O, funnel for adding hot water. The chimney is on the right.

What exactly the Arabs got when they put wine in their stills remains a moot point. That they did do this we know from several statements, but the usual view is that although they distilled wine they did not find the product very interesting. Often they do not mention wine at all.[c] For example al-Anṣārī al-Dimashqī (d. +1327) devotes much space in his cosmography (*Nukhbat al-Dahr*) to the distillation of

[a] Not only so, but as we shall shortly try to demonstrate (pp. 141 ff.), precisely that part of the world had been producing strong alcohol four or five centuries before people in Europe did it. The possibility therefore presents itself that the use of a Rosenhut or cold-still was a secondary development, trickier to carry out but avoiding the greater complexity of water-cooling devices. In pondering these problems we have been much helped by private correspondence with our late friend Dr Ladislao Reti, for which we record our warmest thanks.

[b] And even since Zosimus' sponge and his *mastarion* cold-still eight centuries had passed. Surely there must have been some new impetus.

[c] There was of course the Koranic prohibition of wine, which Bernal (1), p. 203, saw as the main limiting factor, but wine was very well known in Islamic culture, especially after the conquest of Persia.

essential oils and naphtha, but none to wine.[a] Abū'l-Qāsim al-Zahrāwī (Abulcasis, d. *c.* +1013) described the distillation of vinegar 'for whitening'[b] in an apparatus similar to that in which rose-water was distilled, adding that wine can be distilled in the same way.[c] Much earlier, Ya'kub ibn Isḥāq al-Kindī (*fl. c.* +803 to *c.* +870) had alluded to the same thing in his treatise on essential oils, *Kitāb Kīmiyā' al-'Iṭr wa'l-Taṣ'īdāt* (Book of Perfume Chemistry and Distillations).[d] Just beside a picture of an alembic on a stove (Fig. 1499*a*) he says: 'In the same way one can drive up date-wine (*nabīdh*) using a water-bath (*fī'l-ruṭūba*), and it comes out the same colour as rose-water'.[e] In the same century the Jābirian Corpus contains statements that the vapour of boiling wine would catch fire,[f] but that was not going beyond Aristotle.

Perhaps the reason why the great Arabs found the distillate of wine uninteresting was because its alcohol-content was so low. None of them make any reference to cooling, either of still-head, receiver or side-tube, and they were probably quite unaware that there could be any 'spirits' with (as we should say) a boiling-point lower than water,[g] and therefore likely to be lost in the surrounding air if not expressly cooled. Their alembics were evidently quite capable of distilling in quantity not only the essential oils of plants and flowers for civilised life,[h] but also the 'naphtha' or

[a] Tr. Mehren (1), pp. 58, 264; cf. Forbes (9), pp. 48ff.; Wiedemann (22), pp. 246ff. Ruska (22) was convinced that al-Rāzī never knew alcohol, nor Ibn al-Baiṭār either. And if al-Khāzinī (*c.* +1120) had done so, he would hardly have listed olive oil (sp. g. 0·915) as the lightest of known liquids (cf. von Lippmann, 7). Ruska (23), continuing his search, examined the MSS of the most important Arabic treatises on agriculture, and found that although all aspects of wine-growing were dealt with at length there was never any mention of distilled spirits.

[b] This had also been done in a previous generation by al-Rāzī (d. +925) according to Haschmi (priv. comm.). Since the boiling-point of acetic acid is 118° it was theoretically feasible, but in fact the operation is very difficult. That the Chinese may have tried to do this in the +6th century we suggest elsewhere (p. 178). On the 'sharp waters' of the Arabs, which included caustic alkalies, see Ruska & Garbers (1); Leicester (1), pp. 69, 72; Multhauf (5), p. 140. In China *shih hui*[1] (lime) had been slaked to calcium hydroxide (*shu shih hui*[2]) since time immemorial (RP71); while potassium carbonate (*tung hui*,[3] *hui chien*[4]) was got from wood ash, and sodium carbonate (*chien*[5]) from natural deposits (cf. p. 180, and *PTKM*, ch. 7, (pp. 90–1), etc.). Caustic alkalies made by the action of slaked lime on these carbonates were therefore available to the Chinese alchemists also, though we do not hear much about them. Cf. pp. 395, 398.

[c] *Liber Servitoris*, a translation of ch. 28 of his system of medicine, the *Kitāb al-Taṣrīf*. On this see Hamarneh & Sonnedecker (1). For the reference to the distillation of wine see also Sherwood Taylor (6), p. 254; Forbes (9), p. 41.

[d] Dunlop (6), pp. 229ff., voices doubts about the authorship of this work, mainly because of some recipes for the falsification of essential oils; but concedes that parts of it are probably rightly attributed, the others being by a pupil or pupils.

[e] Garbers tr. (1), p. 95; discussed by Haschmi (2, 3). Presumably this means colourless or almost so, not pink. Al-Zahrāwī also made much use of water-baths, including one, the *berchile*, which did not stand on the furnace itself, but was kept at just under boiling-point by a supply of boiling water from a neighbouring vessel directly heated; on this see the discussion of Speter (1) and Ruska (18).

[f] Haschmi (priv. comm.), from the work of Kraus and Steele.

[g] The boiling-point of ethyl alcohol is just under 78° C.

[h] The aromatic constituents of these oils, terpenes and polyterpenes, have boiling-points ranging between 150° and 275° (e.g. pinene at 155°, camphene at 160°, limonene at 175°, caryophyllene at 255° and cadinine at 274°). Similarly geraniol boils at 229°, linalool at 198° and citral at 225°. But of course they will come over well below their boiling-points, if their vapour-pressures are suitable, especially when accompanied by steam. It is fairly clear from the book of al-Kindī that all the perfume-oil processes were steam-distillations (cf. p. 120) even if no water was added to the fresh plant material; and generally done on the water-bath, i.e. much below the boiling temperatures of the oils themselves, thus

[1] 石灰 [2] 熟石灰 [3] 多灰 [4] 灰鹼 [5] 鹼

lighter fractions of petroleum for military use in Greek fire flamethrowers.[a] Yet the apparatus used seems no advance at all on that of Mary the Jewess. Fig. 1499*a*, *b* shows al-Kindī's own drawings,[b] and Fig. 1499*c* Garbers' reconstruction of the still he used in the +9th century for the preparation of all kinds of perfumes and essential oils.[c] Von Lippmann's final opinion was that lack of special cooling arrangements among the Arabs was beyond doubt, so that separation of substances of low boiling-point would have been impossible.[d] This would be true also of the later Arab chemists such as Abū Bakr ibn Zakarīyā al-Rāzī (+865 to +925)[e] or Abū'l-Qāsim al-Sīmawī al-'Irāqī about +1270.[f] But then we are faced with a curious paradox—the most effective still-head cooling device in Renaissance Europe was always called, as we have seen, the 'Moor's head' (Fig. 1466).[g] No explanation of the origin of this term seems to have been

preventing any decomposition. But since their boiling-points are so much higher than that of water they condense very easily without any cooling devices.

[a] Here just the same thing applies. When crude petroleum is distilled, the largest fractions obtained have boiling-points higher than that of water—'ligroin' from 100 to 120°, 'cleaning oil' from 120 to 150°, and kerosene or 'burning oil' from 150 to 300°. Hydrocarbons like dodecane (214°) and cetene (274°) would be in this last fraction, and the octane (126°) would also have been obtained; but the Byzantine and Arabic chemists would have lost all their 'petroleum ether', i.e. pentane (37°) and hexane (69°); probably a good deal of their heptane (98°) as well. The higher b.p. lubricating oils, vaselines and waxy paraffins would have remained behind in their stills. Multhauf (2) makes the interesting point that through many centuries of early distillation there was a prejudice against residues, not overcome (with a better appreciation of the meaning of chemical separation) until Libavius' time at the end of the +16th century. All in all, the preparation of 'Greek fire' or *naft* must have been a hazardous exercise, and one would like to know just how the dangers of fire were overcome (cf. Forbes (9), pp. 52–3). Presumably water-baths were not used, since the Byzantines and Arabs did not much mind what particular mixture of light fractions they got, so long as it would burn fiercely—like our petrol or gasoline —even on water. A certain amount of decomposition did not matter, but even so the furnaces must have been regulated very carefully, especially if the side-tubes were relatively small in diameter.

[b] Garbers (1), pp. 94, 95. [c] (1), p. 19.

[d] (1), vol. 3, pp. 32, 54, 113. See also Wiedemann (15, 22, 29), outstanding for his knowledge of Arabic chemical and technical texts, who could adduce no cooling systems. We say 'special cooling arrangements' having in mind primarily water-cooling, though presumably the Arabs could have achieved something by the use of the cold-still or Rosenhut (cf. p. 125). Although this seems to go back to Zosimus, the fact that neither the Alexandrians nor the Arabs successfully prepared alcohol strengthens the suggestion already made that distilling it without water-cooling was a rather tricky procedure requiring several special conditions, and may therefore have come a good deal later than the first discovery. Dr Reti was loth to accept this, feeling that air-cooling must have preceded water-cooling, but the logical order may not always have been the historical one, as we have found before in the sequence of power-sources (Vol. 4, pt. 2, pp. 192–3) where animal power may not necessarily always precede water-power.

[e] Most of what al-Rāzī says about apparatus is in his *Kitāb Sirr al-Asrār* (Book of the Secret of Secrets), tr. Ruska (14), comm. Ruska (15, 16) with notes on his full bibliography.

[f] See Mieli (1), 2nd. ed., p. 156. Most of the apparatus used by him is described in the *Kitāb al-Kanz al-Afkhar wa'l-Sirr al-A'ẓam fī Taṣrīf al-Ḥajar al-Mukarram* (Book of the Most Glorious Treasure and Greatest Secret on the Transmutation of the Philosopher's Stone), on which see Ruska & Wiedemann (1). His more famous book, *Kitāb al-'Ilm al-Muktasab fī Zirā'at al-Dhahab* (Book of the Knowledge of the Cultivation of Gold) is available in translation by Holmyard (5).

[g] It is true that the oldest device, as used by Alderotti, and presumably therefore also by the +12th-century Salernitan Masters and the shadowy distillers of the *Mappae* and the *Liber Ignium* (though we have no positive knowledge of what they used), seems to have been the rising water-cooled serpentine side-tube (Fig. 1469), but one cannot find Arabic antecedents for that either. The possibility remains open that the men of the +12th century used 'Chinese' stills; both serpent and 'Moor's head' being later developments, neither exactly like the Chinese still-head cooling-bowl with its central collection system.

This might be a rather hazardous hypothesis if no relict traces of the Chinese still were to be found in the Western world. But the fact is, as we have seen (pp. 106, 111 above), that there are such traces both in Europe and the Americas, how and when mediated, and by whom, remains a mystery.

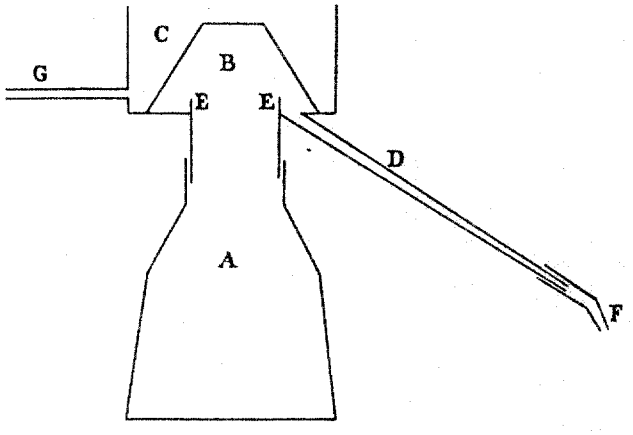


Fig. 1500. A 'Moor's head' still from a Moorish land, cross-section of the Algerian steam distillation apparatus described by Hilton-Simpson (1), p. 20. A, the still body; B, still-head; C, cooling reservoir; D, side-tube; E, beading forming the annular gutter; F, receiver; G, tube for withdrawal of heated water. All parts are made of tinned copper.

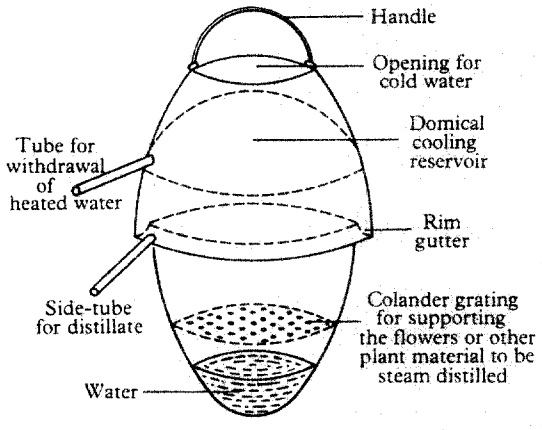


Fig. 1501. Steam distillation apparatus of compact form in tinned copper from Fez in Morocco (orig. drawing, from the specimen in the collection of Dr Stephen Toulmin and Dr June Toulmin, 1963). Here the Moor's head condenser approaches closely to the Chinese type, yet its base which forms the roof of the still is concave in true Western style, not convex, and thus the Hellenistic annular gutter is retained.

attempted by historians of chemistry, but it is hard to believe that it was purely pejorative and does not betray to us some influence from the world of Islam. It is at least a fair comment that Moor's heads do occur in Moorish lands now, as witness the traditional *qaṭṭāra* stills of Biskra and Timgad in Algeria,[a] of Fez in Morocco,[b] and of

[a] Hilton-Simpson (1), p. 20 and pl. III (see Fig. 1500). Thomas Shaw, travelling in the Levant in +1720, saw stills of this kind.

[b] See Goodfield & Toulmin (1), with photographs. I had the pleasure of examining one of these, all of tinned copper, brought back to London from Fez in 1963 by Dr June Goodfield Toulmin, to whom our thanks are due (see Fig. 1501). Its cross-section is quite similar to those of Baumé in +1777 (Schelenz (2), fig. 40). In 1909 Wiedemann (22) published a cross-section of a still then used in Damascus for the preparation of rose-water; it does not make sense as it stands, but the most likely interpretation would approximate it to those just mentioned.

Karachi in Pakistan.[a] If Islamic influence can nowise be substantiated in new researches we may have to look further east, and suppose that 'Moor' meant anyone from the 'Farther Indies', remembering of course that the Chinese still had a water-cooled head built in to its pattern of necessity from the beginning.[b] Here we almost reach a parallel with the case of the magnetic compass related in Section 26, long known in China before its first appearance in Europe *c.* +1180, yet showing no trace in either Arabic or Indian literature of its passage through those intermediate culture-areas.

And what indeed can be said of India? A century ago Rajendralala Mitra (1) claimed that the *surā* of the Saṃhitās, Brāhmaṇas and epics (−8th to +2nd centuries) was wine distilled rather than only fermented, but he produced no cogent proof. For the Tantric period, of course (+6th century onwards), he may well have been right; but for antiquity the last word long remained with von Lippmann, who argued convincingly that *surā* was wine prepared by fermentation, not spirits.[c] It has also been thought that the *Arthaśāstra* (which reached its present form in the +3rd century) mentions spirits among the many kinds of alcoholic drink under the control of the Fermented Beverages Superintendent;[d] but here again an inexcusably loose use of the word 'liquor' was liable to give a false impression, and von Lippmann concluded that we have really no ground for assuming distillation in this source.[e]

The question has now been reopened by Allchin (1), who assembles an argument indicating that distilled strong alcohol was known in Indian antiquity, and that the Gandhāran stills were in fact used for this purpose.[f] The first part is philological. Allchin noticed that certain words have acquired a curious and persistent set of double meanings. Thus *śuṇḍa* means both 'elephant trunk', 'alcoholic drink' and 'tavern'; *śuṇḍin* 'possessing a trunk' and 'maker of alcoholic beverage'; *śuṇḍika* 'seller of alcoholic wares' and 'tavern'. These senses occur as early as the grammarian Patānjalī in the −2nd century, as well as in the *Ramayana* and the *Mahābharata* (−2nd to +3rd centuries). They are never explained, but the association with the side-tube of the still is, Allchin urges, too obvious to be disregarded.[g] At the other end of history Molesworth (1) in his Marathi dictionary of 1857 gives *śuṇḍa-yantra* as meaning baldly an alembic or retort. Furthermore, the oldest certain reference to distillation in an Indian text, though very late (+16th or +17th century), brings in elephants again, for Govinda Dāsa calls the still which he describes[h] *gaja-kumbhavat*, 'resembling an

[a] Jamshed Bakht & Madhihassan (2). They are used mainly for preparing essential oils (*araqiath*), and the *ḥammām-i Mariya* is often used.

[b] In this we are emboldened by the intuition of Schelenz (2), p. 39, favouring westward transmissions from China and India in the history of distillation. The whole question was raised for us in a stimulating correspondence with Dr Ladislao Reti (1965–6).

[c] (9), vol. 2, pp. 204ff.

[d] Ch. 25, Shamasastry tr., pp. 131ff.

[e] *Op. cit.*, pp. 29ff.

[f] Such a view had already been maintained by Mahdihassan (56), p. 164.

[g] Cf. terms derived from shape, such as 'cucurbit' and 'pelican' in the West. The morphological resemblance was first noted by an Indian scholar, V. S. Agrarvala. There are other words with some relevance, such as *pariśrutā*, 'trickling down', in the *Śatapatha-brāhmaṇa* for example, but the significance of this is hard to distinguish from filtration.

[h] Strangely enough, a *dibikos*.

elephant-pot', this referring not so much to the trunk as to the two protuberances on the elephant's head which exude a secretion during rutting. This is the *Bhaiṣajya-ratnāvalī* (Jewel Necklace of Materia Medica), used by Mitra though not clearly mentioned by him.[a]

Secondly, the archaeological. At Pushkalāvatī there were found a large number of receiver-bottles though only one or two alembics or their fragments, and many of these receivers were stamped with *tanga* monograms, sometimes royal seals (*raja-mudrā*), suggesting that the receivers were corked[b] and marketed as such, almost as if 'appellation controlée'. Such seals are mentioned in the *Arthaśāstra*.[c] Large numbers of drinking-cups were also found piled up at the site. As for the chemical technology, although some *ad hoc* experiments would be desirable, it seems fairly sure that stills of Gandhāran type could be used for the preparation of alcohol if small amounts of wine were used, with carefully controlled heating, and the receiver cooled in water. If so, we should have another Asian source for the stimulus of the Moor's head. On the other hand the possibility has to be kept open that the main use for these stills was for mercury; that would be much more in line with the *rasāyana* of the later Tantric alchemical books, and perhaps with the marked opposition of the mainstream Indian religious traditions to wine, *a fortiori* to distilled spirits. The royal seals would be equally appropriate for the purified 'precious' metal, but the disproportion of receivers and alembics would be more bizarre, as also the presence of so many vessels that could have been used as drinking-cups.[d] So perhaps judgment should be suspended for a while, though there is certainly a strong case for Gandhāran alcohol-distillation. But now the moment has come to look more closely at the evidence for alcohol-distillation in early medieval China itself.

(ii) *Ming naturalists*

This has been an intricate story, beset by lack of explicit early descriptions, by the absence of a distinctive technical term for distillation in classical Chinese, and by the misunderstandings not only of Western scholars but of the Chinese naturalists themselves. Nevertheless with patience a coherent picture can be made to come into focus. Li Shih-Chen, in his *Pên Tshao Kang Mu* of +1596, gave two rather confused accounts, the wording of which has given rise to many misapprehensions that need correcting with care, but a close study of his words reveals much. In modern scientific language distillation is called *chêng liu*,[1] an unambiguous binome, but in earlier times one may have to recognise the process by the first word alone, which also means 'to steam' in general, and the apparatus by the word *tsêng*,[2] which can also mean any kind of 'steamer', such as those ancient ones already described (p. 27 above). Other words

[a] Cf. Majumdar (2), p. 251.

[b] With what, one wonders? Cf. p. 143.

[c] Ch. 21, Shamasastry tr., pp. 121, 123.

[d] It should be possible to settle the matter by using modern methods for detecting traces of metallic mercury in the pottery.

[1] 蒸餾 [2] 甑

therefore acquire particular importance as indicators of what was going on, e.g. *shao chiu*[1] or 'burnt-wine' (entirely analogous to *Branntwein* and brandy),[a] for which there are a number of references in Thang literature none of which were taken into account by Li Shih-Chen. The question of such a distillation of *aqua ardens* between the +6th and the +12th centuries has been much debated by Chinese historians of science. Yuan Han-Chhing (*1*) was the first to collect the literary references, Tshao Yuan-Yü (*2*) was convinced to begin with but later changed his mind (*3*), while since then Wu Tê-To (*1*) has provided more pieces of evidence, and we shall here adduce a greater number still.[b] One must of course in assessing probabilities always remember the water-cooling embodied in the basic design of the Mongol and Chinese apparatus. Furthermore, the subject of strong alcohol in Chinese culture is intimately bound up with an entirely different method of getting it, not by distillation but by freezing the water with which it was mixed. We shall leave the discussion of this simple and primitive technique, assuredly originating in Northern or Central Asia, till the end of our survey, not as a half-relevant appendix, but because it may perhaps be the foundation-stone of the story of all alcohol production everywhere, the starting-point from which it may be possible to trace step by step its gradual spread through all the Old World cultures. But before going further, however, it is necessary to purge the sinological literature of a number of mistranslations which have purported to indicate the existence of distillation in China before the +6th century. We have no wish at all to deny the possibility of its existence as far back as Li Shao-Chün or Liu Hsiang; we can only say that there is as yet no positive evidence for it in the Chhin, Han and Chin periods, such evidence not being provided by the words which the eminent sinologists were translating.

Thus, as the first example, let us look at passages in the book of Wang Chhung[2] written about +83, *Lun Hêng*[3] (Discourses Weighed in the Balance), as translated by Forke (4). 'From cooked grain wine is distilled', or 'Distilled wine has different flavours', or 'The cook and the distiller';[c] but in all cases the term in the text is *niang*,[4] which invariably means fermented, never under any circumstances distilled.[d] Elsewhere the characters *chih niang*[5] come together,[e] but they belong to two different grammatical phrases, so that instead of 'Fragrant grass can be used for the distillation of spirits, its perfume being very intense' one should read: '...can be burnt (as incense); and fermented (wine) can be perfumed with it.'[f] In the following century

[a] On the origin of these terms from Lat. *coctum*, and Ger. *gebrannt*, cf. Schelenz (2), p. 65.

[b] The positive view has been warmly supported by Schafer (16), p. 190, and earlier by W. Eberhard in his review of Hermanns (1). Shang Ping-Ho (*1*) concurs. Shinoda Osamu (*3*) and Ōtani Shō (*1*) are more uncertain, but incline to the positive view.

[c] Ch. 5, tr. Forke (4), vol. 1, p. 154.

[d] As we already pointed out, following Dudgeon (2), in Vol. 1, p. 7. Could it be that a similar misunderstanding led Frodsham (1), p. 109, to write (commenting on his translation of the poems of Li Ho, *c.* +810), 'Hsin-fêng was a suburb of Chhang-an where wines were distilled'? In any case, evidence which will be presented below goes to demonstrate that for this period (though not very long before it), his expression could be well justified.

[e] Ch. 18, tr. Forke (4), vol. 2, p. 167.

[f] Or just 'to give a perfume', since *niang* can sometimes mean 'to cause'. Legge (8), pp 152–3, had an *idée fixe* that *chiu* (wine) in the *Shih Ching* always meant distilled spirits; this was supported by a mistranslation due to de la Charme (1) in +1733, but it has no basis in fact.

[1] 燒酒 [2] 王充 [3] 論衡 [4] 釀 [5] 秫釀

came the life of Tshui Shih,[1] studied by Balazs (1), who in a moment of aberration called him at one point a 'destillateur d'eau-de-vie'.[a] The text says that after being Governor of Liaotung he fell upon bad times and gained his living *i ku niang fan chou wei yeh*,[2] i.e. by running a wine-making business and selling congee or rice porridge.[b] Then, as might be expected, the *Pao Phu Tzu* book has caused many to stumble. Elsewhere we refer to the double impossibility of Feifel (1), translating Ko Hung's remark about crabs and hemp: '...if hemp sets distilled spirits in fermentation',[c] which ought to read 'But as for crabs affecting (the setting of) lacquer,[d] or hempseed (oil) spoiling wine (*ma chih huai chiu*[3]), these are matters for which one cannot deduce the (causative) pattern-principle.'[e] In another place Feifel rendered *chiu yün chih shun*[4] as 'wine distilled nine times',[f] but this was a confusion with an ancient process whereby further supplies of carbohydrate in the form of freshly steamed grain were added successively to a fermentation process which would otherwise come to a stop. The context is as follows:[g]

> There are many lesser recipes for consuming elixirs, but since the skill with which they are prepared varies their efficacy is also different. And whatever such factors there may be, an elixir which has not undergone an adequate number of cyclical transformations is like wine that has been just fermented once—it cannot be compared with good strong wine which has been fermented nine times (i.e. by eight additions of steamed grain), (*i tou chih chiu pu kho i fang chiu yün chih shun*[5]).[h]

Finally, even Ware (5), generally so trustworthy, went beyond what we at present dare, in translating the word *fei*,[6] to fly up, as distillation, in the context of mercury. For example, Ko Hung seems to say:[i]

> I know for a fact that at the present day one can become an immortal. I myself can renounce cereal foods, and other things that people normally eat. I aver that mercury can be distilled (*wo pao liu-chu kho fei yeh*[7]), and that gold and silver can be sought out (i.e. made artificially), (*huang pai chih kho chhiu yeh*[8])...

Now although we know that mercury was being distilled in plenty in the ordinary way later on, it was probably being prepared in Han and Chin times mainly by *destillatio per descensum* (cf. p. 55), and therefore it would be safer to translate Ko Hung here with the meaning of sublimation. Moreover it seems significant that descriptions of

[a] P. 107. Cf. Vol. 5, pt. 2, p. 140 and Fig. 1341*b*.

[b] It is true that late Western dictionaries associate the word *ku* with spirits, but this was a development of recent times, and anciently— as can be seen from the Khang-Hsi Dictionary—the meaning was always wine-shops and the wine-trade.

[c] P. 197, from ch. 3, p. 5*b*.

[d] On this see p. 207 below.

[e] Tr. auct. adjuv. Ware (5), p. 61.

[f] (2), p. 6.

[g] Ch. 4, p. 3a, tr. auct., adjuv. Ware (5), p. 72. Wu Lu-Chhiang & Davis (2), p. 237, sensed the pitfall, and contented themselves with 'processed'.

[h] *Tou* is the technical term for submitting wine to successive fermentations. Couvreur in his dictionary got this right, but Giles put carelessly 'to redistil'.

[i] Ch. 3, p. 5b, tr. Ware (5), p. 60, mod. auct.

[1] 崔寔 [2] 以酤釀販鬻爲業 [3] 麻之壞酒 [4] 九醞之醇
[5] 一酘之酒不可以方九醞之醅 [6] 飛 [7] 吾保流珠可飛也
[8] 黃白之可求也

distillation in subsequent centuries rarely use the word *fei*, even for mercury,[a] though we have seen an example of it in the +12th-century text quoted on p. 79 above. Therefore on the whole we should prefer to read: 'I aver that mercury can be volatilised, and that yellow and white (metal, i.e. gold and silver) can be produced (successfully by chemical means).'[b] And the same applies to what Huang Ti did;[c] we should be happier to say for *tao Ting-hu erh fei liu-chu*[1] 'When he came to Tripod Lake he volatilised (or sublimed) mercury'.

We may now consider the best known passage in the *Pên Tshao Kang Mu*.[d] Giving as synonyms for *shao chiu* (burnt-wine) *huo chiu*,[2] 'fire-wine', and *a-la-chi chiu*,[3] Mongol *araki* (which he thought had first been mentioned in the *Yin Shan Chêng Yao*, *c.* +1330), Li Shih-Chen goes on to say:

> The making of burnt-wine was not an ancient art. The technique was first developed in Yuan times (+1280 to +1367). Strong wine (*nung chiu*[4]) is mixed with the fermentation residues (*tsao*[5]) and put inside a still (*tsêng*[6]). On heating (*chêng*[7]) the vapour is made to rise, and a vessel is used to collect the condensing drops (*ti lu*[8]). All sorts of wine that have turned sour can be used for distilling (*chêng shao*[9]).[e] Nowadays in general glutinous rice (*no-mi*[10]) or ordinary rice (*kêng mi*[11]) or glutinous millet (*shu*[12]) or the other variety of glutinous millet (*shu*[13]) or barley (*ta mai*[14]), are first cooked by steaming (*chêng shu*[15]), then mixed with ferment (*chhü*[16]) and allowed to brew (*niang*[17]) in vats (*yung*[18]) for seven days before being distilled. (The product) is as clear as water and its taste is extremely strong. This is distilled spirits (*chiu lu*[19]).[f]

Not much commentary is necessary here except to draw attention to the ferment *chhü*,[16] highly characteristic of Chinese brewing; it is a mixture of *Aspergillus* moulds together with yeasts grown under special conditions on a prepared cereal basis, and the moulds have the function of breaking down the polysaccharides (just as the intrinsic enzymes of malted grain do in the West) so that the yeasts can act upon them to produce the alcohol. An interesting account of the preparation of *chhü* has been translated from the *Chhi Min Yao Shu* of *c.* +540 by Huang Tzu-Chhing & Chao Yün-Tshung (1); we shall quote from this in due course when dealing with the fermentation industries in Sect. 40 (Vol. 6). A little later, among his remarks on the medical uses of strong alcohol, Li Shih-Chen says that it is of the same nature as fire, and that it can easily be set alight, disappearing as it burns away. He concludes the

[a] *TKKW*, ch. 16, p. 2*a*, has *shêng*,[20] to rise up (cf. Sun & Sun tr. (1), p. 280).

[b] Feifel (1), p. 197, was much further off the rails than Ware—'I warrant that one can make people fly (with the aid of) the "flowing pearls" (i.e. mercury)'.

[c] Ch. 13, p. 3*a*, cf. Ware (5), p. 215.

[d] Ch. 25, p. 41*b* (p. 34), tr. auct.

[e] This remark recalls the tradition recorded by Cibot (15) that spirits from cereal wine were first found out by a Shantung peasant-farmer who used mash from a mould fermentation which had gone wrong and was not going to yield a drinkable result.

[f] The use of the word dew (*lu*) here is strangely reminiscent of the 'mountain-dew' beloved in Scots and Irish use for designating whisky, especially when illicit.

[1] 到鼎湖而飛流珠 [2] 火酒 [3] 阿剌吉酒 [4] 濃酒 [5] 糟
[6] 甑 [7] 蒸 [8] 滴露 [9] 蒸燒 [10] 糯米 [11] 粳米
[12] 黍 [13] 秫 [14] 大麥 [15] 蒸熟 [16] 麴 [17] 釀
[18] 甕 [19] 酒露 [20] 升

above passage by quoting from Wang Ying's[1] *Shih Wu Pên Tshao*[2] (Nutritional Natural History) of *c.* +1520 about a particularly strong variety of spirits imported from Hsien-Lo[3] (Siam). There, it seems, they rectified, distilling the wine twice and adding to it aromatic substances. Stored in casks made lacquer-shiny inside by the smoke of burning sandalwood, sealed with wax and matured for two or three years, such 'whisky' was imported by sea; it was expensive but very potent, not only as a drink but as a medicine.[a] This description was in fact several centuries earlier than Wang Ying himself (who had only copied it), or even the +15th-century navigations, so that it will figure presently in our account of pre-European alcohol distillation (p. 145 below).

Many Western scholars, such as Laufer[b] and von Lippmann,[c] have known about this first passage, and were only too happy to accept the late dating of so high an authority, but things are not so simple. There is a second passage in the *Pên Tshao Kang Mu*, even more important, which has generally been overlooked by them. It runs as follows:[d]

Mêng Shen[4] in his *Shih Liao Pên Tshao*[5] (Nutritional Therapy and Natural History, *c.* +670) says: 'Grapes can be used for making wine (*kho niang chiu*[6]). The vine juice (*thêng chih*[7]) is also suitable (for the same purpose).'

There are, in fact, two sorts of grape wine, that obtained by fermentation, which has an elegant taste, and that made like *shao chiu*[8] (by distilling), which has a powerful action (*ta tu*[9]). The makers mix the juice with *chhü*[10] just as in the ordinary way for the fermentation of glutinous rice. Dried raisins ground up can also be used in place of the juice. This is what the emperor Wên of the Wei Dynasty meant when he said that wine made from grapes was better than that from *chhü*[10] and rice, because the intoxicating effect of the former fades away more quickly. In the distillation method many dozens of catties of grapes are first treated with the 'great ferment' (*ta chhü*[11]) such as is used to make vinegar, and then put into the still and heated. A receiver is used to collect the distillate (*ti lu*[12]). This is a beautiful pink colour. Anciently, such brandy was made in the Western countries (*hsi yü*[13]). It was only when Kao-chhang[14] (i.e. Turfan, in mod. Sinkiang) was captured during the Thang period that this technique was obtained.

According to the *Liang Ssu Kung Chi*[15] (Tales of the Four Lords of Liang), Kao-chhang presented 'frozen-out wine' (*tung chiu*[16]), made from dried grapes, to the imperial court. According to (Wan) Chieh Kung[17] the grapes with thin skins tasted best, while those with thick skins tasted tart. He also said that the 'frozen-out wine' made in the Pa-fêng Ku[18] (valley) would keep for years.[e]

[a] There are further references to the distilled spirits of South Asia, in Chêng Ho's time, in Ma Huan's[19] *Ying Yai Shêng Lan*[20] of +1433. Of the Siamese (Hsien-Lo[3]) people he says that they have burnt-wine (*shao chiu*[8]) distilled from both rice and coconuts, presumably palm toddy, sold very cheap (p. 32; Mills (11), p. 107). In Bengal (Pang-Ko-La[21]) there are four kinds of burnt-wine, from rice, from some kind of tree, and from two sorts of palm, the coconut and the *chiao-chang*[22] (*Nipa fruticans*), all abundantly available (p. 76; Mills (11), p. 161).

[b] (1), p. 238. [c] (9), vol. 2, pp. 65–6. Cf. also Goodrich (1), p. 176.

[d] Ch. 25, p. 43*a* (p. 35), tr. auct. [e] The full text is in *TPYL*, ch. 845, pp. 5*b*, 6*a*.

[1] 汪頴 [2] 食物本草 [3] 暹羅 [4] 孟詵 [5] 食療本草
[6] 可釀酒 [7] 藤汁 [8] 燒酒 [9] 大毒 [10] 麴
[11] 大麴 [12] 滴露 [13] 西域 [14] 高昌 [15] 梁四公記
[16] 凍酒 [17] 酆杰公 [18] 八風谷 [19] 馬歡 [20] 瀛涯勝覽
[21] 栟葛剌 [22] 麥葉

Then Yeh Tzu-Chhi,[1] in his *Tshao Mu Tzu*,[2] says that 'under the Yuan Dynasty grape wine was made in the districts of Chi[3] and Ning.[4] During the eighth month people used to go into the Thai-hang Shan[5] (mountains) to test whether their (distilled spirits) were genuine. Genuine (*araqi* spirit) will not freeze, and if you tilt (the vessel) it will flow; while adulterated kinds, which have been mixed with water, freeze solid at the middle. But if they are kept exposed for a long time there is a quantity which will never freeze, however cold it is, even when everything else has frozen solid.[a] This is the essence (*ching i*[6]) of the wine; when taken it can cause death after intense perspiration (lit., after penetrating through the armpits, *i*[7]). Such wine remains very powerful even when two or three years old.'

The *Yin Shan Chêng Yao*[8] (Principles of Correct Diet) says: 'There are many different sorts of (distilled grape) wine. The strongest comes from the Ha-la-huo[9] country (Qara-Khoja), the next from the Western tribes (Hsi fan,[10] i.e. Mongols or Tibetans), and the next from Phingyang[11] and Thaiyuan[12] (in Shansi).'

Some people hold that when grapes are kept for a long time they turn of their own accord into wine. This wine is fragrant, sweet and strong, and it is really the true grape wine.

This passage needs a considerable amount of exegesis, and what has to be said about it is too important to be relegated to footnotes. The thing to do is to take its statements one by one as they come. First, as to grapes in general, there is no reason to doubt that *Vitis vinifera* was introduced from Bactria to China about −126 by Chang Chhien,[13] whose story we told at the outset of the present work.[b] But they may have been in Lung-hsi (mod. Kansu) somewhat earlier, since the *Shen Nung Pên Tshao Ching*, first of the pharmaceutical natural histories, and probably a work of the Early Han, mentions them and says that wine can be made from them.[c] Mêng Shen's remark about the juice or sap is obscure,[d] but it may point to the utilisation of other vines native to China for wine from early times. Li Shih-Chen quotes older treatises[e] as saying that wine can be fermented from 'mountain grapes' (*shan phu thao*[14]) or wild vine species called *ying yü*[15] and *yen yü*,[16] and these have been identified as *Vitis Thunbergii*[f] or *V. filifolia*.[g] Be this as it may, grape wine as we know it was certainly made and drunk, if intermittently, in China from the Han period onwards.[h]

[a] It has been necessary to correct the *PTKM* text here by that of the original book (ch. 3B, p. 8o*a*, *b*) for it is not exactly as Li Shih-Chen abridged and modified it. One thing he left out was that Yeh Tzu-Chhi began by speaking of *araqi* (*ha-la-chi*[17]), or brandy, distilled from grape-wine, not about grape-wine alone. The spirits were, Yeh said, as clear as water, a distillate of wine (*chiu lu*[18]). The passage as amended makes excellent sense. A page later (p. 81*b*) Yeh gives his opinion that distilled spirits from grape-wine first became known in Yuan times.

[b] See Vol. 1, pp. 174ff. His introduction of the cultivated grape-vine was universally recognised in Chinese literature, cf. e.g. *Pên Tshao Phin Hui Ching Yao* (+1505), ch. 32, (p. 771).

[c] Mori ed. (p. 48). Li Shih-Chen noticed this and drew the same conclusion, *PTKM*, ch. 33, p. 9*b*, (pp. 54–5).

[d] The text is correct none the less, as we see from the Tunhuang MS. published by Nakao (1), no. 144, pp. 153–4, no. 174, pp. 178–9. Of course he may have meant just the fruit pulp without the skins.

[e] *PTKM*, ch. 33, p. 11*b*, (p. 56).

[f] CC 768.

[g] Laufer (1), p. 243.

[h] For example the *Hsü Han Shu*[19] records that between +168 and +184 Mêng Tho[20] gave a generous present of grape wine to Chang Chih,[21] and got himself appointed Prefect of Liangchow in consequence.

[1] 葉子奇 [2] 草木子 [3] 冀 [4] 寧 [5] 太行山 [6] 精液
[7] 腋 [8] 飲膳正要 [9] 哈喇火 [10] 西番 [11] 平陽 [12] 太原
[13] 張騫 [14] 山葡萄 [15] 蘡薁 [16] 燕薁 [17] 哈剌基 [18] 酒露
[19] 續漢書 [20] 孟佗 [21] 張詡

Fig. 1502. Wên Ti, ruler of the State of Wei in the Three Kingdoms period, pictured with his colleagues of the States of Shu and Wu in a MS. of +1314, the *Jāmi'al-Tawārīkh* (Collection of Histories) by Rashīd al-Dīn al-Hamdānī (cf. Vol. 1, p. 218), the Chinese portion of which was completed in +1304. Roy. Asiat. Soc. A 27, reproduced in Jahn & Franke (1), pl. 46, cf. tr. p. 52.

What Li says about the technique of distillation calls for no special remark,[a] but Wei Wên Ti's words do. This really was Tshao Phei,[1] of the Three Kingdoms period (r. +220 to +226),[b] and his statement has fortunately been preserved elsewhere.[c] Writing to a friend, Wu Chien,[2] about the fruits of China, he alludes to the grape, saying:

> Grapes...can be fermented (*niang*[3]) to make wine. It is sweeter and more pleasant than (the wine from cereals) made using *chhü* (the moulds and yeasts mixture) or *nieh* (sprouted malt). One recovers from it more easily when one has taken too much. (*Kan yü chhü nieh, shan tsui erh i hsing*[4]).

The meaning of this is not entirely sure. It is evident from Li Shih-Chen's own words, and from much other evidence, that a great deal of grape wine was made in China through the centuries with moulds-and-yeasts mixtures similar to those used im-

[a] Except on the pink colour of the distillate, a subject to which we shall shortly return at a more convenient place.

[b] We take this opportunity of reproducing his picture (Fig. 1502) from the history of China in Rashīd al-Dīn's *Jāmi'al-Tawārīkh* (+1304). It comes from an almost contemporary manuscript (Roy. Asiat. Soc. A 27); see Jahn & Franke (1); Meredith-Owens (1).

[c] *CSHK* (San Kuo sect.), ch. 6, p. 4*a*, *b*; from *I Wên Lei Chü*, ch. 87, *Ta-Kuan Pên Tshao*, ch. 23, and *TPYL*, ch. 972. Also in *PTKM*, ch. 33, (p. 55). Tr. auct.

[1] 曹丕 [2] 吳監 [3] 醲 [4] 甘于麴蘗善醉而易醒

memorially for cereal wines, but the spontaneous fermentation by naturally occurring yeasts from the vines was also known. This is proved by statements such as that in the *Hsin Hsiu Pên Tshao* of +659: 'Unlike other wines, grape wine and mead do not require *chhü*'.[a] As we have phrased the emperor's words above, then, he was saying that 'naturally' fermented grape wine was better than the cereal wines made with moulds as the saccharifying agents; but Yuan Han-Chhing may well be right in interpreting his preference as one for grape wine made with *chhü* as against cereal wine made with *chhü*.[b] This view rests on Yuan's interpretation of what happened in +640, the year of the conquest of Kao-chhang (Turfan),[c] and to that we must now turn.

The most significant passage concerning it has been preserved in the *Thai-Phing Yü Lan*[d] and runs as follows:

> Grape wine was always a great thing in the Western countries.[e] Formerly they sometimes presented it (as tribute) but it was not until Kao-chhang was captured that the seeds of the 'horse-nipple grapes (*ma ju phu-thao*[1])'[f] were obtained, and planted in the imperial gardens. The method of wine-making was also obtained, and the emperor himself took a hand in preparing it. When finished it came in eight colours, and with strong perfumes like those of springtime itself; some sorts tasted like a kind of whey (*thi ang*[2]).[g] (Bottles of) it were given as presents to many of the officials, so people at the capital got to appreciate the taste of it.

This passage, which Yuan Han-Chhing was the first to notice, contributes a good deal to the elucidation of Li Shih-Chen's vague way of talking. When he said that 'this technique was obtained' in +640 or soon afterwards, what did he mean? Grape wine as such, or grape wine made 'naturally' without *chhü*, or the distillation of grape wine? And when he said 'obtained', did he mean that the technique was brought eastwards from Turfan, or that it just grew up in China as the result of some stimulus

[a] Ch. 19, p. 8*a*, (p. 301).

[b] (*1*), p. 97. On wine in general see pp. 73ff., on distilled wine, pp. 94ff.

[c] For the attendant circumstances see Cordier (1), vol. 1, p. 419.

[d] Ch. 844, p. 8*a*, tr. auct. It purports to come from the *Thang Shu*,[3] but we have not been able to find it in either of the two great current versions. It is in *Thang Hui Yao*, ch. 100, (p. 1796).

[e] This of course does not mean Europe, but as the next sentence shows, the small States of Central Asia. It will be remembered that Ssuma Chhien had a good deal to say in the *Shih Chi* (ch. 123) on the grape wine of Ta-Yuan (Ferghana) and An-Hsi (Parthia). There are three separate mentions in this chapter (tr. Watson (1), vol. 2, pp. 266, 268, 279ff.). Chang Hsing-Yün (*1*), who wrote a book on dietetics at the beginning of the nineteenth century, was most apprehensive of the effects of alcoholism, and believed that all Chinese wines and spirits were poisonous. He ascribed the good keeping properties of the Ferghanese wine to the climate, but it may have been in fact strong alcohol obtained by the freezing-out process (cf. p. 151), or alternatively these people possessed adequate means of corking the containers (cf. p. 143).

[f] This is a stumbling-block in the literature, since *ma ju* can also, and often does, mean mare's milk, from which the Mongols made their *kumiss* and distilled their *araki*. Hence translators have to be watchful.

[g] This translation, the most obvious one, is probably wrong, for it seems that *thi* stands for *thi chiu*[4] here, explained as a kind of red wine, and *ang* for *ang chiu*,[5] a kind of greenish-white wine (Morohashi dict. vol. 11, p. 384). So they might have been like our red and white Burgundies, but then that would duplicate the remark just previous about the eight colours. Normally *thi* is associated with milk products (on which see Pulleyblank (11) and the paper of Suzuki Shigeaki (1) for Middle Eastern parallels). *Thi-hu*[6] in Buddhist texts means *ghee* (butter-oil), but where Mongol affairs are concerned more likely whey. The question remains open.

[1] 馬乳蒲桃 [2] 醍盎 [3] 唐書 [4] 醍酒 [5] 盎酒 [6] 醍醐

from Turfan? Yuan Han-Chhing took the view that his words here did not concern distillation at all, but grape wine made without the moulds-and-yeasts mixture, so that it pleased by a floral rather than by a mycological flavour.[a] If that was the technique that came from Turfan, the statement in the *Hsin Hsiu Pên Tshao* just mentioned would not refer to centuries before the +7th. Other scholars, such as Shih Shêng-Han,[b] have preferred to join with old Edkins (18) in thinking that what Li Shih-Chen had chiefly in mind here was the distillation of brandy. But what those who have mostly emphasised the Western origin of this, such as Laufer,[c] have failed to see, is that nowhere in the West at that time was it possible to produce alcohol by distillation, because the Hellenistic–Byzantine stills lacked all head- or condenser-cooling.[d] Therefore that technique cannot have been transmitted to China in the mid +7th century, though it may well have originated there at that time as the result of some stimulus from Turkestan.

What this was may be lying under our very nose in the quotations which Li Shih-Chen gives immediately following about the 'frozen-out wine', i.e. alcohol which has been concentrated by the freezing of its accompanying water. It will be more convenient, however, to postpone the discussion of this, assembling all the relevant information, until the end of the argument. Here it need only be said that while the *Tshao Mu Tzu* (Book of the Fading-like-Grass Master) is a work of the Ming, finished in +1378, the other reference, *Liang Ssu Kung Chi* (Tales of the Four Lords of Liang), is a Thang one, written by Chang Yüeh[1] in +695, but dealing with events of the period +500 to +520.[e] This shows at any rate one thing, over how long a period people in China were familiar with the congelation method of making strong alcoholic solutions, first practised though no doubt it was by the neighbouring peoples of the black North, living on the Thien Shan or beyond the Gobi Desert.

With this we come to Hu Ssu-Hui,[2] the great nutritionist and first discoverer of deficiency diseases,[f] who speaks in his *Yin Shan Chêng Yao* about the brandies of

[a] Yuan adduces supporting opinions on this from later scholars, such as Kao Lien in his *Tsun Shêng Pa Chien* (+1591).

[b] Priv. comm., July, 1958. [c] (1), pp. 237–8.

[d] This statement needs qualification by what has been said above (pp. 125 ff.), but it remains essentially true. We know of no Hellenistic, Byzantine or Arab alcohol.

[e] This is a queer and intriguing book, perhaps the best critique of which was written by Pelliot (47), vol. 2, pp. 677 ff. It cannot be earlier than the +7th century, and Chang Yüeh's authorship is doubtful, but if Lu Shen[3] or Liang Tsai-Yen[4] or Thien Thung[5] wrote it (and all are suspected), the date might well be nearer +650 than +700. In any case, it records traditions in a romancé manner, and none of the Four Lords is a historical character attested from other sources. Nevertheless (to use an adage perversely inappropriate here) there is no smoke without fire, and the freezing-out process could not have been imagined without an empirical basis. Conceivably the 'frozen-out wine' came first to China in +640 or thereabouts rather than +540—but that would not affect our general line of argument.

The original text of the *Liang Ssu Kung Chi* has been preserved only in lengthy quotations. We may find the passage about the frozen-out wine from Kao-chhang (Turfan) also in *Thai-Phing Kuang Chi*, ch. 81, p. 5*a* (vol. 1, p. 336·2), in *TSCC, Shen i tien*, ch. 311, p. 4*a*, and in some editions of *Shuo Fu*, ch. 113. The full form contains various arguments about the genuineness of what the ambassadors presented, but states clearly that the freezing-out process was performed expecially in the Pa Fêng Ku[6] (Eight Winds Valley). [f] Cf. Lu Gwei-Djen & Needham (1), as also Sect. 40 in Vol. 6.

[1] 張說 [2] 忽思慧 [3] 盧詵 [4] 梁載言 [5] 田通
[6] 八風谷

Qara-Khoja[a] and of Shansi.[b] This was in +1330. Half a century earlier, Marco Polo had been in those parts, and mentioned the vineyards of Thaiyuan. 'There grow here (at Taianfu), [he said], many excellent vines, supplying great plenty of wine; and in all Cathay this is the only place where (grape-) wine is produced, being carried thence all over the country.'[c] That he did not mention distilled spirits has been fastened upon by some,[d] disinclined on other grounds to believe in their existence in China at that time, but everyone knows that there were many interesting things which Marco Polo did not mention,[e] and by the end of the +13th century *aqua ardens* may have been so commonplace for him that he was not surprised to find it in Cathay.

(iii) *Thang 'burnt-wine'*

We can now take a look at those writings of the Thang and early Sung which seem to indicate the existence of alcohol distillation from the +7th to the +12th centuries, in all cases prior to the first appearance of *aqua ardens* in the West. Though none may be considered to offer decisive proof, they give rise to a profound suspicion. Let us take them approximately in order of date, as we have done on previous occasions, when for instance we were elucidating the origin of the stern-post rudder.[f] First then we may quote from someone recently mentioned, Mêng Shen in his *Shih Liao Pên Tshao* of +670. There are words in the Tunhuang MS. which could mean:

> Take *chhing liang mi* (some kind of grain) and add one *tou* (10 pints) of pure bitter wine, soak it for three days (to undergo some further fermentation?), then distil (?) over a strong fire many times (*chhing liang mi i shun khu chiu i tou, tzu chih san jih, chhu pai chêng pai pao*[1]). Keep this good stuff, and if you go on a long journey take some; it will ward off hunger for ten days.

Again, in a neighbouring place he says:

> According to the (*Tung Hsüan*) *Ling Pao Wu Fu Ching*[2],[g] one should take *pai hsien mi* (another kind of grain) and (after fermentation?) distil (?) over a strong fire nine times. One can use this as a help for avoiding the eating of cereal foods. (*Pai hsien mi chiu chêng chiu pao, tso pi ku liang*[3]).[h]

But the language is obscure and peculiar, and one cannot be sure that he was not

[a] Pelliot (47), pp. 161 ff., has discoursed on this; it was none other than the ancient Uighur capital some 17 miles east of Turfan. Khoja and Kao-chhang are related forms.

[b] Under the head of the former, he says: 'Take good wine, distil it as it boils, and collect the distillate (*yung hao chiu, chêng ao, chhü lu*[4]).'

[c] See Cordier, in Yule (1), vol. 3, p. 75, from Bk. 2, ch. 37, p. 13, or Moule & Pelliot (1), vol. 2, p. xxvi.

[d] E.g. von Lippmann (5), (9), vol. 2, p. 66.

[e] For instance, scientific astronomy (cf. Vol. 3, p. 378), the magnetic compass (cf. Vol. 4, pt. 1, p. 245), advanced textile machinery (cf. Vol. 1, p. 189) and printed books (Carter, 1).

[f] Vol. 4, pt. 3, pp. 638–9.

[g] 'Manual of the Five Talismans, a Tung-Hsüan Ling-Pao Scripture'. A book with this title was in the *Tao Tsang* once, but it is now lost. The MS. writes Chih[5] for Pao.

[h] Both these passages will be found in Nakao (1), no. 178, pp. 181–2. Tr. auct.

[1] 青粱米以純苦酒一斗漬之三日出百蒸百暴 [2] 洞玄靈寶五符經
[3] 白鮮米九蒸九暴作辟穀粮 [4] 用好酒蒸熬取露 [5] 窒

talking about some preparation of fermented and dried grain—though it would be odd if that were to assist one to abstain from cereals.[a]

In the following century there is another reference to white wine, in the poems of the famous Li Pai[1] (+701 to +762).[b]

> Returning from the mountains one finds that the *pai chiu*[2] has just matured.
> And the yellow chickens, fattened by millet, are ready for the pot,
> Now that autumn has come....

The significance of this and other mentions of *pai chiu* in Thang poetry is not obvious unless one knows that through many recent centuries one of the commonest names for distilled spirits is 'white-and-dry' (*pai kan (erh)*[3]),[c] especially in North China. But there is no certainty that this was what Li Pai was talking about—only the suspicion.[d]

Suspicion grows stronger, however, from the +9th-century references, of which there are a good number.[e] Li Chao[4] (*fl.* +810), talking of wine in his *Kuo Shih Pu*[5] (Emendations to the National History), mentions a 'burnt spring wine' (*shao chhun chiu*[6]) that was made at Chien-nan.[f] Pai Chü-I,[7] the celebrated poet (+772 to +846)

[a] We have not come across the word *pao*, heating, scorching, sun-drying, elsewhere in connection with distillation. Wu Tê-To (*1*), however, felt that these statements should be carefully considered.

[b] Cit. with refs. by Tshao Yuan-Yü (*3*), p. 24. Tr. auct.

[c] Alcohol content *c.* 55%. It is conjectured from the other way of writing *pai kan erh*[8] that the expression may have derived from the *han chiu*[9] of Yuan times. This most probably meant 'sweated wine' (i.e. distilled), and was therefore a direct translation of the Ar. *al-araq*; but it could also perhaps have signified 'wine of the Khan', since *han* was used to transliterate that title. This puts one in mind of the silver fountain with four spouts that William Boucher of Paris built for Mangu Khan at Karakoron in +1254 (cf. Vol. 4, pt. 2, p. 132, and Olschki (4), pp. 57, 63). They are said to have served for the guests four different alcoholic drinks, but kumiss distilled was not one of them. The drinks were grape-wine, fermented mare's milk (*caracosmos, kumiss*), mead (*bal*) and rice-wine (*terracina, cervisia*); cf. Rockhill (5), pp. 207–8, quoted also in Lattimore & Lattimore (1), p. 77; and elsewhere. The distilled *kumiss* could probably not have been made in sufficient quantity. Pien Ssu-I[10] had a poem about *han chiu* in his *Thieh Ti Shih*,[11] *c.* +1338; and in +1751 Tsê Hao[12] stated in his book on popular terms, ideas and customs, *Thung Su Pien*,[13] that the *han chiu* of the Mongols was the same as *shao chiu*.[14]

We are grateful to Dr Chêng Tê-Khun for drawing our attention to this point.

[d] Tshao Yuan-Yü (*3*) did not dare to accept the identity, and his caution was echoed by Shinoda Osamu, in Yabuuchi (*11*), pp. 79, 90. Eberhard, reviewing Hermanns (1), did, however.

[e] Though some are unsubstantial. Poets, when translating, tend to use technical terms in a way which might be deceptive if the reader were not circumspect. For example, Chang Hsin-Tshang (4), p. 112, in his rendering of a poem of about + 808 by Liu Tsung-Yuan, writes: 'We drink the river-water, purer than the best distillation...' Yet the text has only 'pure goblets', filled no doubt with clear wine, but not significant in the present context (see *Chhüan Thang Shih*, ch. 352, in vol. 6, (p. 3941) for the text).

[f] Ch. 3, p. 11 *a, b*. There are other references to this wine, for example in the poetry of Wei Chuang,[15] who exclaimed:

> 'How beautiful the Chin-chiang (river) in the spring,
> And lovely are the girls of Szechuan too,
> Pouring out elegant "burnt spring wine" beside it.' (*Huan Hua Tzhu*[16])

This would have been between +880 and +920. A century later Su Tung-Pho explained, saying: 'In the Thang period there was a wine called "burnt spring", but it was the same as what is now called *shao chiu*,[17] burnt-wine' (Morohashi dict., vol. 7, p. 525). And there is mention of it again in Fan Chhêng-Ta's ode on lichis (*c.* + 1175); cf. Shinoda (*3*), p. 305, Ōtani (*1*), p. 74. Schenk (1), p. 122, was perhaps the first sinologist to recognise that 'burnt spring wine' must have been distilled, but misled by Li Shih-Chen she supposed that it must have been imported from Mongolia.

[1] 李白 [2] 白酒 [3] 白乾(兒) [4] 李鑿 [5] 國史補
[6] 燒春酒 [7] 白居易 [8] 白干兒 [9] 汗酒 [10] 卞思義
[11] 鐵笛詩 [12] 翟灝 [13] 通俗編 [14] 燒酒 [15] 韋莊
[16] 浣花詞 [17] 燒酒

wrote some verses entitled Li-chih Lou Tui Chiu[1] which include the following lines:[a]

The lichis are newly ripe, the colour of a cock's crown,
One catches the first whiff of a perfume like amber from the burnt-wine (*shao chiu*[2]),[b]
How one would like to pluck a branch, and to drink a cup!
But there is no one here in the West with whom to share this beauty.

This could be dated about +820 and starts the run of references to 'burnt-wine'. Less than a decade later Fang Chhien-Li[3] was writing his *Thou Huang Tsa Lu*[4] (Miscellaneous Jottings far from Home), but he was stationed in the far south rather than the far west. Discussing drinks, he spoke of an 'after-burning wine' (*chi shao chiu*[5]), which was kept in sealed pots and pipetted out as needed. What he said was this:[c]

In the south they drink 'after-burning wine' (*chi shao*) taken from pots filled up and then sealed with clay; it is prepared by 'burning' with fire, and matured; if not, it is not good to drink. When the pots are opened there is a tendency for them to be somewhat empty, although the clay seal is still there. When merchants want to know the quality of the wine they bore a very small hole through the seal and insert a reed, withdrawing some of the wine by means of this pipette so that they can see what the taste is like.[d]

They could also see something else, namely the extent to which evaporation had occurred, and what sum, therefore, they ought to offer for the jar. This is redolent indeed of the behaviour one would expect of strong alcohol in a hot climate when people had not found out an adequate form of corking.[e] Again, about a decade later, *c.* +840, Yung Thao[6] wrote a poem in Szechuan in which he said:[f]

Since I reached Chhêngtu the burnt-wine (*shao chiu*) has matured.[g]
I doubt if I shall ever go back to Chhang-an again...

And then there is a highly suspicious phrase in one of the poems of Li Ho[7] (+791 to +817) incorporated in his *Chhang Ku Chi*.[8]

[a] *Chhüan Thang Shih, han* 7, *tshê* 4, ch. 8, p. 11*a*, tr. auct. adjuv. Schafer (16), p. 190.

[b] Some versions read *kuang*,[9] 'the amber sparkle', instead of *hsiang*;[10] which makes better sense So we could read: 'One catches the first glint of amber sparkle in the burnt-wine'.

[c] Cit. *Thai-Phing Kuang Chi*, ch. 233, p. 34*a* (ed. Li Fang in +978). Cf. Wu Tê-To (1), p. 54.

[d] Tr. auct. The passage could be read as if the burning was done in the same vessels as the keeping, but either this was a misapprehension or there has been some corruption in the text.

[e] The history of bungs and corks, perhaps not yet adequately written, is one of those subjects which may seem trivial yet have far-reaching cultural repercussions. It was the main burden of Warner Allen's book (1) on the history of wine in Europe that the exquisite tastes of vintage qualities was unknown in the Middle Ages because casks only were used for storage, the well-stoppered amphora having gone out, and the corked bottle not having come in. The Chinese nearly always used ceramic jars, how well bunged remains to be seen, probably with lacquer as well as wax. In Allen (1) see pp. 88–9, 162, 169, 190–1, 206.

On amphoras see for an introduction Grace (1), though nothing is said of the stoppering. They seem to have been a Canaanite (Phoenician) invention of the −14th century.

[f] *Chhüan Thang Shih, han* 8, *tshê* 6, p. 4*b*, tr. auct., adjuv. Schafer (16), p. 190. Elsewhere Yung Thao spoke of *shao shen chhou*,[11] 'sacrificial burnt-wine for the spirits' (cf. Ōtani Shō (1), p. 73).

[g] The word here used, *shu*,[12] as in the case of Li Pai, has a distinct undertone of cooking over fire.

[1] 荔枝樓對酒 [2] 燒酒 [3] 房千里 [4] 投荒雜錄 [5] 旣燒酒
[6] 鄧陶 [7] 李賀 [8] 昌谷集 [9] 光 [10] 香
[11] 燒神酎 [12] 熟

In the crystal cup the amber (-sparkling) juice is thick,
And the lovely wine runs out like a rivulet of pearly red.[a]

But the Chinese words are more suggestive than this rendering would convey, for they include the expression *hsiao tshao*, meaning a little trough (*Liu-li chung, hu-pho nung, hsiao tshao chiu ti chen chu hung*[1]). Could this not have been a reference to the side-tube of the still? Perhaps it would be better translated:

And the wine-drops from the little channel are a pearly red.

Tshao has overwhelmingly often the meaning of gutter, conduit or flume;[b] and the case is still more strengthened when one knows that in relatively modern times at least *tshao fang*[2] has been the common name for a distillery. So a trickle of wine on a not too clean surface may be more far-fetched than to think that Li Ho knew the side-tubes of stills, and had them in mind when he wrote about his wine-drops.[c]

The last +9th-century witness to be called is Liu Hsün,[3] whose *Ling Piao Lu I*[4] (Strange Things Noted in the South) would have been in the writing about +880. There he said:[d]

In the South it is warmer, and in the spring and winter fermentation takes (only) seven days, in summer and autumn (only) five. When it is ready it is put into an earthenware container, placed over a fire of dung, and 'burnt' (*shao chih*,[5] i.e. heated).
[Author's comm.][e]
There is also a kind which is not 'burnt' (or, heated) and this is called *chhing chiu*[6] ('pure' or 'plain' wine).

Chhing chiu is often mentioned in other texts, such as the *Yu-Yang Tsa Tsu* (+683),[f] and Liu Hsün's statement seems to demonstrate that *shao chiu* was made from it. Furthermore it closes one escape route very neatly. For most of these early mentions of *shao chiu* it would be possible, if not very plausible, to maintain that mulled wine rather than distilled wine was in question, but here Liu Hsün seems clearly to be talking about two kinds of wine in the same sense as Li Shih-Chen, one fermented and stored as such, the other distilled.[g]

Towards the end of the following century, *c.* +990, soon after the beginning of the Sung dynasty, an eminent scholar, Thien Hsi,[7] wrote an interesting little work, the *Chhü Pên Tshao*[8] (Natural History of Yeasts and Fermentations). In this he gave the

[a] Quoted by Lu Yu in *Lao Hsüeh An Pi Chi*, ch. 5, p. 15*b*, and by Fêng Shih-Hua in *Chiu Shih*, ch. 2, (p. 35). Tr. auct.

[b] Many examples have been encountered in Sect. 28 on civil engineering in Vol. 4, pt. 3.

[c] Frodsham (1), p. 239, translated: 'From a little vat the wine drips down.' But vats do not drip, unless leaky and useless. The image of dripping is continued in the lines immediately following, which speak of the fat of 'boiling dragons and roasting phoenix'. Graham (8), p. 102, brings in a wine-cask, which is open to the same objection, and not in the text either.

[d] Cit. *TPYL*, ch. 845, p. 7*a*, tr. auct. Liu is almost certainly talking about rice wine, not grape wine.

[e] This is found only in the *TPYL* version. Even if it were an insertion of the editors, that would make it date to +983, which is also a long time before alcohol distillation in the West.

[f] Cf. Wu Tê-To (1), p. 53.

[g] Earthenware as a practical material for low boiling-point distilling has already been met with in the Japanese pharmaceutical stills (p. 114 above).

[1] 琉璃鍾琥珀濃小槽酒滴眞珠紅 [2] 槽坊 [3] 劉恂 [4] 嶺表錄異
[5] 燒之 [6] 清酒 [7] 田錫 [8] 麴本草

description of the distilled Siamese toddy just as we read it on p. 136 above.[a] Although that was an imported article of commerce,[b] it is obvious from the words of Thien Hsi that in Wu Tai and early Sung times Chinese people understood perfectly clearly what it was that they were drinking, and how it was made. One significant point is that the wine was said to have been 'burnt' twice (*fu shao erh tzhu*[1]), which would not make sense if it was merely warming or mulling.

We still have plenty of time before us ere we reach the mid + 12th century, time of the first alcohol distillations in the West, but from the intervening period we shall quote only two more pieces of evidence. About + 1080 Su Tung-Pho,[2] the great poet-scholar (+ 1036 to + 1101) wrote a rhapsodic ode entitled *Tung-thing Chhun Sê Fu*[3] (Spring Colours by the Tung-thing Lake), in which he thanked and praised the Prince of An-ting, who had made some wine from oranges and had presented him with several bottles of it. Although the language is rather obscure and allusive, the meaning appears to be unmistakable. Su wrote:[c]

> To blend the mixture they use the double-kernelled millet,[d]
> And call on the help of a tube of the triple-ridged reed,[e]
> Suddenly the cloudy vapour condenses like melting ice,
> Whereupon tears come forth dripping down like liquid pearls.

As Alice or somebody said, this is curiouser and curiouser. The side-tube of a still might well be the size of a thick graminaceous stem, the distillate would indeed run from the end of it like a trickle from melting ice, and 'tears' would well describe what dropped into the receiver. One cannot help concluding that what Su Tung-Pho enjoyed was a liqueur something like the *cédratine* of Corsica,[f] though made from fermented millet rather than the trodden grape.

Finally, in + 1117 comes the book of Chu Kung[4] on wine, the *Pei Shan Chiu Ching*[5] (Northern Mountain Wine Manual). None of the tractates on the different sorts of wine which have come down to us have much to say about distilled wine (perhaps for reasons to be mentioned presently), but there is one passage in Chu Kung's text which

[a] In *Shuo Fu* (Ming ed.), *han* 20, ch. 94, tractate 19, p. 2*a*. Reproduced in Japanese by Shinoda Osamu (*3*), p. 305; Ōtani Shō (*1*), p. 73. So far as we know, Thien Hsi's was the earliest description of the Siamese 'whisky'.

[b] Excavations at the site of a port town north of Songkhla in Thailand on the eastern coast of the Malayan peninsula have unearthed large quantities of empty Chinese pottery bottles which might well have been used in this spirits trade. They date from the + 7th to the + 12th centuries. We owe this information to Prof. Janice Stargardt and Prof. Wolfgang Stargardt. The former goes on to say that Chinese trade with this Satingpra region began early in the Thang and continued for centuries. The toddy was made from the palms *Nipa fruticans* and especially *Borassus flabellifera*, which have juices extremely rich in sugar. Other items of this trade were camphor crystals, oils and perfumes.

[c] *TSCC*, *Tshao mu tien*, ch. 226, *i wên* 1, p. 3*a*; also cit. *Chiu Shih*, ch. 1, (p. 8); tr. auct., adjuv. M. J. Hagerty MSS unpub.

[d] *Erh mi chih ho*[6]; an auspicious sign.

[e] *San chi chien*;[7] the numbers complement one another. The plant referred to is probably the white grass', *pai mao*,[8] i.e. *Imperata arundinacea*. *PTKM*, ch. 13, (p. 64).

[f] This is flavoured with the citron, *Citrus medica*, a citrous fruit little seen in Northern Europe, but in fact the first to arrive in the West. It was known to Theophrastus, and the 'Buddha fingers' (*fo shou kan*[9]) of China is a variety of it. Other citrous perfume-oils have also, of course, been used for flavouring liqueurs. See Sect. 38 in Vol. 6 for much further information on the *Citrus* genus in China.

[1] 復燒二次 [2] 蘇東坡 [3] 洞庭春色賦 [4] 朱肱 [5] 北山酒經
[6] 二米之禾 [7] 三脊茅 [8] 白茅 [9] 佛手柑

arouses suspicion. This describes 'fire-pressured wine' (*huo pho chiu*[1]), but very obscurely.[a] Take good *chhing chiu*,[2] he says, and let it settle for three days, then build up a stove of five layers of bricks in a windless room, and put the earthenware vessel on it. Use three *chhêng*[3] (steelyard-weighed lots) of charcoal, and 'put the *lung*[4] right in the centre, with half of the already glowing charcoal underneath.' *Lung*[4] normally, of course, means basket, but it is tempting here to interpret it as a technical term of those days for the catch-bowl of the Chinese still, more especially as *chêng lung*[5] in later times could mean various kinds of steamers for cooking.[b] Anciently, a kind of *lung* called *ling*[6] was a wickerwork net protecting an earthenware vessel like the glass wine-bottles of present-day Italy, so it is not too difficult to see how the catch-bowl could have acquired the name of *lung*. The only other instruction given by Chu is to let it go on heating (i.e. as we suspect, distilling) in a quiet place for seven days. He also speaks of a pipette for sucking up the clear supernatant layer of wine, and says of the 'fire-pressured wine', significantly enough, that it is much better than mulled wine, *chu chiu*[7].[c]

It was about this time (or rather earlier) that Chu Fu[8] wrote his *Chhi Man Tshung Hsiao*[9] (Amusing Anecdotes of the Chhi Man Tribesfolk, in Southern Hunan). In this he has a passage about *tiao thêng chiu*,[10] 'hooked vine wine'.[d]

> This wine [he says] is perfected by fire; it is not any kind of vinegar nor rough-tasting stuff. There are two vessels east and west, and the wine is collected and sucked through a hollow stem.

The difficulty here is the interpretation. The fire might mean only warming or mulling and the last phrase is most probably a reference to the well-known practice of the southern Chinese tribal peoples and the Indo-Chinese cultures in general of sitting round a pot of wine and each person sucking it up through a straw, as we should say. On the other hand the purpose of the two vessels is not clear, and conceivably it might be a reference to the still and the receiver standing side by side, while the 'collecting' hollow stem could refer to the side-tube. But the probability is that distillation is absent here.

To sum it up, from first to last, none of the pieces of evidence for alcohol distillation in the Thang and the early Sung is quite decisive; some are relatively convincing, others less so. But there are times when probabilities accumulate to such an extent as to change quantity into quality and justify a circumstantial conclusion. Before adopting this we ought to look at some of the arguments pro and con which have been advanced in this problem of Thang distillation. For example it has been felt (as by Tshao Yuan-Yü) that the instances are insufficiently numerous. But apart from the likelihood of many more being found as research continues, there may have been rather

[a] Ch. 3, pp. 16*b*ff., Shinoda & Tanaka repr. pp. 135–6. Cf. Wu Tê-To (*1*), p. 54.

[b] By this time the wickerwork must have disappeared, or it would have been burnt by the fire.

[c] If it were not for this last statement, one would be inclined to regard the whole process as some kind of pasteurisation to improve the keeping properties of the wine.

[d] Hsü Pai Chhuan Hsüeh Hai ed., vol. 3, p. 1601.

[1] 火迫酒 [2] 清酒 [3] 秤 [4] 籠 [5] 蒸籠 [6] 苓
[7] 煮酒 [8] 朱輔 [9] 溪蠻叢笑 [10] 釣藤酒

good reasons why the Thang scholars did not expatiate too much on the mountain dew, any more than the peasant-farmers of Co. Longford. In a word, the Excise was at hand—as could only be expected in so bureaucratic a civilisation as that of China. As the study of Wang Chin (7) has conveniently shown, wine taxation, government monopolies, and even prohibition, were features of all the early Chinese dynastic periods. Wang Mang between Early and Later Han established a brewing monopoly or 'nationalisation' of the industry, as in the better known cases of salt and iron; in the San Kuo time there was a prohibition of drinking under the Wei State (*chin chiu*[1]), and later on the Northern Wei exacted the death penalty for infraction of the government brewing monopoly. In the Thang Dynasty, which particularly concerns us, there was a strict prohibition on private wine-making (and no doubt *a fortiori* distilling), while in +847 heavy taxes were imposed on those who were licensed to carry it on. Naturally, therefore, popular cover-names have come down to us. The *Chiu Shih*[2] by Fêng Shih-Hua[3] (+16th century) records that *chhing chiu*[4] was known as 'the sage' (*shêng jen*[5]), and cloudy wine, *cho chiu*,[6] was called 'the worthy' (*hsien jen*[7]);[a] while Buddhist monks (says Tou Phing[8] in his *Chiu Phu*[9] of +1020), to whom it was doubly forbidden, would invite favoured guests to 'take a drop of "wisdom soup"' (*pan-jo thang*[10]).[b] All this, it may be admitted, tends to impede the search for decisive Thang evidence.

Secondly we have seen a number of cases where the texts speak of the colour of the distillate as pink, brown or red, though in some cases (e.g. Li Pai) the white or transparent colour is emphasised. About this there are two things to be said. First one has to reckon with splash in these relatively primitive stills, and if the catch-bowl was large and the still-contents 'bumping' considerably, it would be only too likely that doses of anthocyanin would find themselves in the side-tube. This would easily account for the colours mentioned. But besides this there is the certain fact that from early times down to the present day distillers have added colouring matters artifically to their liqueurs to improve their appearance. Such is the case with the pink *mei kuei chiu*[11] and the delicious green *chu yeh chhing*[12] which we can enjoy in China today;[c] nor is it difficult to find Arabic parallels, not indeed for alcohol, but for the perfumed essential oils, which according to the sure witness of al-Kindī in the +9th century, were coloured artificially with various fat-soluble dyes before appearing in the market.[d]

Certainly the crux lies in the meaning of *shao*.[13] While it could imply no more than heated, mulled or boiled,[e] its universal use in recent centuries to designate distilled must carry a certain authority with it as we trace it back in time to earlier ages.[f] Of

[a] Ch. 2, (p. 45). Based on *Wei Lüeh*, quoted in *TPYL*, ch. 844, p. 1*a*.

[b] P. 2*a*; also in *Chiu Shih*, ch. 2, (p. 47). Lewin (1), pp. 122–3, has collected much information on the Fermented Beverages Authority in the +9th and +10th centuries; it controlled distilled spirits as well as wine.

[c] Alcohol content *c.* 45%. This usage still exists in Japan, as we found in Kyoto in 1971.

[d] See Garbers (1), p. 16. [e] This was sometimes done to stop the fermentation.

[f] There is a complete continuity. Burnt-wine (*shao chiu*[14]) is listed among the wine-shop wares in *Mêng Liang Lu*,[15] Wu Tzu-Mu's[16] description of Hangchow in +1275, (ch. 16, p. 5*b*). And at the dawn

[1] 禁酒 [2] 酒史 [3] 馮時化 [4] 清酒 [5] 聖人
[6] 濁酒 [7] 賢人 [8] 竇苹 [9] 酒譜 [10] 般若湯
[11] 玫瑰酒 [12] 竹葉清 [13] 燒 [14] 燒酒 [15] 夢粱錄 [16] 吳自牧

course many East Asian wines, such as *huang chiu*[1] or Japanese *saké* are normally drunk warm today, but no one could examine the passages adduced above and come away with the feeling that nothing more was involved than 'chambrage' for the dinner-table. Besides, the word *shao* tends to occur in couplet form, as in Pai Chü-I's poem about the lichis, complementary to something else, suggesting the name of a special wine rather than the adjective for any kind of wine heated. To sum it up, we have a similar position here to that encountered at an earlier stage with regard to the stern-post rudder—a cumulative case which carried considerable conviction short of full proof. And perhaps there is a lesson in the fact that years after Wang Ling and I had built up the textual rudder case, Lu Gwei-Djen and I found in Canton the Han tomb model which settled the matter. So we dare to entertain the hope that somebody will one day find a tin or pewter catch-bowl and side-tube in a Thang tomb.

So far we have said almost nothing about the *kumiss* of the Mongols and the *araki* which they distilled from it, except in connection with the history of the still (pp. 103, 105). We have not sought for early Chinese descriptions of *araki* distillation, though they could doubtless be found, because we do not think that it had much influence on Chinese wine distillation. Indeed it is more likely that any transmission went the other way. Here, however, we may quote what Hsiao Ta-Hêng[2] said in his *I Su Chi*[3] of +1594.

> Mare's milk at the beginning is too sweet to drink, and in two or three days it has gone sour and cannot be taken then either. You can use it only for wine, and this is no different from 'brandy' (*shao chiu*[4]). First the (fermented) milk is distilled, then the wine is again distilled, and when this has been done three or four times the taste of it is exceedingly good.[a]

Another point arises now. Earlier in this survey we examined some of the illustrations of stills which can be found in the medieval alchemical books (pp. 68ff.). The work of Phêng Ssu (*TT*907) is too late (+1225) to be of importance for the present argument, but that of Wu Wu (*TT*893), illustrated in Fig. 1446, is significant, for its date, +1163, is just about that of the first still-cooling in the West which permitted the successful distillation of alcohol. We have also illustrated a highly developed still, however (Fig. 1447), from a treatise (*TT*895) which claims to date from the Chin period, and while that one might hesitate to allow, one could suppose reasonably enough that it may be of Thang date, in which case it could be contemporary with the texts which we have been studying. The same applies to the diagram in Fig. 1407 from *TT*908, a text which has been considered Chin in date, but which is now thought to belong rather to the late +9th century.[b] All this, of course, is a separate matter from

market one could buy *shui ching hung pai shao chiu*[5] 'crystal burnt-wine, red and white', which, he said, had a gentle fragrant taste, and evaporated as soon as it entered the mouth (ch. 13, p. 7*b*).

[a] Tr. auct. from *KCCY*, ch. 22, p. 11*a*, adjuv. Serruys (1). On Hsiao Ta-Hêng's book about Mongolian customs see W. Franke (4), p. 213.

[b] It is difficult to impose unitary datings on Chinese alchemical texts, except in certain cases, for so many of them consist of a core to which accretions were added in successive periods. The diagrammatic simplicity of the picture in *TT*908 might well plead for an earlier dating (Liang, if not Chin) than the elegant drawing in *TT*895.

[1] 黃酒 [2] 竇大亨 [3] 夷俗記 [4] 燒酒 [5] 水晶紅白燒酒

those workaday stills of the countryside which we can imagine by projecting backward the designs familiar in our own and recent times (cf. pp. 63ff.).

Of these the Jesuit Cibot (5), writing in +1780, said that 'the Chinese alembics, heated by millet straw, are so simple, or rather so rustic, that we would not dare to give a description of them.' Historians of science and technology could wish that he had not been so coy. Nevertheless, in his special notice on *eau-de-vie*, he remarked that 'we find the brandy of grape(-wine) celebrated in poems of the seventh century, and also indicated in medical books of the eleventh, and perhaps earlier, as an excellent remedy against wounds, bruises and several internal diseases...But if we are to believe the author of the *Pên Tshao Kang Mu*, the invention of brandy from cereal (wine) is not ancient in China, going back only to the Yuan dynasty, that is to say, the end of the thirteenth century...' He then goes off into a rambling soliloquy on the difficulty there is in one invention leading to another—evidently puzzled how to reconcile these two opinions. He also adds the interesting incidental intelligence that 'the Chinese *eau-de-vie* has a very disagreeable taste,[a] but in spite of that the people are used to it and like to drink it warm, more of it indeed than one would dare to mention. Moreover there are those who will only drink that which has been re-distilled in the alembic, and which is so strong that it burns almost like "spirits of wine"...Our European pharmacists are all agreed that it is as good or even better than that from grape-wine for all external uses.' But what is valuable about Cibot's notice is that it raises the question of tradition; evidently in his time scholars took the affirmative view about the passages in the Thang poets.[b]

Going back further than Cibot and his contemporaries, there arises the question of Chinese exports during the Sung, for in no less than eight cases Chao Ju-Kua in his *Chu Fan Chih* (+1242 to +1258, if not earlier, *c.* +1225) mentions wine as carried by the merchants from China to as many countries in the South Seas and Indian Ocean.[c] The word used is *chiu*[1] every time, but Hirth & Rockhill (1) may not have been meaningfully wrong when they translated persistently[d] by the Old China Hand word *samshu* (i.e. *san shao*,[2] thrice distilled),[e] for transport economics would obviously have dictated the carriage of the stronger rather than the weaker liquid.[f] As for distilleries in China, Fang Hsin-Fang[3] has made a special study of the very strong *fên chiu*[4] spirits[g] for which the village of Hsing-hua Tshun[5] south of Thaiyuan in Shansi is famous, and he recounts that all local tranditions say that the distillation started in the Thang time.[h] We ourselves can bear this out because of a personal visit

[a] Not our own experience, it must be said.

[b] Deniel (1), p. 15, saw the point of this, though he himself did not know Cibot's original paper. Huber (1), p. 147, who maintained the same, probably did, though not quoting it. Jesuit relations of this kind must assuredly account for the statements of certain European chemists, such as Demachy (1) in +1773 and later, that the origin of all alcohol-distillation was to be sought in China.

[c] Ch. 1, pp. 3*a*, 4*b*, 7*a*, 8*a*, *b*, 36*b*, ch. 2, p. 16*b*.

[d] Pp. 49, 53, 61, 67, 68, 69, 158, 177. [e] See Giles (14), p. 245.

[f] Schelenz (2) says that Hirth (7) mentions the export of *samshu* in the Sung; we can only find that he says 'wine' (p. 58).

[g] Alcohol content 62%. Named after the river of the province flowing near by.

[h] Yuan Han-Chhing (1), p 96.

[1] 酒 [2] 三燒 [3] 方心芳 [4] 汾酒 [5] 杏花村

Fig. 1503. Modern alcohol vat still for *fên chiu* at Hsing-hua Tshun, Shansi (orig. photo. 1964).

Fig. 1504. Modern vat stills at Shao-hsing, Chekiang (orig. photo. 1964).

made in 1964,[a] on which occasion we were able to read an inscribed stele dated +555 to +557 and connected with a Northern Chou wine official (Chiu Kuan[1]) named Wu Chhêng,[2] who appears to have been the founder of the local industry.[b] It used millet then, and uses kao-liang now, but it is very near the famous vineyards which Marco Polo described and which we also visited, so grape-wine may well have been distilled there in earlier times. The +6th century would seem just not too early, in the light of all the other evidence for the distillation of alcohol in China. Now of course the Chinese

[a] With Dr Dorothy Needham.

[b] This stands outside the Shen-Ming Thing[3] pavilion, inside which is the celebrated well (Ku-Ching Thing[4]) which provided the water.

[1] 酒官 [2] 武成 [3] 申明亭 [4] 古井亭

factories mostly use vat stills of modern type with wide-bore retort tubes and spiral condensers sunk in water-tanks (cf. Fig. 1503 from Hsing-hua Tshun and Fig. 1504 from Shao-hsing in Chekiang, another very famous centre).[a]

(iv) *Liang 'frozen-out wine'*

We must now go back to take a closer look at the stone which may turn out to be the keystone of our arch, namely the story about the preparation of a strong alcohol solution by freezing. The *Liang Ssu Kung Chi* (Tales of the Four Lords of Liang), though written towards the end of the +7th century, deals with events then comparatively recent since they occurred in the early part of the +6th. It gives us the previous information that Kao-chhang (Turfan) presented 'frozen-out wine' (*tung chiu*[1]) to the imperial court about +520, most probably on a number of successive tribute visits. Then, much later, the *Tshao Mu Tzu* book describes, towards the end of the +14th century, how people used to test their spirits by going to huts in the high mountains and leaving it out to freeze; in such conditions genuine strong alcohol solutions would not do so, but imitations, diluted or faked perhaps with piquant herbs, would. Laufer annotated the passage with the words: 'This is probably a fantasy. We can make nothing of it, as it is not stated how the adulterated wine was made.'[b] Yet it is perfectly comprehensible when one knows that freezing-out methods live on in common practice and in scientific work at the present day;[c] if the process is carefully done, the ice formed will consist of pure water and all the solutes will be concentrated in a central liquid phase which does not freeze.

This chain of references is enlarged by other important links. Chang Hua[2] in his *Po Wu Chih*,[3] written about +290, remarks that 'the Western regions have a wine made from grapes which will keep good for years, as much as ten years, it is commonly said; and if one drinks of it, one will not get over one's drunkenness for days'.[d] Clearly this was a description of spirits, not ordinary wine, but in view of the date we believe that it was frozen-out wine, not distilled wine. A very similar thing is said in the biography of Lü Kuang[4] (d. +399), the conqueror of Kucha in Sinkiang in +384, which describes, quoting from his report,[e] the wealth of the citizens' families, many of which 'had as much as a thousand *hu*[5] of grape-wine in their houses. Even after ten years it did not go bad.'[f] But this kind of information about the Western regions was

[a] At times in Chinese history the distilleries have played an unusually important sociological and economic role; cf. the study of Kawakubo Teiro (*1*).

[b] (1), p. 237. He probably read only the *PTKM* version.

[c] We have to thank Prof. Stephen Mason and Dr J. H. Lindsay for reminding us here of the place of 'applejack' in Canadian folklore. That was the country where grandad always left half-a-dozen casks of cider out in the snow and ice during winter-time; then at Christmas a tube would be inserted and the liquor drawn off. The excisemen supposedly turned a blind eye on this. Professor Lynn White has told us equally of 'New Jersey lightning'. Concentrates can also be further concentrated, as in the case of the bottles of Grand Marnier left out in stores through a few Antarctic winters, according to an experience related to us by Dr Launcelot Fleming, formerly Bishop of Norwich.

[d] Ch. 5, p. 4*b*. [e] *Chin Shu*, ch. 122, p. 2*b*, tr. auct., adjuv. Liu Mao-Tsai (1).

[f] About 3000 gallons in our reckoning. This would mean some 18,000 bottles of the size commonly used for wine today.

[1] 凍酒 [2] 張華 [3] 博物志 [4] 呂光 [5] 斛

quite traditional, for as early as −90 Ssuma Chhien had told how in Ferghana (Ta-Yuan) and its neighbourhood 'wine is made from grapes, the wealthier inhabitants keeping as many as ten thousand or more *tan*[1] of it stored away. It can be kept for as long as twenty or thirty years without spoiling. The people love their wine, just as their horses love their alfalfa (fodder).'[a] If these two statements really imply strong alcohol, then the freezing-out method may go back to the −2nd century at least, which is not at all impossible; but the difficulty is to distinguish it from the effects of adequate corking on the preservation of unconcentrated wine (cf. p. 143). We cannot be quite sure. The rather large amounts would plead for the stoppering interpretation, but it is doubtful how effective this was among any ancient people; so 'frozen-out wine' seems on the whole the more probable.[b] Again, Li Chao (fl. +810), whom we encountered on p. 142 above, added to his list of famous wines a *shih tung chhun chiu*,[2] 'spring wine frozen-out on the crags', from Fu-phing in Shensi.[c] Thus between the −2nd and the +14th centuries we have at least six references.[d]

The two passages quoted by Li Shih-Chen, and the others, are probably the oldest on this phenomenon in any world literature.[e] The earliest description in Europe, so far as we can see, occurs in the sixth book of the *Archidoxis* of Paracelsus, written about +1527 but not printed till +1570.[f] This had great repercussions in Europe as an extraordinary fact of Nature. About +1620 Francis Bacon wrote: 'Paracelsus reporteth, that if a glass of wine be set upon a terras in a bitter frost, it will leave some liquor unfrozen in the centre of the glass, which excelleth *spiritus vini* drawn by fire.'[g] And in +1646 Sir Thomas Browne noted that 'Paracelsus in his *Archidoxis*, extracteth the magistery of wine; after four moneths digestion in horse-dung, exposing it unto the extremity of cold; whereby the aqueous parts will freeze, but the Spirit retire and be found congealed in the centre.'[h] There were several other mentions before the end

[a] *Shih Chi*, ch. 123, p. 15*a*, tr. auct., adjuv. Hirth (2), Watson (1). The estimate is about twenty times the preceding one, but there is no need to take either of them *au pied de la lettre*.

[b] Unless of course the people of Sinkiang were distilling in Gandhāran retorts (pp. 86–7, 121).

[c] Ch. 3, p. 9*b* in the Thang Tshung Shu ed.

[d] Doubtless more will come to light. Wang Chia, in his *Shih I Chi* (Memoirs on Neglected Matters), written about +370, has a curious passage about 'gut-rotting wine'. He starts off by telling how Chang Hua, the naturalist (+232 to +300) and author of the *Po Wu Chih* just quoted, used to make a special kind of wine with ferments which he got from the Western Chhiang and Northern Hu tribal peoples. He then goes on to say that the Hu foreigners have a *chih hsing mai*[3] (variety of cereal) which can be malted, and makes a wine that causes chattering of the teeth and apparent drunkenness without shouting or laughter, injuring the liver and intestines. Hence the ordinary people called it 'gut-rotting wine' (*hsiao chhang chiu*[4]). Nevertheless some people experienced pleasure from it, not caring to preserve their lives.

We should hesitate to follow Eberhard (in his review of Hermanns, 1) in his interpretation of this as distilled wine. The story suggests to us rather a wine containing some kind of toxic substance. But it could possibly be an early reference to the outlandish and surprising effects brought about by the 'frozen-out wine', especially as it came from some tribal or city-state people in the north or north-west.

[e] Seneca, in his *Quaest. Nat.*, written in +64, has a curious passage about 'wine frozen by lightning', which, when re-liquefied, 'kills or drives mad those who drink of it' (II, lii, liii, Clarke tr. p. 97). We can probably neglect this as fabulous.

[f] Cf. Pagel (10), p. 274; Debus (15), p. 33. The text is to be found in the Sudhoff ed. vol. 3, pp. 165–6; Strebel ed., vol. 8, pp. 358–9.

[g] *Inquisitio Legitima de Calore et Frigore*, in *Works*, Montagu ed., vol. 1, p. 333.

[h] *Pseudodoxia Epidemica*, Sayle ed., vol. 1, pp. 204–5. He meant, of course, concentrated, the opposite of congealed in this case. Cf. Pagel (10), p. 274; Debus (15), p. 33, (16), p. 71.

[1] 石 [2] 石凍春酒 [3] 指星麥 [4] 消腸酒

of the +16th century, notably one by Conrad Khunrath[a] in +1594, who mixed his frozen-out alcohol with *aqua vitae* distilled in the usual way.[b] Glauber again, in +1657, found that he could concentrate acetic acid by freezing out the water.[c]

The question then acquired considerable theoretical importance in the 'Sceptical Chymist' of Robert Boyle (+1661), who after giving Paracelsus' Latin text embarked upon one of his long-winded but charming discourses, making much of the experiences of 'the Dutch men that Winter'd in Nova Zembla'. In their own words, which he quoted: 'There was scarce any unfrozen Beer in the barrel; but in that thick Yiest that was unfrozen lay the Strength of the Beer, so that it was too Strong to drink alone, and that which was frozen tasted like Water...'[d] And Boyle went on to say that he 'might confirm the Dutchmen's Relation, by what happen'd a while since to a neere Friend of mine, who complained to me, that having Brew'd some Beer or Ale for his own drinking in Holland (where he then dwelt), the Keenness of the late bitter Winter froze the Drink so as to reduce it into Ice and a small proportion of a very Strong and Spirituous Liquor...'[e] What all this was in aid of was the criticism of the spagyrical tradition that fire alone would analyse mixed bodies.[f] Boyle (in the person of his character Carneades) was setting out to make 'the common Assumption of our Chymists and Aristotelians appear Questionable'.[g] Cold had been considered *tam Homogenea quam Heterogenea congregare*, but now it seemed, like heat, also to be able *congregare Homogenea, et Heterogenea segregare*. Thus did the observation known to Wan Chieh and the other Lords of Liang find its place in the theoretical cogitations of nascent modern chemistry.

Naturally the process could be viewed in reverse, not for the concentration of spirituous liquor, but for the winning of pure water from the sea[h] or from any undrinkable aqueous solution. This seems to have occurred first to the Danish physician,

[a] Brother of the more famous Heinrich Khunrath, whom we shall meet in Vol. 5, pt. 5. Cf. Partington (7), vol. 2, p. 88.

[b] *Medulla Destillatoria et Medica*, edition of +1680, vol. 2, p. 304. Cf. Arntz (1), p. 202, who quotes the passage in full.

[c] *Miraculum Mundi Continuatio*, p. 215 in the +1658 edition of *Opera Chymica* (Frankfurt). His words are worth recording: 'Wann man diesen Holz-Essig in Fassern im kalten Winter gefrieren lasst, so gefrieret nur das phlegma, und wird zu Eis, der scharffe Spiritus mit dem Oel geht hineinwarts, und frieret nichts, wird so starck, dass er die Metallen mit Gewalt angriefft, wie ein Aqua Fortis.' The question is an important one, because there is reason to think, as we shall later find, that rather strong acetic acid was known and used in medieval China, yet it is very difficult to produce by ordinary distillation (cf. pp. 178ff. below).

[d] This was the party of Gerard de Veer, who had wintered with Barents. His account was included in 'Purchas his Pilgrimes' (1625 ed., vol. 3, pt. 2, bk. iii, p. 493; McLehose ed. vol. 13, p. 91). It is interesting that they were trying to find a north-east passage to Cathay.

[e] Pp. 95–102.

[f] In his *New Experiments and Observations touching Cold* (+1683 ed.) Boyle (5) described his further studies on freezing. He concentrated leaf extracts, getting all the coloured and flavoured constituents in the unfrozen part (p. 256, and 2nd app., p. 14), and he could do the like with pigments such as gentian and cochineal (1st app., pp. 11, 19). Inorganic colours like green or blue vitriol behaved in the same way (p. 54), and the ice of their solutions was the same as ordinary ice. Also he could ignite the unfrozen alcohol from sack and sherry (pp. 56–7), showing that whatever would not burn off would freeze.

[g] On this topic, see the interesting survey of Debus (14). It was the late Sir Ronald Fisher who often used to remind us of the part played in Boyle's thought by the freezing-out technique.

[h] See the review of Nebbia & Nebbia-Menozzi (2). At the time of writing (Feb. 1971), the Atomic Energy Authority in this country was planning to construct a large-scale plant for the freeze desalinisation of sea-water on the coast of East Anglia; this could be of great help to the U.K.'s water resources always under strain. Cf. Snyder (1).

Thomas Bartholinus,[a] in the same year that Robert Boyle published his book, and Boyle himself recommended the same method to sailors in cold latitudes a few years later.[b] Before long it was widely used; Captain Cook, for instance, supplied fresh water to his crew by melting sea ice in +1773. A scientific study of desalinisation by this means was made in +1786 by Lorgna (1), who carried out a series of successive freezings of the liquid obtained by melting the ice at each stage. After four freezings the ice contained only a trace of salt, but the yield was low. He also tested the process successfully on urine, obtaining a concentrate 'of a very deep red colour' because of the urobilin and other pigments, as well as almost pure water to drink. Today this is proposed—perhaps utilised—in the technique of space travel, a development which would have greatly surprised the Four Lords of Liang. Finally it should be repeated that the 'frozen-out wine' technique plays a growing part in modern chemistry as a safe and delicate procedure for the concentration of dilute solutions.[c] Describing this 'exceedingly useful but hitherto neglected method', Shapiro (1) says that mechanical stirring or shaking is essential to prevent supercooling and the sudden freezing of boundary layers rich in solute. It is not confined to aqueous solutions but will work with any which have a suitable freezing-point,[d] and it is 'almost above reproach with regard to the chemical or physical alteration of the substances being concentrated'.

Finally, the freezing-out phenomenon supplied one of our favourite poets with a useful metaphor. Byron was trying to describe girls who hide a passionate nature under a rather cold exterior manner—but he found the celebrated volcano motif hackneyed and absurd, so he thought of something else.

I'll have another figure in a trice:
  What say you to a bottle of champagne?
Frozen into a very vinous ice,
  Which leaves few drops of that immortal rain,
Yet in the very centre, past all price,
  About a liquid glassful will remain;
And this is stronger than the strongest grape
Could e'er express in its expanded shape.

'Tis the whole spirit brought to a quintessence.
  And thus the chilliest aspects may concentre
A hidden nectar under a cold presence.
  And such are many, though I only meant her,
From whom I now deduce these moral lessons,
  On which the Muse has always sought to enter.
And your cold people are beyond all price,
When once you've broken their confounded ice.[e]

[a] (1), ch. 4, p. 42. [b] (5), p. 59.

[c] Thus Mellanby (1) used it in 1908 for concentrating a protein, diphtheria antitoxin, Palmer (1) later on for milk globulin, and Bawden & Pirie (1, 2) for tobacco-plant viruses.

[d] It may be worth remembering that one of the foundations of the aromatic chemical industry was Mansfield's separation of toluene from benzene by freezing (Campbell (1), p. 84), in 1847.

[e] *Don Juan*, canto xiii, 37, 38; Steffan, Steffan & Pratt ed., p. 452. The heroine here was Adeline, the girl of English aristocratic stock.

(v) *From icy mountain to torrid still*

The moment has now come when we can survey the whole problem and plan perhaps a provisional working hypothesis about the history of alcohol East as well as West. Cibot and Laufer both made the point that it was very odd if the distillation of grape-wine should have come to China from Turfan in +640 and that the Chinese should then have waited seven centuries before applying it to their own indigenous cereal wines. The studies of von Lippmann make it clear that no sort of wine distillation could have come from Turfan at that period because no Western stills had a cooling system until five centuries later.[a] Though the Gandhāran ones probably did, it is not certain that they were used for alcohol.[b] But we know that 'frozen-out wine' did come from Turfan, and had already done so for at least a century before its annexation. Surely then the most likely thing is that the 'frozen-out wine' triggered the first distillation of wine in the East, and that this process was continued in China both for grape and cereal wines thenceforward. The sending of the first alcohol concentrates is the crucial point, for the Chinese would then have acquired (like the Uighurs) the taste for relatively strong alcohol—it may not have tasted very good but at least it made them merry quickly and this was the important thing. That the catch-bowl still, whether 'Mongol' or 'Chinese' in type, already existed in China we cannot yet fully prove, but it may be assumed without undue risk from the time of Thao Hung-Ching onwards, and indeed we suggest elsewhere (p. 178) that the concentration of acetic acid by distillation may have played a part in the solubilisation methods of the *San-shih-liu Shui Fa*, which are otherwise rather difficult to explain. The stills of China could also reasonably have been used in the +6th century for essential oils (a subject on which we have yet to say a few words). One source of obscurity is that we do not know enough about the first origin of the catch-bowl still without the side-tube; after all 'Mongol' and 'Chinese' are only ethnographical expressions, and between +500 and +800 the still used in China may well have been the simple 'Mongol' type. But the side-tube must surely have been present by +900, and probably a good deal earlier, because of several allusions which we have noted in the literary references (pp. 144–5), quite apart from the drawing in the *Chih-Chhuan Chen-Jen Chiao Chêng Shu* (*TT*895), Fig. 1447.

'Frozen-out wine' then, in all its primitive simplicity, was, we would suggest, an important step on the road from beer or wine as such to distilled 'strong liquor'. Its origin in empirical experience among the snows of the Thien Shan or the bitter winds of the Gobi is easy enough to picture, but how on earth could any Taoist in +6th- or

[a] Or, more precisely, no one in the West had discovered how to get alcohol from wine either by water-cooled stills or the subtle use of air-cooled ones, and would not do so for another five centuries. We should perhaps leave open the possibility that the Uighurs of Turfan were using the Mongol or Chinese catch-bowl still, but that would place them firmly within the Chinese culture-area. It is also in a way a superfluous assumption if their 'frozen-out wine' was as potent as we think it was; and we know that that went east.

[b] If that could be proved, then a diffusion stimulus for Chinese alcohol-distillation could have come from northern India, yet it would have been only a stimulus since the Chinese proceeded to use their own stills of quite a different type.

+7th-century Chhang-an have imagined that by submitting wine to intense heat one could get the same result as that brought about by its exposure to intense cold?

One ideological possibility presents itself in the 'similarity of extremes', almost, one might say, the 'identity of opposites'. The 'frozen-out wine' was connected with a *shêng Yin*[1] condition, so perhaps something equally interesting would happen if it were submitted to a *shêng Yang*[2] process. As Li Shih-Chen remarked: 'Burnt-wine is a powerful drug, for it partakes of the nature of pure Yang; its character is similar to that of fire (*Shao chiu shun Yang tu wu yeh, yü huo thung hsing*[3]).'[a] Just so might it have been argued that 'frozen-out wine' partook of the nature of pure Yin, also very dangerous in its way, like frostbite, snow-blindness, and the caustic feel of intense cold. This would have been another aspect of the 'marriage of fire and water'; and it is easy to show that the Chinese elements Fire and Water were indeed related to each other as Yang-Yin opposites.

About +640, the great scholar Khung Ying-Ta,[4] commenting on the Old Text version[b] of the *Shu Ching*'s Hung Fan chapter,[c] wrote as follows:[d]

'Wood can' to 'usefully transformed (*kai pien*[5])'.

[Comm.] These words express its nature; it can be softened and made curved or straight, as is necessary for the making of implements (and objects). Transformation for human convenience is like the fusion and melting (of metal) for implements (and vessels). Just as Wood can be softened and made curved or straight, so Metal can also be remoulded to the heart's desire, in accordance with its use for mankind—that's the meaning of it. From this one can see that the usefulness of Water for irrigation lies in its tendency to seep down and enrich the earth; so also the usefulness of Fire is that it goes upwards, giving combustion and heat. This is quite understandable. Since Water is pure Yin (*shun Yin*[6]), it (naturally) soaks, moistens, enriches) and descends, tending towards the Yin (of the earth). But Fire is pure Yang (*shun Yang*[7]), so (naturally) when it burns and blazes it rises upwards, tending towards the Yang (of the heavens). As for Wood and Metal, they are composed of Yin and Yang mixed together. Therefore their form can be made crooked or straight, that is, altered and changed, transformed for human convenience.

This is a classical statement of the proportions of Yin and Yang in the Five Elements. Earth alone is not specifically mentioned, but from its central position among the four

[a] *PTKM*, ch. 25, (p. 35).

[b] Something has already been said of this famous philological controversy in Vol. 2, p. 248, and later in Needham (56), p. 30. Briefly, texts of the Confucian classics written in ancient characters were supposedly discovered in −148 or −135, and since they differed somewhat from those currently accepted they were commented on about −100 by Khung An-Kuo[8] and later other famous scholars—then they were again lost. Subsequently, between +317 and +322, Mei Tsê[9] claimed to have found both text and commentary, and these were the versions on which Khung Ying-Ta wrote his commentary early in the Thang. Sung scholars were sceptical of the authenticity of these texts, Mei Tsu[10] demolished it in +1513, and the *coup de grâce* was delivered by Yen Jo-Chü[11] in +1745. Nevertheless, this does not mean that many ancient fragments were not incorporated into his pastiche by Mei Tsê in the +4th century, nor that it is without value for statements on points in the perennial natural philosophy of China which may not happen to occur elsewhere. For a succinct statement of the case cf. Hummel (2), p. 909.

[c] See Vol. 2, pp. 242–3.

[d] *Shang Shu Chêng I*,[12] ch. 11, p. 7*b*.

[1] 盛陰 [2] 盛陽 [3] 燒酒純陽毒物也與火同性
[4] 孔穎達 [5] 改便 [6] 純陰 [7] 純陽 [8] 孔安國
[9] 梅賾 [10] 梅鷟 [11] 閻若璩 [12] 尚書正義

directions, it must evidently be equally balanced between Yin and Yang. The former predominates in Metal, which can melt to the liquid state; the latter in Wood, which cannot. A table may elucidate.[a]

M	mixed	Yin > Yang (Yang in Yin)	shao Yin
W	mixed	Yang > Yin (Yin in Yang)	shao Yang
w	pure Yin		thai Yin
F	pure Yang		thai Yang
E	mixed equal proportions		equal balance

Once the product of distillation had been tested, the similarity with alcohol made the other way would have been obvious, and since fire was much more easily and widely obtainable than snow and ice it naturally become the dominant process.[b] Then, much later in time, and by ways which as yet we cannot discern (though Central Asian intermediation may be more likely than Islam and India), the still-cooling of China could have made its way westwards to influence the +12th-century Masters of Salerno and their Italian friends.[c] In this manner for the first time a coherent scheme of the development of means for making alcohol solutions above 40% in strength, throughout the Old World cultures, presents itself, at least as a working hypothesis.[d]

We can now look back once more at Li Shih-Chen's passages and see what misunderstandings arose from them. Distillation of cereal wines did *not* begin first under the Yuan dynasty; Li took Yeh Tzu-Chhi and Hu Ssu-Hui (talking about grape brandy) as his starting-point and ignored most of the Thang and Sung literature. Distillation of grape-wine (or wine of any sort) did *not* come from Western sources through Turfan in the early Thang because it had not been accomplished anywhere at that time without the Asian types of water-cooled still. Distillation of any sort of wine was *not* ancient in the Far West, as might too readily be assumed from Li's words.[e] The Uighurs may well have provided China in +640 with mare's nipple grapes and the recipe for making grape-wine without *chhü* ferment, but what really mattered was the *tung chiu*,[1] the 'frozen-out wine', which they had already been sending for some time previously. Surely this was the father and mother of all 'strong liquor', and the ancestral inspira-

[a] From Table 12 in Vol. 2, p. 263.

[b] There might be a parallel here with certain other deductions from medieval natural philosophy where thinkers were faced by a problem of opposites. In Sect. 45 we shall show how the physicians, at least as early as the +7th century, treated goitre with thyroid glands from domestic animals. To heal an enlargement of an organ by giving more of the same thing might seem a strange procedure, but the physicians had the insight to realise that thyroid hyperplasia was in many cases the sign of a basic deficiency (*hsü*[2]), indicating what we should now call hypothyroidism. In the meantime see further on this Needham & Lu Gwei-Djen (3).

[c] It looks therefore as if we must place alcohol distillation in what has been called the +12th-century cluster of transmissions (Needham (64), p. 61). These include the magnetic compass, the stern-post rudder and the windmill. And for the first two of these no evidence of Islamic and Indian way-stations is perceptible.

[d] Great as the contributions of von Lippmann were, he placed all his money on a loser in declining persistently to admit any creative influence of Chinese culture in the history of chemistry. It would have been better to admit ignorance—which nearly everyone in the West then shared.

[e] For example by Laufer (1), pp. 220ff., esp. pp. 235ff., followed by Shinoda Osamu (2).

[1] 凍酒 [2] 虛

tion of all Chinese distillers. So Li Shih-Chen was probably quite right in saying (if that was what he meant to say) that grape-wine brandy started early in the Thang; and lacking as he did so much of what we know now, he was only wrong in implying (if indeed he did) that it had come from somewhere else.

(vi) *Oils in stills; the rose and the flame-thrower*

By way of an appendix to all the foregoing something remains to be said about the distillation of essential oils.[a] What we should like to have would be a few texts about this practice dating from the +5th, +6th or +7th centuries, i.e. before the appearance of strong alcohol solutions in China; but we have not found anything of this antiquity, and the relevant certain mentions begin in the +10th, i.e. well after the period during which, as we think, the distillation of wine was being successfully carried out. Perhaps the parallel with the Arabic culture-area is deceptive, and one should not assume that because the Arabs and Byzantines did so much distilling of essential vegetable oils and petroleum oils before alcohol distillation started in the West, the same sequence took place in China—it may have been that Chinese stills were first used for vinegar (cf. pp. 128, 178) and other substances in which the alchemists were particularly interested, e.g. mercury. The dry distillation of eggs (as among the earlier Hellenistic proto-chemists), or hair (as among the Arabs subsequently), may have played a part here, though it might be hard to point to any overt evidence of it. But even if we cannot at present carry back the story of the volatile oils beyond that of alcohol, it will be worth while to give a few later quotations concerning it.

Rather strikingly, when we first come upon essential oils as a notable import, they are in close juxtaposition with light petroleum fractions of the 'Greek fire' type. In +958 the King of Champa (Chan-Chhêng,[1] mod. Annam and Tongking), Śri Indravarman, sent as ambassador to China an Arab, or at least an envoy with an Arabic name, Abū'l-Ḥasan (Phu-Ko-San[2]), who presented fifteen bottles of rose-water (*chhiang-wei shui*[3]) and eighty-four glass bottles of Greek fire (*mêng huo yu*[4]).[b] The former came from the Western countries (Hsi Yü[5]) and was intended for sprinkling on clothes, the latter was for pyrotechnics or war, and burnt even better when spread upon water.[c] This was in the Later Chou dynasty (+951 to +960), but rose-water, like the 'petrol', had been prominent in China some twenty or thirty years earlier, under another of those ephemeral dynasties of the Wu Tai period, the Later Thang (+923

[a] On the principles involved something has been said already, pp. 128–9.

[b] *Thai-Phing Huan Yü Chi* (*c.* +980), ch. 179, p. 16*b*, cit. in *Tshê Fu Yuan Kuei* (+1013), ch. 972, p. 22*a*, *b*. Another almost contemporary account is in the *Chuang Lou Chi*[6] of Chang Mi.[7] Cf. Schafer (13), p. 173. See also *Wu Tai Shih Chi*, ch. 74, p. 17*a*, discussed by Fêng Chia-Shêng (*2*), p. 17.

[c] Greek fire 'petrol' had been available in China since at least +917, and probably rather earlier; the first appearance of gunpowder is in the form of slow match for a flame-thrower using it (cf. Sect. 30), in +919. The *Wu Tai Shih Chi* adds a record that the 'fierce fire oil' was useful for removing stains from clothes. One need make no great claim for Chinese originality in this, but it is rather startling to find 'dry cleaning' practised along the Arabs, Annamese and Chinese in the +10th century. For a brief account of the industry at the present day, cf. Popham (1). On its history in the West, Edelstein (1, 2).

[1] 占城 [2] 蒲謁散 [3] 薔薇水 [4] 猛火油 [5] 西域
[6] 妝樓記 [7] 張泌

to +936). Thao Ku[1] tells us in his *Chhing I Lu*[2] (Records of the Unworldly and the Strange) that about +930 the emperor had a miniature city and gardens made of unusual materials laid out in one of the palace halls.[a] This Ling Fang Kuo,[3] as it was called (Country of Numinous Fragrances), had hills and mountains made of lignaloes wood, lakes and rivers of storax and rose-water, trees of cloves and other aromatics, walls and ramparts of frankincense, buildings of rosewood and sanderswood, and human figures carved in sandalwood.[b] Thao himself had probably seen this masterpiece, the constituents of which were said to have come in part from the conquered State of Shu in Szechuan. This reminds us that during the first thirty years of the century Shu had been the home of two outstanding experts on perfumes and aromatic drugs, Li Hsün,[4] the writer of the *Hai Yao Pên Tshao*[5] (Natural History of the Southern Countries beyond the Seas), and his younger brother Li Hsien,[6] alchemist, naturalist, chess master and like Li Hsün a poet.[c] The family was of Persian origin, and it is hard to believe that they were ignorant of the distillation of essential oils. Peppermint oil (*po ho yu*[7]) is said to be mentioned in the *I Hsin Fang* (*Ishinhō*[8]) of +982, which would imply steam distillation.[d]

Pushing further back, there are references to rose-water, in the form of 'rose dew' (*chhiang-wei lu*[9]), as early as about +800. Fêng Chih[10] in his *Yün Hsien Tsa Chi*[11] of *c.* +904 says that whenever Liu Tsung-Yuan[12] (+773 to +819) received a poem from the great scholar Han Yü[13] (+768 to +824) his admiration was such that he insisted on washing his hands in rose dew before reading it.[e] The difficulty about interpreting these early references is that three things have commonly been confused under the name 'rose-water'. There is a way of making a kind of press-juice of the rose petals which may be quite old in China, and is still used at the present time for a flavouring perfume and a cooling drink. The *chhiang-wei* petals[f] are ground to a paste with water, excess water filtered off, and sugar added to form a kind of jam which can be durably stored in porcelain pots; dilution of this then gives a fragrant solution.[g] Secondly, there is the distillation of the essential oil such as was practised in the Arabic culture-area throughout the +9th century (cf. p. 128 above).[h] Third (though of less concern to us here) is the attar of roses, an oil which separates spontaneously on the surface when an aqueous extract of rose-petals is left to stand.[i] At present it is not possible to say what kind of rose-water it was in which Liu Tsung-Yuan washed his hands,[j] and

[a] Ch. 2, p. 58*b*. Cf. Schafer (13), p. 173.

[b] For further information on these perfume sources see pt. 2, pp. 136ff., and on the coloured woods Schafer (8).

[c] See further in Sect. 38 in Vol. 6, and p. 421 below.

[d] Schelenz (2), p. 129, but his reference is garbled, and we have not so far been able to locate it in the great work of Tamba no Yasuyori. The plant, presumably *Mentha arvensis* (R129; CC337), and probably var. *piperascens*, was first mentioned in the *Hsin Hsiu Pên Tshao* of +659.

[e] Ch. 6, p. 46*a*, *b*. Cf. Schafer (13), p. 174.

[f] This is *Rosa multiflora* (CC1144), the ancestor of all rambler rose varieties (cf. Li Hui-Lin (8), pp. 92ff.

[g] Li Hui-Lin (8), pp. 95–6.

[h] Cf. Hanbury (9).

[i] This has been mainly a product of India, and traditionally ascribed to Nur Jehan, the queen of the Mogul Emperor Jehangir, as an invention of about +1612. See Burkill (1), vol. 2, p. 1915.

[j] But 'dew' does, after all, imply drops, and hence a distillate.

[1] 陶穀 [2] 清異錄 [3] 靈芳國 [4] 李珣
[5] 海藥本草 [6] 李玫 [7] 薄荷油 [8] 醫心方
[9] 薔薇露 [10] 馮贄 [11] 雲仙雜記 [12] 柳宗元 [13] 韓愈

we must hope that further Thang allusions will be found whereby we can decide whether the distillation of essential oils was then going on. It certainly went on later, though perhaps rather for other plants, since one gets the impression that rose oil remained a valued import from the Arabic culture-area. Here, for example, is Tshai Thao[1] talking just before +1115 in his *Thieh Wei Shan Tshung Than*[2] (Collected Conversations at Iron-Fence Mountain).[a]

According to an old idea, rose-water (*chhiang-wei shui*) was obtained by collecting the dew from the *chhiang-wei* flowers (roses) in some foreign country. This is in fact not true, for a still (*tsêng*[3]) made of some white metal (*pai chin*[4])[b] is used. The roses are collected and heated, producing vapours which condense and form a water (*chêng chhi chhêng shui*[5]). By means of repeated collecting and repeated heating the (liquid) is strengthened and gives forth great fragrance.[c] That is why it lasts so well.

The perfume of the roses of foreign parts is particularly strong, so the rose-water of the Arabs, even if put into a glass bottle and closely sealed with wax, will still escape to a slight extent and diffuse its delightful odour. One can smell this several dozen paces away, and if sprinkled on clothes it will last for several weeks. In other places abroad where they have not got roses they make a similar liquid from the two kinds of jasmine—but that is only a slave-girl in comparison with the rose-water of the Arabs.[d]

But perhaps opinions differed, for the essential oils of citrous flowers distilled in China were greatly admired throughout the Sung, as we know from many +12th-century references.[e] In the *Yu Huan Chi Wên*[6] of Chang Shih-Nan[7] we read as follows:[f]

The people of San-shan[8] say that...the oranges of Yung-chia[9] are the best in the whole world. There is one kind called *chu luan*[10] the flowers of which have a perfume excelling that of all other citrous flowers or fruits.[g] They are placed, with shavings of a kind of lignaloes (*chien hsiang*[11])[h] and laka-wood (*chiang chen* (*jen*) *hsiang*[12]),[i] in a small steamer (*tsêng*,[3] i.e. a still) made of tin so that the flowers and the bits of wood form alternate layers, only there are usually more flowers than wood. At the opening at the side of the still drops of liquid collect like sweat, and are received in a container. Then the distillation is stopped and the flowers taken out, while the distillate is put back to soak into the wood again. After being left overnight the process is repeated and a fresh distillation (*chêng*[13]) made, in all three or four changes of flowers being used. In the end the chips are dried and kept in sealed porcelain vessels. The perfume is extraordinarily elegant.

[a] Ch. 5, p. 20*b*ff., tr. auct.

[b] Probably tin. If in China it could well have been an alloy of zinc.

[c] This suggests re-distillation.

[d] The passage brings vividly to mind an Arabic merchant of the old tradition, proud of the pure oils which he sold, and despising all diluted forms, with whom we had much converse once at Houmt Souk in Tunisia.

[e] Cf. the passage from the *Ling Wai Tai Ta* of + 1178 on enfleurage, quoted elsewhere, pt. 2, p. 146.

[f] Ch. 5, p. 7*a*, tr. auct.

[g] This is the sour, or 'Seville' orange, *Citrus Aurantium* (see Sect. 38 in Vol. 6).

[h] I.e. garroo wood, the 'sinking aromatic', *Aquilaria agallocha* or *sinensis*, from Annam or Hainan, on which see pt. 2, p. 141 above.

[i] *Kayu* or *laka*, the 'purple liana aromatic', *Dalbergia parviflora*, on which see also pt. 2, p. 141 above.

[1] 蔡絛 [2] 鐵圍山叢談 [3] 甑 [4] 白金 [5] 蒸氣成水
[6] 游宦紀聞 [7] 張世南 [8] 三山 [9] 永嘉 [10] 朱欒
[11] 笺香 [12] 降眞人香 [13] 蒸

In this process then we have both enfleurage and distillation leading to a solid preparation and an essential oil.[a] Although it is not mentioned, a water-bath must almost certainly have been used to prevent damage by over-heating. Chang Shih-Nan's book was finished in +1233, but what he says about the preparation of this 'flower dew' (*hua lu*[1]) is paralleled in almost exactly the same words in Han Yen-Chih's[2] *Chü Lu*[3] (Orange Record), written in +1178, the type-specimen, as we shall later see,[b] of the Sung botanical and horticultural monographs.[c] This mentions also the still of tin. A reference not much earlier is that in the *Mei-Chhi Shih Chu*[4] of Wang Shih-Phêng[5] about +1140, who says that 'citrous flowers distilled (*chêng*[6]) make a perfume, good for keeping insects away from clothes'.[d]

Lastly, it is interesting to read the entry specially devoted to rose-water (*chhiang-wei shui*[7]) in the *Chu Fan Chih*[8] (Records of Foreign Peoples and their Trade), written by Chao Ju-Kua[9] about +1225.

Chhiang-wei shui [he says][e] is the dew of flowers (*hua lu*[1])[f] in the Arab countries (Ta-Shih Kuo[10]). In the Wu Tai period the foreign envoy Phu-Ko-San brought 15 bottles as tribute, after which time it was not often seen. Nowadays a common substitute is made by gathering the flowers, steeping them in water, and distilling (*chêng*[6]), the condensate (*i*[11]) being collected. Rose-water is much counterfeited and adulterated. To test it, the liquid should be placed in glass bottles and shaken about for a while, then if it is full of bubbles moving up and down, it is genuine. The flower (from which it is made) is not the same as the *chhiang-wei* rose of China.

From the first sentences it is hard to say whether Chao Ju-Kua believed that the King of Champa's bottles had contained the essential oil of roses or something still better, but he certainly knew it in the international commerce of his own time. His words on the test describe rather well the rapid separation of two immiscible liquids. And he was right that the rose of the Arabic countries used for its oil was not the same as any of those in China such as *Rosa multiflora*. It was probably then, as now, *Rosa bifera*, derived from the wild *R. rubra* and *R. moschata* in a hybridisation long antedating Pliny's mention of this autumn damask rose.[g]

In sum, therefore, much remains to be learnt about the distillation of essential oils in the Chinese culture-area. Since, so far as we can see, Chinese stills had an effective cooling device from the beginning, it may be that the essential oils followed

[a] Cf. Wu Tê-To (*1*), p. 55. On enfleurage see Hanbury (8).
[b] Sect. 38 in Vol. 6.
[c] Ch. 2, p. 3*a*, tr. Hagerty (1), p. 94.
[d] *TSCC, Tshao mu tien*, ch. 226, *tsa lu*, p. 2*a*.
[e] Ch. 2, p. 4*a*, *b*, tr. auct. adjuv. Hirth & Rockhill (1), p. 203.
[f] The difficulty of translating this is that one does not know whether it had become a technical term for polyterpene perfume distillates by Chao Ju-Kua's time or not. He could hardly have meant dew literally after what Tshai Thao had said a century earlier. Yet he goes on to call the distilled oil a substitute.
[g] We shall return to the Rosaceae, and the monographs of Chinese scholars on them, in Sect. 38 (Vol. 6).

[1] 花露 [2] 韓彥直 [3] 橘錄 [4] 梅溪詩注 [5] 王十朋
[6] 蒸 [7] 薔薇水 [8] 諸蕃志 [9] 趙汝适 [10] 大食國
[11] 液

alcohol instead of preceding it as they did in the West. At present we must be content to say that mercury was perhaps the first thing which the Chinese systematically distilled, then vinegar and the wine from grapes and cereals, then perhaps the vegetable and the mineral oils.[a] But this must remain for the time being a tentative conclusion.

Meanwhile a possible pattern of alcohol in the Old World seems for the first time to be emerging; no small gain brought by this sub-section. Known first from the 'frozen-out wine' of +3rd-century Central Asia, strong alcohol began to drip from the side-tubes of Chinese stills from the +7th century onwards, until eventually in the +12th effective cooling passed to the West and permitted the preparation of Ardent Water to set beside the Burnt Wine of the Chinese.

(9) Laboratory Instruments and Accessory Equipment

Numerous useful accessories are mentioned in *TT*874, a Liang text; and in the +7th century Sun Ssu-Mo gives a list of tools and apparatus essential for the pharmaceutical laboratory.[b] For pounding and grinding the Chinese alchemists used different types of pestle made from jade (*yü chhui*[1]) or stone (*shih chhui*[2]). *TT*886 mentions another sort carved out of willow wood (*liu-mu chhui*[3]), while *TT*885 describes the use of an antelope horn (*ling-yang chio*[4]) for grinding.[c] Fig. 1505 taken from *TT*893 shows a pestle and mortar used by the alchemists of the Sung.[d] Fig. 1506 shows a cast-iron pestle and mortar of Hou Han date, and Fig. 1507 a bronze one of Hsin or Hou Han. One should also visualise the alchemists (or rather their assistants) using the longitudinal-travel edge-runner mill (*yen nien*[5]), already discussed and illustrated (from the *Thien Kung Khai Wu*) in Vol. 4, pt. 2, pp. 195, 197. It is not quite clear how far this goes back, but one specimen of the type worked by the feet and called a *thieh tshao*[6] (iron trough mill), indubitably of the Yuan period, is preserved in the Imperial Palace Museum at Peking, having been excavated very recently. The Sung alchemists must have had these, though they may not be pre-Thang. They were always associated with pharmacy, and are still in use today.

After the process of grinding or pounding, the fine particles were separated from the coarser ones by means of various types of sieve. One made of horse-hair, called *ma-wei lo*,[7] and another of fine silk, *chhing-sha lo*,[8] are mentioned in *TT*874, written in the Liang period.

[a] By +1044 there is an elaborate description of a flamethrower for 'naphtha' or Greek fire which has been discussed in Vol. 4, pt. 2, pp. 145 ff. This pump of interesting design was assuredly not used solely with imported petroleum distillates, but information has not yet come to light on the time when the Chinese began preparing these themselves. It could have been after the tribute of +958, but on the other hand, so far as chemical apparatus was concerned, it could have been as far back as Callinicus himself in the +7th century.

[b] *Chhien Chin Yao Fang*, ch. 1, p. 31*b* (p. 14.2).

[c] This is the text of which Spooner & Wang (1) made a translation, now superseded by that of Sivin (3).

[d] P. 12*a*.

[1] 玉槌 [2] 石槌 [3] 柳木槌 [4] 羚羊角 [5] 研碾
[6] 鐵槽 [7] 馬尾羅 [8] 輕紗羅

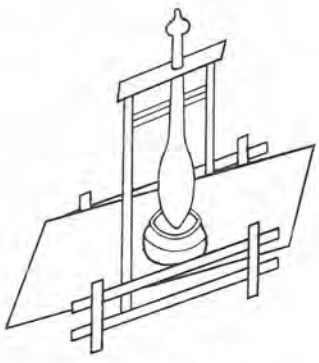


Fig. 1505

Fig. 1506

Fig. 1505. Pestle and mortar, from the *Tan Fang Hsü Chih* of + 1163.

Fig. 1506. Cast-iron pestle and mortar, Later Han in date, from a tomb at Yang-tzu Shan near Chhêngtu excavated in 1957 (Chhêngtu Historical Museum, orig. photo. 1972).

For transferring or removing ingredients the same text describes the use of an iron spoon (*thieh shih*[1]) and iron chopsticks (*thieh chu*[2]). In Chinese museums one may see bronze ladles with a handle as well as three legs (e.g. at Chungking). One of the finest of these, with a collapsible handle, dates from about + 750 (see Fig. 1508). It was part of the same hoard as the named specimens of chemicals described in Vol. 5, pt. 2, p. 161.[a] For collecting substances which adhered to the surface of vessels, a feather, usually from a cock, was used as a scraper.[b] *TT*885 tells us of a silver spoon (*yin pi-tzu*[3]).

Very often the alchemists had to render their reaction vessels as air-tight as they could. Several forms of luting material were used. They ranged from ordinary beeswax to the well-known 'six-and-one mud' (*liu i ni*[4]), a lute made of seven different substances. We discuss this elsewhere.[c]

For reactions in solution a bamboo tube was sometimes used. The *chu-thung*[5]

[a] Anon. (*106*), pls. 63A, B; cf. Hsia Nai, Ku Yen-Wên *et al.* (1), pp. 3ff.

[b] And according to *TT*878 (ch. 20, p. 16*a*) it had to be from a white male chick reared from the egg for two years 'under laboratory conditions'. In the early stages of science, correct technique and empty ritual were hardly distinguishable.

[c] Cf. pt. 3, p. 133, and p. 219 below.

[1] 鐵匙 [2] 鐵箸 [3] 銀匕子 [4] 六一泥 [5] 竹筒

Fig. 1507

(*a*)

(*b*)

Fig. 1508

Fig. 1507. Bronze pestle and mortar, Hsin or Later Han in date, found during the construction of the Chhêngtu-Kunming Railway (Chhêngtu Historical Museum, orig. photo. 1972).

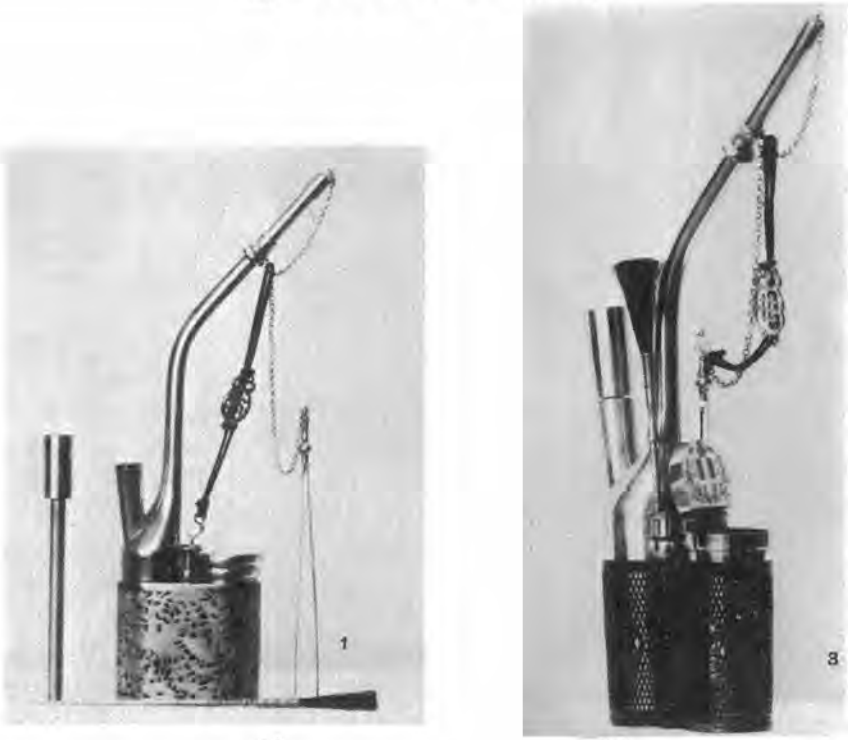
Fig. 1508. Collapsible ladle in silver, part of the hoard of the son of Li Shou-Li, probably buried in +756, at Sian (Anon. (*106*), pl. 63A, B).
(*a*) With handle extended.
(*b*) Handle folded in for transport.

(bamboo pipe), a section of bamboo, with walls thinned by shaving, was immersed in strong vinegar. This is widely used in the *San-shih-liu Shui Fa*[1] (*TT*923; Thirty-Six Methods for Bringing Solids into Aqueous Solutions), a book probably of the Liang period (cf. pp. 169 ff.). *TT*864, another Liang text, describes the use of a bag made of cloth (*pu tai*[2]) for the same purpose.

Bamboo was valuable also for every form of conduit to convey liquids or gases from place to place, as we have already had occasion to emphasise.[a] It also doubtless came in handy for the bubbling of gases through solutions (though the medieval alchemists and technicians would never have thought of it in that sophisticated way). Only just above we noted that the delivery tubes of Chinese mercury stills were made to dip into cold water in the receiver from the +11th century onwards; gases would escape while the mercury condensed. But the focus of interest here, as the ancestor of all

[a] Vol. 4, pt. 2, p. 64.

[1] 三十六水法 [2] 布袋



(*a*) (*b*)

Fig. 1509. Origins of the gas bubbler or Woulfe bottle; typical Chinese tobacco water-pipes.

(*a*) An example from Canton, of brass or silvered copper with open-work sides. The parts are shown separately—on the left the smoke-tube with burner or bowl at the top. The scraper and brush are lying in front, and the pincers stand behind them; on the right, the tobacco box lid is closed. The design concentrated all the necessary utensils within one instrument easily transported. Laufer (42), pl. v, fig. 1; one fourth natural size.

(*b*) Another water-pipe from Canton, of 'tootnague' (here paktong, i.e. cupro-nickel, not zinc; cf. Vol. 5, pt. 2, pp. 212, 225 ff.). Encased in black varnished leather with cut-out patterns. From left to right, the burner or bowl, the scraper and brush, the mouthpiece and tube, the pincers in their socket, and the box for tobacco, with open lid. Laufer (42), pl. vi, fig. 3.

gas-bubblers, lies in the water-pipe (*shui yen tai*[1]) used for smoking tobacco (Fig. 1509), analogous to the *narghileh* or *hookah* of India and Islam, though characteristically much more compact in construction. Asian people liked their smoke cool, so they passed it through plain or scented water. The *narghileh* cannot antedate the first half of the +16th century, when the discovery of the Americas sent the seeds of *Nicotiana Tabacum* flying through all the civilisations of the Old World, but surely it must have been based on some previous experience of bubbling technique and on vessels of particularly suitable form.[a] One of these was no doubt the simple pot with

[a] This problem was seen, though not solved, by Laufer (42), esp. p. 27. For China we might remember the southern tribal, and Vietnamese, custom of drinking wine from a common pot through tubes of bamboo, cane or straw, on festival and ritual occasions (Vol. 3, p. 314, Vol. 4, pt. 2, p. 485).

[1] 水煙袋

Fig. 1510. Double-mouthed *kundika* pot or bottle, of buff clay with *ying-chhing* (shadow blue) glaze; Indian in form but Thang in date. Photo. Royal Ontario Museum, Toronto. Ht. 23·25 cms.

a necked mouth and a second necked or mammiform spout-like orifice on its flank, whence a jet of water or wine could be poured down the throat.[a] This type of drinking-pot (Skr. *kundika*, Mal. *kendi*) was also made of porcelain in China and exported all over South and South-east Asia from about +1350 onwards;[b] then in many places the convenience of it as a bubbler or base for the tobacco water-pipe was recognised, and gradually its form was adapted so as to be most suitable for that employment (Fig. 1510). This is only part of a chapter never yet written on the history of the chemical gas bubbler, the Woulfe bottle, but what more would have to go into it remains to be seen.

Taoist works, for example *TT*885, make frequent reference to weighing, but no special description of the balance or weighing-machine has yet been found in them. It is probable that the alchemists used the ordinary steel-yard, which was always the most common type of balance in China.[c] It is also interesting to note the use of the

[a] The practice continues notably with green glass vessels (*porrón*) in Spain, as every traveller knows.

[b] See the study of Sullivan (8).

[c] Cf. Vol. 4, pt. 1, pp. 24ff. We shall return to this subject momentarily later on (p. 266). As we shall there see, Chhen Shao-Wei in the early +8th century dealt explicitly with the problem of quantitative yield; though most of his figures were arrived at *a priori*, the foundation of his argument was an actual assay. Our collaborator Tshao Thien-Chhin called attention long ago to the proverbial expression often applied to chemical conversions (even when it could not be rigorously true)—*fên hao wu chhien*,[1] 'there is not a grain or a scruple of loss'. This recalls Maslama al-Majrītī three centuries later, who failed to note the increase of weight on calcination of mercury. Could it be that a loss of

[1] 分毫無欠

clepsydra (water-clock) and the sundial for timing the initiation and duration of alchemical experiments, as mentioned, e.g., in the Sung text *TT*229. The burning-time of incense-sticks,[a] and the interval required to cook a meal of rice, are also encountered as units of duration.

A good deal of alchemical apparatus seems to have been ordinary household and kitchen utensils pressed into service. The use of iron chopsticks, iron and silver spoons, stone pestles, etc. has already been mentioned. Other things like large jars, wooden basins, vases and copper basins, for example, are mentioned in *TT*935, a text of *c.* +864. *TT*874 also tells us about such ordinary household utensils as the *chhêng* (or *tang*),[1] a vessel with feet usually used for warming wine; the *thieh chhi*,[2] a container made of iron, and the *kuo*,[3] presumably the large thin-walled cast-iron pan in such familiar use for frying or boiling food in Chinese kitchens.

With this we end our discussion of the equipment of the ancient and medieval Chinese alchemists, chemical technologists and pharmacists. It may have been rather tantalising to consider this apparatus, especially stills, in the rather abstract way to which we have been constrained here by our immediate purpose, but many pages in the rest of these volumes give an idea of what chemical reactions and processes were in fact involved in their use. As for the future, we have no doubt that the further study of the Chinese literature from the Han onwards will throw much more light on the progress of the chemical crafts and techniques in East Asia. One is left once again with the conviction that development in China went on *pari passu* with that in Europe, broadly speaking, and that Ko Hung probably knew quite as much about chemical operations as Zosimus. At any rate we hope that enough has been said about the Chinese equipment to dispel the impression given by some older authorities, who without any access to the original texts could write such words as these: 'They (the Chinese) possessed neither characteristic chemical methods of their own, nor any apparatus originating in their own culture.'[b]

(*g*) REACTIONS IN AQUEOUS MEDIUM

It is often supposed that the Chinese alchemists busied themselves mostly with non-aqeuous reactions of a more or less metallurgical character. But a text first studied by Tshao Thien-Chhin, Ho Ping-Yü & Needham (1) throws a considerable light on the earliest beginnings of the chemistry of inorganic reactions in aqueous medium. Weak nitric acid was employed to bring into solution a large number of inorganic substances,

mercury balanced the gain in oxygen? Goldsmiths of those times certainly had sufficiently sensitive scales, in China as well as in Andalusia.

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[a] Cf. pt. 2, pp. 146ff. and also Vol. 3, p. 330, Vol. 4, pt. 3, p. 570.
[b] Von Lippmann (1), vol. 1, p. 456, cf. p. 459.

[1] 鐺 [2] 鐵器 [3] 鍋

the processes being carried out either in porcelain vessels or in lengths of bamboo tubing which acted in part as a semi-permeable membrane. The text also includes mention of certain curious phenomena which were probably the effects of enzymes from organic material. It thus shows that the making of gold for the preparation of the elixir of immortality was far from being the only interest of these early medieval experimentalists. At the same time mica and certain other minerals had long been regarded in China as among the substances from which potent elixirs might be made,[a] and this no doubt explains the motive of the alchemists in their efforts to dissolve various mineral substances. The title of the text in question is *San-shih-liu Shui Fa*[1] (Thirty-Six Methods for the Bringing of Solids into Aqueous Solutions; *TT* 923). The first thing was to try to date it.

Aqueous solutions of mineral substances hard to dissolve were known to Chinese alchemists at least as early as the time of Ko Hung[2] (+283 to +343), who in his *Pao Phu Tzu*[3] gives an account of the preparation of aqueous solutions of realgar and cinnabar,[b] mentioning an earlier work called the *San-shih-liu Shui Ching*[4] (Manual of the Thirty-Six [Methods for] the Bringing of Solids into Aqueous Solution).[c] Elsewhere he knows how '...to turn the thirty-six minerals directly into aqueous solutions'.[d] Another alchemical treatise, entitled *Huang-Ti Chiu Ting Shen Tan Ching Chüeh*[5] (Explanation of the Yellow Emperor's Manual of the Nine-Vessel Magical Elixir),[e] mentions a *San-shih-liu Shui Fa*, saying that Pa Kung[6] imparted these techniques to the well-known −2nd-century alchemist Liu An,[7] Prince of Huai-nan[8].[f] It adds that 'the solubilisation of alum (*fan shih*),[9] realgar (*hsiung huang*[10]) and cinnabar (*tan sha*[11]) is based on Pa Kung's manual of the thirty-six methods for bringing solids into solution.[g] The methods all depend on the use of nitre, i.e. saltpetre (*hsiao shih*[12]). In the case of the solubilisation of cinnabar, copper sulphate (*shih tan*[13]) is (also) needed.' The *Yün Chi Chhi Chhien*[14] (Seven Tablets of the Cloudy Satchel) *c.* +1022, on the other hand, also attributes a book with a similar name to Thao Hung-Ching[15] (+456 to +536) the great physician and alchemist of the Liang period.[h] The title is rather revealing, namely *Fu Yün-Mu Chu Shih Yao Hsiao Hua*

[a] Cf. Ware (5), p. 186, Feifel (3), p. 15, translating *PPT/NP*, ch. 11, pp. 8*b*ff.

[b] *PPT/NP*, ch. 16, pp. 7*b*, 8*b*, 9*a*, tr. Ware (5), pp. 272, 274.

[c] *PPT/NP*, ch. 19, p. 4*a*.

[d] *PPT/NP*, ch. 3, p. 1*b*. Feifel (1), p. 182, translates, most inadequately, '...to change the thirty-six stones suddenly into water.'

[e] *TT* 878. Date Thang or Sung, but incorporating some material as old as the +2nd century.

[f] Ch. 8, pp. 1*a*, 2*a* and 4*a*.

[g] It is not clear whether Pa Kung was a single adept or 'the Eight Adepts'. The latter may be more probable, at any rate later literature preserved their names, which we take from Hsü Ti-Shan (1), p. 119—Chin Chhang,[16] Lei Pei,[17] Li Shang,[18] Mao Pei,[19] Su Fei,[20] Thien Yu,[21] Wu Pei[22] and Tso Wu.[23] The last of these is certainly historical. *YCCC*, ch. 109, pp. 21*a*ff. however, makes Pa Kung a person who turned into a youth of 15 by art and gramarye at Liu An's court.

[h] *YCCC*, ch. 107, p. 9*a*.

[1] 三十六水法 [2] 葛洪 [3] 抱朴子 [4] 三十六水經
[5] 黃帝九鼎神丹經訣 [6] 八公 [7] 劉安 [8] 淮南
[9] 礬石 [10] 雄黃 [11] 丹砂 [12] 硝石 [13] 石膽
[14] 雲笈七籤 [15] 陶弘景 [16] 雷昌 [17] 雷被
[18] 李尙 [19] 毛被 [20] 蘇飛 [21] 田由 [22] 伍被 [23] 左吳

San-shih-liu Shui Fa[1] (Thirty-Six Methods for the Bringing of Substances into Aqueous Solution [by means of] Transformations caused by Nitre [with a view to the] Ingestion of Mica and all Kinds of Mineral Drugs). It was in one chapter, just as our text still is.

The *San-shih-liu Shui Fa* is in the *Tao Tsang* (Taoist Patrology)[a] but does not reveal the name of its author. It is true that it quotes a saying of an alchemist named Kao Chhi,[2] but unfortunately nothing is known about him or his date. The book is almost certainly the same as that listed in the bibliographical chapter of the *Sung Shih*[3] (History of the Sung Dynasty), +1345, and also identical with the work known to the compiler of the *Thung Chih*[4] (+1150) by the name *Lien San-shih-liu Shui Shih Fa*.[5] The book was thus well known by the Northern Sung (+11th century), but the authorship remains obscure. As we shall see, comparison with other alchemical texts strongly indicates that some at least of the methods described must have been known in the time of Ko Hung (+3rd and +4th centuries). The text now contains more than 36 recipes; and in many cases alternative methods are also given. Perhaps the best conclusion is that we have here a Corpus the beginning of which may go back to the group of Liu An in the −2nd century, but which grew as time went on. The most likely candidate for acceptance as the major contributor is in our opinion Thao Hung-Ching very early in the +6th century.[b]

Another book of interest in the *Tao Tsang* is the *Hsien-Yuan Huang-Ti Shui Ching Yao Fa*[6] (Medicinal Methods of the Aqueous [Solutions] Manual of Hsien-Yuan the Yellow Emperor).[c] So far we have not been able to trace its authorship or fix its date. It treats of all kinds of minerals subjected to more or less similar operations, e.g. triple extraction with water, hot extraction with 'bitter wine' (*khu chiu*,[7] probably vinegar containing other substances in solution), addition of copper sulphate or potassium nitrate to the extracts, mixing with numerous ingredients of vegetable origin, and burying in vessels underground. There are 32 recipes (with two missing), and besides the above methods they generally include evaporating to dryness on the water-bath. But having prepared aqueous solutions of mineral salts and the active principles of plants in a very reasonable pharmaceutical way, each recipe usually ends with the addition of the solution to metallic mercury and its conversion into silver thereby. Thus an alchemical layer seems to have been superimposed on a pharmaceutical layer. This book however, which so far has received no attention, deserves more than we are able to give it here.

In order to have an idea of the content of the *San-shih-liu Shui Fa*, the quotation of a few typical procedures is necessary. First let us look at what is said about a metal and two metallic salts.

[a] *TT*923. On the Patrology itself, see Vol. 5, pt. 3, pp. 113ff. above.

[b] He himself refers, in a passage from the *Pên Tshao Ching Chi Chu* (cit. *CLPT*, ch. 3, (p. 85.2), *PTKM*, ch. 11, p. 25*a*) to a *San-shih-liu Shui Fang*.[8]
Could this have been the name of the collection before he enlarged it?

[c] *TT*922.

[1] 服雲母諸石藥消化三十六水法 [2] 高起 [3] 宋史 [4] 通志
[5] 鍊三十六水石法 [6] 軒轅黃帝水經藥法 [7] 苦酒 [8] 三十六水方

(No. 31) *Chhien-hsi shui*[1]—an aqueous solution of lead.[a]

2 lbs. of lead scrapings mixed with 4 ozs. of nitre (saltpetre), sealed (with lacquer) in a (bamboo) tube and put in vinegar will form an aqueous solution after 100 days.

(No. 41) *Chhien-kung shui*[2]—an aqueous solution of lead.[b]

5 spoonfuls of 'flying frosty snow' (*fei shuang hsüeh*[3])[c] are well mixed first with 'elegant powder of the Metal Elder' (*chin ong hua fên*[4])[d] until damp, and then with mica (powder) and brine, and (finally) nitre (saltpetre), using 2 ozs. of nitre for every lb. (of lead powder). Sealed with lacquer in a bamboo tube, placed in a jar of vinegar, and buried 3 ft. in the ground, the whole being kept warm by means of burning horse-dung; an aqueous solution will be formed after 30 days.

(No. 8) *Tzhu-shih shui*[5]—an aqueous solution of magnetite.

1 lb. of magnetite, 1 oz. of realgar and 1 oz. of copper sulphate (*shih tan*[6]) pounded together, sealed in a bamboo tube with lacquer and put in vinegar for 30 days will form an aqueous solution.[e]

Next consider formulae for the solubilisation of sulphur and several sulphides.

(No. 4*a*) *Tan-sha shui*[7]—an aqueous solution of cinnabar.

1 lb. of cinnabar with the addition of 2 ozs. of copper sulphate and 4 ozs. of nitre (saltpetre), sealed inside a freshly-cut bamboo tube with lacquer, and immersed in vinegar, will form an aqueous solution in 30 days.

(No. 9*b*) *Liu-huang shui*[8]—an aqueous solution of sulphur.

Sulphur suspended in honest vinegar (*shun tshu*[9]), with the addition of 2 ozs. of nitre (saltpetre) and enclosed in a bamboo tube as before, but buried in the ground, will turn after 15 days into an aqueous solution called *pao thien chih cho*[10] (Heaven-enveloping Potion).

(No. 2*a*) *Hsiung-huang shui*[11]—an aqueous solution of realgar.

1 lb. of realgar and 4 ozs. of nitre (saltpetre) are enclosed in a freshly-cut bamboo tube, which is sealed with lacquer and placed in vinegar for 30 days. An aqueous solution will then be formed.[f]

(No. 3*a*) *Tzhu-huang shui*[12]—an aqueous solution of orpiment.

1 lb. of orpiment and 4 ozs. of nitre (saltpetre) are sealed in a freshly-cut bamboo tube with lacquer. If this is placed in vinegar for 30 days an aqueous solution will result.[g]

(No. 3*b*) The same—another method.

(Orpiment) with the addition of 2 ozs. of alum and 2 ozs. of nitre (saltpetre) contained

[a] The term *chhien-hsi* can refer to either tin or lead (RP15), but the context suggests that lead was most probably meant. The acetate and nitrate of tin would have been formed just as easily, no doubt, as those of lead. A similar method for lead and tin together is given in *TT*876, p. 2*a*, *b*.

[b] Kung generally means the iron hub-bearing of a cart-wheel. Its exact significance here is not obvious.

[c] Undoubtedly some white sublimate, but the term does not suffice to identify it. Calomel or corrosive sublimate are perhaps more likely than anything else.

[d] Certainly lead carbonate, though the technical phrase is somewhat unusual. *Chin ong* = *chin kung*[13] = *chhien* (lead), and *chhien hua*[14] is lead carbonate.

[e] The same method is also given in *TT*878, ch. 8, p. 4*b*.

[f] This method is also given in *PPTJNP*, ch. 16, p. 8*b*, where Ko Hung specifies 'the strongest vinegar' (tr. Ware (5), p. 274); and in *TT*878, ch. 8, p. 4*a*; and in *TT*911, ch. 1, p. 9*a*—but they all use half the amount of saltpetre and give the time required as 20 days.

[g] Also given in *TT*878, ch. 10, p. 3*a*.

[1] 鉛錫水 [2] 鉛缸水 [3] 鼈霜雪 [4] 金翁華粉 [5] 磁石水
[6] 石膽 [7] 丹砂水 [8] 硫黃 [9] 淳醋 [10] 包天之灼
[11] 雄黃水 [12] 雌黃水 [13] 金公 [14] 鉛華

(with vinegar) in a porcelain jar and buried for 20 days will form an aqueous solution which tastes sweet and has a yellow colour.[a]

Sulphates and silicates were dealt with either alone or with the addition of decaying organic materials. An example of the former would be a recipe for alum:

(No. 7*b*) *Fan-shih shui*[1]—an aqueous solution of alum.

(Alum) mixed with an aqueous suspension of greenish mica (*yün-ying shui*[2])[b] and 2 ozs. of nitre (saltpetre), placed (with vinegar) in a porcelain jar and buried for 30 days, will form an aqueous solution which tastes bitter and has a dark bluish colour.

Two examples of the latter concern calcium sulphate and potassium sodium aluminium silicate.

(No. 21) *Ning-shui-shih shui*[3]—an aqueous suspension of gypsum or calcareous spar.[c]

1 lb. of *ning-shui-shih* mixed and pounded together with the blood of green ducks (*chhing fu hsüeh*[4]), and put in a bamboo tube will form an aqueous suspension when buried 3 ft. down in damp ground for 10 days.

(No. 28*b*) *Yün-mu shui*[5]—an aqueous suspension of mica.

(Mica) thoroughly mixed with an equal quantity of aqueous extract of cinnamon (wood or bark),[d] brine, and 2 ozs. of nitre (saltpetre), sealed with lacquer in a bamboo tube and buried in the ground to a depth of 3 ft. as before, or put in a dry well and covered for 25 days, will form an aqueous suspension. This is put in a copper vessel and placed on moist ground (for keeping). It is then known as *yün-ying i*[6] (mica juice)[e] and can be used for dissolving *shih chiu ying*[7].[f]

All these are typical of the solubilisation recipes found in the *San-shih-liu Shui Fa* and scattered in many other Thang and pre-Thang alchemical texts.

Recipe no. 1 gives the technical term by which these baths of acetic acid and potassium nitrate were always known in Thang and pre-Thang writings, *hua chhih*[8] (the 'radiant pool').[g]

From the full translation of Tshao, Ho & Needham (1) it can be seen that the types of reaction described in the book are rather multifarious. They can however be divided into a number of groups which it will be convenient to discuss separately.

[a] Also given in *TT*878, *loc. cit.* The wide repetition of these formulae for the sulphides of arsenic (and our references must be far from exhaustive) shows how important arsenical solutions were for the elixir cult.

[b] *Yün-ying* is a kind of greenish mica (RP39), cf. de Mély (1), p. 64.

[c] *Ning-shui-shih* may be either the sulphate or the carbonate of calcium (RP119).

[d] *Cinnamomum Cassia*, the famous tree native to Kuangsi province (R495). Apart from the use of its bark, twigs, buds, peduncles and oil in pharmacy and cooking, it had an age-old reputation as an elixir constituent. It is often mentioned in this connection by Ko Hung; cf. e.g. *PPT/NP* ch. 11, p. 14*a*, *b*, the story of Chao Tho-Tzu,[9] who acquired extraordinary strength by its aid (tr. Ware (5), p. 195; Feifel (3), p. 26).

[e] There is a parallel text on this subject in *PPT/NP*, ch. 11, p. 8*b*, where Ko Hung recommends half a dozen or more substances, both inorganic and organic, for bringing mica into solution or suspension. The passage involves various difficulties of nomenclature and interpretation which it is hardly worth going into here (cf. Ware (5), pp. 186–7; Feifel (3), pp. 16–17; Davis & Chhen Kuo-Fu (1), p. 316). Cf. also *TT*830, pp. 19*b*, 20*a*.

[f] No other reference to this is known to us, but *shih ying* is quartz or rock crystal (RP37).

[g] Cf. Wang Khuei-Kho (2)

[1] 礬石水 [2] 雲英水 [3] 凝水石水 [4] 青鳧血 [5] 雲母水
[6] 雲英液 [7] 石九英 [8] 華池 [9] 趙他子

(1) The Formation and Use of a Mineral Acid

As we noted just now, the *Huang-Ti Chiu Ting Shen Tan Ching Chüeh*[1] makes a very significant statement about the 36 *Shui Fa*.[2] It says that the transformation of alum, realgar and cinnabar into watery (solutions) follows the manual of Pa Kung;[3] and that all the methods depend upon the use of nitre (saltpetre) for their successful achievement. Although this makes no mention of vinegar, it is clear that in most cases explicit directions are given for its addition. Thus both substances are present in 17 recipes, and one or other of them in 31 recipes out of the total of 42. One may suspect that in the 7 where nitrate alone is mentioned and in the 7 where vinegar alone occurs, it was the original intention to direct the use of both, but one or the other dropped out in copying. At the same time there are samples where only one reagent would have been quite effective.[a] In other examples,[b] it seems certain that nitre and vinegar were originally in the text but fell out later, otherwise the procedure could not make sense. In others again neither reagent was necessary, though both are given,[c] or nitre only.[d] In any case the reactions with which we are chiefly concerned were nothing more nor less than the oxidation of the compounds or elements by dilute nitric acid, just as might be done in a modern chemical laboratory.

Most of the reactions of this group described in the text are quite plausible, involving oxidation of the insoluble sulphides of arsenic and mercury, insoluble elementary sulphur and the insoluble metals, by the action of nitrate in the presence of acetic acid. However, (i) the acidity arising from the acetic acid was extremely low, and hence the rate of reaction correspondingly sluggish, requiring weeks instead of minutes; and (ii) in most cases water and H^+ (and its anion, i.e. AcO^-) were not directly added to the solids, but reached them by diffusion through the thick (though pared-down) bamboo 'membrane', which constituted the reaction vessel, so that again the reactions were necessarily slow. No doubt some of the reaction products also diffused outwards as ions and became lost in the surrounding vinegar. But this did not worry the alchemists, because their primary concern was to see the insoluble solids disappear and change into aqueous liquids. The nature of the changes and that of the products formed was beyond their conjecture.

Where colloidal sulphur constituted part of the reaction products, this would be left inside the bamboo tube because the particle size would have been too large for free diffusion. The bamboo vessel therefore acted as a 'semi-permeable membrane', so that the alchemists were able to observe the yellow colour and the turbidity of the resulting solutions. Of course, the reactions carried out in porcelain or metal vessels involved the prior addition of vinegar and took place in essentially closed systems.

We may now deal individually with some of the aqueous solutions prepared using

[a] E.g. recipes (8) and (24).
[b] E.g. recipes (1*b*) and (17).
[c] E.g. recipes (36) and (40).
[d] E.g. recipes (37) and (38). Recipe (39) is very curious, for the acetic acid seems to have been driven off by heat before the nitrate was added, but the salt was soluble to begin with.

[1] 黃帝九鼎神丹經訣 [2] 水法 [3] 八公

nitrate and acetic acid. In order to assist the visualisation of what was probably happening, we offer a number of representations in equational form, but these are not intended to be in any way rigorous and should be taken as no more than reasonable if speculative interpretations. We shall generally omit in our equations ions that appear on both sides of the equal signs, so as to show the basic oxidation-reduction reactions. In the case of recipe no. 1 since ferric sulphate, $Fe_2(SO_4)_3$, is soluble in water anyway it would seem probable that yellow iron alum was originally the substance meant. The dissolved products would then presumably be a complex mixture of potassium and iron acetates and nitrates. Alum also occurs in recipe no. 7; presumably some would dissolve as such in the weak acid. The *Huang-Ti Chiu Ting Shen Tan Ching Chüeh* gives a method for the making of *chhing fan shih shui*[1] which would be an aqueous solution of green vitriol (copperas) or ferrous sulphate.[a] It says:

> Take some *wu fan*[2] alum and out of it select 1 lb. of the blue pieces. First keep them in good vinegar until thoroughly macerated and then put them in a container together with 2 oz. of nitre. Seal the container with lacquer and bury it 3 ft. below ground for 15 days. An aqueous solution will form spontaneously.

Here again since the salt itself is quite soluble some kind of alum was probably what was originally intended.

Another iron recipe is no. 40 which starts with ferrous acetate, not difficult to dissolve but oxidising probably under the conditions given to a blood-red solution of the basic acetate, precipitable by heating.[b] This, if dilute, might explain the colour description in the alchemical name of the product, *hsüan ling chin tzhu hsi shui*[3] (mysterious golden compassionate tide liquid).

The magnetite recipe, no. 8, gives us something different, for nitrate is absent. Here the magnetic iron oxide must have been acting as oxidising agent and the realgar as reducing agent, giving iron sulphate, arsenate or arsenite. For example it might be plausible to write an equation as follows:

$$3Fe_2O_3 + As_2S_2 + 18HOAc \longrightarrow 6Fe^{++} + 2S + 2As^{+++} + 18AcO^- + 9H_2O.$$

Since Fe_3O_4 can be regarded as $FeO.Fe_2O_3$, only the oxidised part Fe_2O_3 is considered for simplicity.

Continuing our examination of the series of solutions of salts of metals we come to copper carbonate in recipes no. 5 and no. 6. Here the mercury can have performed no function. Copper carbonate is of course soluble in weak nitric acid. The recipe is repeated in the *Pên Tshao Kang Mu Shih I*[4],[c] where it is ascribed to Chu Chhüan's[5] *Shen Yin*[6].[d] It is recommended as an eye-lotion, very understandably in view of the oligodynamic action of copper.

The lead salt recipe, no. 41, is embarrassed by uncertainty as to the identification of the reactants, though lead carbonate, used in China from very ancient times as a

[a] *TT*878. Ch. 10, p. 2*a*.
[b] Cf. Vol. 5, pt. 2, pp. 292 ff. above.
[c] Ch. 1, 12*a*.
[d] See immediately below.

[1] 青礬石水 [2] 吳礬 [3] 玄霜金慈沙水 [4] 本草綱目拾遺
[5] 朱橚 [6] 神隱

cosmetic, was certainly present. If the 'flying frosty snow' was calomel or corrosive sublimate, as seems very probable, the mercury might have acted as a catalyst in the oxidising reactions whereby basic lead acetate and a little lead nitrate were produced, besides the adjuvant action of hydrochloric acid. The process was the converse of the second stage of the classical manufacture of white lead, which appears to have been known and used in China as far back as the −4th century, i.e. at least as early as the first European description of it by Theophrastus.[a] The recipe would certainly have yielded a very poisonous drink, if ever aspirants for immortality were counselled to consume it.

The solubilisation of elementary metals by nitrate and vinegar might be represented as follows:[b]

(i) for lead and iron

$$3Pb + 2NO_3^- + 8H^+ \text{ (from vinegar)} + (2K^+) + (8AcO^-) \longrightarrow 3Pb^{++} + 2NO + (2K^+) + (8AcO^-) + 4H_2O,$$

(ii) for silver

$$3Ag + NO_3^- + 4H^+ + (K^+) + (4AcO^-) \longrightarrow 3Ag^+ + NO + 2H_2O + (K^+) + (4AcO^-).$$

Generally, then, mixed acetates of the metals and alkali metals remained in solution, while a certain amount of nitric oxide was given off. In recipe no. 42 we find the additional presence of mercury with metallic lead. The resulting amalgam would certainly have speeded up the process. One cannot feel that the gold recipe, no. 29, gave the alchemists much satisfaction, however, even if nitrate was present. But of course if some salt had been added, as it certainly was in some of the other recipes, the resulting weak *aqua regia* might have made at least a superficial attack upon the noble metal.

Now comes the alchemically important solubilisation of mercuric sulphide, recipe no. 4*a*. The reaction appears to have been either

$$3HgS + 2K^+NO_3^- + 8HOAc \longrightarrow 3S + 3Hg^{++} + 2NO + 2K^+ + 4H_2O + 8AcO^-$$

or

$$3HgS + 8K^+NO_3^- + 8HOAc \longrightarrow 3SO_4^{--} + 8NO + 8K^+ + 3Hg^{++} + 4H_2O + 8AcO^-.$$

As for the function of the copper sulphate (especially mentioned in the *Huang-Ti Chiu Ting Shen Tan Ching Chüeh*) we think that it could well have been a catalyst.

The reaction in recipe no. 4*b* is similar to the preceding one, but the red colour demands an explanation. We suggest that it was due to the presence of selenium as an impurity. Selenium and sulphur are so similar in their properties that they belong to the same group in the Periodic Table. When acidified most selenium compounds are decomposed to form elementary selenium which is brilliantly red. Recipe no. 4*b* omits vinegar, perhaps unintentionally.

[a] Evidence has been given in Vol. 5, pt. 3, pp. 15ff. Here we need only cite the complete statement in the *Chi Ni Tzu*[1] book, ch. 3, p. 1*b* (in *YHSF*, ch. 69, p. 24*b*). Partington (1) considered that the process was known and used in Greece before Theophrastus and that its age outside Greece went back still further. Perhaps it was a chemical discovery of the Fertile Crescent which spread in both directions, east and west.

[b] E.g. recipes (29), (30), (31), (42).

[1] 計倪子

So important did the alchemists consider the bringing into solution of mercuric sulphide that mention of it can be found in a number of other texts. As an example we may give the following. The *Pao Phu Tzu* about +320 gives the same recipe as no. 4*a* but with a different proportion for nitre.[a] The same method is mentioned in the *Huang-Ti Chiu Ting Shen Tan Ching Chüeh*[b] and the *Chu Chia Shen Phin Tan Fa*.[c] Both of these are primarily Thang or Sung texts, but an earlier reference, lesser known, occurs in the *Shang-Chhing Chiu Chen Chung Ching Nei Chüeh*[1] (Confidential Explanation of the Interior Manual of the Nine Adepts; a Shang-Chhing Scripture).[d] This book bears the name Chhih Sung Tzu,[2] a pseudonym of the +4th-century alchemist Huang Chhu-Phing,[3] and there is nothing in the content to suggest a later date. Apart from descriptions of the effects of elixirs, and directions about the auspicious and inauspicious days for embarking on the Great Work, together with details of necessary sacrificial offerings, only one practical method is given, namely the bringing of cinnabar into solution by long heating with vinegar, with or without the addition of lacquer latex. In the omission of nitre this recipe resembles no. 8, but no copper sulphate is present. Perhaps however mercuric acetate was slowly formed. Conversely, the vinegar is omitted in the formula of Chao Hsüeh-Min[4] in his *Pên Tshao Kang Mu Shih I*[5] (Supplementary Amplifications of the Great Pharmacopoeia)[e] of +1769 which includes only cinnabar, copper sulphate and nitrate exactly as in no. 4*b*. One cannot help wondering whether here again the mention of vinegar was not accidentally omitted. It is interesting that Chao quotes the recipe as coming from the *Shen Yin*[6] (Occupations for Retired Scholars) by the famous Ming prince Chu Chhüan[7] (+1390 to +1448), alchemist, botanist, geographer and musician.[f] Chao adds that the solution (mainly mercuric acetate) prolongs life, dispels evil influences, nourishes the spirits and calms the mind.

The sulphur waters in recipes no. 9 and no. 17, recall the sulphur-containing liquids beloved of the Greek proto-chemists.[g] Apparently the 'divine' or 'sulphur water' (*to hudōr tou theiou*, τὸ ὕδωρ τοῦ θείου), prepared from chalk, sulphur, vinegar, and ammoniacal urine, contained calcium polysulphides, very striking in their effects for the ancients because capable of giving coloured precipitates with metal salts, tinting the colours of metals in various ways, and even attacking the noble metals.[h] Here in the *San-shih-liu Shui Fa* we find again the use of vinegar. In no. 9*a* the nitric acid available would only oxidise a small proportion of the sulphur present, but as the reaction-vessel was not buried, atmospheric oxidation to sulphates catalysed by oxides of nitrogen could have occurred. The change would presumably be:

$$S + 2K^+NO_3^- \longrightarrow 2K^+ + SO_4^{--} + 2NO.$$

[a] *PPT/NP*, ch. 16, p. 7*b*, 8*a*.
[b] Ch. 8, pp. 4*a*, *b*.
[c] Ch. 1, p. 8*a*.
[d] *TT*901, p. 1*a*.
[e] Ch. 1, p. 11*b*. This chapter would greatly repay further investigation.
[f] See Vol. 5, pt. 3, pp. 210–11.
[g] Berthelot (2), pp. 46, 47, 68, 139, etc. The recipes are first found in the Leiden papyri of the +3rd century—not much earlier than the present text.
[h] Cf. Vol. 5, pt. 2, pp. 251 ff. above.

[1] 上清九眞中經內訣 [2] 赤松子 [3] 黃初平 [4] 趙學敏
[5] 本草綱目拾遺 [6] 神隱 [7] 朱橚

If the 'dew' in no. 9*a* contained much organic matter, bacterial reduction to sulphides might have followed. We shall return presently to the role of organic ingredients, but the effect of bacterial action may have been particularly important where sulphur was concerned. Thus in recipe no. 21, where calcium sulphate was suspended with duck blood, the putrefying bacteria would undoubtedly reduce the sulphate to calcium sulphide and then to the hydrosulphide and polysulphides, together with some carbonates.

Recipe no. 2*a* is a good case of getting arsenic into solution.[a] Presumably the sulphide and the nitrate formed arsenate or arsenite. It is possible to write out the oxidation-reduction reaction as follows:

$$3As_2S_2 + 22K^+NO_3^- + 4H_2O \longrightarrow 6AsO_4^{---} + 6SO_4^{--} + 22NO + 8H^+ + 22K^+.$$

Under the conditions of no. 2*b* the sulphur seems to have been oxidised not to sulphate, but to free sulphur. For example:

$$3As_2S_2 + 10K^+NO_3^- + 4H_2O \longrightarrow 6AsO_4^{---} + \underset{\substack{\text{[colloidal}\\ \text{sulphur]}}}{6S} + 10NO + 8H^+ + 10K^+.$$

In this way the turbid yellow colour and the sweet taste might be explained. When orpiment was used, as in recipe no. 3*a*, the reaction was probably:

$$3As_2S_3 + 28K^+NO_3^- + 4H_2O \longrightarrow 6AsO_4^{---} + 9SO_4^{--} + 28NO + 8H^+ + 28K^+.$$

In no. 3*b* the yellow colour was again no doubt due to colloidal sulphur. The alum added very probably affected the pH of the medium, thereby controlling the stage of oxidation and giving an arsenite. A possible reaction would be:

$$As_2S_3 + 2K^+NO_3^- + 2H_2O \longrightarrow 2AsO_3^{---} + 3S + 2NO + 4H^+ + 2K^+.$$

It is interesting that already in 1942 Hsüeh Yü (*1*) recognised the general significance of the saltpetre and vinegar in forming a dilute solution of nitric acid, and he suspected that enough chloride was present in the cinnabar recipes (e.g. no. 4) to form weak *aqua regia*.[b] The first publication of the *San-shih-liu Shui Fa* translation by Tshao Thien-Chhin, Ho Ping-Yü & Needham (1) in 1959 evoked considerable interest among practical inorganic chemists, who made a number of computations suggesting that one or another of the methods could not work as they stand. Schneider believed, for example, that one could hardly expect more than 6 or 7 % of acetic acid in the vinegar used, and that only 1 % of this would be dissociated, so the extreme weakness of the nitric acid formed had to be recognised.[c] This, he felt, undermined the plausibility of the equations suggested, and indeed in reproducing them we recognise their speculative nature. Since acetic acid does dissolve some oxides and base metals Schneider was

[a] On this subject cf. pt. 2, pp. 282ff. above.

[b] Mercuric sulphide is readily soluble in warm dilute *aqua regia* (Durrant (1), p. 377; Partington (10), p. 401). In so far as salt was generally, or always, present in the *liu i ni* luting recipes (cf. pp. 20, 219), the chloride could often have formed HCl in the *hua chhih*.

[c] Private communication from Dr Wolfgang Schneider of Braunschweig, July 1960.

inclined to accept the possibility of the magnetite-realgar recipe (no. 8), but he found the solubilisation of metallic lead (nos. 31, 41, 42) inconceivable under the conditions stated. He mentioned only one experiment, with sulphur, to test recipe no. 9; it did not give any sulphate or nitric oxide—but it did not exactly follow the conditions prescribed either. Perhaps on the whole he under-estimated the oxidising potential of nitric acid in dilute solutions, especially in the presence of traces of nitrous acid which might be formed because of the organic matter, and indeed also the possible effects of metallic impurities in the metals used, which might set up galvanic couples.

Later on, the industrial chemist Mêng Nai-Chhang (*1*) made further calculations, from which he concluded that if one sticks to the actual wording of the *San-shih-liu Shui Fa* about the procedures used, metallic lead, tin and copper would perhaps be attacked, but not silver, gold or mercury; so also the sulphides of lead, tin, iron and zinc would dissolve, but not those of mercury or copper. He thought the solubilisation of the arsenical sulphides (nos. 2 and 3) might have been partly possible, but not the magnetite-realgar recipe (no. 8); and he emphasised the buffering effect of the mixture of acetic acid and potassium nitrate. Mêng recorded a single experiment in which nitrate and cinnabar were left for some weeks with 1 M acetic acid, no Hg^{++} then being demonstrable in the solution, but as with Schneider he did not try to reproduce the medieval conditions, where the presence of catalysts and impurities of importance may be surmised. Mêng, again like Schneider, found the very simplified equations of Tshao *et al.* hard to accept, but in addition put forward an alternative interpretation of the 'vinegar bath' (*hua chhih*[1]) procedure, namely that it was a way of purifying the solid inorganic substances rather than bringing them into solution.[a] Thus he noted a statement in the *Thai-Chhing Chin I Shen Tan Ching* (*TT*873) that strong vinegar which had been left a long time in contact with gold was a form of 'gold solution' (*chin i*[2]) and should be used for moistening the 'six-and-one lute' (*liu i ni*[3]), furthermore that the gold itself became soft and crumbly to the touch. This, he suggested, was a way of purifying the gold from traces of lead; yet silver would be a more likely impurity, and as for lead, why not just complete the cupellation in the furnace? Similarly, according to Mêng Nai-Chhang, it might have been a case of purifying cinnabar from small amounts of accompanying iron sulphide—after all, weak nitric acid is still used industrially for purifying crude asbestos and talc. The whole question remains open, but it is safe to say that the best way forward will be to carry out a series of experiments imitating as closely as possible exactly what the Liang alchemists say that they did, and using reagents as impure as those which they are likely to have had. In this endeavour there is one further point which ought not to be missed.

It is curious, and perhaps significant, that the *San-shih-liu Shui Fa* and texts of similar pre-Thang date never give any hint of concentrating the vinegar. Whether distillation would have been possible at the time we discuss elsewhere (p. 155). But if this had been done and kept secret, for oral transmission only, a very different complexion would be given to the matter. Distillation of vinegar is mentioned several

[a] (*1*), p. 29.

[1] 華池 [2] 金液 [3] 六一泥

times in the Geberian books about +1290,[a] and may conceivably have been done already by the Hellenistic or Byzantine proto-chemists, more probably by the Arabs. Glacial acetic acid (if the Chinese alchemists could have got it) will dissolve sulphur, iodine and many other things ordinarily insoluble, and certainly it would have given with saltpetre a much stronger nitric acid solution. Could that, one wonders, have been the real explanation of most of the recipes in the *San-shih-liu Shui Fa* and its kindred texts? But if so, what are we to make of the ascription of the nitre-vinegar methods to the Eight Adepts at the court of Liu An? One may willingly accept the possibility of a distillation of vinegar in the +6th century while being reluctant to do so for the −2nd. Whether then the method was only fathered on them by later writers, or whether they were really the kin of Mary the Jewess, further research may reveal.

The difficulty in this whole problem is that the concentration of acetic acid by distillation is exceedingly troublesome, even with the aid of a column, because of the formation of hydrates.[b] Separation by distillation is avoided in modern chemical industry, and when concentration is necessary it is done by liquid extraction with a solvent such as ethyl acetate. In former times the weak acid was neutralised with lime, and the calcium acetate after drying was distilled with concentrated sulphuric acid, a procedure certainly not possible in +6th-century China. Nevertheless we may retain the hypothesis that in some way or other the alchemists of that time did manage to concentrate their acetic acid; and if so, then with higher nitric acid levels, perhaps with some free hydrochloric acid, and certainly with unconscionable durations of time, much of what they say they did may actually have been done.[c]

One possibility which presents itself is that their strong 'vinegar' might have been the pyroligneous acid obtained by the destructive distillation of green wood.[d] It would need no stretching of belief to attribute this to them, even though mention of such an operation has not so far been found in the medieval literature.[e] But pyroligneous acid usually contains no more than 10% acetic acid, together with smaller amounts of methyl alcohol and acetone,[f] so it would hardly have served their purpose better than ordinary vinegar.

[a] E.g. *Summa Perfectionis*, ch. 52 (Russell tr., p. 108, Darmstädter tr., p. 55), and *De Investigatione Perfectionis*, ch. 3 or 4 (Russell tr., p. 9, Darmstädter tr., p. 98). It was also done by Leonardo da Vinci (*c.* +1510) as the first stage of his remarkable preparation of acetone, in MS. K_3, 114r., noted by Reti (7), p. 665. The acetic acid was then treated with potassium and calcium carbonate (from the calcined tartar of the wine) to give the acetates, and these were then dry distilled producing acetone (*acqua risolutiva*).

[b] Some strength can be gained if the first fractions are rejected, but perhaps the main purpose of distilling vinegar in medieval times was purification rather than concentration.

[c] For advice on this subject we are most grateful to the late Dr Ladislao Reti, who was both a historian of science and a chemical industrialist of many years' experience. He agreed that only an extended series of laboratory experiments would settle the problem.

[d] This suggestion was made to us by Prof. Stephen Mason, then of Norwich. See Sudborough (1), p. 150; Perkin & Kipping (1), pp. 92, 154; Ure (1), vol. 1, p. 8, vol. 3, p. 557. The oldest descriptions in Europe seem not to be earlier than the +17th century (Partington (7), vol. 2, pp. 359, 419).

[e] Yet it is strange that the taste corresponding to the element Wood in the symbolic correlations (Table 12, in Vol. 2, p. 262) was *suan*,[1] sour or acidic. So much is still buried in the alchemical texts of China that one would not be at all surprised to come upon the distillation of wood.

[f] Ost (1), p. 403.

[1] 酸

However, there is one way in which acetic acid could certainly have been concentrated in those old days, namely by 'freezing out' the water, just as was done, as we have seen (p. 151 above), for wine and alcohol. Could this not have produced acetic acid at a concentration of 60% or more? As we have seen,[a] Glauber did something of this kind successfully in +1657. And since there is some reason to believe (p. 152) that the method was known in China as early as the −2nd century, the Eight Adepts could have employed it after all. Just as in the case of distillation, such a proceeding would very likely have been transmitted by oral tradition and not committed to paper.[b]

Lastly one must not underrate the possible importance of the pared bamboo tube. Its walls could perhaps have constituted a semi-permeable membrane within which hydrogen ions might conceivably have tended to concentrate, sodium and potassium ions passing through in the other direction. The acetate ion would have remained outside just as most of the nitrate ions would stay inside. In this way the pH within would perhaps be much higher than could be expected if the whole reactions were taking place in a single vessel, and that would be one of the first things to test if any serious effort were made to reproduce the conditions described in the text.[c]

(2) 'NITRE' AND *HSIAO*; THE RECOGNITION AND SEPARATION OF SOLUBLE SALTS

The first question raised by the oxidation-reduction reactions described in the *San-shih-liu Shui Fa* is that of 'nitre', one of the most protean words in the history of chemistry, and paralleled in a closely similar way in China by the word *hsiao*.[1,2] By the time of Robert Boyle and John Mayow nitre meant saltpetre, but in antiquity it was something quite different. 'A review of disputations on what salts this term comprised among the ancients would itself fill a volume' wrote the Hoovers, 'but from the properties named it was no doubt mostly soda, more rarely potash,[d] and sometimes both mixed with common salt.'[e]

In the book of the prophet Jeremiah we read:[f] 'Though thou wash thee with nitre and soap, yet thine iniquity is marked before me, saith the Lord.' And in the book of Proverbs it is said:[g]

> Confidence in an unfaithful man in time of trouble
> Is like a broken tooth, or a foot out of joint;
> As one that casteth off garments in winter, or as vinegar upon nitre,
> So is he that singeth songs to a heavy heart.

[a] P. 153 above. Cf. Schildknecht (1); Schildknecht & Schlegelmilch (1).

[b] Yet another way in which strong acetic acid could have been produced by very simple means was the distillation of verdigris (copper acetate). This was done by the Geberian writer (*De Inventione Veritatis*, ch. 23) who called it *oleum viridis aeris* (cf. Darmstädter tr., p. 114). No reference to this has so far appeared in a medieval Chinese text, but it would be well to look out for it. Basic copper acetate (*thung chhing*[3]) appears first in the *Chia-Yu Pên Tshao* of +1057. Cf. RP9.

[c] We are indebted to Prof. Fridemann Freund of Cologne for emphasising this aspect of the matter in personal discussion.

[d] Theophrastus, *Hist. Plant.* III, 9, mentions nitre from wood ash.

[e] (1), p. 558, in notes on Agricola; cf. p. 562.

[f] 2, 22, a text of about −600.

[g] 25, 19–20, a −3rd- or −2nd-century text.

[1] 消 [2] 硝 [3] 銅青

Thus the detergent effervesced with acid, and indeed sodium carbonate it was. This salt occurs naturally, mixed with some bicarbonate, as well as the chloride (2 to 57%) and the sulphate (1 to 70%), in parts of the Egyptian desert, notably the Wadi Natrun where there is a succession of salt lakes annually inundated, and has been gathered, purified and used for thousands of years.[a] The proper name for it was natron, a word derived from the ancient Egyptian *ntry*, hence our modern symbol for sodium; but by assimilation with Gk. *nizō* (*νίζω*) and *nizomai* (*νίζομαι*), to wash, 'nitre' resulted, via Gk. *nitron* (*νίτρον*) and Lat. *nitrum*. From the IVth Dynasty onwards (*c.* −2900) natron was used, never salt, for that desiccation which was the essential process in mummification,[b] being regarded too as a great cleanser, destroying all fat and grease.[c] But it was also used in many industrial arts, such as those of incense, glass-making and the bleaching of cloth.[d] Nitre continued to have this meaning as late as Agricola, but from the beginning of the +14th century onwards it was applied also to saltpetre—understandably enough, perhaps, since all these salts were collected from incrustations on the ground. Hence much confusion, even throughout the +17th century, when saltpetre was often called *sal nitri*.[e]

There was natron also in China, where it went by the name of *chien*[1,2] or *shih chien*.[3] A salty incrustation found on soil surfaces,[f] it was discussed towards the end of the last century by Stuhlmann (1) and Schlegel (11), who gave analyses showing an average composition of some 12% sodium carbonate, 64% sodium sulphate and 24% sodium chloride.[g] These were all traditionally separated by differential crystallisation and filtration or decantation;[h] though sometimes the carbonate occurred naturally in purer form. The crude salt came into commerce coloured brown by organic matter, hence its name *tzu chien*[4].[i] This was much used as a desiccating agent, detergent, bleach and mordant.[j] We do not find *chien* very prominent in the pharmaceutical natural histories, probably because it belonged as 'lye' rather to the kitchen

[a] See Lucas (3).

[b] See Lucas (1), pp. 297ff., 307ff. and most fully in (4). Cf. also Vol. 5, pt. 2, pp. 75–6, 299 above.

[c] So it would have been, under suitable conditions, saponifying the triglycerides by alkaline hydrolysis; cf. Perkin & Kipping (1), p. 177.

[d] The very confused accounts in Pliny, *Hist. Nat.* XXXI, 106ff., XXXVI, 191, 194, have been elucidated by Bailey (1), vol. 1, pp. 49ff., 147ff., 169ff., 173, 280ff.

[e] The first critical examination of the evidence was probably that of Beckmann (1), 4th ed., vol. 2, pp. 482ff. One of the best discussions is that of Partington (5), pp. 298ff. See also Crosland (1), pp. 76, 106; Reinaud & Favé (1), pp. 14ff.

[f] Like the *tequesquite* of Chile or the *trona* of other parts of the world. Kalgan and northern Shansi were eminent sources. Cf. Torgashev (1), pp. 327ff.

[g] See also Anon. (99), reporting carbonate up to 53% from northern Hopei and 43·6% from Shansi. Here the chloride could be as low as 1%, and the sulphate only a trace, though it could also rise to 31%. But perhaps these were partially refined products. Earlier analyses were those of Abrahamsohn (1) and von Engeström (2) in +1772.

[h] The best carbonate (*pai chien*[5]) was marketed rather pure, with only about 1% of chloride and but a trace of sulphate. The Glauber's salt separated was also rather pure.

[i] This had up to 20% of chloride and up to 30% of sulphate.

[j] Also, when pure, as 'baking powder' for steamed bread. The traditional test of its purity was how much dough could be made to rise by a given quantity of the sample. Yeast of course was always used as well, but the small amount of acid formed was sufficient to produce bicarbonate and hence carbon dioxide.

[1] 鹼 [2] 鹹 [3] 石鹼 [4] 紫鹼 [5] 白鹼

and the workshop than to the pharmacy. In the *Pên Tshao Kang Mu* it is included in the entry for lake or ground salt, *lu hsien*[1];[a] as well as having a small section of its own,[b] where it means chiefly *hui chien*[2] ('ash-natron'), i.e. the potash from plants, the preparation of which by burning, solution, filtration, and crystallisation, is described.[c] The mixture of calcium and magnesium carbonates deposited as 'fur' or 'boiler scale' was also called *chien*, but given a separate account since it was recognised as something else.[d] Certainly in China there was a confusion of name as in the West, but it was a different one; potassium nitrate was never confounded with sodium carbonate, the trouble came rather with the sulphates of sodium and magnesium, as we shall now see. In interpreting the Chinese terms therefore it is wiser not to translate *hsiao*[3,4] by 'nitre', as one might be tempted to do, but rather to invent a parallel witch-word, and give it a special equivalent of its own, 'solve'. The reason for this designation will quickly become apparent; the Chinese alchemists were dealing with several soluble salts which could act as metallurgical fluxes, or pharmaceutical cathartic-diuretics, or generators of nitric acid for the solution of minerals.[e]

Sodium sulphate in its crude form was known in the pharmaceutical natural histories[f] as *phu hsiao*[5] (crude-solve), *hsiao shih phu*[6] (crude solve-stone),[g] *yen hsiao*[7] (salt-solve), and *phi hsiao*[8] (skin-solve).[h] Much confusion arose over the terms *phu hsiao* and *mang hsiao*[9] (prickle-solve), the second being regarded by pharmaceutical writers in later times as the purified form of the first, and getting its name from the 'spiky' appearance of the prismatic crystals.[i] There was also confusion among such writers between these two terms and *hsiao shih*[10,11] (solve-stone), potassium nitrate or saltpetre. A Thang specimen of *mang hsiao* (*bōshō*) preserved in the Shōsōin Treasury at Nara in Japan, where it had been deposited in +756, turned out on analysis in 1954 to be none other than Epsom salt, i.e. crystalline magnesium sulphate ($MgSO_4 . 10H_2O$);[j] and on the basis of this result Masutomi & Yamasaki very reasonably suggested that *phu hsiao* was always mirabilite, i.e. Glauber's salt, sodium sulphate ($NaSO_4 . 10H_2O$).[k] Since the two salts occur naturally mixed in Chinese deposits, and the sodium salt

[a] Ch. 11, (p. 44), cf. RP118 (correcting their *chien*[2] *to hsien*[1]). According to Li Shih-Chen, it was first brought into this context by Chu Chen-Hêng in his *Pên Tshao Yen I Pu I* of +1330, and so towards the end of the Yuan period. It could be called *lu chien*,[12] and was like *hui chien*,[2] i.e. very alkaline.

[b] Ch. 7, (p. 91).

[c] This potassium carbonate was also employed as a detergent and in baking. In medicine it was used cautiously as an antacid in hyperacidity.

[d] Ch. 11, (p. 76), cf. RP134.

[e] Schmauderer (4, 5) recalls that precisely the same sort of nomenclature arose in the West. Saltpetre, nitric acid and potassium carbonate were called by Glauber, about +1650, *menstruum universale*, because there was nothing he knew of which they would not bring into fusion or solution.

[f] Cf. RP123.

[g] This name was due to a confusion the nature of which will appear in what follows.

[h] Because of its use in tanning, as Li Shih-Chen explains.

[i] Lei Hsiao[13] (about +470) explains that crystals with the appearance of awns of wheat picked out from *phu hsiao* are *mang hsiao*; *PTKM*, ch. 11, (p. 49).

[j] There were only traces of calcium, chlorine and potassium.

[k] In Asahina (1), no. 35, pp. 289ff. and p. 496.

[1] 鹵鹹 [2] 灰鹼 [3] 消 [4] 硝 [5] 朴消 [6] 消石朴
[7] 鹽消 [8] 皮消 [9] 芒消 [10] 消石 [11] 硝石 [12] 鹵鹼
[13] 雷敩

crystallises before the magnesium one, the idea of a purification relationship could easily have arisen in the minds of those who were not actually doing the fractional crystallisation themselves.[a]

From the results of their analyses Masutomi & Yamasaki came to the following conclusions. (*a*) A Chinese origin of the specimen is well supported by the description in the Thang pharmacopoeia (*Hsin Hsiu Pên Tshao*), +659. (*b*) Since all *Pên Tshao* authorities averred that *mang hsiao* was obtained in the process of refining *phu hsiao*, it would be correct to identify *phu hsiao* with Glauber's salt (sodium sulphate) and *mang hsiao* with Epsom salt (magnesium sulphate). (*c*) *Hsiao shih*[1] ought to be considered a general term for sulphates like *phu hsiao* and *mang hsiao*. Properly speaking, the characters *hsiao shih*[2] should be used for saltpetre (potassium nitrate), and only if this is done (or assumed where textually necessary) can the statements in the pharmaceutical natural histories be brought into consistency. (*d*) The word *hsiao*[3] in the term *hsiao shih*[1] originally meant something that would dissolve readily in water, not something which would liquefy other things as a flux does. Hence *hsiao shih*[1] must have meant in the past only *phu hsiao* (sodium sulphate) and *mang hsiao* (magnesium sulphate). We accept the first two of these conclusions, but the second two will not answer. We do not think that one can find in the literature any sharp distinction between the two ways of writing *hsiao* in *hsiao shih*. Although in the majority of cases the pharmaceutical naturalists may have written the word *hsiao*[3] for *hsiao shih* with the water radical,[b] there was never any such trend among the alchemical texts that we have studied, where we find the word *hsiao*[3,4] written freely in both forms, with the stone radical and with the water radical.[c] As for the fourth argument we fail to see any sufficient basis for it; after all, potassium nitrate too dissolves freely in water.

In late times, moreover, the term *mang hsiao* changed its meaning and came to signify sodium sulphate. Chang Hung-Chao gives a set of analyses[d] of products from Hopei and Shansi, made during the early years of this century, which showed them to contain from 36·2 to 81·1 % Na_2SO_4, the balance being mainly water of crystallisation, though magnesium sulphate was present in some specimens in the range of 2·0 to 7·3 %. Current usage continues this acceptation.[e] What brought about the change from the traditional term *phu hsiao* we do not know.

The *Shên Nung Pên Tshao Ching*[f] says that *phu hsiao* can 'transform seventy-two different minerals'.[g] Yuan Han-Chhing takes this to mean either the dehydration of

[a] The two salts were not clearly distinguished in Europe till the time of Joseph Black in the mid +18th century.

[b] But take, for example, Lei Hsiao's recipe in *CLPT*, ch. 3, (p. 85.2, 86.1); the word is written twice with the stone radical and once only with the water one.

[c] In the *Thai-Chhing Shih Pi Chi* the stone radical is used exclusively. The *Pao Phu Tzu* book mentions saltpetre in two chapters (ch. 11 p. 10*b* and ch. 16, p. 9*a*, ff.); the first uses the stone radical and the second the water one. In his index Ware (5) takes no notice of this difference in orthography, very reasonably, for in Chinese the two are in truth interchangeable.

[d] (*1*), pp. 244, 245.

[e] As may be seen in modern pharmacopoeias, e.g. Anon. (57), vol. 4, p. 242.

[f] Earliest of the Chinese pharmaceutical natural histories, dating from the −2nd and −1st centuries.

[g] Mori ed., ch. 1, (p. 24). Repeated many times afterwards, as by Sun Ssu-Mo in *CCIF*, ch. 2, (p. 14.2); and cit. *CLPT* ch. 3, (p. 87.1).

[1] 消石 [2] 硝石 [3] 消 [4] 硝

the Glauber's salt on exposure to air, leaving different mixtures of anhydrous salt and hydrates, or its action at high temperature as a flux capable of melting a number of silicates.[a] The *Thai-Chhing Shih Pi Chi* says that for *phu hsiao* one should select a specimen that has not been exposed to the wind, not dehydrated in appearance, but with a lustrous blue colour; while for *mang hsiao* one should select a specimen that looks like snow piled up in the shade, with a pleasant smooth appearance.[b] The *Ming I Pieh Lu* states that *phu hsiao* remains unchanged in the ground for a thousand years and that the refined product is white as silver.[c] Li Shih-Chen explains that the word *hsiao*[1] is included in its name because it dissolves so readily in water, brings many substances into solution or liquefaction and fuses in the furnace. After purification what is found above in the supernatant fluid (i.e. the magnesium salt) is called *mang hsiao*[2] or *phên hsiao*[3] (basin-solve) or *ma ya hsiao*[4] (horse-tooth solve),[d] while the efflorescent sodium salt[e] is called *fêng hua hsiao*[5].[f] Li Shih-Chen also cautions that *mang hsiao* should never be confused with *hsiao shih*[6] (solve-stone), saltpetre.

In its more purified form sodium sulphate was known as *hsüan ming fên*[7] (mysterious bright powder) and *pai lung fên*[8] (white dragon powder).[g] This purified form was first brought into prominence by the Taoist Liu Hsüan-Chen[9] in the time of Thang Hsüan Tsung (r. +713 to +755).[h] Liu has thus been called the Glauber of Chinese alchemy,[i] and the medicinal virtues of the purified salt were expounded in a monograph entitled *Hsüan Ming Fên Chuan.*[10] An earlier method for purifying sodium sulphate given in the *Ming I Pieh Lu* is quoted in the *Pên Tshao Phin Hui Ching Yao.*[j] It says that

some crude but clean *phu hsiao* (sodium sulphate), irrespective of quantity, should be taken (for refining) during the winter months when there is frost or snow. It is mixed with three ounces of the pods of the soap-bean tree (*tsao chia*[11]),[k] which have been heated gently for a while and pounded to a powder, then dissolved in six cupfuls of hot water. After removing the insoluble residue left at the bottom, the solution is filtered through two layers of thin paper, poured into an iron pan and evaporated until half of it is left. When cooled to a luke-warm temperature the solution is transferred to an earthenware pot and left to cool by itself in the open for a night. The next morning masses of crystals will have formed. These are dissolved in six cupfuls of boiling water and boiled together with eight ounces of large radish (*lo po*[12]) cut into pieces about two-tenths of an inch thick until the radish is cooked. The solution is again transferred to an earthenware pot, the pieces of radish (and any precipitate) having been removed (by filtration), and again left to cool by itself in the open for a night.

[a] (*1*), p. 242. The exact number 72 is of course not to be taken literally.
[b] *TT*874, ch. 3, p. 13*b*.
[c] *PTKM* ch. 11, (p. 49), as for the rest of this paragraph.
[d] Because of the prismatic crystal form.
[e] On standing in dry air, water of crystallisation is lost, leaving the anhydrous salt as a powder.
[f] A good detailed account of the differential crystallisation of the two sulphates can be found in the *Wai Kho Chêng Tsung*[13] (Orthodox Manual of External Medicine) of +1617 (ch. 12, p. 26*b*).
[g] RP124. [h] *CLPT*, ch. 3, (p. 88.1), and *PTKM* ch. 11, (pp. 52–3).
[i] Porter Smith (2). [j] Ch. 1, (p. 115).
[k] *Gleditschia sinensis*, R387. The pods contain much saponin; cf. Needham & Lu Gwei-Djen (1).

[1] 消 [2] 芒消 [3] 盆消 [4] 馬牙消 [5] 風化消 [6] 消石
[7] 玄明粉 [8] 白龍粉 [9] 劉玄眞 [10] 玄明粉傳 [11] 皂莢 [12] 蘿蔔
[13] 外科正宗

Next day further masses of crystals will have formed. After removing them from the mother liquor and drying them, these are put in a good paper bag and suspended in a place exposed to the wind. They will then turn by themselves into powder form.

Here the use of organic substances as reagents to precipitate impurities is of interest.

The *Tan Fang Ching Yuan* (+8th century) describes the chemical properties of *mang hsiao* ($MgSO_4$) saying that it can 'subdue' (*fu*[1]) orpiment, i.e. reduce the fusion point of the latter so that decomposition or sublimation will no longer take place at the usual temperature.[a] The same book also mentions among the properties of *ma ya hsiao* that it preserves (*yang*[2]) cinnabar and fixes (*chih*[3]) sal ammoniac.[b] So much for these sulphates.

Saltpetre, potassium nitrate (*hsiao shih*,[4,5] solve-stone)[c] acquired in the pharmacopoeias the synonyms *mang hsiao*[6,7] (prickle-solve),[d] *khu hsiao*[8] (bitter-solve), *yen hsiao*[9] (blaze-solve),[e] *huo hsiao*[10] (fire-solve), *shêng hsiao*[11] (natural solve) and *ti shuang*[12] (ground-frost).[f] Significantly (as we shall see), *mang hsiao*[6,7] was a name never used by the Taoist alchemists as a synonym, though they had a number of others of their own.[g] Ma Chih,[13] in the second half of the +10th century, clearly pointed out that one should not be muddled by the varying usages of the three terms; *mang hsiao*,[6,7] *phu hsiao*[14,15] and *hsiao shih*[4,5] were all definitely different things.[h] Nevertheless confusion among the pharmaceutical naturalists concerning these was not to be avoided. We have already differentiated (so far as is possible) *mang hsiao* and *phu hsiao*; now we must make clear what *hsiao shih* was.

In the *Shen Nung Pên Tshao Ching*, *phu hsiao*[16,17] and *hsiao shih*[18,19] are both listed and described separately.[i] The major emphasis is on their therapeutic and macrobiotic properties. This is evidence for the −2nd century. The name *hsiao shih*[19] itself first appears, however, in the −4th-century *Chi Ni Tzu* book (cf. pt. 3, p. 14 above) with its list of drugs and chemicals.[j] Then in the *Lieh Hsien Chuan* (Lives of Famous Hsien), the oldest parts of which date from the −1st century though the whole was not stabilised until the +3rd or +4th, we read of 'Mr Miner's Pick', the immortal Chhih

[a] Cf. pt. 3, p. 158.

[b] *CLPT*, ch. 3, (p. 86.2 and p. 88.2).

[c] RP125; Chang Hung-Chao (*1*), pp. 241ff.

[d] Because its crystals also are prismatic. Hence the +18th-century Western description of 'prismatic nitre' as opposed to 'cubic nitre', i.e. sodium nitrate (Crosland (1), p. 76; Mellor (1), p. 503).

[e] This excellent expression came in with the *Wai Tan Pên Tshao* and the *Tsao-Hua Chih Nan*, somewhere about +1040. It would reflect the first proto-gunpowder mixtures of that time.

[f] *PTKM*, ch. 11, p. 27*b* (p. 54).

[g] E.g. *pei ti hsüan chu*,[20] 'the mysterious pearl of the emperor of the North'. We need not examine further alchemical synonyms and cover-names, such as *ho tung yeh*[21] (the wilderness east of the river) and the more practical *hua chin shih*[22] (metal-changing stone).

[h] In the *Khai-Pao Pên Tshao*, *c.* +970, in *PTKM*, *loc. cit.*

[i] Mori ed., ch. 1, (p. 24).

[j] Ch. 3, p. 3*a*, in *YHSF*, ch. 69, p. 36*a*. Cf. Vol. 2, pp. 275, 554. Some scholars date the *Chi Ni Tzu* book as late as the −1st century on the ground that it cites the *Chou Pei Suan Ching*, but that argument lacks force if our dating of this mathematical and astronomical classic is acceptable (cf. Vol. 3, pp. 19ff.).

[1] 伏 [2] 養 [3] 制 [4] 硝石 [5] 消石
[6] 芒硝 [7] 芒消 [8] 苦消 [9] 焰消 [10] 火消
[11] 生消 [12] 地霜 [13] 馬志 [14] 朴硝 [15] 朴消
[16] 朴硝 [17] 朴消 [18] 硝石 [19] 消石 [20] 北帝玄珠
[21] 河東野 [22] 化金石

Fu,[1] a temple librarian skilled in alchemy.[a] He knew how to make mercury (*shui hung*[2]) and transmute cinnabar (*lien tan*[3]), which he used to consume together with saltpetre (*hsiao shih*[4]), gaining thereby the aspect of a young man and outlasting many generations. Then in Thao Hung-Ching's *Ming I Pieh Lu* of *c.* +500 *mang hsiao*[5, 6] appears as a new item together with a statement that it is derived from *phu hsiao*[7, 8] (cf. p. 182 above). Thao Hung-Ching also pointed out certain characteristics of *hsiao shih*,[9, 4] saying:[b]

Some people formerly obtained a certain substance with a colour and nature more or less similar to that of *phu hsiao*, bright like the light of early dawn and resembling a handful of salt or snow, but not (as hard as) ice. When it is burnt or strongly heated in the fire a bluish-purple flame (*tzu chhing yen*[10]) arises, and again it turns to a limy ash, not boiling and bubbling like *phu hsiao*. This is what is said to be the genuine *hsiao shih*. There are those who say that *mang hsiao* is another name for it, but that is made nowadays by refining *phu hsiao*. Huangfu (Shih-An[11])[c] concurs with me that the matter cannot be decided by argument and examination; it is necessary to try the experiment and compare and record what happens in this method of transforming *hsiao shih*. In the *San-shih-liu Shui (Fa)* it is said to come from Lung-hsi (Kansu), and from Chhinchow in Szechuan; while that found at the capital, Chhang-an, comes from the Western Chhiang tribespeople. Nowadays in the mountains everywhere north of Tang-chhang there are places with a salty earth (*hsien thu*[12]) which produce it.

Since the *Ming I Pieh Lu* resumed +3rd-century knowledge, the potassium flame test probably goes back at least that far.[d] We suspect that this must be one of the oldest references to a flame test in any civilisation, for all the European mentions seem to be of the Renaissance time or at least not earlier than Latin Geber.[e] The salt must have been KNO_3, the deflagration of which on charcoal is a striking phenomenon. If heated by itself it first decrepitates, losing mechanically entangled water, melts at 338 °C. and finally gives off oxygen, leaving the nitrite. Moreover, the *San-shih-liu Shui Fa* belongs to this date, and perhaps also to this author. Since that text describes the use of acetic acid, perhaps in concentrated form, to liberate nitric acid from saltpetre and dissolve a number of inorganic substances otherwise not easily soluble (cf. pp. 172 ff.), the identity of the salt as KNO_3 may be taken as established.[f]

It looks as if confusion was sparked off by a statement of Thao Hung-Ching's earlier in the same passage that in its therapeutic effects *hsiao shih* is similar to *phu hsiao*, and that according to some, *hsiao shih* and *phu hsiao* come from the same place, though he said specifically that they were not the same thing.[g] The confusion was

[a] Kaltenmark (2), p. 171.

[b] *PTKM* ch. 11, p. 25*a* (p. 54), quoting him by name, therefore primarily from the *Pên Tshao Ching Chi Chu*; also *CLPT*, ch. 3, (p. 85.2). Cf. Chang Hung-Chao (1), p. 243. Contemporary biographers of Thao Hung-Ching also give saltpetre (*hsiao shih*[12]) as an elixir constituent (Strickmann, 2).

[c] I.e. Huangfu Mi (+215 to +282).

[d] Attention has often been drawn to the importance of this text, as by Yen Tun-Chieh (20).

[e] Cf. Debus (13) and Partington (4), p. 76.

[f] It will be remembered, too, that the solubilisation formulae of the *Shui Fa* type go back quite a long time further. Even if we doubt their existence in the −2nd century among the techniques of Liu An and the Eight Masters (as tradition affirmed, cf. p. 168), they are certainly in the *Pao Phu Tzu* book, which is evidence for the +3rd (*PPT/NP* ch. 11, p. 8*b*, ch. 16, pp. 7*b*, 8*b*, 9*a*; tr. Ware (5), pp. 186, 272, 274).

[g] Cit. *CLPT*, ch. 3 (p. 85.2); *PTKM*, ch. 11, (p. 54).

[1] 赤斧 [2] 水銀 [3] 鍊丹 [4] 消石 [5] 芒硝 [6] 芒消
[7] 朴消 [8] 朴消 [9] 硝石 [10] 紫青煙 [11] 鼻甫士安 [12] 鹹土

established when Su Ching[1] in the +7th century confirmed the equation of *hsiao shih* with *mang hsiao*, saying:

Nowadays crude *phu hsiao* is refined by heating it in solution until *mang hsiao* is formed... This is *hsiao shih*.[a]

Identification of *hsiao shih* with *mang hsiao* seems then to have become a prevailing practice among the Chinese pharmaceutical naturalists from the Thang until the days of Li Shih-Chen towards the end of the Ming, though it was clearly pointed out by Ma Chih in the +10th-century *Khai-Pao Pên Tshao*[2] (as we have seen) that *hsiao shih* was obtained as a crystalline deposit on the ground (*ti shuang*[3]) and did not belong to the same category as *phu hsiao* and *mang hsiao*.[b] He added that Thao Hung-Ching could not have been well acquainted with the substances themselves.[c] Li Shih-Chen further quoted a statement of Su Sung to the effect that *hsiao shih* was collected by sweeping together crystals found on the earth and that all of it would burn up in the flame when tested in the fire.[d] In this connection we shall also remember from pt. 3, pp. 137, 159 above the deflagrating mixture experiment apparently attributed to Sun Ssu-Mo in the +6th century by the Sung compendium *Chu Chia Shen Phin Tan Fa* (*TT*911). The attribution is quite reasonable and potassium nitrate must have been involved.

The identification of saltpetre by observing the lilac or purple colour flame test is also mentioned in the +7th-century Thang alchemical text about the wandering monks; i.e. the *Chin Shih Pu Wu Chiu Shu Chüeh* (*TT*900), which we have given on p. 139 of pt. 3 above. It was in +664 that Chih Fa-Lin[4] recognised the presence of saltpetre in northern Shansi and referred to its 'liquidising' properties, both as a metallurgical flux and as precursor of nitric acid in the solubilisation or *Shui Fa* technique (cf. pp. 169ff.).[e] Only a few years before (+659) the *Hsin Hsiu Pên Tshao* had reproduced Thao Hung-Ching's text about the potassium flame,[f] so it was common knowledge. In connection with all this the *Huang Ti Chiu Ting Shên Tan Ching Chüeh* says:[g]

It is difficult to procure saltpetre of good quality. Inferior specimens cannot bring realgar and cinnabar into solution. If one gets some saltpetre which looks genuine one should take a few pounds of it and try it (with vinegar) on realgar and other minerals to see if they are dissolved or not. If it does not bring them into solution it cannot be deemed to be genuine

[a] *Hsin Hsiu Pên Tshao*, ch. 3, pp. 9*b*, 10*a* (p. 19).

[b] *PTKM*, ch. 11, p. 27*b* (p. 54).

[c] Actually he certainly was, as other passages here quoted show.

[d] *PTKM*, ch. 11, (p. 55), from *Pên Tshao Thu Ching* (+11th century). Fused potassium nitrate is indeed a powerful oxidising agent, charcoal (as in this case), sulphur and phosphorus burn on it brilliantly, with the formation of the carbonate, the sulphate and the phosphate. The oxidation is as good as that with concentrated nitric acid, and faster, almost explosive in its effect. Decomposition gives the potassium flame, and oxides of nitrogen go off. Cf. Partington (10), p. 311; Ephraim (1), p. 590; Durrant (1), p. 334. By contrast, sodium nitrate, the 'cubic nitre' (because of its crystal form) of the +18th century, is not a powerful oxidising agent.

[e] The same book mentions the purple flame test also in another entry, probably concerned with powdered potash alum from Persia (cf. pt. 3, p. 139 above).

[f] Ch. 3, pp. 10*b*, 11*a*, *b*.

[g] *TT*878, ch. 8, p. 12*a*. Though compiled in Thang or Sung it contains some material as old as the +2nd century.

[1] 蘇敬 [2] 開寶本草 [3] 地霜 [4] 支法林

saltpetre. In appearance it looks very much like crude *phu hsiao* (sodium sulphate), and it is not rock-like but soft. One should first take a piece of it and place it upon burning charcoal. If purple smoke is emitted and the specimen turns to a kind of ash then it is of good quality, but if it fuses and bubbles for a long time then it is *phu hsiao*. It is difficult to get genuine (saltpetre), and even when you find any that appears suitable for use the test of bringing realgar or cinnabar into solution must be carried out before you can be sure (that it is genuine).

In another place the same book repeats the test to distinguish between crude sodium sulphate and saltpetre, saying that the former when heated boils and liquefies like alum, but the latter emits bluish-purple smoke and turns into a kind of ash without liquefying.[a] But the *Shen Nung Pên Tshao Ching* itself had said rightly long before that *hsiao shih* melts when heated on a fire.[b] And the *Pao Tsang Lun* of +918, remarking that saltpetre comes up like the grass of the field, says that it does not lose weight if fused some time in a crucible.[c] Yet it can turn all metals (i.e. their ores) into a soft and flowing condition.

In the *Chen Yuan Miao Tao Yao Lüeh* (*TT*917), that Thang work which has the oldest reference to a proto gunpowder mixture (cf. pt. 3, p. 159), there is a test for saltpetre depending on its strong oxidising property.[d] It runs as follows:

As for the 'fixation' (*fu huo*[1]) of saltpetre (*hsiao shih*[2]) it can be tested on a red-hot charcoal fire. If it fuses to an oily liquid and does not move (*tung*[3]) in the heat, then it is said to be 'fixed' or 'subdued'. Just melting it in a vessel by itself will not tell you whether it is crude (lit. raw, *shêng*[4]) or treated (lit. ripe, *shu*[5]). It always takes the shape of (lit. likes to stick to) the container which it is in. Now if you test it by putting it in the fire, that which is not 'subdued' will burst into a bright flame on meeting the charcoal.

In other words the alchemists of the +8th and +9th centuries were well able to distinguish between potassium nitrate and other salts of the alkali metals.

The *Ming I Pieh Lu* applies what the *Pên Ching* said of *phu hsiao* to *hsiao shih* (saltpetre), namely that it is capable of producing changes (*hua*[6]) in seventy-two different minerals.[e] As with Chih Fa-Lin, this probably refers both to furnace flux effects and to solution by weak nitric acid. 'Because it dissolves and transforms all ores and minerals' said Ma Chih in +970, 'it is called "solve-stone".'[f] Li Shih-Chen quotes a book by Shêng Hsüan Tzu,[7] the *Fu Hung Thu*[8] (Illustrated Manual on the Subduing of Mercury),[g] repeating this and saying that to test saltpetre one can put a little of the sample on a piece of quartz (*pai shih ying*[9]) that has just been heated over a fire, then if the sample fuses into the quartz it is genuine saltpetre. The same text

[a] *TT*878, ch. 16, p. 5*b*, 8*a*.

[b] *Lien chih ju kao*,[10] *CLPT*, ch. 3, (p. 85.2); Mori ed. ch. 1, (p. 24).

[c] *Thu Ching Yen I Pên Tshao*, ch. 1, p. 29*b*.

[d] The passage was first discovered by Fêng Chia-Shêng (*4*), p. 36.

[e] *PTKM* ch. 11, (p. 54); *Pên Tshao Phin Hui Ching Yao*, ch. 1, (p. 112). Again, seventy-two only means a large number. The same quotation from *CLPT* ch. 3, (p. 85.2) gives twelve instead of seventy-two.

[f] *PTKM*, ch. 11, p. 25*a* (p. 54).

[g] Extremely difficult to date; Wieger (6) thought Ming, but that is wrong. At least three alchemists bore this pseudonym in various forms, Tung Fêng[11] of the San Kuo period, Wang Yuan-Chih[12] of the Sui (*c.* +510 to +635) and Hsüeh Chih-Wei[13] of J/Chin. Perhaps the second is the most likely author.

[1] 伏火 [2] 硝石 [3] 動 [4] 生 [5] 熟 [6] 化
[7] 昇玄子 [8] 伏汞圖 [9] 白石英 [10] 鍊之如膏 [11] 董奉 [12] 王遠知
[13] 薛知微

mentions the offensive odour of nitre beds.[a] This could conceivably refer to the hydrogen sulphide of volcanic regions where nitrate might occur beside fumaroles, but it is much more likely that manure beds sodden with urine and decaying organic material, as in the stables, latrines and *salpêtrières* of Europe, were what was meant. If we could date this book more closely we might gain a better idea of the time at which 'nitre beds' were purposively worked in China, and hence of the first beginnings of the purification of the salt there.[b] *Shih phi*[1] (stone-spleen) seems to have been a mixture of saltpetre and other salts, probably from some native deposit.[c]

Whatever the exact date of Shêng Hsüan Tzu's book, it cannot have been later than about +1150, when Yao Khuan[2] wrote an account of the 'nitre' problem which is one of the most interesting we have found outside the pharmaceutical natural histories. For in his *Hsi Chhi Tshung Hua*[3] Yao started out by quoting him as follows:[d]

In his *Fu Hung Thu* (Illustrated Manual on the Subduing of Mercury) Shêng Hsüan Tzu records a method of testing *hsiao shih*[4] (saltpetre) imported from Wu-Chhang (Udyāna). He says: 'Its colour is bluish. If you heat a piece of white quartz and then put a drop of the nitre on it, it will sink in. The Taoist books say that saltpetre from Wu-Chhang can liquefy or dissolve all metals and minerals. If consumed it can prolong life. The places where it is produced have an extremely loathsome smell, so that birds cannot fly over them, but if one puts on a single garment and passes by, all the parasites in and on one's body turn to water and one will gain longevity or immortality. Pieces shaped like little goose quills are the best kind.'[e]

Then in his *Fên Thu*[5] (Illustrated Manual on Powders, i.e. Salts) Hu Kang Tzu[6] says: 'Bluish saltpetre (*chhing hsiao shih*[7]) is also called the Mysterious Pearl of the Emperor of the North (*pei ti hsüan chu*[8]).'[f] The *San-shih-liu Shui Fang*[9] (Thirty-six Methods for Making Aqueous Solutions) further describes a process for dissolving *tséng chhing*[10] (copper carbonate) in which naturally occurring saltpetre (*chêng hsiao shih*[11]) is used.[g] From all this it may be seen that (some of) the saltpetre used nowadays is apparently not natural saltpetre.

The *Yao Ming Yin Chüeh*[12] (Secret Instructions on the Names of Drugs and Chemicals)[h] says: 'According to ancient tradition *hsiao shih*[13] (saltpetre) can liquefy and dissolve all kinds of metals and minerals; and if eaten can prolong life. But we have never found out where it is produced. We only know its name, which is as good as not having it at all. Recently Thao

[a] *PTKM* ch. 11, (p. 54). 'This salt comes from places which smell so horribly foul that birds can't bring themselves to fly over them....'

[b] Cf. Partington (5), pp. 314ff. The history of 'nitre-beds' in Europe has been studied by Multhauf (9), who finds that the saltpetre supply was an important limiting factor for the development of firearms in Europe between the + 14th and the + 18th centuries. The first reference to 'saltpetre plantations' occurs in + 1406. At times there was a considerable importation from Asia, mainly Indian in origin.

[c] RP125, 135*a*, following *PTKM*, ch. 11, (p. 77). It was first mentioned, without pharmaceutical use, in the *Ming I Pieh Lu*.

[d] Ch. 2, pp. 36*a*ff.

[e] Was this a reference to prismatic crystal form?

[f] We have come across Hu Kang Tzu before (Vol. 4, pt. 1, p. 308), but he is hard to date exactly. He must have been at work in the Thang or a little earlier. Cf. p. 80 above.

[g] Cf. Tshao, Ho & Needham (1), p. 126.

[h] This is perhaps another name for the *Thai-Chhing Shih Pi Chi*[14] (*TT*874), completed early in the +6th century. At any rate, the exact text of the following quotation appears in that work, ch. 3, p. 13*a*. This is shown by Ho Ping-Yü (8).

[1] 石脾 [2] 姚寬 [3] 西溪叢話 [4] 消石 [5] 粉圖
[6] 狐剛子 [7] 青消石 [8] 北帝玄珠 [9] 三十六水方
[10] 曾青 [11] 正消石 [12] 藥名隱訣 [13] 消石 [14] 太清石壁記

Yin-Chü (Thao Hung-Ching) compiled a pharamaceutical natural history in which he said that *phu hsiao*[1] (plain-solve) is the *phu* (i.e. the crude unpurified form) of *hsiao shih* (solve-stone, hence the same *hsiao shih phu*[2]); and he also said that *mang hsiao*[3] (prickle-solve) and *shih phi*[4] (stone-spleen) if boiled together (and let stand in the cool) will form real *hsiao shih*[5] (saltpetre). Yet no one has been able to identify *shih phi*[4] since. Indeed, the facts have been misrepresented. We must believe that there are both naturally-occurring (*chêng*[6]) and false (*yen*[7]) forms of saltpetre.[a] The *Ching*[b] says that *hsiao shih*[5] (saltpetre) is the most magical and wonderful chemical substance in the world. Thao (Hung-Ching) says that there is none of the natural form (to be found) nowadays. He is not entirely wrong.'

Now the (*Pên Tshao*) *Thu Ching*,[c] quoting from alchemical and medical books of the Liang and Sui periods, explains that although the (saltpetre) now obtainable is not the true sort, it shows similar properties and therefore can be employed. So the substance we have today is usable.

Tshui Fang,[8] in his *Lu Huo Pên Tshao*[9] (Spagyrical natural History)[d] says: '*Hsiao shih*[10] (saltpetre) is a Yin mineral; it does not belong to the class of "rocks", and it is got by boiling (certain kinds of) lake or ground salt (*hsien lu*[11]). It is now called *yen hsiao*[12] (blaze-solve). At Shang-chhêng in Hopei and along the rivers Huai[13] and Wei[14] people scrape it up from the salty soil, and make it from (the filtered) drippings. After being boiled together with *phu hsiao*[15] (sodium sulphate) and salt (*hsiao yen*[16]) it can control and subdue (*chih fu*[17]) lead (by acting as a flux), and it can remove the "halo" (*yün*,[18] a discoloration) on copper or bronze. It is not produced at all in the South. *Phu hsiao*[15] can ripen skin or hide (in tanning), and *mang hsiao*[19] can be used as a drug (magnesium sulphate).'

Present-day commentaries on *hsiao shih*[5] say:[e] 'It lies like a kind of frost upon the ground. In (certain) mountains and marshy places this *ti shuang*[20] appears during the winter months; people sweep it up, collect it and extract and dissolve it with water, after which they boil (to evaporate) it, and so it is prepared. It is named "solve-stone" because it can dissolve and transform all kinds of ores and minerals, not because it belongs to the same class (of salts) as *mang hsiao*[19] and *phu hsiao*[15] (nitre).'[f]

The (*Pên Tshao*) *Thu Ching* further says: 'Physicians and pharmacists use only pieces that are not yet refined, slightly bluish in colour, regarding them as *phu hsiao*.[15] After refining has been carried out, the pointed (crystals) that form at the top of the pans are called *mang hsiao*,[19] while the limpid or transparent crystals (*chhêng ning*[21]) which collect at the bottom are called *hsiao shih*[5].'

Again it says: 'By refining *phu hsiao* or *ti shuang* a solid white substance like a stone is formed; this is *hsiao shih*[5] (saltpetre) and there is no other sort.'

But I maintain that there is natural *hsiao shih*[5] (saltpetre) to be got, just as is said in the

[a] There might be a parallel here with one of the terms for steel, *wei kang*,[22] 'false steel'. It was perfectly good steel, but made by co-fusion, not by cementation or direct decarburisation. See Needham (64), p. 110, (32), and Sect. 30.

[b] Doubtless the *Shen Nung Pên Tshao Ching*, but the words are not found in the best modern edition, Mori (*1*), ch. 1, p. 25.

[c] Edited by Su Sung in +1070.

[d] Probably another name for his *Wai Tan Pên Tshao*[23] (Iatro-chemical Natural History), *c.* +1045.

[e] Parallel passage in *CLPT*, ch. 3, (p. 85.2). It seems to be Ma Chih speaking.

[f] As already mentioned, these saline cathartic-diuretics, the sulphates of sodium and magnesium, seem to have been introduced into medicine by Liu Hsüan-Chen about +730, or at any rate popularised by him (cf. p. 183).

[1] 朴消 [2] 消石朴 [3] 芒消 [4] 石脾 [5] 消石 [6] 正 [7] 贗
[8] 崔昉 [9] 爐火本草 [10] 消石 [11] 鹹鹵 [12] 鹼消 [13] 懷
[14] 衛 [15] 朴消 [16] 小鹽 [17] 制伏 [18] 暈 [19] 芒消
[20] 地霜 [21] 澄凝 [22] 僞鐵 [23] 外丹本草

Manuals of the Immortals (Hsien Ching[1]), without resorting to refining processes. What they make today by boiling and refining is of course also called *hsiao shih*, and that is what is mostly used. *Yen hsiao*[2] can indeed subdue the eight minerals, and *mang hsiao*[3] can be used as a drug. One can only use what one can get hold of. *Hsiao shih*[4] is really not some magical chemical substance (unobtainable) in the world.

Finally, the *Tan Fang Ching Yuan*[5] (Mirror of the Alchemical Elaboratory)[a] in its chapter on the solves (nitres) mentions five kinds; *ma ya hsiao*[6] (horse-tooth solve),[b] *phu hsiao*[7] (sodium sulphate), *mang hsiao*[8] (magnesium sulphate), *so sha hsiao*[9] (shrink-sand solve), and *khang hsiao*[10] (pit solve). As for *hsiao shih*[11] (saltpetre), it is included in the chapter on the various minerals, as one can see if one looks it up there.

And the (*Pên Tshao*) *Thu Ching* says that at Jen-ho[12] (in Chekiang) *yen hsiao*[13] (salt-solve) is found ten *li* east of the city, and when it is refined it gives *phu hsiao*.[7] Also in the winter months (saltpetre) effloresces on the ground in the form of transparent glittering fragments, so it is called *shuang hua*[14] (frost-flowers). Another name is *chien chi*[15] (sword-spines). When nitre is included in prescriptions it is considered to be of the same class as *hsüan ming fên*[16] (purified Glauber's salt, sodium sulphate) and *tzu hsüeh*[17] (purple snow).[c]

Reading over this one gains a vivid idea of the terminological morass in which the medieval alchemists and iatro-chemists laboured. We need not analyse the mistakes and misconceptions of each particular writer, nor yet point out how right he happened to be. But if one thing more than any other comes out crystal clear from this account, it is that methods for the collection and purification of potassium nitrate were steadily developing during the seven centuries preceding the first knowledge of the salt in Islam or the West, i.e. between +500 and +1200;[d] and probably during the last three or four of these, i.e. from the late part of the Thang period, it was being turned out on a manufacturing scale by artisans who achieved a fairly constant product but were not able to explain to the scholars exactly how they did so. Why should one then be surprised that formulae for proto-gunpowder[e] began to appear during the last half of the +9th century? Furthermore, by the beginning of the +8th at least, the sulphates of sodium and magnesium had been separated by differential crystallisation and were being used in medicine.

An interesting account of the use of saltpetre in pharmaceutical alchemy is found in the *Yu Huan Chi Wên*[18] (Things heard and seen on my Official Travels), written about +1233 by Chang Shih-Nan.[19] What he says is this:[f]

The *I Chien Chih*[20] records[g] that when Yü (Yün-Wên[21])[h] was summoned from Chhüchow, where he was Governor, to attend at the temporary headquarters of the emperor, and was

[a] A work of the early Thang, before +800.
[b] A name surely derived from observations of crystal form.
[c] This last salt has not yet been identified.
[d] See immediately below, p. 194.
[e] By this we mean compositions relatively low in nitrate. As is well known, the earliest formulae for true gunpowder in any civilisation appeared in the *Wu Ching Tsung Yao* of +1044 (cf. Needham (47), pp. 246–7).
[f] Ch. 1, p. 8*a*, tr. auct.
[g] This book was composed by the eminent literary critic and editor Hung Mai[22] (+1123 to +1202).
[h] The distinguished Sung general (*c.* +1108 to +1174); cf. Vol. 4, pt. 2, s.v.

[1] 仙經 [2] 餳消 [3] 芒消 [4] 消石 [5] 丹房鏡源 [6] 馬芽消
[7] 朴消 [8] 芒消 [9] 縮砂消 [10] 坑消 [11] 消石 [12] 仁和
[13] 鹽消 [14] 霜花 [15] 劍脊 [16] 玄明粉 [17] 紫雪 [18] 游宦紀聞
[19] 張世南 [20] 夷堅志 [21] 虞允文 [22] 洪邁

resting in the reception-hall outside the north gate, he was taken ill with a severe attack of diarrhoea (perhaps dysentery) which he had contracted on account of the great heat of the journey. This lasted for several months. On the 9th day of the ninth month he had a dream in which he found himself in some palace of the immortals. A man robed as one of their officials asked him to sit down, whereupon he noticed a rhymed inscription written on the wall which said:

'The poison of summer heat has gone to the spleen
And the damp *chhi* has accumulated in the feet;
If this be not dispelled diarrhoea will follow,
If diarrhoea should not, there will be malaria instead.
Only by heating realgar as the chymists do,
Mixing with bread and taking with liquorice-root[a]
Stirred all together in the form of a posset,
Then indeed will blessed relief ensue.
All other prescriptions of doctors are off the mark.'

He followed this and got well.

I, Chang Shih-Nan, when in Szechuan, visited all the Taoists at their temples in the woods searching for this 'Only-heated Method (*Tu lien fa*[1])' but I could hardly find anyone who knew it. Suddenly one day I met a Taoist from Chhing-chhêng Shan who explained it to me as follows. 'The elixir manuals say that if you can capture the dragon you can subdue the male (*cho tê lung, fu tê hsiung*[2]). This means that realgar (*hsiung huang*[3]) on meeting with the fire volatilises, giving rise to vapour and smoke, and it is most difficult to subdue (*fu*[4]). This method, therefore, grinds the realgar, any amount, to powder, and then after the crucible has become red-hot, this is put in together with powdered saltpetre. On stirring with a rod of peach-wood the mass liquefies, then it is quickly poured out on to an earthenware dish, and this is tilted a little so as to decant the clear layer. When the rest has solidified, take it out, grind it fine, and make it into a cake with steamed bread-crumbs suitable for cutting up into pills as large as peas. The dosage is from 3 to 7 pills. One should use 1/10 oz. of saltpetre for every ounce of realgar.'

This is a secret method of the iatro-chemical school (*tan tsao chia pi fa*[5]) and it is very hard to obtain. But, as the men of old said, 'It is better to give away prescriptions rather than to give away medicine'—therefore I record it here.

It is not very difficult to make sense of this passage. Both the arsenical sulphides burn when heated in air, forming SO_2 and volatile arsenious oxide (As_2O_3),[b] and this, in the form either of an arsenite or an arsenate, was what the iatro-chemists were after, for use as an intestinal disinfectant. In later centuries a mixture of saltpetre and orpiment was much used as a flux in metallurgy, the two being heated together and the melt poured out and powdered when solid.[c] Thus the arsenical sulphides and their oxidation products dissolve in potassium nitrate, which acts as a floating layer preventing arsenious oxide loss. The nitrate-based melt in Chang Shih-Nan's process could easily be decanted from the lower layer, and he would have obtained a mixture

[a] *Kan tshao*,[6] *Glycyrrhiza glabra*, cf. Porter Smith (1), p. 136.
[b] Partington (10), p. 629.
[c] Agricola, *De Re Metallica*, Hoover & Hoover tr., pp. 233, 236–238, cf. 245, 247.

[1] 獨煉法 [2] 捉得龍伏得雄 [3] 雄黃 [4] 伏 [5] 丹竈家秘法
[6] 甘草

of arsenates and arsenites together with some unchanged sulphide.[a] One may then reflect that potassium arsenite was nothing other than the famous Fowler's Solution (Liquor Arsenicalis) of 'modern' (or at least, recent) medicine,[b] and even more, that arsenic in organic combination, as acetarsone (stovarsol) or carbamino-phenylarsonic acid (carbasone), has been extensively used down to the present time in the treatment of amoebic dysentery.[c]

To discuss the saltpetre industry in China is to invade the province of Sect. 34, but a few words about it are indispensable here. Porter Smith (2) tells us that in late nineteenth-century China the manufacture of nitrate of potash from the efflorescent salts found on the surface of certain soils, and on walls and places charged with urine, was widely carried on, just as traditionally in Europe. Further details are available in a brief but valuable report of 1925 (Anon., 98), where analyses showed that although the industry was then still essentially a rural one, carried on by certain farmers ('saltpeterers', *hsiao hu*[1]) in their spare time, the traditional procedures were so good that products of up to 98·2% purity were sold to government bureaux.[d] The account describes the collection and leaching of the soil, followed by evaporation, removal of impurities, separation from other salts, crystallisation and recrystallisation. The yield was generally only a fraction of an ounce for each catty of earth except in a few places in Heilungchiang where as much as three ounces could be obtained for each catty. About the same time Read (12) described the industry at and around Ho-chien in S.W. Hopei. The percolation was done in large brick tanks, with matting used as the filter (Fig. 1511); after the evaporation the saltpetre crystallised around maize sticks which could be lifted out, while the dark mother-liquor, *lu yen shui*,[2] was used for salting out soya-bean curd and as a fertilizer. Recrystallisation of the first crop, called *khu yen*[3] (bitter salt), gave a pure white product at a yield of 50 lbs. from 250 cu. ft. of earth. A study of the Chinese nitrate-containing soils was made in 1935 by Hou Kuang-Chao, especially the solonchaks of Honan, which are capable of producing as much as 30,000 lbs. of saltpetre per acre each year.[e]

As for traditional descriptions of the methods of preparation and purification there are a couple of pages in the *Thien Kung Khai Wu* (Exploitation of the Works of Nature), +1637, but no illustrations.[f] Here *yen hsiao*[4] (salt-solve) is defined as crude saltpetre from Shansi, paralleling *chhuan hsiao*[5] from Szechuan and *thu hsiao*[6] (earth-solve) from Shantung. It is explained that the recrystallised saltpetre is properly called *phên hsiao*[7] (basin-solve), while more elongated crystals forming at the top round the

[a] Perhaps also the polyarsenites of potassium (Partington (10), p. 627).

[b] Lauder Brunton (1), p. 647; Sollmann (1), p. 610; Clark (1), p. 609.

[c] Clark (1), p. 641.

[d] Out of forty analyses, from places in Hopei, Honan, Shensi and Liaoning, about one third were over 90% and a further third over 80%.

[e] A short notice of this will be found in Kovda (1), Engl. tr., pp. 121–2. During the second world war my friend Dr Wu Ching-Lieh of the 23rd Arsenal at Lu-hsien used to tell me of the substantial deposits of potassium and sodium nitrate near Khaifêng and along the Lunghai Railway. See also Torgashev (1), pp. 380ff.

[f] Ch. 15, pp. 6*a*, *b*, 7*a*, tr. Sun & Sun (1), pp. 269–70. Cf. *PTKM*, ch. 11, (p. 49).

[1] 硝戶 [2] 鹵鹽水 [3] 苦鹽 [4] 鹽硝 [5] 川硝
[6] 土硝 [7] 盆硝

Fig. 1511

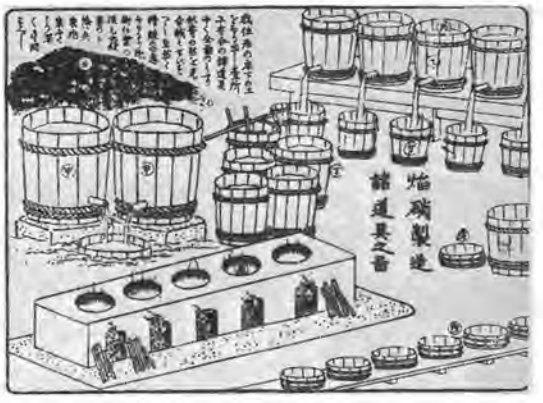

Fig. 1512

Fig. 1511. The saltpetre (nitre) industry at Ho-chien-fu, showing the removal of the percolated earth, with old percolating jars in the foreground. From Read (12).

Fig. 1512. A saltpetre works in Japan, from the *Nihon no Sangyō Gijutsu* (Industrial Arts and Technology in Old Japan) by Ōya Shin'ichi (*1*). The drawing (p. 177) is of the early nineteenth century.

edges are *ma ya hsiao*[1] (horse-tooth solve). Both these can be used for making gunpowder, but by-products also crystallising which cannot, are termed *mang hsiao*[2] and *phu hsiao*.[3] Whether these were really magnesium and sodium sulphates is a question which would require further consideration. A similar process of separation by differential crystallisation had been described by Li Shih-Chen a few decades earlier.[a] *Mang hsiao* and *ma ya hsiao* were called by him *shui hsiao*[4] (water-solve), while *hsiao shih* was called appropriately *huo hsiao*[5] (fire-solve). The only illustrated traditional account of the saltpetre industry which we have come across is that produced at Yedo by Chojiya Heibei (*1*) in 1863, *Shoseki Seirenho*,[6] valuable and interesting though brief.[b]

All this brings out one aspect of Chinese proto-chemistry which has so far had very little attention, namely its quasi-empirical successes in separating salts.[c] In Sect. 37 on the salt industry we shall see how even more difficult problems were solved in the use of the brine deposits of Szechuan, which necessitated dealing with borates as well as with sulphates, chlorides and nitrates. The 'nitre' complex, too, is simply one typical example of the difficulty of identifying the substances used by the medieval

[a] *PTKM*, ch. 11, (p. 56); cf. Anon. (57), p. 244.

[b] Twenty years later Kinch (1) gave some analyses of crude Japanese saltpetre, p. 115. Occasional illustrations of the equipment used for the differential crystallisations dating from the first half of the century or even the late +18th can be found; we reproduce (Fig. 1512) one given by Ōya Shin'ichi (*1*).

[c] On the development of solution analyses in Europe during the Renaissance, especially in connection with spa waters, from about +1200 onwards, see Debus (13).

[1] 馬芽硝 [2] 芒硝 [3] 朴硝 [4] 水消 [5] 火硝 [6] 硝石製煉法

alchemists and pharmacists. The most helpful signs to go by are always the descriptions of the properties of the substance concerned mentioned in any given Chinese text. Thus of *hsiao shih* (which goes back as a name to the −4th century) it is often later said that it gives a bluish-purple flame when put in the fire,[a] a statement which immediately rules out salts of sodium and magnesium. The oldest description of this test comes from about +500, but it could safely be placed a couple of centuries earlier, as far back as Ko Hung. Many alchemical and pharmaceutical texts from the −2nd century onwards also say that *hsiao shih* can liquefy ores, acting as a flux, and dissolve minerals to form aqueous solutions.[b] There are also instances where *hsiao shih* is said to produce explosions or deflagrations,[c] and we have of course the gunpowder formulae with *hsiao shih* in them.[d] In such circumstances one can feel fully justified in extrapolating back the results of analyses of modern samples of *hsiao shih* which show it to be saltpetre. Rightly therefore was it called in Arabic *thalj al-Ṣīn* (Chinese snow) for it was recognised and used in China long before anywhere else.[e]

The oldest extant Arabic mention is in the *Kitāb al-Ǧāmi' fī al-Adwiya al-Mufrada* (Book of the Assembly of Medical Simples)[f] finished by Abū Muḥammad al-Mālaqī Ibn al-Baiṭār[g] about +1240. Others follow shortly after, for example Ibn abī Uṣaybi'a, in his history of medicine mentioned on p. 226 of pt. 3 above, but as he refers back to the otherwise unknown Ibn Bakhtawayhī and his *Kitāb al-Muqaddimāt* (Book of Introductions),[h] it would be wise to place the first knowledge of saltpetre among the Arabs in the earliest decades of the +13th century.[i] On the other hand their understanding of its use in war, especially for gunpowder, belongs to the latest decades of the same century, as we know from the book of al-Ḥasan al-Rammāḥ,[j] *Kitāb al-Furūsīya wa'l-Munāṣab al-Ḥarbīya* (Treatise on Horsemanship and Stratagems of War),[k] which cannot have been composed before about +1280. The same date, as near as makes no matter, can be accepted for the completion of the *Liber Ignium ad Comburendos Hostes* of Marcus Graecus (whether or not there was ever any such individual person), and by this time both saltpetre and gunpowder, or at least proto-gunpowder, had become acclimatised in the Latin West.[l]

[a] See pp. 185, 187. [b] Cf. p. 183 above. [c] Cf. p. 186.

[d] First in the *Wu Ching Tsung Yao* of +1044 (*Chhien Chi*, ch. 11, pp. 27*b*, 28*a*; ch. 12, pp. 58*a*, *b*, 65*a*, *b*); and abundantly thereafter. See Sect. 30 in Vol. 5, pt. 1.

[e] In Vullers' Persian–Latin lexicon there is another phrase, *namak shūra Chīnī* (salt of the Chinese salt-marshes); Partington (5), p. 335. The other Arabic name was *bārūd*, which may or may not be connected with hailstones, recalled by the saltpetre crystals on the ground.

[f] Tr. Leclerc (1); see pp. 71, 200, 333, 420.

[g] 'The son of the Veterinary Physician' of Malaga, himself perhaps the greatest pharmaceutical naturalist of all Islam (d. +1248). See Mieli (1), p. 212; Partington (5), p. 310, following Romocki (1), vol. 1, p. 37.

[h] This was in connection with freezing mixtures, on which see pt. 3, pp. 225–6 above. Cf. von Lippmann (8); Partington (5), p. 311.

[i] Bloch (5) describes two of their probable points of production on the western shores of the Dead Sea.

[j] 'The lancer'; cf. Section 30, where he prominently appears.

[k] Cf. Partington (5), pp. 200ff. Though Al-Rammāḥ does not use the term *thalj al-Ṣīn*, his book is remarkable for the extensive use it makes of Chinese materials and the numerous pyrotechnic devices which bear the name 'of China'.

[l] Cf. p. 123 above; the gunpowder and the alcohol recipes belong to the very latest strata of the compilation. See Partington (5), pp. 42ff., 60.

(3) Saltpetre and Copperas as Limiting Factors in East and West

Thus we now have a flood of light on the long-known evidence for the primary invention of gunpowder in China. It seems clear that lack of saltpetre in the West must have been the great limiting factor for this development. The oldest mentions of gunpowder in Europe are all unquestionably of the late +13th century, preceding its general introduction in the +14th. In China, on the other hand, we have the first reference to the gunpowder mixture in the +8th or +9th century, its appearance in war early in the +10th, and its widespread military use in the +11th and +12th before it reached Islam and Europe in the +13th.[a]

Secondly we have here a chapter in the earliest history of the use of the mineral acids, not as isolated and purified products, but as part of a procedure quite ancient and primitive in that distillation was probably not involved. If nitric and hydrochloric acids were only to appear as such as the products of distillation, sulphuric acid could be obtained also by the simple combustion of sulphur, and it is likely that this method preceded the distilling way.[b] It is generally accepted that mineral acids were quite unknown both to the ancients in the West[c] and to the Arabic alchemists.[d] The first

[a] The full evidence is given in Sect. 30 in Vol. 5, pt. 1. There is a résumé in Needham (47).

[b] It was not until the +17th century, however, that the 'oil of sulphur' resulting was recognised as identical with the 'oil of vitriol' produced by distilling ferrous or cupric sulphate. Neither of the 'oils' seems much to antedate +1530, the first mentions being in Brasavola, Valerius Cordus and Mattioli; cf. Partington (4), p. 47, (7), vol. 2, p. 96; Sherwood Taylor (4), pp. 95–6, 191.

[c] The question is of course not absolutely settled. The late Professor J. R. Partington drew our attention in 1959 to certain passages in the Greek proto-chemical writings, especially Zosimus (*Corp. Alchem. Gr.*, III, i, 8 and III, xlvii, 6, 7), which might conceivably be interpreted in this sense. But although the translation of these passages by Berthelot & Ruelle reads unintelligibly, Partington's versions involve excerpting the text rather forcefully and interpreting certain words very boldly (e.g. *botanē*, 'the weed', for saltpetre). One rarely encounters anything as puzzling in classical Chinese, except where textual corruption calls for massive emendation.

[d] This is true in the main, but 'not exactly' (as our Chinese friends so often have occasion to say). It is true that 'sharp waters' are frequently mentioned in the Jābirian Corpus and al-Rāzī, but in fact they all seem to be fairly caustic alkalies rather than the acids which the name might lead one to expect (cf. Ruska & Garbers (1); Ruska (14), pp. 66–7; Multhauf (5), p. 140). Nevertheless, the Arabic alchemists knew that corrosive vapours were to be obtained by distilling vitriols (sulphates) mixed with other materials. In the middle of the +10th century al-Mas'ūdī wrote: 'As for us, may God preserve us from applying ourselves to researches which weaken the brain, ruin the sight and jaundice the complexion in the midst of subliming vapours, vitriolic fumes and other mineral exhalations' (tr. de Meynard & de Courteille (1), vol. 8, p. 177, eng. auct.). Among the passages which indicate that Arabic alchemists were capable of using a mineral acid without quite knowing what it was, we may quote one from the *Kitāb Sirr al-Asrār* (Book of the Secret of Secrets) written by al-Rāzī towards +910. What he seems to be doing is making pure aluminium sulphate from alunite (the sulphate plus the hydroxide), and getting sulphuric acid in order to do it. The passage runs: 'Take white (Yemeni) alum, dissolve it and purify it by filtration. Then distil (green ?) vitriol with copper-green (the acetate), and mix (the distillate) with the filtered solution of the purified alum, afterwards let it solidify (or crystallise) in the glass beaker. You will get the best *qalqadīs* (white alum) that may be had' (tr. Ruska (14), p. 88, eng. auct.; cf. Stapleton, Azo & Husain (1), p. 373). The version given by Singer (8), p. 51, diverges much from this, and seems to be unreliable.

The late Dr E. J. Holmyard maintained that the preparation of nitric acid is to be found in the Jābirian Corpus (+9th century), but so far as we know, the text has never been identified and published. Wiedemann (27), however, found and translated a passage in al-Qazwīnī (*c.* +1250) which speaks of the oily nature of the fumes of heated vitriol, and perhaps of the heating of water with which they are brought into contact; the encyclopaedist also recorded that vitriolic vapours are injurious to mice and

account of the making of nitric acid (*aqua fortis, scheidewasser*) is often said to occur in the Geberian *De Inventione Veritatis*,[a] a tractate composed in the West at the end of the +13th or the beginning of the +14th century. Partington however has shown that it is also found in the *Pro Conservanda Sanitatis* of the French Franciscan Vitalis du Four, *c.* +1295.[b] It was always a matter of distilling the nitrate with alum and especially ferrous sulphate.[c] If salt was added, or sal ammoniac, a mixture of nitric and hydrochloric acids (*aqua regia*) was obtained; and this was also in Geber, by +1300 or so. Sulphuric acid (as oil of vitriol) came a good deal later, probably at the beginning of the +16th century, and hydrochloric acid not until about +1600.[d] Thus the availability of saltpetre must again have been a primary limiting factor.[e] It is interesting that the new recognition of a salt long known in East Asia,[f] and the transmission of the technique of its purification, should have permitted two developments in the West each so important as the manufacture of gunpowder and of nitric acid.[g]

The absence of nitrate from the reagents of the early medieval West restricts the significance of the references to acetic acid in the Greek proto-chemical texts. Such allusions there certainly are, e.g. in the +5th-century tractate of John the Archpriest, which speaks of the strongest white vinegar (*to leukon oxos drimutaton*, τὸ λευκὸν ὄξος δριμύτατον),[h] and in the probably +8th-century 'Practice of the Emperor Justinian'.[i] Von Lippmann was doubtless right in rejecting the speculation of Berthelot that such words concealed the use of crude mineral acids, and Greek texts which distinctly mention these, together with nitrate, are not plausibly to be dated earlier than +1300.[j]

Whether *aqua fortis* was known in China before modern times we cannot yet say, but the following story suggests the desirability of further researches on the borderline between Chinese and Indian chemical technology. In the former culture-area at any rate all the *dramatis personae* were ready to play their parts as early as the Thang period, from which this story dates;[k] if not considerably earlier. The alums had been

flies, driving them out from a room thus fumigated. This is found in the mineralogical section of his 'Cosmography', and the best translation of the passage is doubtless that given by Ruska (24), p. 23.

[a] Ch. 23; Russell tr., p. 223, Darmstädter tr., p. 113. On the Latin Geberian corpus in general see Multhauf (5); Sarton (1), vol. 2, p. 1044.

[b] (4), p. 40. Cf. Sarton (1), vol. 3, p. 531.

[c] The green crystals were calcined first to give the reddish anhydrous salt.

[d] First in the writings of 'Basil Valentine', then in those of Oswald Croll. But Reti (11) has provided strong evidence of an earlier preparation, from a Bologna MS. of the +15th century. Also if 'oil of bricks' was impure HCl, it might go back to the +10th century (cf. Vol. 5, pt. 3, p. 237 above). On the history of the industrial preparation of the mineral acids see Sherwood Taylor (4), pp. 90ff., 99.

[e] Later on it also entered into the manufacture of sulphuric acid, for about +1745 Joshua Ward added saltpetre to the sulphur, aiding its oxidation during the burning to make oil of sulphur, increasing yields and bringing down the price (Sherwood Taylor (4), p. 97).

[f] It will be remembered that one of the +13th–century Arabic terms for saltpetre was *thalj al-Ṣīn*, 'Chinese snow'.

[g] The central position of green vitriol (ferrous sulphate) is also worth noting. It was a raw material for all three of the strong mineral acids. Cf. p. 199 below.

[h] *Corp. Alchem. Gr.* IV, iii, 15, Berthelot & Ruelle (1), vol. 3, p. 255; cf. von Lippmann (1), p. 71.

[i] *Corp. Alchem. Gr.* V, xxiv, 2, Berthelot & Ruelle (1), vol. 3, p. 369; cf. von Lippmann (1), p. 114.

[j] *Corp. Alchem. Gr.* V, i, 18, 41, 42, Berthelot & Ruelle (1), vol. 3, pp. 312, 317, 318; von Lippmann, *loc. cit.*

[k] We gave it already in Vol. 1, p. 212, but we have retranslated it here.

known since the −4th century,[a] nitrate occurs also at least as early as the time of Ko Hung (and with certain identification in the *San-shih-liu Shui Fa*); and both ferrous sulphate (*lü fan*[1]) and sal ammoniac (*nao sha*[2]),[b] (for the making of *aqua regia*) appear in the *Hsin Hsiu Pên Tshao*[3] by +660.[c] Effective stills had by then come into existence in China.[d] There is thus some reason for anticipating that further research may uncover evidence of the preparation of nitric acid and a mixture of nitric and hydrochloric acids in China well before the +13th century and perhaps as far back as the Thang. A search in the Sung alchemical literature might well prove fruitful. Now for the story.

Wang Hsüan-Tshê[4] was an official who left China in +648 as ambassador to the court of Magadha (modern Patna) where at that time Harsha Vardhana, the friend of Hsüan-Chuang[5] the great pilgrim, was reigning. But then Harsha died, and a usurping minister (A-Lo-Na-Shun[6] in the Chinese records) thought fit to attack the Chinese party, plunder their goods, and kill most of Wang's retinue. Wang, however, was a man of resource; he escaped to the mountains, made contact with the Kings of Nepal and Tibet, who were at that time allied with China, and descending again with an army of considerable size, gave battle to the usurper and completely overthrew him. The ambassador then returned home by another route, taking with him the usurper and other Indian prisoners, whom he presented to the emperor at Chhang-an (modern Sian) with a report on his proceedings.

An account of this, written a little over two centuries later, is of great interest, as it preserves what may be one of the earliest passages on mineral acids. In the *Yu-Yang Tsa Tsu*[7] of Tuan Chhêng-Shih,[8] written in +863, we read:[e]

Wang Hsüan-Tshê[4] captured an Indian prince named A-Lo-Na-Shun. He had with him a scholar versed in arts and gramarye named[f] Na-Lo-Mi-So-Po,[9] who said he was two hundred years old. (The Emperor) Thai Tsung was very interested and invited him to live in the Chin-Yen Mên[10] (Palace), to make the drugs for prolonging life. The Emperor asked the Minister of War, Tshui Tun-Li,[11] to be in charge of it. (The Indian) said, 'In the country of the Brahmins there is a substance called *Pan-Chha-Cho Shui*[12] (Pan-Chha-Cho water)[g]

[a] *Chi Ni Tzu*, ch. 3, p. 3*a* (in *YHSF*, ch. 69, p. 26*a*).

[b] There is a +2nd-century mention of this in Wei Po-Yang (*Chou I Tshan Thung Chhi Fên Chang Chu Chieh*, ch. 2, p. 26*b* (ch. 30); *Tshan Thung Chhi, Tao Tsang* ed. *TT*990, ch. 2, p. 35*b*), where advice is given not to put ammonium chloride on ulcers.

[c] *Pên Tshao Kang Mu*, ch. 11, pp. 31*a*, 53*b*. A very important text, the *Chen Yuan Miao Tao Yao Lüeh*[13] (Classified Essentials of the Mysterious Tao of the True Origin of Things, *TT*917) mentions both nitrate and sal ammoniac. This is the text which has the first proto-gunpowder formula; cf. Vol. 5, pt. 3, p. 78. Though that itself is probably of the + 8th or + 9th century, the older parts of the book go back to the time of the putative author, Chêng Ssu-Yuan[14] (Chêng Yin), in the + 4th century.

[d] See pp. 155ff. above.

[e] Ch. 7, p. 7*a*. A parallel account in the *Chiu Thang Shu*, ch. 198, p. 12*b*, tells how the emperor scoured the country to collect minerals and drugs for Na-Lo-Mi-So-Po's experiments, but that when the elixirs were completed they did not prove very effective, so eventually he was sent back to his own country. The *Chiu Thang Shu* was not completed till +945, but it was based on official archives and documents.

[f] The Indian form *Nārāyaṇasvāmin* has been conjectured.

[g] 'Punjab water' has been conjectured, others think *phāṇṭa* water, i.e. a liquid prepared by filtration.

[1] 綠礬 [2] 硇砂 [3] 新修本草 [4] 王玄策 [5] 玄奘
[6] 阿羅那順 [7] 酉陽雜俎 [8] 段成式 [9] 那羅邇娑婆 [10] 金鑾門
[11] 崔敦禮 [12] 畔茶佉水 [13] 眞元妙道要略 [14] 鄭思遠

which is produced in the mountains in stone vessels, has seven varieties of different colours, is sometimes hot, sometimes cold, can dissolve herbs, wood, gold and iron—and if it is put into a person's hand, it will melt and destroy it. If you want to collect this water you have to use a 'camel's skull' placed in a stone vessel, and pour it out into a gourd.[a] Whenever this water is present there are also stone columns looking like men guarding it. Anyone from another mountain who shows the way to this water will die... Finally the Indian died in Chhang-an.

One of the best things about this account is its date, which is very firm. Foreshadowing perhaps the later 'alkahest' or universal solvent of Paracelsian iatro-chemistry,[b] this passage suggests at any rate that a mineral acid was known in the +7th century. It gives some colour to the hints about strong acids in Ray's history of chemistry in India. Already in the +11th century the *Rasārṇavakalpa* has much on the 'fixation' or 'killing' of metals.[c] The *Rasārṇava Tantra* (dated by Renou & Filliozat as of the +12th century)[d] speaks of the 'killing' of iron and other metals by a *viḍa* (solvent?) which is prepared from green vitriol (*kāsīsa*), pyrites, etc.[e] From the *Rasaratna-samucchaya* (compiled according to Renou & Filliozat about +1300) which reproduces material from the *Rasendra-chūḍāmaṇi* of Somadeva (+12th or +13th century), the process of 'killing' certainly seems to be the formation of salts from metals.[f] Neogi drew attention long ago[g] to the apparent presence of oil of vitriol in the later Indian alchemical treatises under the name 'essence of alum', produced by distillation. This is certainly mentioned in the *Rasaratna-samucchaya*[h] and in the *Rasaprakāśa-sudhākara*[i] of Yaśodhara (+13th century), though they do not distinctly say that the alum and the ferrous sulphate must be distilled together; but neither of these works would be older than the time of Geber in the West.

The date of Na-Lo-Mi-So-Po was not, however, so much earlier than the beginning of the 'oil of bricks' tradition there (cf. Vol. 5, pt. 3, pp. 237–8 above). And his 'camel's skull' reminds one of another curious story in Chinese literature about a special container. The word *tiao*[1] is used today for designating the whale[j] but anciently *chi tiao*[2] meant a fabulous kind of dragon (*lung*[3]), the fat of which could only be collected in eggshells. Works such as the *Pên Tshao Thu Ching* (+1062) quote a lost *Kuang Chou Chi*[4] of the Chin period by one Phei Yuan,[5] which said:[k]

> The *tiao*[2] frequents Lingnan (the country south of the mountains, i.e. Kuangtung). It has the head of a serpent and the body of a tortoise, and it lives in water or in (swampy) forests. Its fat is so light that it can penetrate all vessels, whether of metal or pottery, so it has to be conserved in eggshells; then only it will not leak away.

The details are unimportant here, the content is suspicious. Might this not also be a disguised reference to corrosive liquids?

[a] Could this be a veiled reference to distillation?
[b] In an interesting study, Reti (6) has concluded that this was probably alcoholic caustic potash.
[c] Roy & Subbarayappa tr., pp. 65ff., 71ff., 87, etc.
[d] vol. 2, p. 169.
[e] Ray (1), 2nd ed., p. 138.
[f] Ray (1), 2nd ed., pp. 188ff.
[g] (1), p. 50.
[h] Ray (1), 2nd ed., pp. 173–4.
[i] Ray (1), 2nd ed., pp. 122, 153.
[j] R103.
[k] Tr. auct., from *Khang-Hsi Tzu Tien*, p. 284.

[1] 弔 [2] 吉弔 [3] 龍 [4] 廣州記 [5] 裴淵

The mention of green vitriol (ferrous sulphate, $FeSO_4.7H_2O$)[a] just above induces us to emphasise the status of this salt also as one of the great primary limiting factors of chemical advance. Although the point has not been made, so far as we know, by historians of chemistry, it came about by the necessity of things that certain substances much more than others acted like doors which would yield to the push, and let the practitioners through into a world which could generate the theoretical and experimental chemistry of today. So just as potassium nitrate led to gunpowder and to nitric acid, ferrous sulphate led to not only one, but all three, of the strong mineral acids, true foundation-stones of chemistry and chemical technology. Hence very suitably did the late Western alchemists call it by the name of *leo viridis* (the green lion).[b]

Crystalline ferrous sulphate in impure form was known to the Hellenistic protochemists as *chalcanthon* (χάλκανθον), *misy* or *sory*,[c] all being mixtures of the sulphates of copper, iron and aluminium in various proportions, derived from the oxidation of naturally occurring sulphide minerals (pyrites, marcasite).[d] The old Chinese name *lü fan*,[1] 'green alum',[e] paralleled our 'green vitriol', and was no further off the mark than 'flower of bronze' (*chalcanthon*),[f] not indeed so far, since copper and tin were never really involved. Yet copper did come in in a curious way, since green vitriol got the name of copperas (O.F. *couperose*), very puzzling till one realises that it probably derives from *aqua cuprosa*, i.e. the solution resulting when copper sulphate mine-waters have been passed over scrap-iron and the iron has gone into solution by exchange as sulphate, leaving the copper deposited.[g] Ferrous sulphate in its purer form was also called *atramentum* because of the black colour given with tannins and widely used for dyes and ink.[h] Here again this name was exactly mirrored in the other Chinese term, *tsao fan*.[2]

Now every one of the mineral acids needed copperas for its preparation, usually calcined from the blue-green to the anhydrous reddish form.[i] About +1300 Vitalis du Four and the Geberian writer were distilling it with saltpetre and alum to get nitric,[j] soon after +1500 Brasavola and Valerius Cordus were distilling it alone to get sulphuric,[k] and towards +1600 Thölde ('Basil Valentine') was distilling it with

[a] On the vague word vitriol, already in Pliny, and derived no doubt from the glassy appearance of hydrated sulphate crystals, see Crosland (1), p. 84. Later on it was sometimes synonymous with the equally vague copperas, of which there were also several sorts, distinguished by colour or place of origin.

[b] Multhauf (5), p. 195.

[c] Berthelot (2), pp. 14–15, 241–2; Crosland (1), p. 229. It was an important constituent of the cementation mixture for purifying gold, or bringing about the surface-enrichment of gold alloys (cf. pt. 2, p. 250 above).

[d] Marcasite was an old name for sulphide minerals (Partington (10), p. 853; Berthelot (2), pp. 253, 257).

[e] RP132.

[f] Doubtless so called because of a confusion with the green salts of copper.

[g] This 'wet copper' method of Cu production will be the subject of our next sub-section. There are other derivations, e.g. 'rose of Cyprus' (Mellor (1), p. 448), less convincing.

[h] Sherwood Taylor (4), pp. 82, 121. Ink is still to this day *atrament* in Polish.

[i] Reddish because of the presence of ferric oxide, Fe_2O_3, into which all the sulphate would be converted if roasted long enough.

[j] Partington (4), p. 40; Sherwood Taylor (4), p. 92, Cf. Vol. 5, pt. 3. pp. 237–8.

[k] Partington (4), p. 47; Sherwood Taylor (4), pp. 95–6, 191. It is curious that the distillation with nitre so long preceded the distillation alone. But this same simple process continued in industrial use at

[1] 綠礬 [2] 皂礬

ordinary salt and alum to get hydrochloric.[a] If this did not happen in China it may have been because the stills were not quite suitable, being mostly of the cooled head type (cf. pp. 63 ff.), true retorts appearing rather later. Moreover ferrous sulphate was not mentioned in the *Shen Nung Pên Tshao Ching*; its first special entry in a pharmaceutical natural history occurring in Ta Ming's[1] *Jih Hua (Tzu) Chu Chia Pên Tshao*[2] of +972, though some account of it had been given under another head in the *Hsin Hsiu Pên Tshao* of +659.[b] It was made in a similar way to that of Europe, sulphurous

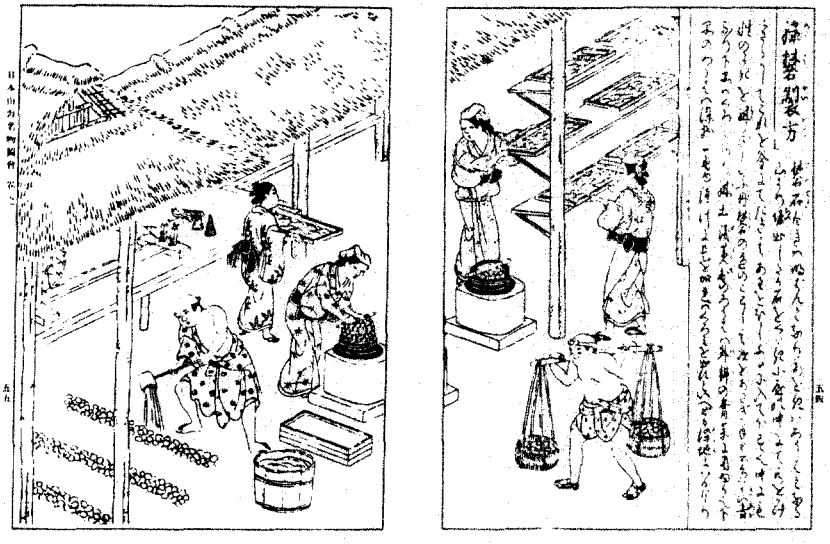

Fig. 1513. A Japanese ferrous sulphate works, from the *Nihon Sankai Meibutsu Zue* (Illustrations of Processes and Manufactures), + 1754, pp. 54–5.

coal and hepatic iron pyrites (marcasite, 'the gangue of coal, commonly called bronze-coal', *mei than wai kung shih, su ming thung than*[3]) being burnt in a heap covered over with mortar to exclude excess of air (Fig. 1513).[c] But wherever in the world doors were opened by knowledge of these salts, limiting factors it is certainly right to call them.

Nordhausen down to as late as 1900. Clow & Clow (2) have written on its central position in the industrial revolution.

[a] Partington (4), p. 56, (7), vol. 2, p. 200; Sherwood Taylor (4), p. 99. The acid may have been produced in unrecognised form long before under the name of 'oil of bricks' (cf. pt. 3, pp. 237–8), but this is not quite certain. See also p. 197 above.

[b] Cit. *PTKM*, ch. 11, (pp. 73–4). Su Ching and the other naturalists said that the best was got from Kuachow, near mod. Tunhuang (Kansu). All speak of its use in dyeing. Chinese ink, of course, was always something else (cf. Sect. 32).

[c] Porter Smith (1), p. 122. The process is described in *TKKW*, ch. 11, pp. 4*a* ff., tr. Sun & Sun (1), pp. 206–7, 213, but their version and notes need explanations and should be used with circumspection. In relatively late times Chinese ferrous sulphate was produced particularly pure.

[1] 大明　[2] 日華子諸家本草　[3] 煤炭外礦石俗名鋼炭

(4) The Precipitation of Metallic Copper from its Salts by Iron

In recipe no. 1 of the *San-shih-liu Shui Fa* we are told that 'when more vinegar is mixed with (the solution) and it is then rubbed on iron, the iron will (look) like copper'. Since the method concerns the solubilisation of iron alum, or perhaps ferric sulphate, the treatment is meaningless as it stands, but it has undoubtedly strayed in here from a discussion of copper sulphate (so often confused with alum on account of a similarity of nomenclature, *fan shih*[1] and *tan fan*[2]). Nevertheless the words are of great interest for they concern an industrial process very old in China, namely the winning of metallic copper by precipitation from solutions of its salts in the presence of metallic iron.[a]

In +1086 the great scientific scholar Shen Kua[3] (+1030 to +1094) wrote in his *Mêng Chhi Pi Than*[4] (Dream Pool Essays) the following passage:[b]

> In the Chhien-shan[5] district of Hsin-chou[6] there is a bitter spring which forms a rivulet at the bottom of a gorge. When its water is heated it becomes *tan fan*[7].[c] When this is heated it gives copper. If this 'alum' is heated for a long time in an iron pan the pan is changed to copper. Thus water can be converted into copper—an extraordinary change of substance, really unfathomable. According to the *Huang Ti Nei Ching, Su Wên*[d] 'there are five elements in the sky, and five elements on the earth. The *chhi*[e] of Earth, when in the sky, is moisture. Earth produces metal and stone (as ores in the mountains), but water can also produce metal and stone'. These instances then are proofs (that the principles of the *Su Wên* are right). It is like water dripping in caverns and (slowly) forming stalactites, or like the formation of crystals from well and spring water at the spring and autumn equinoctial seasons, or like selenite[f] (*yin ching shih*[8]) deposits from strong brines; all show the transformations from moisture. So also the *chhi* of Wood, when in the sky, is wind, and both Wood and wind can generate Fire. Such is the nature of the Five Elements.

The passage clearly shows that Shen Kua was prevented by a too uncritical acceptance of the classical five-element theory from attaining an understanding of the true nature of solution and mixture. Yet we cannot place such an +11th-century mind in the right perspective without tracing the parallel development of thought in Europe.[g] The observation of the precipitation of metallic copper in powdery or solid form by iron, with the formation of iron sulphate, described in the opening paragraph, was an excellent one. T. T. Read (4) tells how in our own times a process for the winning of copper from mine waters by precipitation with scrap iron was developed at Butte, Montana, in ignorance of the fact that it had been well known in Moorish Spain.[h]

[a] On the coating of other metal surfaces by ion exchange something has already been said in the metallurgical part of the Introduction (pt. 2, p. 246). See also Haschmi (5).

[b] Ch. 25, para. 6, tr. auct. Cf. Hu Tao-Ching (*1*), vol. 2, pp. 792ff. Echoes of this can be found in various places, e.g. *PWYF*, Shih I, ch. 1, p. 7*a* (vol. 6, p. 4246.3).

[c] 'Bitter alum', lit. 'gall alum', impure copper sulphate (RP87).

[d] The Han medical classic.

[e] I.e. *pneuma*; cf. Vol. 2, p. 369.

[f] Calcium sulphate (RP120).

[g] A résumé has been given by Multhauf (7).

[h] Cf. T. T. Read (8).

[1] 礬石 [2] 膽礬 [3] 沈括 [4] 夢溪筆談
[5] 鉛山 [6] 信州 [7] 膽礬 [8] 陰精石

'Basil Valentine', in his *Currus Triumphalis Antimonii*, noted the power of iron to precipitate copper from 'an acrid ley in Hungary',[a] an effect which Paracelsus[b] and Libavius[c] still in the +16th century believed demonstrated the transmutation of metals, as also Stisser as late as +1690.[d] Van Helmont (+1624) and Nicholas Guibert (+1603)[e] surmised that the copper was in the solution beforehand, and the exchange of metals was proved by Joachim Jungius (+1630),[f] then by Robert Boyle in his 'Treatise on the Mechanical Causes of Chemical Precipitation' (+1675). It would therefore be unjust to censure Shen Kua for accepting as a transmutation of metals a process which was not properly understood until six centuries after his death.

What has not generally been appreciated is how old the technique was in China.[g] Two Han references begin the story. The *Huai Nan Wan Pi Shu*[1] says that if *pai chhing*[2] (basic copper carbonate, azurite) meets iron it turns it into copper;[h] this may not be quite as old as Liu An, the prince of Huai-Nan, himself (*d.* −122) but it will not be much later. The statement is repeated in the entry for copper sulphate (*shih tan*[3]) in the *Shen Nung Pên Tshao Ching*,[i] the first of the pharmaceutical natural histories and undoubtedly complete by the Later Han (+1st and +2nd centuries) though mainly of the Former (−2nd and −1st centuries).[j] Thus both these references are older than the remark of Pliny, *c.* +77, that iron 'if smeared with vinegar or alum, becomes coppery in appearance',[k] and also better, because both distinctly specify salts of copper while Pliny's reference could be merely to the effects of rusting.[l] Knowledge of the copper precipitation effect appears again about +300 in the *Pao Phu Tzu* book where Ko Hung says[m] that if a saturated solution of copper carbonate (*tshêng chhing*[4])[n] is placed in contact with iron the latter will take on a red colour like

[a] There has been, of course, much doubt as to the date of 'Basil Valentine'. His work is of the late +16th and early +17th centuries, not the +15th, which was the period traditionally ascribed to it. Some earlier material was no doubt contained in it. See J. Read (1), pp. 183ff; von Lippmann (1), p. 640; Leicester (1).

[b] In *Chirurgia Magna* (+1536), see *Opera Omnia* (Geneva ed., +1658), vol. 3, pt. 1, p. 43; cf. Partington (7), vol. 2, p. 137.

[c] *Commentariorum Alchymiae* (+1606), pp. 20ff.; *Syntagma* (+1611), pp. 280–1; cf. Partington (7), vol. 2, p. 255.

[d] Roscoe & Schorlemmer (1), vol. 2, p. 413. Cf. our discussion in pt. 2, pp. 24, 35, 67, 245, pt. 3, p. 207 above.

[e] See Duveen & Willemart (1); Partington (7), vol. 2, p. 268.

[f] See Kangro (1); Pagel (15), pp. 102–3; Leicester (1), p. 111.

[g] A brief but good account was given by Chang Hung-Chao (1), pp. 316ff. Cf. also the remarks of Wang Chia-Yin (1), p. 60; Hung Huan-Chhun (1), p. 39.

[h] Cit. in *Thai-Phing Yü Lan*, the imperial encyclopaedia of +983, that great source of ancient fragments, ch. 988, p. 5*a*.

[i] Cit. in *TPYL*, ch. 987, p. 4*a*; also *CLPT*, ch. 3, (p. 89.2).

[j] The text is accepted by Mori Tateyuki in his reconstruction, ch. 1, (p. 24). So also Ku Kuan-Kuang ed., ch. 3, (p. 54); and Chang Hung Chao (1), p. 316.

[k] *Hist. Nat.* XXXIV, 149; see Bailey (1), vol. 2, p. 61.

[l] Cf. Bailey (1), vol. 2, p. 188.

[m] *PPT/NP*, ch. 16, p. 5*a*, tr. Ware (5), p. 268. We have given the whole passage in translation above, pt. 3, p. 104. Ko Hung was well aware that the copper was deposited as a layer on the iron, and did not think that the iron had all been transmuted to copper.

[n] In its entry for another form of copper carbonate, malachite (*khung chhing*[5]), the *Shen Nung Pên Tshao Ching* says that it will turn iron into gold (or a golden colour), cit. *CLPT*, ch. 3, (p. 90.2). Though rather more difficult to interpret, this is best taken as a further reference to the 'wet copper method', precipitation on iron.

[1] 淮南萬畢術 [2] 白青 [3] 石膽 [4] 曾青 [5] 空青

copper.[a] Next in time, *c.* +500, comes the statement of Thao Hung-Ching about 'bird-droppings alum' (which must have contained copper sulphate),[b] and he too was quite clear that the copper was an external layer. Very soon afterwards would come the *San-shih-liu Shui Fa*; interesting to note is the nuance of its Liang wording which cautiously does not commit itself to an actual transmutation. Then in +659 there is a mention in the *Hsin Hsiu Pên Tshao*.[c]

In the Sung period (+10th century onward) we begin to find evidence of the industrial use of the process. We have just read the passage in Shen Kua's book of +1086. An interesting story in the *Lung Chhuan Lüeh Chih*[1] of Su Chhê[2] (+1039 to +1112; the brother of the famous poet Su Tung-Pho[3]) tells of his scepticism about it.[d] As a civil official he had to deal with a merchant who came before him and said that he had a secret method of converting iron into copper by means of copper sulphate (*tan fan*). Su Chhê said that secret methods were forbidden and if there was any value in this it ought to be disclosed to people in general, so that the public could benefit. The merchant was unwilling to do this and left, after which Su Chhê and his friends tried the effect of copper sulphate on old knives without success. This would have been about +1080. But before long the process became well known, for from about +1090 onwards, as Nakajima Satoshi (*1*) has shown in a special study, the 'wet method' (*shih shih chih lien*[4]) came into extensive use as a result of a temporary scarcity of ore for making copper cash.[e] Copper was extracted in large-scale production both from ground water containing copper salts and from solutions obtained by leaching piles of low-grade ore. The *Sung Shih* says:[f]

> The method of producing 'steeped copper' (*chhin thung*[5]) is to make (lit. forge) thin plates of cast-iron and immerse them in rows in troughs of blue vitriol solution (*tan shui*[6]). After some days a layer of red powder is formed by the copper sulphate over the surface of the iron; this is collected by scraping and after three purifications in the furnace gives good copper. Broadly speaking for every pound of copper 2 lbs. 4 ozs. of iron are needed. The Hsing-li Factory at Jao-chou and the Chhien-shan Factory at Hsin-chou produced a definite amount of this 'vitriol copper' (*tan thung*[7]) each year.

This would refer to about +1100.

[a] Another mention of the matter, not much earlier, was that in the *Wu Shih Pên Tshao*[8] (in *TPYL*, ch. 988, p. 5*a*).

[b] *CLPT*, ch. 3, (p. 84.1), translated in full pt. 3, p. 130 above.

[c] Cit. *CLPT*, ch. 3, (p. 90.1). And in Tsan-Ning's *Ko Wu Tshu Than* of *c.* +980, (p. 28).

[d] Ch. 5, p. 3*a*.

[e] Individual installations at this time were producing outputs of some 400 tons a year purely by this method (Collins (1), pp. 18, 240). According to Sahlin (1) the process was first used in Europe, probably in Hungary, about the last decade of the +15th century, whence the distich on a famous mug:

> 'Eisen war ich, Kupffer bin ich
> Silber trage ich, Gold bedeckt mich'.

A dish bearing the same motto, and ornamented with models of minehead equipment, is illustrated by Smith (6), fig. 14. The great centre for this ware was Herrengrund in Bohemia (cf. Alexander, 1). In Sweden at the great Kopparberg mines the 'wet copper' method started only from about +1750. Cf. Lindroth (2).

[f] Ch. 180, p. 22*a*, tr. auct.

[1] 龍川略志 [2] 蘇轍 [3] 蘇東坡 [4] 濕式製錬
[5] 浸銅 [6] 膽水 [7] 膽銅 [8] 吳氏本草

The path of the 'wet copper' men was not always easy however, for adequate supplies of the natural solution were sometimes scarce. In a book of memorabilia entitled *Chhing Po Tsa Chih*,[1] by Chou Hui[2] in +1193, we find the following passage:[a]

In the Chhien-shan district of Hsin-chou, there used to be a stream of (blue) vitriol water (*tan shui*[3]) flowing down out of the mountains over some waterfalls. It was utilised in the 'steeping method' of making copper for the melters. The flow continued even when the weather was dry, but more abundantly in spring and summer, less so in autumn and winter. It is said that in olden times a man lost his keys in the water, and when he recovered them on the following day, they had all turned to copper. In recent years the stream almost stopped flowing, so the steeping method took longer and required more labour. Formerly there were some pits full of vitriol water, and others that were dry, but all the earth round about them contains vitriol, so it is called 'vitriol earth' (*tan thu*[4]). While it saves labour and gives more profit to use vitriol water, less satisfactory results can still be obtained by using the vitriol-containing earth, and after all, though the water can be exhausted this earth is available in plenty. So three officials of the Bureau of Forestry were appointed to search everywhere for vitriol waters and places where they had formerly been, so that profit could be obtained from both earth and water.

This place, the same as that spoken of by Shen Kua, is in northern Chiangsi quite near the Fukien border, a fact which doubtless accounts for the remark of the Jesuit Louis Lecomte in the last years of the +17th century that 'in the province of Fokien there is a spring whose water is green and changes iron into copper.'[b]

Under the Yuan dynasty in the +14th century the growing use of paper money led to the decline of the method and later sources indicate that it fell out of use, being known only from literary mentions. Yet it never died out, as we may infer from the reference in the *Thien Kung Khai Wu*[5] (Exploitation of the Works of Nature) in +1637, where we read:

If iron objects (lit. vessels) are heated and then thrown into (lit. quenched in) copper sulphate solutions, the iron acquires the colour of copper.[c]

(5) The Role of Bacterial Enzyme Actions

It is evident from the recipes given in the *San-shih-liu Shui Fa* that the intervention of bacteria cannot be overlooked, and was often positively encouraged. Even when organic matter was absent they may have been at work; thus in no. 5*b* denitrifying bacteria from the earth may well have reduced the nitrate, forming ammonia and giving the blue copper ammonium carbonate. The reduction of sulphates to sulphides and polysulphides has already been mentioned.[d]

Bacteria probably played a greater role however, in the putrefaction of the organic matter which had been added (often in considerable quantity) to the mixture. We note that of plant substances, expressed juice or extract occurs four times,[e] from root, wood

[a] Ch. 3, p. 39*b* (ch. 12, p. 3*b*), tr. auct. [b] (1), p. 111.
[c] Ch. 11, p. 5*a*. See on this the commentary of Yoshida Mitsukuni (2). On other late encyclopaedias see de Mély (1), pp. xxiii, xxix, 114, 116, 145.
[d] See p. 176 above. [e] Recipes (16), (28*b*), (30) and (32*b*).

[1] 清波雜志 [2] 周輝 [3] 膽水 [4] 膽土 [5] 天工開物

or fruit; while expressed oil comes once,[a] and plant sap twice.[b] Blood was a favourite ingredient on the animal side (eight mentions),[c] but we find beetle larvae once[d] and dung once.[e] It is obvious that highly colloidal solutions of partially degraded proteins would have been produced in these examples, and if the insoluble minerals such as quartz or jade[f] had been added very finely ground to an impalpable powder, then having regard to the charge on the particles, milky suspensions would probably have been produced. The alchemists could never have distinguished these from true solutions, and even today we should have recourse to the centrifuge to clear them.

One or two other features of the organic additions might be mentioned.[g] Some of the saps (as in recipe no. 25) may have been rich in tannin, which would affect the capacity to form permanent suspensions. Again, in recipe no. 30, which deals with the solution of metallic silver, some suspicion is aroused by the presence of the fruits of the *mu ching*[1] shrub. Whether or not our identification of this as *Vitex negundo*[h] is right, there is no doubt that many fruits and grasses contain large amounts of cyanogenetic glucosides. On autolysis or putrefaction it is not at all impossible that enough cyanide might be freed to effect the solution of the noble metals.[i] It may thus be significant that this recipe omits nitrate, though we have naturally assumed that this was not its intention.

(6) Geodes and Fertility Potions

Much interest attaches to the use of conglomerate nodules or geodes (recipes no. 25 and no. 27). In the first of these, the *chiu tzu shih*,[2] 'the stone with nine little ones', appears to be a variety of nodule or geode with loose centres found in conglomerate rocks.[j] It seems to be related to the *aetites* or 'eagle-stone', an object of interest to the old European naturalists.[k] Geodes and aetites were discussed at some length by Pliny before +77 who emphasised the belief in the value of the latter as a childbirth talisman.[l] Here we reproduce an illustration of a geode from the *Chêng Lei Pên Tshao*[3] (Reorganised Pharmacopoeia) of +1249; its earthy or gravelly contents can be seen escaping from the broken-open shell (Fig. 1514). The obvious association with fertility no doubt led to the attempts of our alchemists to get its virtue into solution, almost as if it was an active principle or a biologically effective *Wirkstoff*.

The raw material of recipe no. 27 in the *San-shih-liu Shui Fa* is at first sight a difficult item. *Shih nao*[4] ('stone brain') is identified by Read & Pak (*1*) as paraffin,[m]

[a] Recipe (18). [b] Recipes (25) and (26).
[c] Recipes (6*a*), (11), (13), (21), (32*a*, *b*, *c*), (38). [d] Recipe (32*a*).
[e] Recipe (22). [f] Recipes (11), (13), (18), (21), (22), (25), (26), (28*b*), (32*a*, *b*, *c*).
[g] Recipe (34) is unusual—simply the extraction of an organic material.
[h] R148.
[i] Such a possibility has already arisen (pt. 3, pp. 88, 98–9 above) as a conceivable explanation of one of Ko Hung's potable gold elixirs. [j] According to Chang Hung-Chao (*1*), p. 270.
[k] See Bromehead (2); and Vol. 3, p. 652 above.
[l] *Hist. Nat.* XXVI, 140, 149 ff. Cf. Bailey (1), vol. 2, pp. 123, 127, 257, 262ff.; Bidez & Cumont (1), vol. 2, pp. 201, 346. [m] RP67.

[1] 牡荆 [2] 九子石 [3] 證類本草 [4] 石腦

but this can only be a loose modern usage, and has no authority from the *Pên Tshao Kang Mu* itself (The Great Pharmacopoeia) of +1596, which they were abstracting. *Shih nao yu*[1] does, it is true, mean naturally occurring petroleum and its light fractions such as paraffin and naphtha[a] but with this we are not here concerned. Again, Read & Pak give *shih nao* as a synonym of *wu hsüeh yü shih*,[2] flaky arsenolite,[b] but if they had read Li Shih-Chen attentively, they would have seen that this is expressly denied in his text four times.[c] We thus isolate the proper meaning, which refers to haematitic

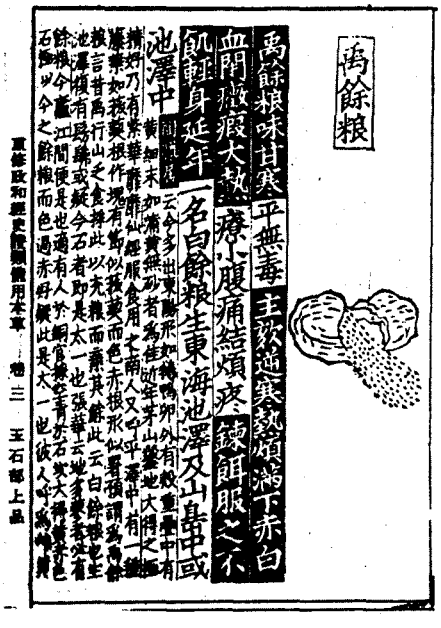

Fig. 1514. A geode (*yü yü liang*) from ferrugineous clay; a page of the *Chêng Lei Pên Tshao* (Reorganised Pharmacopoeia) of + 1249, ch. 3 (p. 91).

nodules of hydrated ferrugineous geodic clay (ironstone), and so makes the term more or less synonymous with *thai i yü liang*[3] and *yü ai*[4].[d] De Mély, though giving an erroneous character for *ai*, rightly makes the connection with the rattling geodic nodules called *aetites*.[e] Now Li Shih-Chen significantly recounts the traditions concerning these stones. He says[f] that they belong to the class of stalactites, by which he means that they have to some extent an organic form, being rounded 'brain-like' *fossilia*, not amorphous mineral. He quotes Thao Hung-Ching[5] as saying that they are not to be found in the ordinary formularies but only in the 'manuals of the immortals'.[g] The general view was that they were suitable for the preparation of elixirs of longevity and immortality; Su Ching[6] is cited with reference to an adept of the Sui period (late

[a] *PTKM*, ch. 9, pp. 62*a* ff.
[b] RP90.
[c] Ch. 9, pp. 61*a*, *b*; ch. 10, pp. 26*a*, *b*.
[d] *PTKM*, ch. 10, p. 12*a*.
[e] (1), pp. 111, 225.
[f] Ch. 9, p. 61*a*.
[g] *Loc. cit.*

[1] 石腦油 [2] 握雪礜石 [3] 太一餘糧 [4] 禹哀 [5] 陶弘景
[6] 蘇敬

+6th century) Hua Kung,[1] who succeeded in this method, and a number of earlier examples are mentioned. These matters are also set forth in the *Chêng Lei Pên Tshao* of +1249,[a] and in many other works of the same character. We thus have to do again with something like *aetites*, and most probably with the preoccupation of getting a fertility-promoting and longevity-promoting virtue into solution.[b]

(7) Stabilised Lacquer Latex and Perpetual Youth

We now come to the curious case of lacquer. Recipe no. 33 in the *San-shih-liu Shui Fa* directs that to make lacquer solution (*chhi shui*[2]) which will still be fluid 50 days later, 18 large crabs kept overnight (*ta su hsieh*[3])[c] are to be put into each pint of the lacquer.[d] Here it is not a question of bringing something very hard and insoluble into solution but rather of preventing something liquid and creamy from rigidifying and concreting as it normally would do. Sinologists meeting in Chinese literature with statements about the harmful effects of crabs on lacquer may have thought them an old wives' tale relating to the lacquered bowls or dishes in which the shell-fish were placed, but a study of the subject shows that the references are really all to the effects on the unpolymerised latex. Thus the story is more interesting chemically and more significant philosophically.

The effect of crab tissues on lacquer is a *locus communis* in ancient Chinese literature. Probably the oldest references are in the *Huai Nan Tzu*[4] book (*c.* −120) which says that crabs spoil lacquer, so that it will not dry and cannot be used.[e] Then Chang Hua[5] in his *Po Wu Chih*[6] (Record of the Investigation of Things), written about +290, says that crabs unite with lacquer forming a 'medicine of the Holy Immortals' which can be taken orally.[f] Shortly afterwards Ko Hung refers to the effect more than once. The *Pao Phu Tzu* speaks of crabs and lacquer in the following words:[g]

> Pure lacquer (-tree latex) prevented from becoming sticky (i.e. setting), if eaten, enables a man to associate with the spirits and attain longevity or immortality. The method of making it edible is to take ten large specimens of 'the Gutless Lordling' (*wu chhang kung*[7]), otherwise known as crabs,[h] and throw them into lacquer, or else use an aqueous suspension of mica or of jade. When this potion is ingested the nine parasites will quit the body and bad blood will leave by way of the nose.[i]

[a] Ch. 4, (pp. 115, 116).

[b] There might be a certain parallel here with the iatro-chemical belief in a 'natural balsamum' capable of preserving from decay and so prolonging life (cf. Mazzeo, 1). We refer to such ideas in other contexts elsewhere (Vol. 5, pt. 2, pp. 74 ff., 294 ff.), *mumia* as a drug, and material incorruptibility.

[c] Probably fresh-water *Eriocheir sinensis* (R214), the commonest species. The term *su* means 'kept overnight', as one can see from the *Hsieh Phu*,[8] ch. 2, p. 5*a*, so the crabs were not to be too fresh. No doubt a certain amount of autolysis enhanced the action of their tissues.

[d] Similar procedures are found in various other texts, for instance *TT*945, ch. 2, p. 8*b*. Sometimes the crabs are omitted; *TT*875, ch. 2, p. 6*a* uses only cinnabar and vinegar—or so it says.

[e] Ch. 6, p. 4*a*, ch. 16, p. 14*b*. [f] Ch. 4, p. 6*a*. [g] *PPT/NP* ch. 11, p. 10*b*, 11*a*, tr. auct.

[h] This is a very old expression, first occurring perhaps in the −2nd-century *Han Shih Wai Chuan* (cit. *SF*, ch. 80, p. 4*b*). We have also noticed it in the *Pei Hu Lu* (cit. *LS*, ch. 13, p. 7*b*, in vol. 2, p. 878).

[i] The translation of Feifel (3), p. 20 is rather unsatisfactory here, while that of Ware (5), p. 190, misses the point that the lacquer must not be allowed to set.

[1] 化公 [2] 漆水 [3] 大宿蟹 [4] 淮南子 [5] 張華 [6] 博物志
[7] 無腸公 [8] 蟹譜

Another chapter has a passing mention of the effect of crabs on lacquer.[a]

When one comes to the Sung there are many references. Fu Kung's[1] *Hsieh Phu*[2] (Discourse on Crustacea) quotes Thao Hung-Ching (+5th century) as saying:[b]

> According to the recipes of the immortals, crabs thrown into lacquer form an aqueous solution, which brings longevity when consumed.

The great naturalist-monk Tsan-Ning[3] refers twice to the phenomenon. In his *Wu Lei Hsiang Kan Chih*[4] (On the Mutual Responses of Things according to their Categories),[c] *c.* +980, he says that it is the 'fat' (*kao*[5]) of the crabs which is responsible; and Su Sung[6] in his *Pên Tshao Thu Ching*[7] (+1070) refers[d] the effect to the 'yellow' (*huang*[8]), which might be roe, but more probably means hepatopancreas, as in the words of Tsan-Ning. The latter's other reference[e] mentions the mixing of the crab material with 'damp', i.e. not set, lacquer, with the result that it remains liquid. That the *San-shih-liu Shui Fa* refers to crabs as such may be an indication of early date. Yet another Sung reference, from the +12th century, in Li Shih's[9] *Hsü Po Wu Chih*[10] (Continuation of the Record of the Investigation of Things)[f] simply says that 'after coming in contact with crabs, lacquer will not concrete.'

Since lacquer produces a well-known allergic reaction involving swelling and inflammation of the skin, etc., it is not surprising that crab tissues were appealed to as a method of therapy. In the *Pên Tshao Kang Mu* Li Shih-Chen gives crab extract or brei together with several plant drugs as an antidote.[g] Elsewhere he quotes a story from a Sung source, the *I Chien Chih*[11] of Hung Mai[12] (+1123 to +1202) to the effect that a thief having been blinded with lacquer was healed by the application of crab brei.[h]

All this is quite comprehensible if the basic facts about lacquer are recalled. After being tapped from the tree, *Rhus vernicifera*, the creamy grey latex, left to itself, gradually separates into four or five layers of different properties, but if held in complete darkness in airtight conditions can be conserved almost without change for several years. On exposure to light, warmth and a relatively damp atmosphere, however, the latex turns first to a chocolate brown colour and eventually sets to a hard brown extremely resistant substance.[i] This material, previously impregnated with various

[a] *Pao Phu Tzu* (ch. 3, p. 5*b*) says: 'I can guarantee that it is possible to sublime mercury and to search out (the art) of making gold and silver...As for the transformation of lacquer by crabs and the spoiling of wine by hemp (-seed oil)...'. Feifel writes (1), p. 197: 'I warrant that one can make people fly (with the help of) the *liu-chu*[13] and that one can make gold and silver...If, however, the crab heals the lacquer-sickness, if hemp sets distilled spirits in fermentation...' So this begins by missing the reference to sublimation and ends by a biochemical impossibility. Ware (5), p. 61, did see that it meant stopping the setting of the lacquer.

[b] P. 8*b*. [c] P. 1. [d] Quoted in *CLPT*, ch. 21, (p. 426.2).

[e] In *Ko Wu Tshu Than*,[14] ch. 1, p. 13. [f] Ch. 9, p. 5*a*.

[g] Ch. 35, p. 20*a*. [h] *PTKM*, ch. 45, p. 24*a*.

[i] Set lacquer is almost untouched by strong acids and alkalies, insoluble in all the usual solvents, extremely resistant to bacterial attack, heat-stable up to 400–500°, as an electrical insulator only ten times less effective than mica—in fact, as a vegetable product altogether extraordinary. It makes an excellent surface for laboratory benches in China.

[1] 傅肱 [2] 蟹譜 [3] 贊寧 [4] 物類相感志 [5] 膏
[6] 蘇頌 [7] 本草圖經 [8] 黃 [9] 李石 [10] 續博物志
[11] 夷堅志 [12] 洪邁 [13] 流珠 [14] 格物麤談

colours, black, red, gold or silver, or afterwards carved and treated in various ways, has been the basis of China's lacquer industry for more than two thousand years.[a]

Lacquer may be said to have been the most ancient industrial plastic known to man. The chemistry of the process is of considerable interest.[b] As much as 75 per cent of the latex consists of one or another catechol derivative (urushiol, laccol, moreacol),[c] having two hydroxyl groups on a single ring and one long side-chain (C_{15} or C_{17}) containing at least one or two double bonds. The oxidising and polymerising agent is the enzyme laccase, and the process needs oxygen as well as manganese as co-enzyme. The discovery of laccase by Gabriel Bertrand (1) in 1894 was one of the great milestones in the history of enzyme chemistry.[d] But the process becomes even more interesting when we set it in the broad framework of its biological significance. First the laccols are closely related to the active principles of the poison-oak and poison-ivy (e.g. lobinol), which also have a deleterious action on man. Secondly laccase as a catechol-oxidase is closely related to the polyphenol-oxidases which play such a prominent part, not only in the darkening of plant tissues, but also in the protein-tanning and melanin-blackening of the exo-skeleton or cuticle throughout the whole world of insects.[e] Indeed polyphenols and their oxidases having similar functions have a still wider distribution among invertebrates. Besides, there is the close parallel among the higher animals of the formation of melanin, the primary black and brown pigment, by the action of tyrosinase on tyrosine. Thus the lacquer process is only one special case, though of outstanding industrial importance, of a general pattern almost as widespread as plant and animal life itself.

What part, then, were the crab tissues playing? There can be no doubt that the ancient Chinese, before the −2nd century, had accidentally discovered a powerful laccase inhibitor. By preventing the action of the enzyme the darkening and polymerisation were also prevented. So great an interference with the course of nature, analogous to the arrest of a spontaneously occurring rigidification and ageing process, must have seemed highly significant to the alchemists, preoccupied as they were by the preservation of supple youth and the postponement or elimination of ankylosis and death. Moreover this action of crustacean tissues is not unique, for other researches have shown that they contain a powerful though somewhat enigmatic inhibitor for D-amino-acid oxidase.[f] Even some of the alleged therapeutic effects of crab tissues might now make sense, e.g. the case of the thief if full setting had not occurred; though the action on the dermatitis was presumably imaginary since the poisoning is due to the

[a] Excellently preserved and beautifully patterned lacquer bowls, boxes and other objects, not only from the Han but from the −4th-century Warring States period, are preserved in contemporary Chinese museums, e.g. at Chêngchow.

[b] See the reviews of Brooks (1) and (2).

[c] The compounds are named in accordance with the species of tree which yields them, here *Rhus vernicifera* from China and Japan, *Rhus succedanea* from Annam, and *Melanorrhoea laccifera* from Cambodia.

[d] The most recent and complete study of it is due to Keilin & Mann (1, 2), who have established that it is a copper-containing protein accompanied by a blue pigment which may be its prosthetic group.

[e] See the reviews of Wigglesworth (1), H. S. Mason (1) and Dennell (1). The original discovery of the tanning was due to Pryor (1), and it was Bhagvat & Richter (1) who established the extreme richness of insects as well as plants in polyphenol oxidases.

[f] Sarlet, Faidherbe & Franck (1).

urushiol itself and not to the laccase or the polymer. As regards the belief that powdered mica or jade would also prevent the coagulation of lacquer latex, one wonders whether perhaps crab tissue was not already added. Of course if the mineral was in the form of an impalpable powder the colloidal solution of latex would be affected by the charge on the particles, and it is just possible that in such conditions the laccase enzyme protein might be prevented from gaining access to its substrate.

(*h*) THE THEORETICAL BACKGROUND OF ELIXIR ALCHEMY

(1) Introduction

Our focus now shifts from the Chinese alchemists' identifiable chemical and protochemical accomplishments to the assumptions and concepts with which they themselves sought to explain their methods and aims. This shift in point of view is perhaps more radical than might at first appear. If we wish to understand the inner coherence of alchemical theories we must, for the moment, set aside the yardstick of modern chemistry (although it will still be essential as an exploratory tool) and try to reconstruct the alchemist's abiding goals, his own standards of success and failure, as clues to how his concepts determined both what he did in his elaboratory and how he rationalised unforeseen results.

By 'theory' we mean simply the attempt to explain alchemical phenomena systematically using abstract and non-anthropomorphic concepts. In practice this means that we shall examine the application of the most fundamental and general notions of Chinese natural philosophy—the Five Elements, the Yin and Yang, the *chhi*, the trigram and hexagram systems of the 'Book of Changes', and so on—to the experience of the laboratory. We shall study how these notions were adapted to alchemical concerns either by extending their definitions, or by creating new concepts or new connections to integrate them.

It is necessary to stress that the field of alchemical theory is defined here by what alchemists did, thought, and knew about. Theoretical conceptions never exist in a vacuum; their implications and significance depend upon the matrices in which they are embedded. To pluck the 'advanced' elements out of the matrix and discard the 'retrograde' aspects is a procedure bound to lead to fundamental distortions, for the two regularly turn out to be integral and inseparable, one element defining the range of possibilities of the other. Demarcating our field of investigation so as to include any ancient Chinese activity which might fall into the area of modern chemistry would allow the casting of the net wider, but at the cost of putting many of the alchemical adept's own concerns out of bounds. Not only would we confound ideas that originally had nothing to do with each other, but we would have to reject so many central aspects of alchemy that there would be no possibility of comprehending what held it together, and no hope of ultimately making more than superficial comparisons with the traditions of other cultures.

In order to understand what the ancient Taoist adepts had in mind as they worked

in their laboratories, we must examine seriously such topics as the belief in the growth of minerals within the earth, the command of time, and the role of number in establishing correspondences between the apparatus and the greater cosmos (never entirely distinct from the more familiar function of number in recording the invariant weights of reactants and products). Nor can we ignore the associated Taoist rituals, offerings, and incantations which were used in connection with every phase of the process.[a] The alchemist was applying chemical and physical procedures to the quintessentially religious end of transcending his mortality. The new observations and discoveries which today interest students of the history of science were also valued by the alchemists themselves, but not usually as the main objectives for which they were striving.

The Taoist's end in view was, one might say, perfect freedom in perfect fusion with the cosmic order. For the early Taoist philosophers this seems to have been mainly a state of heart and mind, but as we have seen, alchemists and other adherents of Taoist religion thought of perfect freedom as limited to a special state of being, that of the immortal *hsien*.[1] Immortality could be attained by a variety of means, two of which in particular mark the alchemist's Way. First there was the construction of chemical models of the cosmic process. These were apparently meant to serve as objects of ecstatic contemplation, leading to a gnosis which brought one closer to union with the Tao. Second was the production of elixirs of supramundane virtues, the action of which—upon the adept himself, upon others, or upon base metals—gave him not only personal immortality at his pleasure, but also transferable wealth and a more-than-human power to cure disease and make others immortal. The first path led the alchemist in the direction of physics, the second toward medical therapeutics, metallurgy and other technical arts.

(i) *Areas of uncertainty*

It is still too early to attempt a truly historical study of the theoretical side of Chinese alchemy, in which one could see how concepts and their relations developed and changed both through mutual influence and the pressure of wider intellectual and social currents. First, too few of the documents which have survived the attrition of successive Chinese cataclysms can yet be dated precisely with confidence, and this leaves even their logical connections obscure. Secondly, with a large part of the clearly dated literature, one cannot be sure that its vague and obscure language is in fact concerned with laboratory operations rather than with the physiological and sexual disciplines which used alchemical language.[b] We know already that most of the alchemical treatises which have been translated into Western languages actually come out of the 'dual-cultivation' régime of the Southern School of Taoism in the Sung

[a] At the same time we regret the impossibility of doing justice to the subject of alchemical ritual here. One of us (N.S.) has collected material bearing on this topic, and plans a special study. See also above, Vol. 5, pt. 2, pp. 128ff.; including our account of the *Shang-Chhing Chiu Chen Chung Ching Nei Chüeh* (*TT* 901).

[b] See Vol. 5, pt. 5.

[1] 仙

and Yuan periods.[a] These practices, a blend of Internal Alchemy and sexual disciplines (*nei tan*[1]), were not in principle irreconcilable with the art of the External Elixir (*wai tan*[2]), but most devotees resembled the 'spiritual alchemists' of the European Renaissance in their explicit disdain for the actual work of the furnace.

To reduce these two fundamental areas of uncertainty will require a good deal of critical work on individual writings. In relation to the second problem, the most fruitful clues are likely to come from the study of just those sources which have the least to do with laboratory alchemy, and thus are least likely to attract students of ancient science. But the small body of sources the meanings and times of which are known does not yet provide a basis for understanding the changing character of alchemy and of its links with the other arts of Taoism. Here we can only examine the widest possible variety of evidence in order to sketch out the ideas and notions which were most general in alchemy rather than those which can be identified definitely with given periods and movements.

There is, in fact, much information in writings on 'alchemical' breath control, meditation, and sexual techniques which can be used to throw light on the intellectual background of *wai tan* alchemy, for most early adepts combined all these practices, considered them complementary, and explained them with the same concepts. However, in order to keep from losing sight of what is actually information about the Outer Elixir, it is necessary to 'presume guilt'. We consider no text chemically alchemical (i.e. *wai tan*[2]) unless it either prescribes operations so clearly that they could conceivably be carried out in the laboratory, or, if the emphasis is on theory, unless it clearly reflects knowledge of the details of laboratory procedure or the interactions of real chemical substances.

(ii) *Alchemical ideas and Taoist revelations*

Before we proceed to scrutinise the alchemists' theories, one other major limitation of our present understanding must be made explicit. One can seldom hope to reconstruct the competition of different ideas for survival and further elaboration simply on the basis of their abstract merits, without attention to their social consequences; ideas which affect the rate of social change, whether in a tiny sect or a great civilisation, are often selected or rejected for very extrinsic reasons. It is thus necessary to ask whether

[a] The term 'dual cultivation' was coined by Liu Tshun-Jen (1) to refer to *shuang-hsiu*,[3] 'a tendency to integrate the eugenic *fang-chung*[4] studies with the physico-mental cultivation of the Golden Pill [i.e. *chin tan*[5]], in fashion since the + 10th century', i.e. to bring together sexual practices and other *nei tan* physiological techniques. We believe—and seek to demonstrate in what follows and in pt. 5—that sexual practices were part of *nei tan* from the beginning, but also that even in the Sung many of Liu's sources still reflect first-hand knowledge of laboratory processes. For these reasons we cannot accept all his arguments, but here we retain 'dual cultivation' to designate the late movement to which Liu originally applied it; though we re-define the term to refer to an amalgamation of chemical and psycho-physiological practices in which the latter generally predominated. In referring to the history of alchemy as a whole rather than to this late movement, we use the terms 'laboratory alchemy', 'proto-chemical alchemy' or 'external alchemy' (*wai tan*[2]) on the one hand; and 'physiological alchemy' or 'internal alchemy' (*nei tan*[6]) on the other, as synonyms. For a list of treatises which have been translated, see Sivin (1), pp. 322–4.

[1] 內丹 [2] 外丹 [3] 雙修 [4] 房中 [5] 金丹 [6] 內丹

alchemy was but an appendage of Taoism, neglected by all but a few specialist practitioners and non-practising patrons; or on the other hand part of a central revelation which defined the character of Taoist religion. It is clear that for early Chinese alchemy the latter is the case. Alchemy was an actual part of the founding revelation of the Mao Shan school, the group responsible for completing and putting into practice the first great intellectual synthesis of Taoism.[a] It was bound, therefore, to be affected by the application of that revelation to a particular social and historical milieu.

The chain of events which led to the establishment of Mao Shan, or Mt. Mao, as the first major permanent centre of Taoist practice began in +349 or slightly earlier with visitations by immortals to a young man named Yang Hsi[1] (traditional dates: +330 to +387) at the Eastern Chin prefectural capital, Chü-jung,[2] not far from modern Nanking. Between +364 and +370, in a series of visions, there appeared to Yang a veritable pantheon of celestial functionaries, including the Lady Wei of the Southern Peak (Nan Yo Fu-jen,[3] Wei Hua-Tshun[4]) and the brothers Mao Ying,[5] Mao Ku,[6] and Mao Chung,[7] whose names were given to the three peaks of the nearby Mt. Chü-chhü[8].[b] In the course of these interviews, aided almost certainly by cannabis,[c] Yang took down in writing a number of sacred texts which the immortals assured him were current in their own supernal realm, as well as oral elucidations and answers to Yang's queries about various aspects of the unseen world. He treasured and disseminated these scriptures as the basis of a new Taoist faith more elevated than the 'vulgar' sects of his time. He was sponsored and joined in his revelations by Hsü Mi[9] (+303 to +373), an official of the court, and his son Hsü Hui[10] (+341 to *c.* 370). The family connections of the Hsüs were estimable in more than the conventional sense, for Hsü Mi's uncle married the elder sister of Ko Hung,[11] the great exponent of personal access to the realm of the immortals; and they were also related to the family of Thao Hung-Ching[12] (+456 to +536), the most eminent Taoist magus of his time.[d] We have

[a] See Vol. 2, pp. 154ff. and Vol. 5, pt. 2, pp. 128ff., pt. 3, pp. 39, 41, 77, 121 above.

[b] The three Mao brothers were supposedly alchemists of the − 1st century, but Wei Hua-Tshun was a contemporary. She seems to have been one of the founders of Taoist liturgiology, and a great teacher of meditation aided by psychotropic drugs. In what follows we have been greatly aided by access to an unpublished study by Strickmann (3). On dates see *Chen Kao*[13] (Declarations of Perfected (or Realised) Immortals, *c.* + 500), ch. 20; *Chen Hsi*[14] (The Legitimate Succession of Perfected (or Realised) Immortals, + 805) of Li Po,[15] in *YCCC*, ch. 5, p. 2*a*, and the narrative in Chhen Kuo-Fu (*1*), pp. 32–4. Michel Strickmann (priv. comm.) is inclined to think that Liu Phu,[16] the son of Wei Hua-Tshun, who transmitted the 'Five Amulets' (*Wu Fu*[17]) to Yang in + 349 or + 350 was also a real person; if so, there is nothing in the primary sources about truly visionary experiences before + 364.

[c] See Vol. 5, pt. 2, pp. 150ff. To the evidence given there about cannabis one could add a fine + 6th-century example from a *Wu Tsang Ching* (Manual of the Five Viscera), attributed to Chang Chung-Ching but certainly not by him: 'If you wish to command demonic apparitions to present themselves you should constantly eat the inflorescences of the hemp plant.' Cf. Miyashita Saburō (*3*).

[d] See the biography by Ishii Masako (*4*). Strickmann has noted in the course of correspondence that in eight generations of the Hsüs, four alliances with the Kos are recorded (*Chen Kao*, ch. 20), and that Hsü Mi's own principal wife had been the daughter of Thao Hung-ching's ancestor in the seventh generation (inclusive). In much of what follows we are indebted to Dr Strickmann.

[1] 楊羲 [2] 句容 [3] 南嶽夫人 [4] 魏華存 [5] 茅盈
[6] 茅固 [7] 茅衷 [8] 句曲 [9] 許謐 [10] 許翽
[11] 葛洪 [12] 陶弘景 [13] 眞誥 [14] 眞系 [15] 李渤
[16] 劉璞 [17] 五符

already encountered Hsü Mi's alchemist brother Mai[1].[a] In +367 Hsü Mi was informed by Mao Ying that in nine years he would be transferred from the terrestrial bureaucracy to that of the Superior Purity Heaven (*Shang-Chhing Thien*[2]). That this heaven might be available for such heady assignments had been revealed to no Taoist save Yang Hsi and his patrons.[b] Hsü apparently remained active in his post at the capital, despite repeated celestial admonitions, but his son Hsü Hui, having returned his wife to her parents, moved into the retreat his father had built at Mt. Mao, and there until his premature death he devotedly practised the operations revealed to Yang for his benefit by the immortals.[c] Yang and the Hsüs had vindicated Ko Hung's belief in the unseen world—not supernatural in Chinese terms, but concerned only with eternal things and thus more desirable than mundane society—which he had urged with such amplitude in his *Pao Phu Tzu* (*Nei Phien*).

Four generations later, when Thao Hung-Ching retired from the Chhi court in +492 to Mt. Mao, he built the Hua-yang Kuan[3] (Effulgent Yang Abbey) and proceeded to seek out the revelations and revive the spiritual experiences of Yang and the Hsüs as the basis of a religious community. The background of the Hua-Yang Abbey could hardly be better described than in the words of Michel Strickmann:[d]

> What was to become the Mao Shan tradition began as the highly individual practices of three men, of whom one was a visionary and another held a full-time job. They were building upon a common base provided by the Way of the Heavenly Master (Thien Shih Tao[4]), a Taoist group specialising in the cure of disease through formalised communication with the celestial hierarchy.[e] Like most reputed founders, Yang and the Hsüs founded no order; and though between their own time and that of their eventual editor portions of their brilliant synthesis spread somewhat (first only among friends and relations), no independent organisation arose to perpetuate their names or realise the teachings of their celestial masters.[f] Thao also had the example of earlier 'abbey' (*kuan*[5]) communities, whose functions were perhaps more intimately related to their patronage than to their particular doctrines. Individual financial support involved their Taoist members with ceremonies for the well-being of their patron's family, both living and dead, and probably with the guardianship of some of his infant sons.
>
> Thao had the wit to apprehend that analogous services, on a correspondingly grander scale, could elicit the patronage of the Liang emperor himself, thus providing the highest possible auspices for a revival of Taoism (for by Thao's time the Heavenly Master cult had fallen apart in South China). Once Thao had seen to the elaborate details of collecting, codifying, annotating, and publishing the Annunciations of the Immortals, and had thought through the problem of administrative organisation, the community was soon assembled, and

[a] See pt. 3, p. 76.

[b] Yang was always the intermediary, for only he was granted waking visions; anyone could dream of the immortals, of course, so dreams were given much less significance. The sequence of annunciations concerning Hsü's appointment is recorded in *Chen Kao*, chs. 1–4.

[c] See above, pt. 3, p. 121 and, for Hsü Mi's alchemical activities, pt. 2, p. 110.

[d] Priv. comm., 4 August 1970, to one of us (N.S.), edited with permission to take into account a later discussion on this point with M. Strickmann and K. M. Schipper.

[e] See above, Vol. 2, pp. 155–7. We are even less inclined now than when that was written to speak of Taoist 'monasticism'.

[f] For documentation see *Chen Kao*, chs. 19–20.

[1] 邁 [2] 上清天 [3] 華陽館 [4] 天師道 [5] 館

ceremonial was adopted and elaborated. Ceremonial, despite the ideological emphasis on revelation and visionary experience, must always have been the chief preoccupation of the majority at Hua-Yang Abbey. These Taoists busied themselves with ceremonies in support of the health of both Ruler and State, with the discovery of auspices, and not least with the concoction of a timely elixir. The sound fiscal basis of the enterprise enabled it to pass unscathed through the disestablishment of Taoist organisations in +504 (this very year in fact marks the inception of Thao's alchemical operations), and in time to take hold upon the intellects (and purse-strings) of the Thang.

Thao apparently first learned of the Mao Shan writings through a few fragments in the possession of his teacher, Sun Yu-Yüeh.[1] Sun had in turn been the disciple of Lu Hsiu-Ching,[2] who had journeyed through the haunts of Taoism to be initiated into, collect, and catalogue (by +471) the major scriptures of the rival Ling-Pao[3] tradition,[a] picking up along the way some documents which emanated from Yang Hsi.[b] Since Lu was neither particularly concerned nor overly fastidious about the authenticity of the latter, most were probably poor copies or forgeries; many fakes had already been produced within the select circles which knew of the Mao Shan revelations.[c] In Thao's subsequent search, first among relatives of the Hsüs and then on a long voyage to the southeast, his acknowledged model was Ku Huan[4] (d. +485), a contemporary of Lu's. Ku had devoted much energy to seeking out (in a more limited way than Thao) the scriptural remains of Mt. Mao, and first applied a knowledge of Yang Hsi's calligraphy and that of the Hsüs to what he recognised as the essential task of separating authentic from doubtful documents.[d]

Thao Hung-Ching eventually discovered, and proceeded to edit and annotate, a remarkably intimate day-to-day record of his predecessors, including letters which had passed between them and journals of visitations by one or another immortal, often for no more exalted purpose than to offer medical advice or to negotiate some minor celestial-bureaucratic detail. In this record Thao found much of alchemical interest, which is duly preserved in his *Chen Kao*[5] (Declarations of the Perfected (or Realised)

[a] Cf. Kaltenmark (4).

[b] In +471 Lu presented his 'Tripartite Catalogue of Scriptures' to Emperor Ming of the Liu Sung dynasty. According to a rather hostile later Buddhist source, Lu claimed that there existed a total of 1228 rolls, of which 1090 were circulating in the world and 138 were still in the Celestial Palace of the immortals. This number comprised 'prescriptions' (*yao fang*[6]), which in early Taoist circles meant chiefly instructions for preparing substances which conferred immortality. See *Fa Yuan Chu Lin*[7] (+668), ch. 69, p. 5*b*; and on the subject of 'medicines', Schipper (1), p. 13. The organisation of Lu's catalogue was based on the Three Vehicles of the Buddist Tripiṭaka, and its application to Taoism goes back to a division of the celestial scriptures revealed to Yang Hsi in +364; see *Shang-Chhing Thai-Shang Pa Su Chen Ching*[8] (Realisation Canon of the Eightfold Simplicity; a Shang-Chhing Thai-Shang Scripture), *TT*423, pp. 4*a*–5*b*. Citations in *Chen Kao*, ch. 19–20, carry the designation *san phin mu*[9] or *san chen*[10] *phin mu*. The tripartite division was still reflected in the last great version of the Patrology, the *Chêng-Thung Tao Tsang*[11] of + 1444 or + 1447 (cf. pt. 3, pp. 116–17). See Holmes Welch (3), pp. 129–131; Chhen Kuo-Fu (1), vol. 1, pp. 38–46 and 106–107; and, on Lu Hsiu-Ching himself, Ōbuchi Ninji (1), pp. 259–276.

[c] See *Chen Kao*, chs. 19–20. These forgeries and their detection will be discussed in a major study of the formation of the Mao Shan corpus now under way by Michel Strickmann.

[d] Cf. *Chen Kao*, ch. 19, p. 1*a*.

[1] 孫游嶽 [2] 陸修靜 [3] 靈寶 [4] 顧歡 [5] 眞誥
[6] 藥方 [7] 法苑珠林 [8] 上清太上八素眞經 [9] 三品目
[10] 三眞 [11] 正統道藏

Immortals), or in the now fragmentary *Têng Chen Yin Chüeh*[1] (Confidential Instructions for the Ascent to Immortality).[a]

The three progenitors of the Mao Shan cult had shared with other sects of their time a belief in an imminent apocalypse which Thao calculated would fall in +507, to be followed in +512 by the descent of the Sage to gather up the elect, the only survivors.[b] Yang Hsi had been well supplied with graphic and elegantly phrased details of the catastrophes by Wei Hua-Tshun's colleague the Lady of the Circumpolar Zone (Tzu Wei Fu-jen[2]), and had been assured by her that among the singular methods and supreme arts which would be practised in those latter days was alchemy:

> Some will cyclically transform in their furnaces the darksome semen (*yu ching*[3]) of cinnabar, or refine by the powder method the purple ichor of gold and jade. The Lang-kan elixir will flow and flower in thick billows; the Eight Gems (*pa chhiung*[4]) will soar in cloudlike radiance.[c] The Crimson Fluid will eddy and ripple as the Dragon Foetus (*lung thai*[5]) cries out from its secret place. Tiger-Spittle and Phoenix-Brain, Cloud Lang-kan and Jade Frost, Lunar Liquor of the Supreme Pole (*Thai Chi yüeh li*[6]) and Divine Steel of the Three Rings (*san huan ling kang*[7])— if a spatulaful of (one of these) is presented to them, their spiritual feathers will spread forth like pinions. Then will they (be able to) peruse the pattern figured on the Vault of Space, and glow forth in the Chamber of Primal Commencement....[d]

Among the scriptures taken down by Yang Hsi, Thao had also found actual instructions for alchemical preparations. Two of these formulae still exist in their entirety. One, called *Thai-Shang Pa-Ching Ssu-Jui Tzu-Chiang (Wu-Chu) Chiang-Shêng Shen Tan Shang Ching*[8] (Exalted Manual of the Eight-Radiances Four-Stamens Purple-Fluid Crimson Incarnation Numinous Elixir, a Thai-Shang Scripture), is preserved in the *Shang-Chhing Thai-Shang Ti Chün Chiu Chen Chung Ching*[9] (Ninefold Realised Median Canon of the Imperial Lord, a Shang-Chhing Thai-Shang Scripture);[e] a work otherwise devoted to techniques for encountering various deities

[a] There is a new critical edition of the *Chen Kao* by Ishii Masako (*1*), who has also reported favourably on its general authenticity (*2*, *3*). Although no substantial portion of this has been translated, Schipper (1) provides a complete rendering of the *Han Wu Ti Nei Chuan*[10] (Intimate Biography of Emperor Wu of the Han, *TT*289), which, as he has demonstrated, is a product of the Mao Shan ambiance. Two thin slices of historical and legendary material about the real Martial Emperor have merely been placed outside a filling of three typical revelations originally quite unconnected with him.

Both the *Chen Kao* (*TT*1004) and the *Têng Chen Yin Chüeh* (*TT*418) were probably completed about +499, according to Strickmann (3), but the former was intended to arouse the interest of the Emperor, and the latter (part of which is now preserved only in *TPYL*) was meant for cultic use.

[b] *Chen Kao*, ch. 13, pp. 8*b*, 9*a*. The basic Mao Shan doctrine on the coming of this messiah is found in *Shang-Chhing Hou Shêng Tao Chün Lieh Chi*[11] (*TT*439).

[c] On the Lang-Kan gem and elixir see below, pp. 217, 268, and elsewhere, pt. 2, p. 296.

[d] *Chen Kao*, ch. 6, p. 2*b*, tr. Strickmann (2), mod. auct. Any such translation must still be very provisional.

[e] *TT*1357, ch. 2, pp. 8*b*–18*a*, where it is explicitly continuous with the more uncompromisingly magical portion (see p. 17*a*). It is also reprinted separately, without the ascription, in *YCCC*, ch. 68, pp. 1*a*–9*b*, under the slightly different, and probably more correct, title: *Thai-Shang Pa-Ching Ssu-Jui Tzu-Chiang Wu-Chu*[12] *Chiang-Shêng*[13] *Shen Tan Fang* (Eight-Radiances Four-Stamens Purple-Fluid Five-Peal Incarnate Numinous Elixir, a Thai-Shang Scripture).

Thao could not be sure that this treatise was part of the original Yang-Hsü corpus, since his copy was not in Yang's handwriting, and thus might have been one of the many forgeries then circulating (see

[1] 登眞隱訣 [2] 紫微夫人 [3] 幽精 [4] 八瓊 [5] 龍胎
[6] 太極月醴 [7] 三環靈劒 [8] 太上八景四蘂紫漿絳生神丹上經
[9] 上清太上帝君九眞中經 [10] 漢武帝內傳 [11] 上清後聖道君列紀
[12] 五珠 [13] 降生

in meditation—making them appear from within one's body, from the sun and moon, and from inside unusually coloured clouds that conceal the immortals as they travel through the sky. The elixir recipe itself, for all its twenty-four ingredients and 104 days of heating, is clearly phrased in the language of the laboratory, and could be carried out in one today. The ingredients are given elaborate cover-names, but all are defined in notes recording oral instructions (*khou chüeh*[1]) ascribed to the first Patriarch of Taoism, Chang Tao-Ling (+2nd century): e.g. Crimson Tumulus Vermilion Boy (*chiang ling chu erh*[2] = cinnabar, HgS), Elixir Mountain Solar Animus (*tan shan jih hun*[3] = realgar, As_2S_2), Arcane Belvedere Lunar Radiance (*hsüan thai yüeh hua*[4] = orpiment, As_2S_3). The formula is not dissimilar on the whole to later alchemical recipes in terminology and technique.

The second is atypical in its adaptation of vegetable processes; it falls between conventional alchemy and the art of growing the marvellous *chih* plants (*ling chih*[5]), the most famous of which is the 'magic mushroom'.[a] This is the *Tung-Chen Ling Shu Tzu-Wên Lang-Kan Hua Tan Shang Ching* (Divinely Written Exalted Manual in Purple Script on the Lang-Kan (Gem) Radiant Elixir; a Tung-Chen Scripture), originally part of a *Tung-Chen Thai-Wei Ling Shu Tzu-Wên Shang Ching*[6] (Divinely Written Exalted Canon in Purple Script; a Tung-Chen Thai-Wei Scripture).[b] A fourteen-ingredient elixir is treated in a precisely phased fire for three protracted periods,[c] after which an elixir appears inside a 'bud' of seminal essence (*ching*[7]). Planted in an irrigated field, after three years the elixir seed develops into a tree with ring-shaped fruit, one of the names of which is Supreme-Pole Arcane Chih (*thai chi yin chih*[8]). The fruit when planted yields a new plant resembling the calabash, with a peach-like fruit called the Phoenix-Brain Chih (*fêng nao chih*[9]). When this intermediate is raised to higher degrees of perfection through two further replantings, the adept harvests a fruit resembling the jujube which, when eaten, brings about assumption into the heavens. We can appreciate that this extravagantly impractical recipe is an attempt to assimilate into alchemy legends like that of the *lang-kan*[10] gems which since the Chou and Han had been said to grow on trees in the paradise of Khun-lun,[11] where also were found the peaches of immortality.[d]

Chen Kao, ch. 10, p. 5*a*). We are somewhat less reluctant to accept it, because in a number of passages parallel to the text of *Tung-Chen Ling Shu Tzu-Wên Lang-Kan Hua Tan Shang Ching* (see below), which Thao verified as in Yang's calligraphy, the later version is almost certainly derivative. Cf., for instance, *YCCC*, ch. 68, pp. 4*a*–5*b*, with *TT*252, pp. 3*b*–5*a*.

[a] See pt. 2, pp. 121ff.

[b] But now found separately under the title *Thai-Wei Ling Shu Tzu-Wên Lang-Kan Hua Tan Shen Chen Shang Ching*[12] (Divinely Written Exalted Spiritual Realisation Manual in Purple Script on the Lang-Kan Gem Radiant Elixir; a Thai-Wei Scripture), *TT*252. Since this text is no longer incorporated in a Mao Shan scripture the history of which can be traced, its authenticity is not beyond question. The old collection, *Tung-Chen Thai-Wei Ling Shu Tzu-Wên Shang Ching*, is not in the *Tao Tsang* now, and must be lost.

[c] See below, pp. 266ff.

[d] Schafer (13), p. 246. The Lang-kan Elixir and its transformations are described in the extant Purple-Script treatise *Huang-Thien Shang-Chhing Chin Chhüeh Ti Chün Ling Shu Tzu-Wên Shang Ching*,[13] *TT*634; see also *Chen Kao*, ch. 5, p. 3*b*.

[1] 口訣 [2] 絳陵朱兒 [3] 丹山日蒨 [4] 玄臺月華 [5] 靈芝
[6] 洞眞太微靈書紫文上經 [7] 精 [8] 太極隱芝 [9] 鳳腦芝
[10] 琅玕 [11] 崑崙 [12] 太微靈書紫文琅玕華丹神眞上經
[13] 皇天上清金闕帝君靈書紫文上經

As we shall shortly see, Thao must also have had access to other writings on alchemy, including the *Huang Ti Chiu Ting Shen Tan Ching*[1] (The Yellow Emperor's Canon of the Nine-Vessel Spiritual Elixir),[a] which Ko Hung claimed had been made public by Tso Tzhu,[2] an early denizen of Mt. Mao at the end of the Han[b]. If this is indeed the book which has been passed down in the Taoist Patrologies with a large bulk of expository material added, it is probably the oldest extant Chinese work devoted to the operational side of alchemy, paralleling the more ambiguous *Tshan Thung Chhi*.[c]

Then came a day in +504 when dreams of favourable auspices for an elixir were granted simultaneously to Emperor Wu of the new Liang dynasty and to Thao, and the question of choosing one method from among many became pressing. We do not have to depend upon hagiographic writings for the outcome of Thao's deliberations, which led to his settling upon the Ninefold Cyclically Transformed Numinous Elixir (*chiu chuan shen tan*[3]), because a surviving fragment of the *Têng Chen Yin Chüeh* records his own words. He commences with a line of transmission from the Supreme-Pole Perfected (or Realised) Immortal (*Thai chi chen jen*[4])[d] through intermediaries to Mao Ying, who he says was taught the formula in −98, and passed it on to his brothers. It was the elder of these two, Mao Ku,[e] who revealed it to Yang Hsi, and bid him show it to the Hsüs. Thao found it among the literary remains of his predecessors. He goes on to remark:

Thus all those who studied the Tao in the Han and Chin periods talked about mixing and taking Potable Gold (*chin i*[5]), and ascending to become an immortal, but they did not mention the Nine-cycle (Elixir). Thus this formula of the Realised Immortals, from the time it was first taught here below, has never been carried out.[f]

[a] *Huang Ti Chiu Ting Shen Tan Ching Chüeh*,[6] *TT*878. Ch. 1 is evidently the original canon, for the other nineteen chapters of this version explain and amplify it, and thus would be the *chüeh* (explanations meant to be orally transmitted). Although no positive evidence has been adduced for this early date, the canon corresponds to quotations in *PPT/NP*, and thus may possibly be what it claims to be, an example of the early Thai-Chhing[7] tradition into which Ko Hung had been initiated. The added chapters cannot be assigned a single date of composition, for they cite very divergent opinions (e.g ch. 11, 5*b* and 10*a*) and lump together heterogeneous material; in fact some recipes are said explicitly not to be worth using (ch. 15, p. 4*b*; ch. 16, p. 11*a*). A date of compilation in the early Sung is indicated by the statement that 'horse-tooth alum (*ma chhih fan*[8]) comes these days from Mao-chou,[9] which is within the administrative control of I-chou[10]' or modern Chhêngtu[11] (ch. 16, p. 4*b*). This was true through the Sung, but the name I-chou was used only during the periods *c.* +620 to +627, +977 to +988, and +994 to +1001, according to the Szechuan gazetteer *Chhung-Hsiu Ssu-Chhuan Thung Chih*[12] (revision of +1730), ch. 2, pp. 6*a*, 28*a* and ch. 5, 41*a* and 45*b*. The late Thang and most of the Sung are also ruled out by the assertion 'Now a Sage reigns, the known world (*huan yü*[13]) is united, and the Nine Provinces (or the Empire) are free of trouble' (ch. 14, p. 2*a*).

Chhen Kuo-Fu, after an extended comparison of this work with the two Mao Shan scriptures just cited, finds a general affinity but no evidence of mutual borrowing, (*1*), vol. 2, pp. 378–383.

[b] *PPT/NP*, ch. 4, p. 2*a*; tr. Ware (5), pp. 69–70.

[c] See pt. 3, pp. 50ff.

[d] The best known holder of this title was Tso Tzhu,[14] but he comes too late.

[e] Mao Ku, who had been given the post of Certifier of Immortality Registers (*ting lu*[15, 16]) in the celestial bureaucracy, was responsible for revealing the mystical biography of his elder brother, the 'Biography of Director of Destinies Mao' (*Mao Ssu-ming Chuan*[17]) to Yang Hsi. Strickmann (2) finds indications that this scripture was the source of Thao's formula (see *Chen Kao*, ch. 5, p. 4*a*).

[f] *TPYL*, ch. 671, pp. 1*a*, *b*, tr. auct.

[1] 黃帝九鼎神丹經 [2] 左慈 [3] 九轉神丹 [4] 太極眞人
[5] 金液 [6] 訣 [7] 太清 [8] 馬齒礬 [9] 茂州
[10] 益州 [11] 成都 [12] 重修四川通志 [13] 寰宇
[14] 左慈 [15] 定錄 [16] 籙 [17] 茅司命傳

Lines of transmission of this sort tend to weary sinologists, and historians of science all the more, but Strickmann (2) has had the perspicacity to see Thao's point, and to link it with the statement in a biographical account by Thao's disciple Phan Yuan-Wên[1] that this was the elixir Thao decided to make. For Thao's rationale *was* this genealogy. What swayed him was that the method had descended through a series of celestial divinities to Yang Hsi, Hsü Mi, and Hsü Hui, in the very hand of one of whom Thao's copy was written. No one else had ever known of it, and the Recluse of Hua-yang would be the first mortal to prepare it.

After some notes on the ritual for the formal transmission of the canon, Thao cites a few details which clearly signify that the Medicine was indeed chemical and not physiological or mental in nature:

> One who wants to mix the Nine-cycle (Elixir) first makes a Spirit Pot (*shen fu*[2]), using a clay vessel from Jung-yang[3] (Honan), Chhang-sha[4] (Hunan), or Yü-chang[5] (Chiangsi)—what is called a 'tile pot'. In antiquity the Yellow Emperor heated the Nine-Cauldron Elixir (*chiu ting*[6]) at Mt. Ching,[7] and the *Thai-Chhing Chung Ching*[8] (Thai-Chhing Median Canon) also has a Nine-Cauldron Elixir method; thus from his time onwards elixir aludels have been called 'ritual cauldrons' (*ting*[9]).[a] One uses chaff for the fire to heat them. The building for the furnace (i.e. the laboratory, *tsao wu*[10]) is constructed in an inaccessible place next to a stream on one of the Great Mountains. It must be forty feet long and twenty feet wide, with three openings towards the south, east, and west. First observe the purification rites (*chai chieh*[11]) for a hundred days, and then plaster the vessel with lute to make the Spirit Pot.... Take equal parts of these six substances: left-oriented oyster-shell from Tung-hai (Chiangsu), kaolin from Wu commandery (Chiangsu), mica powder, earth turned up by earthworms, talc, and alum.[b]

This mixture is of course the famous six-one lute (*liu i ni*[12]), which is specified in almost every elixir formula, with minor variations in ingredients, for coating reaction vessels and sealing the junctions between vessels and covers.[c]

Thao had a space cleared for a laboratory on the other side of the ridge from Hua-yang Abbey, even diverting a stream through a hole bored in the rock to provide the eastward-flowing current needed by every alchemist.[d] But there we may leave him, for his repeated failures from +505 on, and even his rather dubiously documented success in *c.* +528, are irrelevant here.

There should be no need for further proof that the history of Chinese alchemical ideas will not fall into proper perspective until much more is known of the social connections of esoteric Taoism. Thao Hung-Ching merely stands at an obvious nodal point. His predecessors had adapted and combined many of the individual medita-

[a] It was after these nine ritual cauldrons that the 'Yellow Emperor's Canon of the Nine-Vessel Spiritual Elixir' (*Huang Ti Chiu Ting Shen Tan Ching*[13]) was named. This sentence is apparently an explanatory note by Thao Hung-Ching which became incorporated in the text.

[b] *TPYL*, ch. 671, pp. 1*b*, 2*a*, tr. auct.

[c] See pp. 19ff., 35–6, 112, 163 above; and Sivin (1), pp. 160–8.

[d] Cf. *PPT/NP*, ch. 4, p. 14*a*; tr. Ware (5), p. 90.

[1] 潘淵文 [2] 神釜 [3] 滎陽 [4] 長沙 [5] 豫章
[6] 九鼎 [7] 荊山 [8] 太清中經 [9] 鼎 [10] 竈屋
[11] 齋戒 [12] 六一泥 [13] 黃帝九鼎神丹經

tional and mediumistic practices of their time. Then on the content of their revelations, seen in the light of other traditions which he knew, and which he incorporated, Thao founded a well-patronised and enduring community dedicated to pursuing every conceivable means of co-opting individuals (especially those of the more genteel classes) into the Unseen World, and performing other conventional religious services on their behalf. Alchemy was a charter member of the Mao Shan synthesis. But medicine and astronomy too were gradually included in the Patrologies,[a] for the compilation of which the Mao Shan school was largely responsible.[b] Kristofer Schipper has called this patrician group the 'middlebrow wing of Taoism', for its concerns had not a great deal to do either with the ontological paradoxes of Lao Tzu and Chuang Tzu on the one hand, or what would later become the everyday pastoral responsibilities of the village priest on the other. Their intellectual omnivorousness was prefigured only by that of Ko Hung. Their synthesis of magic, religion, and science, doubtless too promiscuous for the taste of most modern readers when seen as a whole, was perfectly suited to that of countless Chinese enthusiasts for a millennium. The cult gradually spread to Mt. Lo-fou[1] near Canton, and other great Taoist centres. Finally a succession of Mao Shan patriarchs like the hereditary Celestial Masters (*thien shih*[2]) of the priestly Chêng I[3] tradition controlled many or most of the Taoist abbeys in China until they were taken over by the Chhüan-chen[4] sect in the thirteenth century under Mongol policy.[c]

(2) The Spectrum of Alchemy

Anyone who tries to sort out the relations between theory and practice has to begin by acknowledging that every possible variation in both their proportion and the quality of their connection can be found in one or another of the documents. Some alchemical writings consist only of instructions for laboratory operations, with no attempt to provide a theoretical rationale. Others are nothing but rationale, and the actual process is recapitulated only as the conceptual discussion requires. It will be convenient for heuristic reasons to consider these extremes as the ends of a spectrum, with most of the extant literature falling somewhere in between. This is not a wholly arbitrary overview, for writings near either end of the spectrum tend to have certain characteristics in common. In general the highly theoretical material reflects an attempt to construct a laboratory model of the larger cycles of change which take place in Nature, using two ingredients, or sometimes two main ingredients, which correspond to Yin and Yang. This tendency might be called scientific in the classical sense of the word, since alchemical speculation was concerned primarily with contemplating natural process rather than with manufacturing some product. At the other extreme, where the connections with both medicine and the thaumaturgical tendencies of Taoism are more obvious, we find an often purely practical concern with the manu-

[a] See pt. 3, pp. 113ff.
[b] Holmes Welch (3), pp. 129–130.
[c] See Soymié (4); Welch (3), p. 126.

[1] 羅浮山 [2] 天師 [3] 正一 [4] 全眞

facture and employment of elixirs of immortality, agents of transmutation, and other substances—even (to reinforce the parallel with Hellenistic aurifaction and aurifiction) artificial pearls, jade, and so on. Authors of this sort were willing to countenance any possible means, any available formula, self-contradictory or impractical features notwithstanding. This latter tendency might be called technological, in the sense that the product was all-important, and we shall see that reflections of the artisan's ability to control Nature, uncommon elsewhere in Chinese thought, furnish an important part of its ideology. We shall also use the word 'pragmatic' for writings at this end of the spectrum and the approach that they imply, but it refers simply to their valuing of ends over means, and not at all necessarily to a command of laboratory practice. Nor does this term necessarily imply unconcern with the Unseen World, or for the rituals, spells, and taboos by which one paid one's respects to it.

Before going further, a caution is in order about the danger of finding in this idea of a spectrum of alchemy a real inherent structure rather than a taxonomic convenience—or, worse still, thinking of it as a 'model'. As for the genetic relations between the two extremes and the middle, at this point we can offer no more than a few scattered clues, which only a great deal of thoughtful and critical study in the future can make coherent. We do not know which tendency developed from which, and out of what necessities. The oldest extant alchemical books include both highly pragmatic and highly theoretical treatises, but they represent too tiny and accidental a remnant to encourage the conclusion that a synthesis of the two approaches came only later. There is certainly no reason to suppose that they represent different schools of alchemy. The reader interested in any aspect of esoteric thought in ancient China can hope for no better advice than that of Rolf Stein: 'I prefer to believe, not in borrowings between schools, but in a common ground, an underlying structure, which can manifest itself variously in different milieus or movements but which the majority of thinkers hold in common.'[a]

(3) The Role of Time

In order to form a clear idea of what the theoretically oriented alchemists were doing, one must keep in mind the very special importance of time in Chinese natural philosophy, for it was all the more crucial in alchemy. In the brief review which follows we shall stress the dynamic and temporal aspects of concepts such as the Tao and the Five Elements, which are not considered in those lights by modern students of Chinese philosophy as often as they should be.[b]

Scientific thought began, in China as elsewhere, when men tried to comprehend how it is that although individual things are constantly changing, always coming to be and perishing, Nature as a whole not only endures but remains conformable to itself. In the West the earliest attempts to identify the underlying and unchanging reality tended to be concerned primarily with some basic material substrate out of which the

[a] Stein (5), p. 40, eng. auct.
[b] A more recent version of this material has appeared in Sivin (14).

things around us are formed.[a] In this way one could think of all phenomenal things, for instance, as being composed of air (or rather *pneuma*, πνεῦμα) in some state of condensation or rarefaction. Thus a tree growing out of a seed is not matter being created out of nothing, but only air, which has existed all the time, gradually taking on a new physical form. In China theories roughly of this sort, explaining material things as composed of *chhi* in one state or another, were also sketched out in the first great period of natural philosophy, though they did not play a central role in physical speculation.[b] But the earliest, and in the long run the most influential, kinds of scientific explanation, those so basic that they truly pervaded the ancient Chinese world-view, were in terms of time.[c] They made sense of the momentary event by fitting it into the cyclical rhythms of natural process, for the life-cycle of an individual organism—birth, growth, maturity, decay, and death—had essentially the same configuration as those more general cycles which went on eternally and in regular order, one fitting inside the other: the cycle of day and night which regulated the changes of light and darkness, the cycle of the year which regulated heat and cold and the farmer's growing seasons, and the greater astronomical cycles.[d]

All these cycles nested. Early Chinese cosmography, as described in the Treatises on Harmonics and Calendrical Astronomy (*lü li chih*[1]) of the dynastic histories, built up its mathematical model of the cosmos in terms of time rather than (as was more the case in the European tradition) of geometric space. The cycles of the day, the month, and the year were fitted together to form larger periods—in early astronomy, the Rule Cycle (*chang*[2]) of nineteen years, equalling 235 lunations, or the Obscuration Cycle (*pu*[3]) of seventy-six years.[e] These were defined to begin and end with the winter solstice (for the month which contained the solstice was taken by astronomers as the 'first month' for computational purposes), and the new moon (the beginning of the month) falling at midnight (the beginning of the day) of the same day. A larger cycle was needed to make them fall on a day of the same sexagenary designation (in terms of the cyclical characters, *kan chih*[4]).[f] These four cycles—day, month, sixty days, and year—were only part of a much larger system which also included eclipse and planetary cycles, in fact all cycles which were known to be periodic. The period which included them all, the Great Year (Grand Polarity Superior Epoch, *thai chi shang yuan*[5])[g] which began and ended time with a universal conjunction of sun, moon, and planets, was calculated in the Triple Concordance system (San Thung Li[6]) of Wang Mang's time (*c.* −5) to be 23,639,040 years long. A century later, in the Quarter Day system (Ssu Fên Li[7]), based on somewhat more precise values for individual periodic phenomena,

[a] This idea has been developed to some depth in de Santillana (2). See also Vol. 2, p. 245 and Vol. 4, pt. 1, pp. 3ff., 13–14.

[b] See above, Vol. 2, pp. 6, 40–1, 42ff., 371–374. The fundamental role of the *chhi* concept in early medicine is analysed in Porkert (1), on which see also the critique of Needham & Lu Gwei-Djen (9).

[c] Cf. Granet (5), pp. 86–114; Needham (55, 56); Sivin (8); van der Sprenkel (1).

[d] See Vol. 3, pp. 390ff.

[e] See above, Vol. 3, pp. 406–407 and, for a fuller treatment, Sivin (9).

[f] See Vol. 3, pp. 396ff.

[g] See Vol. 3, p. 408.

[1] 律曆志 [2] 章 [3] 蔀 [4] 干支 [5] 太極上元
[6] 三統曆 [7] 四分曆

the Great Year was of such stupendous length that it was not even calculated Practically speaking, the length of the overall cycle was so great simply because more precise fractions tend to have larger common denominators. But to work out the exact value of the Great Year cycle would in any case have been irrelevant philosophically. What mattered was the demonstration that the unending time through which the natural world remained constant (or changed gradually, according to one's theory)[a] was the sum of finite processes which were known to regulate individual cycles of growth and decay, birth and death. The life rhythms of a swarm of mayflies meshed because they occupied a certain brief phase in the round of the seasons, just as the events of a certain autumn made sense in terms of its relation to astronomical periods.

In order to make the Tao of a particular thing intelligible, its life-cycle needed to be located with respect to the greater periods. The different parts of a cycle could be analysed in terms of a number of concepts, for instance the Yin and Yang, which were the passive and active phases through which any natural cycle must pass. Another variable was the so-called Five Elements (*wu hsing*[1], for which 'Five Phases'[b] would be both a more accurate and a more literal translation). We have seen earlier that these were not material elements in the modern sense, but a finer division of the cycle into five qualitatively and functionally distinct parts.[c] The 'element' Fire, for instance, represented the phase in which activity was at its highest, and thus soon would have to begin declining; in the cycle of the year summer was the time of Fire. The trigrams and hexagrams of the 'Book of Changes' were the third set of concepts which could be applied similarly to analyse change in terms of constant cycles.[d] These concepts belong of course to the most general level of early Chinese physical theory; the various fields of Chinese science, such as medicine, geomancy or alchemy, simply applied them to different classes of phenomena.

(i) *The organic development of minerals and metals*

What was true of the mayfly was true also of the mineral, for its process of growth was time-bound too. Like thinkers in other great ancient civilisations, the Chinese alchemists believed that Nature was an organism and everything had a life-cycle; therefore minerals and metals also grew inside the earth, slowly developing along a scale of perfection over immense stretches of time.[e] This process differed from other

[a] Linear theories of time in China have been studied in Needham (55, 56); cf. also Vol. 7.

[b] Or 'Five Phasers', which captures the force of the original a bit better even though it does not lie as well on the tongue. Some thoughts on this difficult problem of translation have been offered by Needham & Lu Gwei-Djen (9).

[c] See Vol. 2, pp. 243ff. [d] See Vol. 2, pp. 304 ff.

[e] This point as well as many others essential to the argument which follows were first established as generally valid by Mircea Eliade (4, 5, 8); see also Welch (3), pp. 114–117, in which the summary of Sivin (2) is however inaccurate. Although Eliade was limited on the Chinese side by the paucity and greatly varying quality of translated documents and monographic studies available, the fundamental good sense of many of his working hypotheses will be obvious to anyone familiar with the whole literature. One exception is his opinion that the alchemists 'were "experimenters", not abstract thinkers or erudite scholastics' (8), p. 77. One can easily find examples of all three, sometimes united in a single person.

[1] 五行

kinds of growth in two respects which taken together provided the basic rationale of alchemy. First, if and only if this sequence of maturation stages continued to its end, the product, usually gold, would be invulnerable to further transformation. Since gold is not subject to decay and death, the process is not cyclical. To a man whose world-view makes cycles of change the norm, the linear perfection of gold will more or less inevitably come to signify the redemption of man. Secondly, unlike vegetable and animal growth-cycles, the mineral cycle can be not only interrupted (or, as many peoples think of it, aborted) by the miner but also speeded up by the smelter, hence, following his lead, by the alchemist. These ideas, in the specific form they took in the Chinese elixir tradition, merit close examination (cf. Fig. 1516).

The notion of the organic development of minerals and its proto-scientific explanation in terms of *chhi* exhalations have already been described in connection with mineralogy, and Greek parallels have been pointed out.[a] Here it will only be necessary to adduce a few relevant documents from the alchemical literature. We may begin, however, by reviewing the appearance of this idea at the beginning of systematic thought about Nature in China. The princely alchemist Liu An's[1] *Huai Nan Tzu*,[2] one of the oldest cosmological treatises (*c.* −125), follows its primitive scheme of biological evolution with a theory of development in the mineral world; and like the speculations of the early pre-Socratics, it lies barely this side of the line which separates proto-science from myth. Here we partially retranslate, rendering rather more literally than in Sect. 25(*b*):

The *chhi* of balanced Earth[b] copulates (*yü*[3]) with Dusty Heaven. After 500 years the Dusty Heaven gives birth to (the yellow mineral) *chüeh*[4,5] which after 500 years gives birth to yellow mercury,[c] which after 500 years again gives birth to the yellow metal (gold). The yellow metal in 1000 years gives birth to the yellow dragon. The yellow dragon, entering (the earth) and going into hibernation (or pupation) engenders the Yellow Springs.[d] When the dust from the Yellow Springs ascends to become the yellow cloud, (its) Yin and (the supernal) Yang beat upon one another, produce peals of thunder, repel each other and fly out as lightning. That which was above flows downward. The running streams flow together and unite in the Yellow Sea.[e]

[a] See Vol. 3, pp. 636ff.

[b] In alchemical theory *chêng chhi*[6] means 'balanced *chhi*', i.e. balanced with respect to Yin and Yang; in opposition to '*phien chhi*',[7] 'unbalanced *chhi*', which occurs in the corresponding position in the next paragraph of this passage. The Han commentary of Kao Yu[8] refers the balanced Earth-element to the Central Land (*chung thu*[9]), which earlier in the chapter is identified with Chi-chou,[10] one of the nine archaic provinces of China, corresponding to modern Hopei, Shansi, Honan north of the Yellow River, and Liaoning west of the Liao river. Balances and imbalances of Yin and Yang in the Five Elements recall the translated passage and the tabulation on pp. 156–7 above.

[c] We follow Wang Nien-Sun[11] in deleting eight characters in this sentence which are redundant and violate parallels with the later paragraphs.

[d] This term signified, we know, something corresponding to She'ol or Hades, as well as the Plutonic regions in general, from Chou times onwards (Vol. 5, pt. 2, pp. 84–5).

[e] Ch. 4, pp. 12*a*ff. tr. auct. adjuv. Erkes (1), pp. 79, 80. Cf. above, Vol. 3, pp. 640–1. It is interesting that in this passage gold is not yet thought of as the terminal or immortal avatar in an age-long maturation, the sign and warranty of redemption or salvation. John Major of Dartmouth College has written a monograph on the ideas expressed in this chapter of the *Huai Nan Tzu* book.

[1] 劉安 [2] 淮南子 [3] 御 [4] 鈌 [5] 訣
[6] 正氣 [7] 偏氣 [8] 高誘 [9] 中土 [10] 冀州 [11] 王念孫

This passage and the four which follow, all worded much like it, may be reduced to a general scheme (Table 117).

The *chhi* of X Earth $\xrightarrow{Y \text{ years}} Z$ mineral $\xrightarrow{Y \text{ years}} Z$ quicksilver $\xrightarrow{Y \text{ years}} Z$ metal $\xrightarrow{1000 \text{ years}} Z$ dragon $\xrightarrow{Y \text{ years}} Z$ springs, where X is an attribute, Y a number of years,[a] and Z a colour.

Table 117

Paragraph	X	Y/100	Z	Mineral	Metal	Element
1	balanced	5	yellow	realgar (or yellow jade?)	gold	Earth
2	unbalanced	8	caerulean (blue-green)	malachite	lead	Wood
3	vigorous	7	scarlet	cinnabar	copper	Fire
4	weak	9	white	arsenolite	silver	Metal
5	passive	6	black	slate (or grindstone?)	iron	Water

In this schema the deductive categories of the Five Elements have largely taken over the function of providing coherence, though the sequence of images still owes something to the looser and less logical association of mythology. The basic structure is familiar enough, for it depends on the normal number, colour, and metallic correspondences of the Five Elements, taken in a special sequence related to the Mutual Production order which characterises organic processes.[b] The mineral correlates of Earth and Water are archaic and no longer certainly identifiable, though there is no doubt that they were chosen because of their colour. By the time of Ko Hung the alchemical Five Minerals (*wu shih*[2]) had become stabilised as (in the same order) realgar, laminar malachite, cinnabar, kalinite (potassium alum) or arsenolite, and magnetite.[c]

(ii) *Planetary correspondences, the First Law of Chinese Physics, and inductive causation*

Although the planets did not play the paramount role in Chinese alchemy that they did in the West,[d] the correspondence of the Five Planets (*wu hsing*[3]) to the Five Elements naturally gave rise to schematic concordances which did not differ in spirit

[a] These were of course chosen with numerological considerations in mind, depending on the normal Five-Element associations, etc. Caerulean, blue-green in the Table, translates *chhing*.[1]

[b] See Vol. 2, pp. 254ff. The order E–W–F–M–w has been called by Major (1) the 'Smelting Order'.

[c] Cf. pt. 3, pp. 86, 96. *PPT/NP*, ch. 4, p. 9*b*, gives kalinite (crude alum, *fan shih*[4]), but as the editor remarks, arsenolite (*yü shih*[5]) appears instead in ch. 988 of *TPYL*. This is a familiar confusion, since the characters *fan*[6] and *yü*[7] so much resemble each other. Nevertheless, the best available edition of *TPYL*, the Sung version reproduced in 1960, reads *fan shih*[4] at this point (ch. 988, p. 3*a*). True, that does not settle the question, for the same text from *PPT/NP* is also quoted earlier (ch. 985, p. 2*b*), and there it reads *yü shih*.[5] Both of these compounds were too important in later alchemy to allow of an *a priori* solution.

[d] See Vol. 2, pp. 351ff.

[1] 青 [2] 五石 [3] 五星 [4] 礬石 [5] 礜石 [6] 礬 [7] 礜

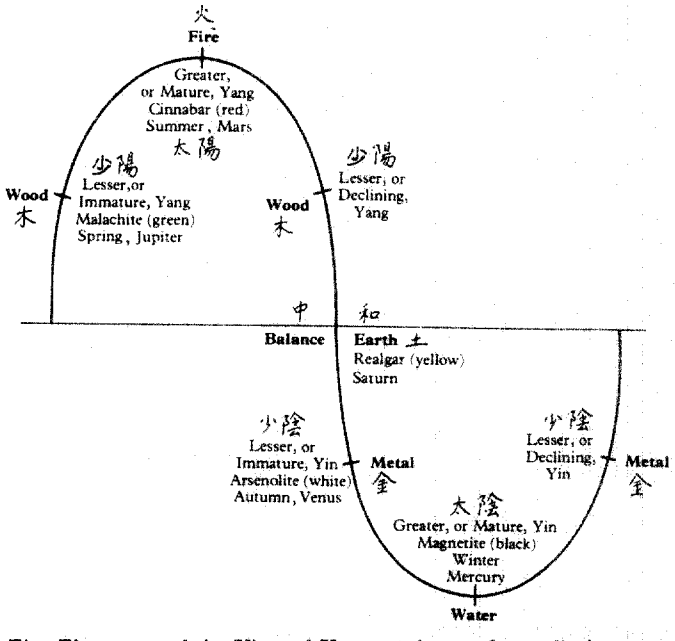

Fig. 1515. The Five Elements and the Yin and Yang as phases of a cyclical process. Cf. Fig. 277 on p. 9 of Vol. 4, pt. 1 above.

from those just discussed, since their function was the same. An important collection of elixir recipes which reached final form in the middle of the eighth century ascribes to the author of the *Huai Nan Tzu* book a method for making Five-Mineral Elixir (*wu shih tan*[1]), of which it says in a prefatory note:[a]

The Five Minerals (*wu shih*[2]) are the seminal essences of the Five Planets. Cinnabar is the essence of the mature Yang (*thai yang*[3]), Mars. Magnetite is the essence of the mature Yin, Mercury. Malachite is the essence of the young Yang (*shao yang*[4]), Jupiter. Realgar is the essence of Divine Earth (*hou thu*[5]), Saturn. Arsenolite is the essence of the young Yin, Venus. A medicine made from the essences of the Five Planets can give a man perpetual life, exempt from death for ever.

The five substances in this set of correspondences are the classical series, not those of Liu An. The 'mature' Yin or Yang is what we should call its maximum state. Having thus reached its height, its decline is about to begin, accompanied by reversion to its opposite (*wu chi pi fan*[6]). This is in accordance with what has been termed the First Law of traditional Chinese Physics (and Chemistry), namely that 'any maximum state of a variable is inherently unstable', and the process of going over to its opposite must necessarily set in.[b] Thus the winter solstice is the point when the Yin ascendancy, having reached its zenith, starts to fade, and the Yang, which will be maximal at the

[a] *Thai-Chhing Shih Pi Chi*[7] (*TT*/874), ch. 1, p. 13*a*, tr. auct.

[b] This formulation was first used by one of us (N.S.) at the Bellagio Conference on Taoist Studies, 1968. Cf. Sivin (2).

[1] 五石丹 [2] 五石 [3] 太陽 [4] 少陽 [5] 后土
[6] 物極必反 [7] 太清石壁記

summer solstice, begins to reassert itself. The 'young', or immature phase, represents a level intermediate between the point of balanced polarity and the maximal phase. In the cycle of the year, equal intensity of Yin and Yang is reached at the equinoxes, so the young Yang would fall betweeen spring equinox and midsummer. If we represent an ideal cyclical process by a sinusoidal curve (Fig. 1515),[a] the correspondence between the Five Elements and the five phases of Yin and Yang (mature, immature, and balance) is easily visualised. The planetary associations of the text thus turn out to be simply the usual correspondences of the planets with the Five Elements.

In the West the influence of the planets was direct; but in China it is perhaps confusing even to use the word 'influence', for the relation was one of correspondence.[b] We have just seen the association between the seminal essences of the planets and the minerals depicted not as emanation or influence, but as identity. The *chhi* of a planet could stimulate response in a metal or mineral only when they were categorically related—tuned to the same note, so to speak—within the unitary system of the physical world. The Stoic and Neoplatonic universes, which furnished the cosmic ideology of European alchemy (and to a large extent that of Islam), were organismic too, but in general influences within them proceeded in one direction, down a fundamentally linear hierarchy of value. In Chinese thought, which got along without a gradation of being based upon proximity to a Supreme Intelligence, it was possible to relate the activity of celestial bodies quite acausally to the formation of minerals in complex and interesting ways. A good example is the following excerpt from an unidentified 'Secrets of the Great Tao' (*Ta Tao Mi Chih*[1]). It is quoted in the *Huan Tan Chung Hsien Lun*[2] (Pronouncements of the Company of the Immortals on Cyclically Transformed Elixirs) dated +1052, by Yang Tsai,[3] whose graphic description of mercury-poisoning guarantees that it is concerned with the Outer Elixir:[c]

Venus, the Metal planet, is the seminal essence of Metal (*chin chih ching*[4]). It accepts the vital anima[d] of the moon, and holds within itself the *chhi* of the Earth planet Saturn.[e] Thus

[a] Cf. Vol. 4, pt. 1, p. 9. It would perhaps be more adequate to think of Yin and Yang as two sinusoidal curves out of phase by 180°, so that at any moment their sum is constant. Of course either visualisation lends Yin–Yang theory a mathematical concreteness which it usually lacked. In the few instances where interdependent measured variables were used to represent Yin and Yang forces, the actual curve was generally a so-called zig-zag function, which only approximates to a sinusoidal curve. See below, p. 275, esp. Fig. 1519*a*.

[b] I.e. what we called in Vol. 2 symbolic correlation.

[c] *TT*230, pp. 11*a*–12*a*, tr. auct. On mercury poisoning, see p. 80 above, as also pt. 2, pp. 282ff. and Ho Ping-Yü & Needham (4).

[d] For convenience in this translation we use anima and animus for the *pho*[5] and *hun*[6] 'souls' respectively; see pt. 2, pp. 85ff. above.

[e] In this passage, as we shall see, the planets each correspond to one of the Five Elements, and are related according to their Mutual Production order (see Vol. 2, pp. 253–261). Various verbs are used to express the relation: *han*[7] (to hold within), *chhuan*[8] (to transmit), *chiang*[9] (to descend into), *shou*,[10] *tê*[11] (to accept). The active verbs express an unambiguous sequence; A *chhuan* or *chiang* B, and B *shou* or *tê* A, mean that the element A immediately precedes B in the Mutual Production order. The static verb *han* in philosophical writing refers always to a latent aspect (e.g. the Yin concealed within the Yang during the maculine phase of a process), and does not, rigorously speaking, imply a necessary direction of evolution.

[1] 大道密旨 [2] 還丹衆仙論 [3] 楊在 [4] 金之精 [5] 魄 [6] 魂
[7] 含 [8] 傳 [9] 降 [10] 受 [11] 得

inside it, yellow in colour, is the floreate essence (or radiance) of Metal (*chin hua*[1]).[a] The stimulus of the lunar *chhi* is manifested as anima, and anima belongs to Water.[b] When subsequently (the floreate essence) has received (the *chhi* of) Metal, the Watery *chhi* will respond to Mercury (the Water planet) and give birth to lead. (E–M–w).[c]

Jupiter is the Wood planet, the vital animus of the sun and the essential *chhi* of Water.[d] This animus is scarlet, because (it corresponds to) Fire. Fire gives birth to Wood.[e] In response to the *chhi* of Mars (the Fire planet), cinnabar is born. Cinnabar holds within it the Yin *chhi* of Wood, and thus contains quicksilver. Quicksilver is called the Caerulean Dragon;[f] and the Caerulean Dragon belongs to Wood (w–W–F).

Mercury is the Water planet, and the seminal essence of Water. It transmits the *chhi* of Venus, the Metal (planet). Its flowing seminal essence responds to Earth, also receiving the vital anima of the moon, and gives birth to lead. Thus lead produces the floreate essence of Metal. The floreate essence of Metal has the Five Colours,[g] and is named 'Yellow Sprouts' (*huang ya*[2]). The *chhi* of the Water planet descends into Wood and gives birth to laminar malachite[h] (E–M–w–W).

Mars is Fire, and the seminal essence of Fire. It receives the *chhi* of the Wood planet (Jupiter) and also transmits the animus of the sun. Its flowing seminal essence enters Earth (or the earth) and gives birth to cinnabar. The animus (of cinnabar) belongs to Fire and so it is born out of Wood.[i] Since within it there is Yin, it gives birth to mercury. Fire gives birth to Earth. Earth contains the Balanced Yang,[j] and gives birth to realgar, the sapidity of which is sweet. (W–F–E).

[a] In the third paragraph this substance is identified as 'Yellow Sprouts' (*huang ya*[2]), which is not an elixir ingredient but rather an intermediary product in prototype processes. In our discussion below (pp. 256, 259, 261) we note that its chemical identity depends entirely upon the process.

[b] This sentence seems garbled, though its meaning is in any case probably much as we have rendered it. The *hun*[3] and *pho*[4] are normally the Yang and Yin personal vitalities which at death leave the body to return to the supernal and terrestrial realms respectively (see above, pt. 2, pp. 85ff.). Here the words are used in a more abstract way (signalled by their identification with the Yang sun and the Yin moon) to refer to the cosmic Yang and Yin forces.

[c] In order to make the often indirectly expressed sequence of planet/element correspondences easier to follow, we have inserted at the end of each paragraph, in abbreviated form, the Mutual Production sequence of the elements discussed. We let W stand for Wood, and w for Water. The other capital letters are self-explanatory; cf. Vol. 2, p. 253.

[d] This appears at first sight contradictory, since Water is Yin and one would not expect a correspondence with the masculine animus (*hun*) of the sun. But the sense of the assertion that Wood (the immature Yang) is the essential *chhi* of Water is simply that the former follows the latter in the Mutual Production succession.

[e] This statement is the inverse of the usual sequence, given correctly for the same substances in the fourth paragraph. The text as a whole is corrupt enough to suggest that confusion here is not unlikely.

[f] This is merely an added Five-Elements association; the Caerulean Dragon (*tshang lung*[5]) is the eastern of the four main divisions of the sky, and thus corresponds to Wood (see Vol 3, p. 242). The Caerulean Dragon mentioned in Table 117 above has a different written character (*chhing lung*[6]), but the two are essentially of the same meaning, blue-green. Certain contexts of course dictate translation as definitely blue or green, but not this one. There is an old but good paper on this subject by von Strauss-und-Torney (1). See also Hirth (25), p. 7.

[g] The floreate essence of Metal is Earth, which mediates and reconciles the Five Elements, just as 'Yellow Sprouts' represents the unity of opposites in the alchemical process.

[h] Laminar malachite corresponds to Wood, as cinnabar to Fire, in the Five Minerals system (see above, pt. 3, p. 96).

[i] The character *tzu*[7] is obviously misplaced in this sentence.

[j] 'Balanced Yang' (*chêng Yang*,[8] whose antonym is *phien Yang*[9]), is a technical term for the pure creative Yang force which emerges from the reconciliation of opposites. See below, pp. 236, 251ff., and above, pp. 157, 224. The phase of cosmic balance is represented by the element Earth. Sweetness corresponds to Earth in the system of the Five Sapidities (*wu wei*[10]), as does realgar among the Five Minerals.

[1] 金華 [2] 黃芽 [3] 魂 [4] 魄 [5] 蒼龍
[6] 青龍 [7] 自 [8] 正陽 [9] 偏陽 [10] 五味

Saturn is Earth. It accepts (the *chhi* of) Fire. The Earth planet holds the Balanced Yang within, and thus has realgar (F–E).

Thus the Five Planets transmit from one to another the floreate essences of sun and moon in rotation according to (the) Mutual Production (order of the elements, *hsiang shêng*[1]), each conforming to its Tao.[a]

Here, as indeed generally in alchemical writing, *chhi*[2] is not matter but a kind of configurational energy[b] which endows with structure a certain kind of matter and gives it determinate qualities. *Ching*[3] or *ching chhi*,[4] 'seminal essence' with its *chhi*, and *hua*[5] or *ching hua*,[6] 'radiance' or 'floreate essence' or 'seminal radiance', are terms for energy (in the colloquial, qualitative sense) deriving from some organised entity and applied to bring about a similar organisation in another entity.[c] In other words, these concepts come into play in order to explain change and transformation. *Hua* (lit. 'florescence') refers to the essence in its aspect of emerging from something, while *ching* (lit. 'seed, semen') refers to the essence in its function of actively forming or nurturing something else. From our point of view, it was two ways of looking at the same total phenomenon, namely the production of something with certain determinate qualities from something else, which might or might not have the same qualities.

One example of the seminal essence is the most mundane variety of *ching*,[3] namely human semen, a concentration of personal vitality which transmits characteristics from father to offspring. In other words, the configurational energy of the father imposes itself on the material basis (*chih*[7]) provided by the mother to bring about its organisation as a foetus.[d] Typical of *hua*,[8] on the other hand, is the red 'inner essence' (i.e. the oxide) which emerges as a red powder when mercury is heated in air. In the Mutual Production series of the Five Elements, analogously, the radiance or floreate essence (*hua*) of an element is the one which precedes it (i.e. its formative essence seen as emergent from its predecessor), and the seminal essence (*ching*) is the

[a] The order in which the Five Planets are treated in this passage is not exactly the Mutual Production enumeration order, but the so-called Modern order (see Vol. 2, pp. 253–261). The Mutual Production order, as we have seen, governs the relations between planets which correspond respectively to the outer and inner aspects of each substance—in the first paragraph, for instance, Earth and Metal. The only exception is the second paragraph, for Fire follows rather than precedes Wood in the *hsiang shêng* series. This exception is possibly due to a textual confusion, for the fourth paragraph, where the outer aspect is also cinnabar, repeats the same pair of planets, those corresponding to Wood and Fire, but in the correct Mutual Production order.

[b] The term is Manfred Porkert's. One can see how near this conception comes to Neo-Confucian *li*[14] (cf. Vol. 2, pp. 472ff.). It may be thought to illustrate rather well the character of the Chinese mind as *anima naturaliter materialistica*, always drawing ideas away from the noumenal, the spiritual and the transcendental, to incarnate them in the immanence of the actual. Here *chhi*,[3] although itself energetic, may possess qualities which some schoools attributed to *li*,[9] but even for the Neo-Confucians *li* was only manifested when incarnated in *chhi* (J.N.).

[c] The picture is clouded by ambiguities which call for constant alertness. Both *ching*[4] and *ching hua*[7] also have a wider meaning which includes the specialised functional senses of both *ching and hua*. Porkert (1) renders this sense as 'structive potential'. On all these interpretations cf. the critique of Needham & Lu Gwei-Djen (9), especially in relation to the implicit parallel with embryonic induction and determination.

[d] Note the parallel here with Aristotelian ideas of form and matter in generation. These come up for discussion elsewhere, e.g. in pt. 5; and meanwhile Needham (2).

[1] 相生 [2] 氣 [3] 精 [4] 精氣 [5] 華 [6] 精華
[7] 質 [8] 華 [9] 理

one which follows it (i.e. its forming essence as imposed upon its successor).[a] It is easy to see that this functional terminology could be applied to any stimulus–response reaction. The medieval Chinese applied it throughout the realm of scientific thought, including physics, and as we see here, chemistry; which makes apparent to us that their basic concepts of action were inclusive of the biological.[b]

The purpose of the document we are considering is to account for the dynamic relations between certain mineral substances, characterised as aspects of the Five Elements. Thus we see Yellow Sprouts (floreate essence of Metal) and mercury described as 'held within' lead and cinnabar respectively. In the eye of the alchemist's mind the inner aspect was a possible state of the outer material, and could become manifest as the result of alchemical processes. But the relations discussed in this quotation are not static, since the Five Elements are in turn functionally related to each other by the Mutual Production succession order, which governs the quasi-biological evolution of one thing or one phase of a cyclical process out of another. The genetic character of the lead/Yellow Sprouts and cinnabar/mercury relationships is established by making them correspond to the Mutual Production sequences Metal–Earth and Wood–Fire. The element sequences are not as a rule expressed directly, but more often given in terms of the planets—the Five Elements seen in their cosmological function. Only when we recognise that the fundamental level of discourse is not astronomical at all can we perceive the simple, and to the Chinese thinker familiar, sense behind the apparently very odd assertions about interactions of planets.

It would be sorely misreading the text to see in it any suggestion of physical influence exerted by planets upon terrestrial minerals. The sun and moon are no less passive in this schema than the planets. While the latter serve in the theory as aspects of the Five Elements, the former—or, to be more precise, the *hun* vitality or animus which characterises the sun and the *pho* vitality or anima of the moon—stand for the cosmological aspects of Yang and Yin.

We can thus proceed to reduce the second and most of the fourth paragraph of the text to a straightforward assertion: 'There exists the genetically related binary system mercury/cinnabar, of which mercury, corresponding to Wood, is the young (i.e. immature) Yang phase and cinnabar, corresponding to Fire, is the mature Yang phase.' The modern reader no doubt prefers a plainer formulation, for he knows how important direct statement has been in the growth of modern science. But for the ancient alchemist, the richness of association was desirable enough to be paid for in simplicity and testability. What brought the planets into alchemical theory was a motivation, in the last analysis, aesthetic.

[a] Unfortunately this distinction is not rigorous in all alchemical writing, and one can find instances of *ching* and *hua* used in senses opposite to the distinction drawn here. There is great need for a systematic philological study of the *chhi* concept in science, having regard to the remarkable beginnings made by Porkert (1) in his work on the conceptual foundations of Chinese medicine.

[b] Cf. p. 307 below.

(iii) *Time as the essential parameter of mineral growth*

The protean metalline metamorphoses of the *Huai Nan Tzu* book were avoided by later alchemists, who accepted much more straightforwardly the archaic idea of the gradual perfection of minerals within the terrestial matrix. Here the idea is expressed with pristine simplicity in one of the most influential of all alchemical writings, the supplementary instructions (*chüeh*[1]), probably of the early Sung, which now accompany the Han or pseudo-Han 'Yellow Emperor's Canon of the Nine-Vessel Spiritual Elixir':[a]

Realgar occurs in the same mountains as orpiment, and is formed by the transformation of orpiment. (This latter) great medicine of heaven and earth (i.e., of the natural order) is called 'doe yellow' (*tzhu huang*[2]). When eight thousand years have passed, it transforms into realgar,[b] the variant name of which is 'imperial male seminal essence' (*ti nan ching*[3]). After another thousand years have passed it transforms into yellow gold, with the variant name 'victuals of the Perfected (or Realised) Immortals' (*chen jen fan*[4]).

The theory of this type most significant for the development of alchemy begins, as did Liu An's, with a hierogamy, and the time span, while still defined numerologically, is chosen more carefully for its cosmic significance. The *Tan Lun Chüeh Chih Hsin Ching*[5] (Mental Mirror Reflecting the Essentials of Oral Instruction about the Discourses on the Elixir and the Enchymoma), a theoretical treatise probably of the Thang, rationalises the preparation of the elixir of immortality by analogy with geological process:[c]

[a] *Huang Ti Chiu Ting Shen Tan Ching Chüeh* (*TT*878), ch. 14, p. 1*a*, tr. auct. The same sequence of three yellow substances is given with intervals of a thousand years between each, in *Shen Hsien Fu Erh Tan Shih Hsing Yao Fa*[6] (The Immortals' Method for Ingesting Cinnabar and (Other) Minerals and Using Them Medically), *TT*417. This interesting but undated treatise belongs to the quasi-alchemical tradition concerned with processing natural minerals and stones to make them edible rather than transforming them into elixirs (see pp. 168ff. above). The first of the two transformations represents the inverse of a known geological process, for some orpiment is actually formed by the weathering of realgar; Dana (1).

[b] The common appellation of realgar, *hsiung huang*,[7] might be translated literally 'buck yellow'. *Tzhu and hsiung* are the general designations for genders of animals, and have no exact English equivalents; we render them by terms that at least apply to a number of species.

[c] *TT*928, p. 12*b*, tr. auct. The version in *YCCC*, ch. 66, p. 12*b*, is corrupt. The last character of the title is given as *chien*[8] in *TT*598, and *chao*[9] in the *YCCC* version, but both of these were simply means to avoid a Sung tabu. The sole basis for very provisionally assigning this work to the Thang is the unlikelihood that a Sung writer would have chosen a title which included a tabued word. This must be weighed against the statement that a disciple of Wei Po-Yang[10] who took the elixir 'is on Mt. Thai-pai[11] now, over a thousand years old', which would imply a date after the mid-twelfth century. But taking the mention of a millennium literally is ruled out by the inclusion of the treatise in *YCCC*, which was compiled early in the + 11th century.

One of us has a complete translation of this interesting source in draft (Sivin, 5). Its highly philosophical content is so divorced from the practical work of the furnace, and there is so much stress on processes within the alchemist's psyche or body, that we cannot be sure as yet how far the book is concerned with the preparation of the Outer Elixir. At the same time, its subject matter, concepts and language are so consistent with those of less ambiguous texts that relevant material need not be ignored.

[1] 訣 [2] 雌黃 [3] 帝男精 [4] 眞人飯 [5] 丹論訣旨心鏡
[6] 神仙服餌丹石行藥法 [7] 雄黃 [8] 鑑 [9] 照
[10] 魏伯陽 [11] 太白山

Natural cyclically-transformed elixir (*tzu-jan huan tan*[1]) is formed when flowing mercury (*liu hung*[2]), embracing Sir Metal (*chin kung*[3] = *chhien*,[4] lead), becomes pregnant. Wherever there is cinnabar there are also lead and silver. In 4320 years the elixir is finished. Realgar (*hsiung*[5]) to its left, orpiment (*tzhu*[6]) to its right, cinnabar above it, malachite (*tshêng chhing*[7]) below. It embraces the *chhi* of sun and moon, Yin and Yang, for 4320 years; thus, upon repletion of its own *chhi*, it becomes a cyclically-transformed elixir for immortals of the highest grade and celestial beings. When in the world below lead and mercury are perfected by an alchemical process (*hsiu lien*[8]) for purposes of immortality, (the elixir) is finished in one year.[a] The fire is first applied in the eleventh month, when the Single Yang (*i Yang*[9]) comes into being,[b] and the elixir is finished by the eleventh month of the next year. The natural cyclically-transformed elixir is what immortals, celestial beings, and sages of the world above gather and eat. What (the alchemist) now prepares succeeds because of its correspondence on a scale of thousandths (*hsiang erh chhêng chih, ta chhien chih shu*[10]).[c] Taking the product also results in eternal life, transformation into a feathered being, and power (*kung*[11]) equal to that of heaven.

We shall return shortly to the period of 4320 years in connection with the alchemist's side of the analogy between the Work of the laboratory and the Work which takes place in the womb of Mother Nature. There we shall see[d] that although the adept's period of a year is metaphysically derived from what we might call the temporal macrocosm of 4320 years,[e] historically the longer period was obviously chosen

[a] This phrase has a very *nei tan* (physiological alchemy) flavour; cf. pt. 5. below.

[b] The rebirth of Yang at the moment of the winter solstice is here expressed in the language of the *Tshan Thung Chhi* as the hexagram Khun ䷁ changing into Fu ䷗ (see Vol. 2, p. 332, Table 17, the final transition in the Diurnal Cycle).

[c] Or, to translate very literally, '(that through) correspondence it succeeds (is because of) numerical relations to the great thousands.' This understanding of the Chinese sense is only tentative, for (as Prof. A. F. P. Hulsewé has suggested in private correspondence) one or more characters are very probably missing from the middle of the text. In modern writings *hsiang*[12] often means 'symbol' or 'symbolise', but in early alchemical discourse, so far as we know, the word always refers to a relationship of correspondence. In other words, the things so related are coordinate, each partaking equally of the quality of the other, rather than the more concrete or hierarchically inferior standing for the more abstract or hierarchically superior. We do not in the least want to discourage Jungian or other psychological interpretations of Chinese alchemy, but it does seem indispensable that the analytical categories of such an interpretation be allowed to grow out of a close reading and precise understanding of the sources rather than be imposed ready-made. It does not seem likely that any psychologist will succeed at this task if he does not take the trouble to learn to read medieval Chinese accurately and critically.

[d] Pp. 264–6.

[e] For an extended cosmogonic derivation in terms of four stages of 1080 years each, see *Thung Yu Chüeh*[13] (Lectures on the Understanding of the Obscurity (of Nature), *TT*906), pp. 1*a* to 2*b*. This book belongs to a group of cognate treatises the content of which overlaps: *Huan Tan Chou Hou Chüeh*[14] (Oral Instructions on Handy Formulae for Cyclically Transformed Elixirs), *TT*908, which duplicates *TT*906 to p. 20*b*; *Yü Chhing Nei Shu*[15] (Inner Writings of the Jade-Purity (Heaven), *TT*940), which up to p. 7*a* is the same as *TT*906, pp. 20*b* to 27*a*; and *Hung Chhien Ju Hei Chhien Chüeh*[16] (Oral Instructions on the Entry of the Red Lead into the Black Lead) *TT*934, which overlaps, with variations in wording, the later part of *TT*940. The content of all these tractates is extremely theoretical, and equally applicable to both chemical and physiological alchemy. Despite some conventional attempts to lend an air of antiquity, as well as the inclusion of some plausible late Thang material, they were probably all compiled in the Sung. Only *TT*940 is listed in the bibliographical treatise of the *Sung Shih*. Finally, *Tan Lun Chüeh Chih Hsin Ching*, the treatise we have just quoted, is textually cognate with part of *TT*908, ch. 2.

[1] 自然還丹 [2] 流汞 [3] 金公 [4] 鉛 [5] 雄 [6] 雌
[7] 曾青 [8] 修鍊 [9] 一陽 [10] 象而成之大千之數
[11] 功 [12] 象 [13] 通幽訣 [14] 還丹肘後訣 [15] 玉清內書
[16] 紅鉛入黑鉛訣

to correspond to the number of double-hours (*shih*[1]) in the round year of 360 days. We are quite serious in representing the two directions of correspondence as related to two distinct realities within the alchemist's universe of significance. That he did not find them contradictory testifies to the coordinate nature of correspondences as the Chinese used them. It is interesting that the writer should have expressed the relation of the two time periods in terms of order of magnitude, a concept the easy and correct use of which is far from prevalent today.

This document also alludes to two minor but not insignificant alchemical themes: the notation of the geological coupling of minerals and metals, and the idea that there exist within the earth certain substances of such quality that only immortals can have access to them. We shall postpone slightly a discussion of the second theme, since its very ample documentation makes more adequate study possible.

The regular association of certain plants with mineral deposits, and of the latter with deeper strata of metals or metallic ores, has already been considered in Section 25 in connection with geological prospecting.[a] In the text from the *Kuan Tzu* book (compiled perhaps in the late −4th century) cited there, superficial cinnabar is considered a sign of deeper gold.[b] Ko Hung (*c.* +320) agrees, again making a parallel between the evolution of gold in the mountains and in the furnace:

> When the manuals of the immortals (*hsien ching*[2]) say that the seminal essence of cinnabar gives birth to gold, this is the theory of making gold from cinnabar. That is why gold is generally found beneath cinnabar in the mountains.[c]

The coupling of cinnabar with lead ores in *Tan Lun Chüeh Chih Hsin Ching* lacks classical precedent, and we do not know from what empirical generalisation it derives. The common presence of silver in ores of lead is a commonplace in Chinese alchemy as in modern geology, and a key to one of the prototype two-element processes of the proto-scientific art.[d]

Another simple account of the subterranean evolution of metals appears in the *Chih Kuei Chi*[3] (Pointing the Way Home (to Life Eternal); a Collection) of Wu Wu,[4,5] whose manual of equipment and procedures, *Tan Fang Hsü Chih*[6] (Indispensable Knowledge for the Chymical Elaboratory), is dated +1163.[e] The former work is definitely concerned with physiological and meditational alchemy,[f] but the author was conversant with the Outer Elixir tradition and is clearly reflecting it here:[g]

[a] See Vol. 3, pp. 675–680.
[b] See Vol. 3, p. 674.
[c] *PPT/NP*, ch. 16, p. 5*a*; tr. Ware (5), p. 268, mod. auct.
[d] See pp. 257ff.
[e] *TT*914 and *TT*893 respectively. The latter figures prominently in our study of alchemical apparatus (pp. 11, 68ff. above).
[f] See, for instance, its sympathetic likening of Taoist concentration and breath control (*tshun shen pi hsi*[7]) to Chhan Buddhist meditation (*chhan ting*[8]); preface, p. 1*b*. It is more than likely that Wu's path was a blend of Inner and Outer alchemy, including other meditative techniques, and the sexual practice of 'cycling the semen'—in other words, that 'dual cultivation' which largely absorbed alchemy in Sung and later times. See below, pt. 5.
[g] *TT*914, preface, p. 2*b*., tr. auct. A remark on the previous page shows that Wu was also familiar with the organisation of the classical pharmaceutical natural histories.

[1] 時 [2] 仙經 [3] 指歸集 [4] 吳悟 [5] 悞 [6] 丹房須知
[7] 存神閉息 [8] 禪定

Quicksilver, under the stimulus of the *chhi* of Yin and Yang for 800 years, forms cinnabar (*sha*[1]); after 3000 years it forms silver; after 80,000 years it forms gold—the longer the firmer (*chien*[2]),[a] through a thousand metamorphoses and a myriad transformations. The sages cycle (*yün*[3]) Water and Fire,[b] following the model of the operation of the *chhi* of Yin and Yang, in order to bring to completion the virtue (of the elixir); this is what is called 'surpassing the ingenuity of the Shaping Forces of Nature (*to-tê tsao-hua chi chê yeh*[4])'.[c]

As we have seen, the archaic and ubiquitous idea of the evolution of minerals and metals along a scale of perfection was rationalised in China in terms of the Five-Element and Yin-Yang theories, provided with much concrete detail, and related to cosmic process by the choice of specific time spans.[d] It was perhaps inevitable that at least for purposes of meditation upon the creative potential of the Tao, this idea was further imaginatively extended to link it with other Chinese convictions.

One possibility was to involve the vegetable kingdom by extrapolating, so to speak, the growth of minerals backward. Philosophically this was not much of an innovation, for the idea of the fixity of species had been rejected from the start, to allow the possibility of one species metamorphosing into another, and to explain spontaneous generation.[e] Transformation was ordinarily thought of either as a binary relation, in the sense that a certain species could change spontaneously into another particular species, or as a chain relation, in which the metamorphoses form a natural series. The chain relation is represented by the *Chuang Tzu* book's renowned theory of a cycle which begins with 'germs' (*chi*[5]) in the water and evolves organically step by step to man, who in due but unspecified course reverts to the germs.[f] Where this passage is quoted in the *Lieh Tzu* book (compiled by *c.* +300), the continuity is broken, probably through late editorial inadvertence, by some typical examples of the simple binary relation:

Sheep's liver changes into the goblin sheep underground. The blood of horses and men becoming will-o'-the-wisp;[g] kites becoming sparrow-hawks, sparrow-hawks becoming cuckoos, cuckoos in due time again becoming kites; swallows becoming oysters, moles becoming quails, rotten melons becoming fish, old leeks becoming sedge, old ewes becoming monkeys, fish roe becoming insects—all these are examples of things altering and metamorphosing....[h]

[a] The implication is plainly that the harder the gold, the more perfect it is. That this conviction should be held by a man of Wu Wu's experience is additional evidence that the assumptions of both aurifiction and aurifaction could coexist in the mind of an alchemist without collision. See above, pt. 2, pp. 8ff. pt. 3, p. 102.

[b] 'Water' and 'Fire' here mean both the elements, which correspond to Yin and Yang and thus to the reactants in the standard two-element processes (see below, pp. 251ff.), and the heating fire and cooling water of the actual apparatus. These were functionally equivalent.

[c] The last sentence could also be phrased: 'robbing, or carrying off, their mechanisms (and making them work for human benefit)' (J.N.). We shall encounter this motif again in pt. 5.

[d] For a parallel in sexual alchemy, see below, pt. 5.

[e] These were not categorically distinguished from sudden transformations involving one individual, like a man changing into a woman or a were-tiger. All are intermixed under the rubric 'transformations' (*pien hua*[6]) in *TPYL*, ch. 887–888, a trove of instances. We shall discuss them systematically in Vol. 6, Sect. 39.

[f] See Vol. 2, pp. 78–79. It is interesting that the Sung scholar Chêng Ching-Wang[7] should have commented on this passage mainly in terms of binary transformations; see Vol. 2, pp. 420–2.

[g] On this see more extensively Vol. 4, pt. 1, pp. 72ff.

[h] Ch. 1, pp. 6ff.; tr. A. C. Graham (6), pp. 21–2, misprint corrected. The passage from the *Huai Nan Tzu* book translated earlier in this sub-section is immediately preceded by five chains which trace

[1] 砂 [2] 堅 [3] 運 [4] 奪得造化機者也 [5] 幾 [6] 變化 [7] 鄭景望

Another binary relation known to every physician in classical times was that between pine resin (*sung chih*[1]) and the *fu-ling*[2] fungus, a parasite upon the roots of pine trees, prized as an immortality medicine.[a] The fungus was supposed to be formed when pine resin flowed into the ground and remained there for a thousand years. When it grew especially close about the roots of the tree it was called 'pachyma spirit', or *fu shen*[3].[b] Origin from pine resin was also ascribed to amber (*hu-po*[4]) by Thao Hung-Ching,[5] who introduced amber into the pharmacopoeia; though 'an old tradition' cited by Su Ching[6] (between +650 and +659) had *fu-ling* metamorphosing into amber after a second millennium, and amber into jet (*i, hsi*[7]) after a third.[c]

Here, then, is an alchemical assimilation of these motifs into an account formally similar to the mineral sequences we have already examined:

In the great Tao of heaven and earth, what endures of the myriad phenomena is their primal and harmonious *chhi* (*yuan ho chih chhi*[8]). Of the things that exist in perpetuity, none surpass the sun, moon, and stars.[d] Yin and Yang, the Five Phases (Elements), day and night, come into being out of Earth (*i thu*[9]),[e] and in the end return to Earth. They alter in accord with the four seasons, but that there should be a limit to them is also the Tao of Nature. For instance, when pine resin imbibes the *chhi* of mature Yang for a thousand years it is transformed into pachyma fungus. After another thousand years of irradiation it becomes pachyma spirit; in another thousand years it becomes amber, and in another thousand years crystal quartz (*shui ching*[10]). These are all seminal essences formed through irradiation by the floreate *chhi* of sun and moon.[f]

This passage is not greatly innovative either in form or content; in fact it demonstrates how little originality is often needed to bring out the inherent connections of two long-established notions (in this case metamorphosis and subterranean maturation). The framework of physical explanation is perfectly typical of alchemical theory. To paraphrase as simply as possible, the cyclical processes of Nature (the Tao) can give rise to

the devolution of legendary and fabulous ancestors into men, feathered creatures, beasts, creatures with scales, and those with shells (ch. 4, pp. 11*b*, 12*a*; Erkes (1), pp. 76ff.).

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[a] This is *Pachyma* (tuckahoe or Indian bread), the sclerotial condition of *Polyporus cocos* (R838). Cf. Burkill (1), vol. 2, p. 1618, and *PTKM*, ch. 37, pp. 3*a*ff. Besides being generated, as was thought, from pine resin, it had also a correlate, the dodder (*thu-ssu*[11]), with which it was thought to be connected as a root is with the branches and leaves of a plant. This is *Cuscuta sinensis* (R156), a Convolvulaceous phanerogam parasitic on willow branches. For further background see Vol. 4, pt. 1, p. 31.

[b] *CLPT*, ch. 12, p. 18a (p. 296.2), and *PTKM*, ch. 37, (p. 2). Both books cite two statements, one from a commentary to a passage which does not appear in the current text of the *Huai Nan Tzu* book (cf. ch. 17), and one from the *Tien Shu*[12] (Book of Arts) of Wang Chien-Phing[13] (+5th century). These, with others, had been collected by Chang Yü-Hsi in his *Chia-Yu Pên Tshao* (+1060).

[c] *CLPT*, ch. 12, pp. 19*b* and 20*b* (p. 297.2), and *PTKM*, ch. 37, (p. 8), entry for jet.

[d] The translation of these first two sentences is tentative, for their construction is so loose semantically that the connection of the various ideas has to depend almost entirely on interpretation.

[e] Not out of *the* earth, but as mediated by the five-elements phase Earth, in which Yin and Yang are in a perfect state of dynamic balance. The *chhi* of Earth is spoken of as primal (i.e. undifferentiated) and harmonious. Note that the Chinese natural philosopher spoke of the formation of phenomenal things in terms of both this primal *chhi* and the creative *chhi* of the Yang phase of a cycle. *Chhi* is in this context best thought of as an organising energy, and balance and creativity as two of its functional aspects.

[f] *Yü Chhing Nei Shu*[14] (Inner Writings of the Jade-Purity (Heaven), *TT*940), p. 2*a*, tr. auct. A somewhat abridged and generally inferior text appears in *Thung Yu Chüeh* (*TT*906), pp. 21*b*–22*a*.

[1] 松脂 [2] 茯苓 [3] 茯神 [4] 琥珀 [5] 陶弘景 [6] 蘇敬
[7] 瑿 [8] 元和之氣 [9] 依土 [10] 水晶 [11] 菟絲 [12] 典術
[13] 王延平 [14] 玉清內書

things which endure, or even exist perpetually, since they have a perfectly balanced internal phasing which attunes them to the Tao's recurrent pattern.[a] The heavenly bodies embody the balance of cosmic forces (mediated by the element Earth) and are thus a paradigm of eternity.[b] At the same time the alternation of the sun and moon (and of the light and *chhi* they radiate) is identical with the cyclical domination of Yin and Yang. In the course of the cosmic cycles, exposure of pine resin underground to the configurational energy released in the recurring creative phase ('the *chhi* of mature Yang', *thai yang chih chhi*[1]) gives rise to a sequence of substances which not only endure and improve underground but are all capable of conferring immortality upon human beings.

Implicit in this sequence of ideas is a most important theme which can be glimpsed again and again in the alchemists' writings. Although the perfection of the elixir is the result of a repeated cyclical process, at each step of the treatment the intermediary product is not the same, but rather progressively exalted. Thus superimposed upon the cycle is a progressive upward tendency, which does not reverse itself.[c] The culmination of the process is irreversible—that is, no longer subject to the cyclic cosmic agencies which brought it about. In this way the adept's operations upon his materials parallel the effect of the elixir, once made, upon himself. His immortality is characterised again and again as invulnerability to the ravages of time, freedom from the cyclical attrition which governs the ageing and death—as inevitably as the birth and growth—of ordinary men. This idea is one of the crucial links between Chinese, Indian and Arabic alchemy, as well as between laboratory alchemy and other techniques of immortality in China.[d] Only our present defective comprehension of it precludes the treatment in depth which it deserves.

(iv) *The subterranean evolution of the natural elixir*

Another extension of the theory of mineral development led to positing an evolutionary branch the terminus of which was not gold, but the natural analogue to the mercuric elixir which theoreticians of alchemy valued more than any precious metal. The fact that every quality characteristic of gold varied over a certain range in native specimens of the metal encouraged early aurifactors to ignore the assayer's single standard of purity, and to envision the making of gold of still greater quintessential purity than any metal found in mines or streams. Although it is clear that the concept of the natural elixir was motivated by the desire to find a parallel for the alchemist's own Work, it was philosophically feasible because, like gold, cinnabar exists in a certain range of qualities, from very crude and irregular forms to magnificent blood-red rhombohedral crystals. The extrapolation which led to the natural elixir may be

[a] See pp. 404, 477 ff.

[b] The association of perfect *krasis* with perfect enduringness was an idea greatly prominent also among the Arabic alchemical theorists (cf. pp. 394, 487, 481 below). There we describe its transmission to the Latins of Western Europe from the time of Roger Bacon onwards. It certainly had one set of roots in Greek medicine, but the earlier Chinese speculations of which the Arabs received the gist could surely have been another.

[c] Cf. pp. 221 ff. above and pp. 246, 272 ff. below.

[d] See the sub-sections on physiological alchemy, pt. 5 below.

[1] 太陽之氣

followed in a remarkable extended passage from Chhen Shao-Wei's[1] *Ta-Tung Lien Chen Pao Ching Hsiu Fu Ling Sha Miao Chüeh*[2] (Mysterious Teachings on the Alchemical Preparation of Numinous Cinnabar, Supplementary to the Perfected Treasure Manual, a Ta-Tung Scripture), written perhaps *c.* +712,[a] which must be considered one of the most valuable of the surviving early treatises on account of its disquisition on the alchemy of cinnabar and its clear instructions for preparing the alchemical elixir:[b]

The highest grade of cinnabar grows in grottoes in Chhen-chou[3] and Chin-chou[4] (both in modern Hunan), and there are several types.[c] The medium grade grows in Chiao-chou[5] (centered on modern Hanoi) and Kuei-chou[6] (in Kuangsi), and is also of various sorts. The lower grade occurs in Hêng-chou[7] and Shao-chou[8] (in Hunan). That there are various grades is due to variation in purity of substance (*chhing cho thi i*[9]), diversity in perfection (*chen hsieh*[10])[d] and shadings in fineness of the *chhi* of which they are formed. Those which, stimulated by metal and mineral (influences) (*kan thung chin shih*[11]), take on a balanced *chhi*, confer, when ingested, access to the Mysteries and consecration among the Realised (or Perfected) Ones as an immortal of the highest grade (*thung hsüan chhi chen wei shang hsien*[12]). Even those composed of unbalanced *chhi* cause, when taken, perpetual life on earth.

Now the highest grade, lustrous cinnabar (*kuang ming sha*[13]), occurs in the mountains of Chhen-chou and Chin-chou upon beds of white toothy mineral (*pai ya shih chhuang*[14]). Twelve pieces of cinnabar make up one throne (*tso*[15]). Its colour is like that of an unopened red lotus blossom, and its lustre is as dazzling as the sun. There are also thrones of 9, 7, 5, or 3 pieces, or of one piece. Those of 12 or 9 pieces are the most charismatic (*ling*[16]); next are those which occur in 7 or 5 pieces. In the centre of each throne is a large pearl (of cinnabar), 10 ounces or so in weight, which is the monarch (*chu chün*[17]). Around it are smaller ones, 8 or 9 ounces (or in some cases 6 or 7 ounces or less) in weight; they are the ministers (*chhen*[18]).[e]

[a] *TT*883. In *YCCC*, ch. 69, the title appears as *Chhi Fan Ling Sha Lun*[19] (On Numinous Cinnabar Seven Times Cyclically Transformed). Sivin (1), pp. 47–48, suggests possible dates in the +6th or +8th century, but the earlier date is ruled out by a reference to O Prefecture (O-chou[20]) in the second part of the book, published under a separate title and mistakenly placed before the first part in *YCCC*; see ch. 68, p. 12*b*. This designation was given to the prefecture for a few years around the beginning of the +7th century, and then from the Five Dynasties period onwards. Since names once given tended to remain current among the people even after they had been officially changed, only dates prior to the end of the +6th century are ruled out. See the *Hupei Thung Chih*[21] (Historical Geography of Hupei Province), i.e. Yang Chhêng-Hsi *et al.* (1), (1921 ed.), ch. 5, p. 4*b*; and also above, p. 218.

[b] This translation is excerpted from an unpublished critical edition and translation of the writings of Chhen Shao-Wei by one of us (Sivin, 4). Of three available editions, the basic text was *YCCC*, ch. 69, pp. 5*b*–8*a*.

[c] Cf. Fig. 1523.

[d] The antithesis between *chen chhi*,[22] 'perfected (or realised) *chhi*', and *hsieh chhi*,[23] 'deviant *chhi*', in alchemical theories appears to be functionally equivalent to that between *chêng chhi*,[24] 'balanced *chhi*' and *phien chhi*,[25] 'unbalanced *chhi*'. For instance, earlier on, Chhen says that 'lustrous cinnabar is endowed with the clear, limpid, balanced and realised (*chen chêng*[26]) *chhi* of mature Yang' (*YCCC*, ch. 69, p. 2*b*). The underlying idea is that perfection in a mineral implies balance with respect to the dynamic forces of the cosmos—Five Elements, Yin and Yang, and so on. The parallel with the medical conception of health in China is obvious—and for that matter with similar conceptions in the Greek and Arabic cultures also.

[e] This is reminiscent of the drug classification in the *Shen Nung Pên Tshao Ching* (cf. Vol. 6, pt. 1).

[1] 陳少微 [2] 大洞鍊眞寶經修伏靈砂妙訣 [3] 辰州 [4] 錦州
[5] 交州 [6] 桂州 [7] 衡州 [8] 邵州 [9] 清濁體異
[10] 眞邪 [11] 感通金石 [12] 通玄契眞爲上仙 [13] 光明砂
[14] 白牙石牀 [15] 座 [16] 靈 [17] 主君 [18] 臣 [19] 七返靈砂論
[20] 鄂州 [21] 湖北通志 [22] 眞氣 [23] 邪氣 [24] 正氣
[25] 偏氣 [26] 眞正

They surround and do obeisance to the great one in the centre. About the throne are a pec[1] (*tou*[1]) or two of various kinds of cinnabar, encircling the 'jade throne and cinnabar bed'. From among this miscellaneous cinnabar on the periphery may be picked (pieces in the shapes of) fully formed lotus buds, 'nocturnal repose', and azalea (*fu-jung thou chhêng, yeh an, hung chüan*[2]).[a] The lustrous and translucent specimens are also included in the highest class of cinnabar.

There is also a cinnabar which resembles horse teeth; that with a white lambent lustre (*pai fu kuang ming chê*[3]) is white horse-tooth cinnabar (*pai ma ya sha*[4]) of the highest grade. There is another, tabular like mica; that with a white lustre is white horse-tooth cinnabar of the middle grade. (Cinnabar) which is round and elongated like a bamboo shoot and red or purple in colour is purple numinous cinnabar (*tzu ling sha*[5]) of the highest grade. If it occurs in stony, flat prisms with a virid lustre, it is purple numinous cinnabar of the lower grade. Of (the purple numinous cinnabar) produced in Chiao-chou and Kuei-chou, only that which occurs in throne formations or which is found inside rocks when they are broken open, and is shaped like lotus buds and lustrous, is also included in the highest grade. That which is granular in form and translucent (*thung ming*[6]), three or four pieces weighing a pound, is of the middle grade. That which is laminar in form and transparent (*ming chhê*[7]) is of the lower grade. All that produced in Hêng-chou and Shao-chou is purple numinous cinnabar. Like that with a red lustre found inside rocks when they are broken open, it is lower-grade cinnabar. If creek cinnabar, granular in form and translucent, is subdued, refined, and ingested, (the alchemist) will attain perpetual life on earth, but he will not become an immortal of the highest grade. Earthy cinnabar grows in earth caves (or, mines in the earth) (*thu hsüeh*[8]), as creek cinnabar matures (*yang*[9]) in mountain rills. Because earth and mineral *chhi* are intermixed, these varieties are not suitable as ingredients of the higher kinds of medicine or for use in alchemy.

The very highest grade of cinnabar is that which occurs in throne formations. When one of the monarch pieces from the centre of the throne is obtained, subdued, refined and introduced into the viscera, the efficacy of cinnabar is particularly manifest. (This central piece) is named 'Superior Cinnabar Belvedere' (*shang tan thai*[10]).[b] It produces a permanently balanced *chhi* (i.e. bodily *pneuma*),[c] and allows one to transcend one's mundane involvements. If it is further taken in the sevenfold-recycled or ninefold-cyclically-transformed state, then without ado (*tzu-jan*[11]) the anima is transformed and the outer body destroyed, the spirit made harmonious and the constitution purified. The Yin *chhi* is dissolved, and (the persona) floats up, maintaining its shape, to spend eternity as a flying immortal of the highest grade of Realisation. Thus one knows that the realised seminal essence of the Yang[d] has

[a] The odd term *fu-jung thou chhêng*,[12] 'fully formed lotus buds', occurs twice more in this passage (once in the *TT*883 version only), and the same metaphor is also found in other writings (e.g. below, p. 242). The *fu-jung* flower is that of the lotus *Nelumbo nucifera* (R 542; CC 1449). The next two characters *yeh an*[13] (lit., 'nocturnal repose') must surely be the name of another flower. We have had no success at identifying it, though naturally a number of flowering plants have names beginning with *yeh*, and this one might be a textual corruption. As for *hung chüan* (interpreting it as *chüan*[14]), the name must refer to *Azalea* or *Rhododendron* spp., not now precisely identifiable (cf. R 201, 203; CC 524–6, 529, 530).

[b] Alternative translation: '(Taking this elixir) is called "Ascending the Elixir Belvedere".'

[c] The assumption is that taking an exceptional cinnabar, because of the internal balance of its *chhi*, will induce a corresponding balance in the adept who ingests it. As the balance in the mineral defines its perfection, the balance in the man certifies the state of immortality.

[d] See our notes earlier on *chêng Yang*[15] (p. 228) and *chen chhi*[16] (p. 237).

[1] 斗 [2] 芙蓉頭成夜安紅絹 [3] 白浮光明者 [4] 白馬牙砂
[5] 紫靈砂 [6] 通明 [7] 明徹 [8] 土穴 [9] 蠆
[10] 上丹臺 [11] 自然 [12] 芙蓉頭成 [13] 夜安 [14] 鵑
[15] 正陽 [16] 眞氣

imbued the *chhi* (of this cinnabar) so that it exhibits a perfectly rounded nimbus, symmetrical and without imperfection. When cinnabar has been subdued and refined so that it takes the shape of a lotus bud and is translucent with a nimbus, it has become a medicine of the highest grade, which when ingested results in immortality (or, which is ingested by immortals).

The 'Canon'[a] says that cinnabar is a natural cyclically-transformed elixir, and that the vulgar are unable to gauge its fundamental principles. The uninitiated all know about 'jade throne' cinnabar. But the 'golden throne' and 'celestial throne' are cinnabars of the Purple Dragon and Dark Flower of the Most High (*thai shang tzu lung hsüan hua*[1]),[b] and not the kind which vulgar fellows can see or know about. Any devoted gentleman of the common sort, after storing up merit, can refine jade throne cinnabar alchemically and by taking it attain immortality. But as for golden throne cinnabar, a man born with immortality in his bones must first refine his spirit to a state of pure void (*chhing hsü*[2]) and live as a hermit in a cliff-bound cave. Then the immortals will gather it and feed it to him. He will forthwith be transformed into a Feathered Being (i.e., an immortal) and will bound upwards into the Lofty Purity (of the heavens). Lastly celestial throne cinnabar is collected and eaten only by the Celestial Immortals and Realised Officials in heaven. It is no medicine for lesser immortals.

When jade throne cinnabar has imbibed the pure seminal essence of Yang sentience for six thousand years it is transformed into golden throne cinnabar, the throne of which is yellow. In the centre are five pieces growing in layers, surrounded by forty or fifty small balls.[c] After 16,000 years of imbibing (essence), golden throne is transformed into celestial throne cinnabar, in which the throne is jade-green. There are nine pieces in the centre, growing in layers, pressed closely about by 72 (smaller) pieces. It floats in the midst of the Grand Void, constantly watched over by one of the spirits of the Supreme Unity (Thai I[3]). On a Superior Epoch day (*shang yuan*[4])[d] the Realised Officials descend to collect it. The mountain (on which it is found) suddenly lights up; the whole mountain is illuminated as if by fire. This celestial throne cinnabar is collected (only) by Realised Officials; people of the world can have no opportunity to gather it.

The fundamental principles of cinnabar are deep and arcane,[e] but worthy and enlightened gentlemen who have their hearts set upon floating up (to become immortals) must learn to distinguish the various qualities of the Medicine, high from low. Only then will they be ready to regulate the phases of the fire, to combine the Yin and Yang subduing methods, and then without further ado be consecrated as Perfected or Realised Immortals of high grade.

[a] This must be the no longer extant (and possibly non-existent) 'Canon for Making the Perfected Treasure' (*Lien Chen Pao Ching*[5]), to which Chhen Shao-Wei's works are supposed to be supplementary instructions.

[b] The Most High (Thai Shang[6]) is, like the Supreme Unity (Thai I[3]) in the next paragraph, one of the great celestial divinities of Taoism.

[c] Here we follow the reading of the *TT*883 and Chhing Chen Kuan[7] versions; the basic text has 'forty-five' (*ssu-shih-wu*[8]).

[d] The Superior Epoch day, one of three epoch days during the year, was the fifteenth day, or full moon, of the first calendar month. *TPYL*, ch. 30, p. 2*a*, quotes the *Shih Chi*,[9] the first of the dynastic histories (*c.* −90), ch. 24, p. 3*a* (tr. Chavannes (1) vol. 3, p. 235), to the effect that on this night offerings were made to the Supreme Unity, and comments that this is the origin of the Lantern Festival later held on the same night. On the Han cult of the Supreme Unity, see Cammann (9).

[e] The *TT*883 version reads with equal plausibility: 'The fundamental principles of cinnabar are as inaccessible as a high mountain, but superior worthies and enlightened gentlemen who have their hearts set...'

[1] 太上紫龍玄華 [2] 清虛 [3] 太一 [4] 上元 [5] 鍊眞寶經
[6] 太上 [7] 清眞館 [8] 四十五 [9] 史記

Of the many qualities of cinnabar enumerated above, 'creek cinnabar' and 'earthy cinnabar' were crude varieties used mainly in the commercial distillation of mercury. The kinds useful to the physician and alchemist were all exceptionally large tabular or orthorhombic crystals of substantially pure crystalline mercuric sulphide.[a] The white beds in which these minerals grew would have been drusy quartz.

Anyone who has not learned from Lynn Thorndike (1) or Frances Yates (1) to appreciate the remarkable capacity of science to coexist with magic may be troubled or even scandalised by certain tensions implicit in this text, but alchemy and even early medicine reflect them throughout. The recurring resort to scientific *chhi* and Yin–Yang explanations does not seem to sit well with the frequent reminders that the final issue of the alchemical process was expected to be an appointment to the ranks of the Spiritual Civil Service. We cannot pretend that we understand the historical dynamics of Chinese alchemy until someone has succeeded in explaining why this very real contradiction never generated sufficient dialectical voltage to be faced or resolved.[b]

It seems finally to have withered away with the ascendancy of internal or physiological alchemy in the Thang and Sung, when concern with an objective hierarchy of immortals and divinities was somewhat displaced by direct attention to the aim of what a Jungian would call psychical integration. This emphasis on personal growth is too apparent to overlook in a few lines of an alchemical poem in the 'Arcane Memorandum of the Red Pine Master' (*Chhih Sung Tzu Hsüan Chi*[1]), probably of the Thang or earlier:

> Successful means solidly building the Wall,[c]
> Indispensable to distinguish the Hard and the Soft,[d]
> Necessary that the maturing come within man,
> Due to the concentration of his heart and mind.[e]
> If his heart and mind have reached divinity, so will the Medicine;
> If his heart and mind are confused the Medicine will be unpredictable.
> The Perfect Tao is a perfect emptying of the heart and mind.
> Within the darkness—unknowable wonders.
> When the wise man has attained to the August Source,
> Then in time he will truly reach the clouds.[f]

We can only suggest for the moment that the structure of the Unseen World may have been all along in a very deep sense that of the human spirit.

[a] For a discussion of these varieties of cinnabar, see below, pp. 301ff.

[b] One must always remember the overwhelming persuasion of ancient Chinese thought that a specifically material immortality within the natural world was possible (cf. Vol. 5, pt. 2, pp. 71ff., 93ff. above). Also there is hardly any limit to the co-existence of different forms of experience within any one culture. Would Louis Pasteur, for example, have had any objection to attending mass on the Feast of St Michael and all Angels?

[c] I.e. the immurement of the spirit from the flow of chance perceptions, thoughts and images (cf. pt. 5).

[d] I.e., Yang and Yin.

[e] *Hsin*[2] is translated throughout as 'heart and mind', since neither 'heart' nor 'mind' alone would convey the sense of the original.

[f] Quoted in *Tan Lun Chüeh Chih Hsin Ching* (*TT*928), p. 14*a*; see also *YCCC*, ch. 66, p. 14*a*. Translation from critical edition in Sivin (5).

[1] 赤松子玄記 [2] 心

A second tension prevalent in alchemy prompts us to ask what credit Chhen Shao-Wei should be given for innovation in his account of super-cinnabar, despite his insistence that a Realised Immortal revealed the contents of his book to him one day in a mountain cave?[a] Any hope of answering this question must be greatly qualified by our inability to draw an absolute line between revelation and inspiration, but it is obviously relevant to ask how much of the information in the document was already known. We can throw light on this point to the extent that datable documents allow. Fortunately, they serve to assure us that at least the bare conception of throne formations of exceptional alchemical value was known well before the time of Chhen's epiphany.

A landmark of pharmacology, Hsü Chih-Tshai's[1] *Lei Kung Yao Tui*[2] (Answers of the Venerable Master Lei concerning Drugs), *c.* +565,[b] in the course of its enumeration of the varieties of cinnabar, makes this assertion, bland by comparison with Chhen's but an anticipation none the less:

> There is a spirit throne cinnabar (*shen tso*[3]), as well as a golden throne cinnabar and a jade throne cinnabar. If they are taken, (even) without having passed through the alchemical furnace (*ching tan tsao*[4]), they will forthwith extend one's destined span of life.[c]

As has been remarked in our study of mineralogy,[d] in the middle of the +7th century Su Ching[5] also speaks of 'lustrous cinnabar', of which

> one crystal grows separately in a 'stone shrine' (*shih khan*[6]). The largest is the size of a hen's egg, and the smallest the size of a jujube or chestnut. It is shaped like a lotus, and when broken it resembles mica, lustrous and transparent. It grows on a stone 'belvedere' inside the shrine. If he who finds it carries it on his person, it will keep him from all evil.[e]

Finally the great pharmacognostic critic Khou Tsung-Shih[7] provides an illuminating description of the mining of large cinnabar crystals at Chin-chou in his 'Dilations upon Pharmaceutical Natural History' (*Pên Tshao Yen I*,[8] preface dated +1116):

> The Old Crow Shaft (*lao ya ching*[9])...has a depth and (underground) extent of several hundred feet. First wood is piled up inside to fill the excavation and then it is set on fire. Where the dark stone cracks open there are small 'shrines'. Within each of these is a bed of white stone, which resembles (white) jade. Upon this bed grows the cinnabar, the small (crystals) like arrow-heads and the larger like lotuses. Their lustre is so great that they reflect light as well as mirrors.[f] When they are ground up their colour is a vivid red. The larger specimens of the cinnabar, together with their beds, weigh from seven or eight up to ten ounces.[g]

[a] *YCCC*, ch. 69, p. 1*a*. The encounter is dated in the Thien-Yuan[10] reign-period, which has not been identified with certainty. See Sivin (1), pp. 47–8.

[b] We name him as the author here, though he purports to be the commentator of an earlier Lei Kung text incorporated in his work. [c] Cit. *CLPT*, ch. 3, p. 3*a*, tr. auct. [d] Vol. 3, p. 649.

[e] Cit. *CLPT*, ch. 3, pp. 3*a*–3*b*, tr. auct.; cf. Okanishi (5), p. 99.

[f] 'Arrow-head' (*chien tshu*[11]) and 'mirror-face' (*ching mien*[12]) are the two most common terms used today for very high grades of cinnabar used in seal pigment. The two are mentioned together with lustrous cinnabar in the *Thien Kung Khai Wu* of +1637, ch. 16, p. 1*b*, in a passage mistranslated in Sun & Sun (1), pp. 279–80.

[g] Cit. *CLPT*, ch. 3, p. 5*b*, tr. auct.

[1] 徐之才 [2] 雷公藥對 [3] 神座 [4] 經丹竈 [5] 蘇敬
[6] 石龍 [7] 寇宗奭 [8] 本草衍義 [9] 老鴉井 [10] 天元
[11] 箭鏃 [12] 鏡面

Putting all these data together, we can reasonably posit that Chhen Shao-Wei was responsible, whether by inspiration or revelation, for adding texture to the idea of supra-normal formations of cinnabar. What interests us is that one of the conceptions which he newly applied was that of chain metamorphosis.

There is evidence that Chhen's description of super-cinnabar did not remain an utter secret after all. The *Lung Hu Huan Tan Chüeh*[1] (Explanation of the Dragon-and-Tiger Cyclically Transformed Elixir), evidently of the Wu Tai, Sung or later, follows Chhen's jade throne → golden throne → celestial throne sequence, specifying the same time-intervals between metamorphoses, and speaks of cinnabar of the highest grade as 'natural cyclically-transformed elixir'.[a] What is hardly less significant, a distant but on-pitch echo appears in the literary remains of the great Thang statesman Li Tê-Yü[2] (+787 to +849), by Taoist lights at best a 'devoted gentleman of the common sort.' His 'Essay on Smelting the Yellow', by which he means alchemy, begins:[b]

Someone asked me about the transformation involved in 'smelting the yellow'. I said: 'I have never studied these matters, so how am I to deny that there is such a thing? Still, with the aid of perfected principles one can always inquire into Nature and all its phenomena. Now lustrous cinnabar is a natural treasure of heaven and earth. It is found in rock caverns, growing on snowy beds, and resembling newly grown lotuses before the red buds have burst open. The tiny (crystals) do obeisance in a ring, while the large one occupies the centre. This corresponds to the configuration at the celestial pole, and the respective positions proper to ruler and ministers.[c] (The mineral) is lustrous and transmits light (*wai chhê*[3]). Those who gather it trace along the vein of mineral (*shih mo*[4]) (till they find it). Truly, it has been cast (*chu*[5]) by the Shaping Forces.[d]

It was not the idea of mineral evolution that interested Li, political moralist that he was. The excellence of the configuration of lustrous cinnabar lay in its resonance with the metaphysics of monarchy, which Confucius had long before illustrated with the image of the central Pole Star surrounded by genuflecting asterisms.

(4) The Alchemist as Accelerator of Cosmic Process

There is a piece of dialogue in Ben Jonson's play 'The Alchemist' (+1610) which might well serve as the text for our argument as it gradually unfolds:[e]

Subtle: Why, what have you observ'd, Sir, in our Art,
Seems so impossible? *Surly:* But your whole Work, no more.

[a] *TT*902, ch. 1, pp. 2*b*, 4*b*–5*a*.

[b] For a very early instance of the term *huang yeh*[6] for alchemy, see above, pt. 3, p. 36.

[c] An allusion to *Lun Yü*,[7] II, i, tr. Legge (2), vol. 1, p. 145: 'The Master said, "He who exercises government by means of his virtue may be compared to the north polar star, which keeps its place while all the stars turn towards it."' Cf. Vol. 3, pp. 259ff.

[d] Huang Yeh Lun,[8] in *Li Wên-Jao Wai Chi*,[9] ch. 4, pp. 6*a*–6*b*, reprinted in *Wên Yuan Ying Hua*,[10] ch. 739, p. 15*a*, tr. auct. In the preface to his 'Rhyme-prose on "Smelting the Yellow"' (*Huang Yeh Fu*[11]), which is considerably cooler toward the Outer Elixir than this essay, Li mentions the date +831 in connection with his interest in alchemy. See *Li Wên-Jao Pieh Chi*,[12] ch. 1, p. 1*a*.

[e] Act II, Scene iii. Duncan (1), p. 706, has pointed out that the ideas expressed are, as would be expected, Paracelsian. See also pp. 223, 231, 236 above, and p. 506 below.

[1] 龍虎還丹訣 [2] 李德裕 [3] 外徼 [4] 石脉 [5] 鑄
[6] 黃冶 [7] 論語 [8] 黃冶論 [9] 李文饒外集
[10] 文苑英華 [11] 黃冶賦 [12] 李文饒別集

That you should hatch Gold in a furnace, Sir,
As they do Eggs in *Egypt*! *Subtle:* Sir, do you
Believe that Eggs are hatch'd so? *Surly:* If I should?
Subtle: Why, I think that the greater Miracle.
No Egg but differs from a Chicken more
Than Metals in themselves. *Surly:* That cannot be.
The Egg's ordain'd by Nature to that end,
And is a Chicken *in potentia*.
Subtle: The same we say of Lead, and other Metals,
Which would be Gold, if they had time. *Mammon:* And that
Our Art doth further.

We have already seen how well Subtle's answer applies in China, and are ready to explore the transition to Sir Epicure Mammon's amplificatory remark.[a] Let us begin by summarising the next propositions which we shall endeavour to demonstrate.

Since the formation of minerals and metals is bound by time, and thus attributable to the same cosmic forces which are responsible for other life cycles, there is a very direct connection between the chemical operations of Nature and the practical techniques of the metal-working artisan. In extracting a metal from its ore, or making strong steel from brittle cast iron, he was demonstrating that man can imitate natural process, that he can stand in the place of Nature, and bring about natural changes at a rate immensely faster than in Nature's own time. The discovery that the speed of mineral growth processes, unlike those of plants and animals,[b] can be controlled by man, must certainly have been one of the main factors that led to the beginning of what we have called proto-scientific alchemy. For the alchemist went on to design processes for reproducing at a much faster rate the cyclical rhythms of Nature which controlled the maturing of minerals and metals in the earth. No man could wait 4320 years to see Nature make an elixir, but by fabricating one with his own hands in a few months or a year he would have a unique opportunity to experience and study the cyclical forces responsible for that change and thus for all natural change. No undertaking could be more quintessentially Taoist. And when the elixir acted in projection it was nothing less than a 'time-controlling substance'.[c] It accelerated the time-scale of perfection; and once the further point of perfection was reached, it cancelled time's attrition (for that is what perfection implied). Fig. 1516 has been designed to show how the deceleration of human ageing was the counterpart of the acceleration of the forming of the imperishable metal. Ko Hung says this almost in as many words: 'All the numinous fungi can bring men to longevity and material immortality—and this belongs to the same category as the making of gold'.[d] And he goes on to quote the

[a] Cf. Eliade (5), pp. 175ff. Arabic alchemical thought, intermediate between those of China and later Europe, also had this idea. In those parts of the Jābirian Corpus and al-Rāzī's *Kitāb Sirr al-Asrār* which went to form the Latin *De Aluminibus et Salibus* a couple of hundred years later we find much talk of mercury and sulphur turning into gold and silver in hundreds of years within the earth—but also God has given power to men to accomplish the change in a few days. Fermenting like yeast, the elixirs do just this. See the translation of Ruska (21), Lat., pp. 62, 64, Germ., pp. 96, 98.

[b] The control of growth- and differentiation-rates in plants and animals had to await the development of modern biology, one of the latest of the post-Renaissance sciences.

[c] The phrase was first used by one of us (N.S.) at the Bellagio Conference on Taoist Studies (1968).

[d] *PPT/NP*, ch. 16, p. 5*a*, *b*, tr. auct., adjuv. Ware (5), pp. 268–9.

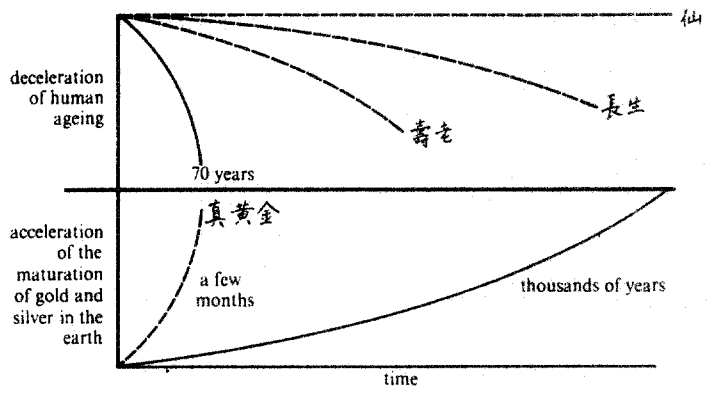

Fig. 1516. Diagram to illustrate the conception of 'time-controlling substances'. Above, the deceleration of human ageing, the attainment of prolongevity through gerontological continuance (*shou lao*) to centuries of life (*chhang shêng*) or material immortality as a *hsien*. Below, the acceleration of the normal maturation of gold and silver in the earth, 'true yellow gold' (*chen huang chin*) being produced in a few months instead of long ages.

optimistic words of Huang Shan Tzu:[1] 'Since heaven and earth contain gold, we also can make it.'[a]

What needs emphasising is that the alchemist's enterprise, as he himself defined it, was not chemistry in any usual sense of the word but physics.[b] The concern that brought his models of the cosmic process into existence was not directly with the properties and reactions of various substances. These properties and reactions were no more inherently important than the characteristics of pigments which a painter must master in order to produce the picture which exists in his mind's eye. Chemical knowledge and proto-chemical concepts were by-products, and alchemists did not lack the acumen to record and build upon them. But the aim of the process, which conditioned every step in its planning, was the model of the Tao, the cyclical energetics of the cosmos.

Looking at all the evidence impartially, one cannot escape the conclusion that the dominant goal of proto-scientific alchemy was contemplative, and indeed the language in which the Elixir is described was ecstatic. Here is one of a hundred descriptions which might be adduced to prove the point:

Open the reaction-vessel. All the contents will have taken the shapes of golden silkworms or jade bamboo shoots, or of lions, elephants, oxen, or horses, or the form of a human general of great courage. The shapes will vary, but they will all be induced by the spiritual force of the sun, planets, and stars, and the *chhi* of the heroes of sky and earth. What congeals in these amazing ways is the essence of water and fire, Yin and Yang.[c]

[a] An obscure alchemist, apparently of the Han period, but not mentioned elsewhere by Ko Hung. A Huang Shan Chün has two 'biographies' in the *Tao Tsang*.

[b] Although of course we can discern a considerable element of the former in his processes. We shall have more to say about proto-chemical ideas below, pp. 298ff.

[c] *Chin Hua Chhung Pi Tan Ching Pi Chih*[2] (Confidential Instructions on the Manual of the Heaven-Piercing Golden Flower Elixir), +1225; *TT* 907, ch. 2, p. 16*a*, tr. auct. This is the book by Phêng Ssu & Mêng Hsü which we draw on so much elsewhere (pp. 3, 35ff., 43, 58, 71ff.) in connection with chemical apparatus.

[1] 黃山子 [2] 金華冲碧丹經祕旨

In a second example we can readily identify what the alchemist was looking at:

> If you wish to prepare yellow gold, take 1/24 ounce (*chu*[1]) of Cyclically Transformed Elixir and put it into a pound of lead; it will become real gold. You may also first place the lead in a vessel, heat it until it is liquefied, and then add one spatula of the Scarlet Medicine to the vessel. As you look on, you will see every colour flying and flowering, purple clouds reflecting at random, luxuriant as the colours of Nature—it will be as though you were gazing upwards at a gathering of sunlit clouds. It is called Purple Gold, and it is a marvel of the Tao.[a]

One could hardly hope for a better description of what a cupeller sees on his lead button as it oxidises and the oxide is moved by surface tension.[b] But the richness and vividness of the particulars bespeak a state of heightened awareness which one is naturally tempted to link with the alchemist's meditative practices, since we see it so widespread in the texts. We cannot rule out the possibility that drugs played a role in this tendency to perceive *multum in parvo*, many descriptions coming close to those reported by takers of hemp and other hallucinogens today, but ecstatic introspection was so common in ancient China that this is hardly a necessary hypothesis.[c]

The alchemist undertook to contemplate the cycles of cosmic process in their newly accessible form because he believed that to encompass the Tao with his mind (or, as he would have put it, his mind-and-heart) would make him one with it. That belief was precisely what made him a Taoist. As we have pointed out earlier, the idea behind Taoist ataraxy is not at all unlike one of the central convictions of early natural philosophy in the West, namely that to grasp intellectually the constant pattern which underlies the phenomenal chaos of experience is, in that measure, to be freed from the bonds of mortal finitude.[d] The idea that scientific knowledge leads to spiritual power also accounts for the extreme attention given to ritual purity—to fasting, cleanliness, invocations and spells, and the location of the laboratory in a place safe from contamination by contact with the profane.[e]

Before returning to the main thread of our exposition, it is necessary to acknowledge an obvious question. If the use of the alchemical process was contemplative, why was the adept at such pains to construct a complex object of meditation in the external world rather than in his mind? After all, a purely mental quest might well have been just as rewarding. The best answer we can offer is a reminder that laboratory alchemy was only one of many means to Taoist transcendence of the mortal condition. Each discipline had its adherents, who chose it because its style suited them (and most found it useful to choose more than one). Those who found an external object useful practised external alchemy; those who did not practised internal or physiological

[a] *Thai-Chhing Chin I Shen*[2] *Tan Ching* (Manual of the Potable Gold or Metallous Fluid and the Magical Elixir or Enchymoma; a Thai-Chhing Scripture), probably between +500 and +550, in *YCCC*, ch. 65, p. 15*b*, tr. auct. Another version is found in *TT*873. For other examples of heightened awareness in descriptions of alchemical products, see Sivin (1) and Maul (1).

[b] The significance of this passage was immediately apparent to the historian of metallography Cyril Stanley Smith (priv. comm. 29 October 1968).

[c] See however pt. 2, pp. 150ff. above.

[d] See Vol. 2, pp. 63ff.

[e] On the further significance of such withdrawal cf. Vol. 5, pt. 3, pp. 36, 82–3 above.

[1] 銖 [2] 太清金液神丹經

alchemy; others found what they needed in sexual techniques or devotional objects;[a] those who needed no object at all sought the same end in more classical forms of meditation. External alchemy took the directions it did because some Taoists found the conjunction between spiritual perfection and the design of laboratory processes not only natural but obvious. We hope in what follows at least to begin making their reasoning accessible.

There was nothing man could do to make plants or animals grow to maturity in any but their own good time.[b] The only control the farmer exerted was to choose whether his crops or stock were to grow at all, and at the proper moment to terminate their life-cycles by harvesting or slaughtering in order to sustain the life-cycles of the human beings who were to consume them. Here one cannot but repeat Mencius' story of the man of Sung, 'who was grieved that his growing corn was not longer, so he pulled it up. Returning home, looking very stupid, he said to his people, "I am tired today. I have been helping the corn to grow long." His son ran to look at it, and found the corn all withered.'[c] This conviction that man's benefit lies in conforming to and when possible furthering the inexorably paced work of Nature lies close to the heart of Chinese quietism and Taoist ataraxy.[d] Equally, the realisation that the rate of mineral growth was controllable was one of the stoutest ideological props of the quest of the Taoist magus for a state of affairs in which, as Ko Hung[1] put it, 'my span of life is up to me, not to Heaven.'[e] That realisation was no innovation of the alchemist, although he was certainly the first to make philosophical use of it. In truth it is a distant cousin of the assertion often made about great artificers and inventors like Chang Hêng[2] (+78 to +139) that 'their ingenuity (or workmanship) rivalled (or equalled) that of the Shaping Forces.'[f] As Eliade has shown for many cultures, and Granet began to demonstrate for China, a consciousness of superhuman responsibility for interfering in the life-cycle of minerals was embodied in the rituals (often obstetrical in imagery) of the miner who delivered the ores from their womb and the smelter who converted them rapidly into metals much further along the scale of maturity.[g] Both were taking unto themselves dangerous powers, and needed all the protection that tabus and rituals could provide. This need was also urgent in alchemy.[h] That metal-workers succeeded made them magicians and heroes.[i] The alchemists, who accepted

[a] The most general view, however, was that sexual techniques alone could lead to lengthened life but not to immortality. See, for instance, *Huang Ti Chiu Ting Shen Tan Ching Chüeh* (*TT*878), ch. 4, pp. 1*a*–2*b*, which makes this point but also says: 'Or if he only takes the Medicine, and does not obtain the essentials of the Art of the Bedchamber, then it will be impossible for him to live for ever.' This is because if adepts 'give free rein to their emotions and desires, without knowing that they can equitably regulate the dispersion (of their *chhi*), they are hacking at the trunk of their lives.' On this whole subject see pt. 5 below.

[b] This is not to deny the existence of beliefs in the possibility, for instance, of growing plants instantly by magic. The tradition of this in Chinese culture has been traced by van Gulik (4).

[c] See Vol. 2, pp. 576–7.

[d] See Vol. 2, p. 66.

[e] We discuss this slogan more fully below in pt. 5.

[f] *Chin Shu*,[3] ch. 11, p. 3*b*, is an example of this.

[g] Eliade (5); see also Granet (1), pp. 496–501.

[h] The most complete collection of alchemical rituals is probably that in the *Huang Ti Chiu Ting Shen Tan Ching Chüeh* (*TT*878).

[i] Eliade (5), pp. 87–108.

[1] 葛洪 [2] 張衡 [3] 晋書

the reality of the magic-ritual experiential universe of the smith, were at the same time ready to apply to it an abstract proto-scientific analysis. They saw the parallel between the metallurgist's midwifery and the operation of the Shaping Forces in Nature, and adapted to cosmic concerns the arts of maturing metals.

That the apparently artificial conditions of the laboratory could be made profoundly natural and responsive to the operation of the larger Tao is an axiom of alchemy. As the 'Supplementary Instructions to the Yellow Emperor's Nine-cauldron Spiritual Elixir Canon' put it,

> When earth mixes with water to form mud, and is kneaded (*hsien*[1]) (by subterranean processes) below a mountain, there will be gold, and generally cinnabar above it. When this (cinnabar) is ceaselessly metamorphosed and cycled, and once again forms gold, this is merely a reversion to the root substance, and not something to be wondered at.[a]

How could the alchemist be sure that what went on in his reaction-vessel represented a cosmic process? If it did not, like the man of Sung he would be overruled by the Tao, and his elixir would wither. Given the character of the Chinese system of thought, success was bound to be a question of establishing correspondences[b] which would ensure the identity of his process with that of Nature. The adept had at his disposal a diversity of approaches ranging from highly abstract theories to magical invocations. The complex design of most extant alchemical processes obviously depended upon so many considerations of every kind that today we can hardly begin to explain particular choices of ingredients, apparatus, and treatment. The one area in which we have at least begun to glimpse the rationale behind the concrete processes is at the same time the most abstract and very probably the most crucial, namely that which has to do with the application of correspondences by the use of qualitative or quantitative analogy.

There were three primary points of application which could be used to plan a particular process as a recapitulation of the natural evolution of metals: materials, apparatus, and the timing of combustion. We shall see that all three possibilities were actually exploited, generally in conjunction. Time was the key to all three, for the Way of Nature is cyclical. It was easily within the operator's means, through timing, to make his process a microcosm which 'succeeds because of its correspondence on a scale of thousandths.'[c] Since the cosmic cycles fall naturally into phases (generally marked by Yin–Yang states or the Five Elements), he had the option of temporally phasing some aspect of his treatment. For instance, he could vary the intensity of the fire so that it gradually increased or decreased at a measured tempo, analogous to that of the alternation of Yin and Yang in the course of the year. If this controlled variation in the temperature of the process was exerted upon two ingredients, or two main ingredients, he could expect that the phasing would set up inside his sealed vessel an

[a] *Huang Ti Chiu Ting Shen Tan Ching Chüeh* (*TT*878), probably compiled in the Sung (+ 10th cent.), ch. 13, p. 2*a*, tr. auct.

[b] See Vol. 2, pp. 261 ff.

[c] I.e. what we called in Vol. 2 symbolic correlations. Cf. p. 227 above and pp. 264ff. below. We may continue to use the two terms interchangeably.

[1] 堪

alternating pattern of ascendance. First the Yin reactant would be dominant, and then the Yang one. The alternation would ensure that their qualitative correspondence to Yin and Yang became a dynamic correspondence to that rhythmic interplay of the positive and negative forces which was responsible for the maturation of metals as well as for all other growth. The alchemist could invoke further guarantees of fidelity to cosmic process by controlling the design or dimensions of the apparatus to produce a spatial microcosm as well. The furnace might be oriented with respect to earth and sky by what we would consider ritual means; then again, its measurements might be planned for numerological significance connected with the Order of Nature; or its form might be based upon that of the womb or its analogue the cosmic egg.

Let us now proceed to examine the ways in which these possibilities, and others created by their interplay, were actually applied, in order to throw more light on the ideas which evolved them. Again we can hope to do no more than demonstrate how a few basic strategies were embodied in a great variety of tactics. It is impossible to say very much about the development of these tactics when the chronological relations of so many sources can still only be guessed at. We must also remind the reader that some alchemists seem quite unconcerned with cosmic parallels, and indeed with any rationalisation of the process at all. But this almost purely pragmatic approach is the exception, and even so an acquaintance with theory is often implicit in its documents.

By the +16th century European alchemists had also come to appreciate the timing of reactions, and many a medieval Chinese adept would have agreed with the words of William Blomfield, written in +1557:

> But if thou wilt enter the *Campe of Philosophy*
> With thee take Tyme to guide thee in the way;
> For By-paths and Broade wayes, deep Vallies and hills high,
> Here shalt thou finde, with pleasant sights and gay;
> Some shalt thou meete which unto thee shall say
> *Recipe* this, and that; with a thousand things more
> To *Deceive* thy selfe, and others; as they have done before.[a]

(i) *Emphasis on process in theoretical alchemy*

Although one cannot conclude that the *Chou I Tshan Thung Chhi* (+142) was the *fons et origo* of theoretical alchemy merely because it is the oldest book of its kind which we can still examine, it was certainly considered a basic canon by later theoretically oriented alchemists, who referred to it often and adapted its idea of a chemical process based upon cosmic patterns.[b] We have seen earlier that no one can even say with confidence what the book was meant to be about. It can be—and has been—read as a poetic treatise on the inner significance of the 'Book of Changes', on cosmology,

[a] 'Bloomefields Blossoms', in Ashmole's *Theatrum Chemicum Brittannicum*, 1652, pp. 305–23.

[b] Studying its exegesis and adaptation in early alchemical and other Taoist treatises is indispensable for evaluating the *Tshan Thung Chhi*, since none of its early commentaries survive, and the late ones represent very tendentious readings. In particular, as we have noted (pt. 3, p. 57), they re-interpret the alchemical level entirely in terms of the enchymoma.

on breath control, on sexual techniques, on laboratory alchemy, or on any combination of these.[a] Although the uncertainty is real enough, it is not very relevant to the later development of alchemy. Those alchemists who used the book simply assumed that it really was about the Outer Elixir, and that its purpose was to describe in recondite language the metaphysics of the laboratory process. So reading it, they were no less satisfied than those who applied its concepts (and still do, for that matter) to physiological disciplines.[b]

Here we recall a comment of the bibliographer Chhao Kung-Wu[1] (d. +1171) on the 'Essay upon the Sun, Moon, and the Dark Axis' (*Jih Yüeh Hsüan Shu Lun*,[2] *c.* +740) of Liu Chih-Ku:[3]

In the reign of the Brilliant Emperor he was Prefect of Chhang-ming[4] in Mien-chou[5] (Szechuan). At that time there was an edict seeking out gentlemen who understood the Elixir Medicine. Chih-Ku said that of the great Medicines of the immortals, none falls outside the scope of the *Tshan Thung Chhi*. He therefore composed this essay and submitted it to the court.[c]

The *Lung Hu Huan Tan Chüeh* puts it just as unequivocally:

For the Cyclically Transformed Elixir there is no formula; the *Chin Pi Ching*[6] and the *Tshan Thung Chhi* are its formulae.[d]

The preface to the oldest extant commentary upon the latter, written *c.* +945 by Phêng Hsiao,[7] a priest of the Chêng-I[8] denomination of Taoism in Szechuan, sees in it the prototype of the cosmic model (though Phêng was interested in laboratory alchemy only to the extent that its ideas and imagery were incorporated in 'dual cultivation').[e] He wrote:

(Wei Po-Yang) compiled the *Tshan Thung Chhi* to show that in preparing the Elixir one's Tao is the same as that of the Shaping Forces of Nature. Therefore he drew upon the symbols of the 'Changes' to develop this point.[f]

[a] See Vol. 5, pt. 3, p. 74. [b] See pt. 5.

[c] *Chao-Tê Hsien-sêng Tu Shu Hou Chih*[9] (the sequel included in *Chün-Chai Tu Shu Chih*,[10] +1151), ch. 2, p. 33*b*, tr. auct. This note appears in the body of the 20-chapter edition compiled by Chhao's disciple Yao Ying-Chi[11] from Chhao's 4-chapter edition with posthumous addenda, and first printed in +1249 (ch. 16, p. 10*b*).

[d] *TT*902, ch. 1, p. 1*a*, tr. auct. See also *YCCC*, ch. 70, p. 1*a*. The *Chin Pi Ching* remains one of the great enigmas of Chinese alchemical literature, constantly mentioned and quoted (especially from the Sung on) as a text of great authority, but without agreement as to alternative names, authorship, or provenance. For instance, the citation from it by Wu Tshêng which we have quoted earlier (pt. 3, p. 150) is to be credited to the *Chin Tan Chin Pi Chhien Thung Chüeh*[12] in the *nei tan* section of *YCCC*, ch. 73, p. 7*b*. As Chhen Kuo-Fu (*1*), pp. 287–9, has noted, a number of quotations attributed to the *Chin Pi Ching* in late works actually come from the *Tshan Thung Chhi*. Since at the moment we have nothing to add to Chhen's review of the problem, we refer the reader to his note.

[e] 'Dual cultivation' is (as we saw, p. 212) the term coined by Liu Tshun-Jen (1) to describe a late form of internal or physiological alchemy which depended greatly on a variety of sexual techniques. We do not agree with his view that laboratory alchemy played little or no part in it. See below, pt. 5.

[f] *Chou I Tshan Thung Chhi Fên Chang Thung Chen I*[13] (*TT*993), preface, p. 1*b*, tr. auct. Although this commentary has no date, Phêng's *Chou I Tshan Thung Chhi Ting Chhi Ko Ming Ching Thu*[14] (*TT*994) is dated +947.

[1] 晁公武 [2] 日月玄樞論 [3] 劉知古 [4] 昌明 [5] 綿州
[6] 金碧經 [7] 彭曉 [8] 正一 [9] 昭德先生讀書後志
[10] 郡齋讀書志 [11] 姚應績 [12] 金丹金碧潛通訣
[13] 周易參同契分章通眞義 [14] 周易參同契鼎器歌明鏡圖

But the surest sign of the book's importance is its ubiquity. The majority of later writings (especially of the Thang and Sung) which quote any authority on theory quote it, very often citing it simply as 'the Canon'.[a]

The process of the *Tshan Thung Chhi*, when it is read on the laboratory-alchemical level, involves two ingredients which are sealed in a reaction-vessel and subjected to the cyclically regulated influence of heat. The reactants, as we have seen, are likened to Yin and Yang both directly and by the use of many Yin–Yang embodiments—dragon and tiger, fire and water, husband and wife, and so on. The equitably phased variation in the intensity of the fire is also explained in terms of the cosmic Yin–Yang cycles which condition the coming-into-being and passing away of phenomena. The sequence of steps is controlled by the use of the *I Ching* trigrams and hexagrams. The reaction-vessel is likened to the undifferentiated primordial chaos (*hun-tun*[1]) from which phenomenal things are eventually formed. Each of these themes became perennial, but there was a less obvious influence upon later generations too. In the *Tshan Thung Chhi* the emphasis is on the process, and the product is practically ignored. There are no instructions for compounding, no rituals for ingestion, and a mere couple of cursory descriptions of that immortal beatitude which to pragmatic alchemists like Ko Hung was the whole point.[b] In this sense the *Tshan Thung Chhi* was a precursor of the extreme theoretical tendency in later alchemy. Among its posterity we find occasionally such a concern with gnostic rapture, achieved by contemplating the process, that the practical steps between understanding the reaction and becoming an immortal are skipped altogether. Perhaps the clearest of many examples occurs in the *Thai Ku Thu Tui Ching*[2] (Most Ancient Canon of the Joy of the Earth),[c] an undated work, possibly Thang or earlier, on the fixing ('subduing', *fu*[3])[d] of minerals and metals:

> This discussion of the Five Metals is not the great doctrine of the Perfect (or Realised) Tao. But if (the devotee) attains a clear and penetrating understanding of these Five Elements, one can proceed to a discussion of fire-subduing, and can then talk to him about the Tao of projection (*tien hua*[4]).[e] When he has comprehended every aspect of the Five Elements, he will be a man of balanced Realisation, and the Three Worms[f] will leave his body.[g]

[a] This point may be verified even from the few treatises which have been translated into Western languages; see e.g. Fêng & Collier (1) and Spooner & Wang (1).

[b] That the adept's life is lengthened once the elixir enters his mouth is stated in ch. 1, p. 24*a*. His journey through the void and enrolment among the immortals is described very briefly in ch. 1, p. 19*b*, and ch. 3, p. 10*b*.

[c] In this very provisional translation of the title, 'Earth' (*thu*[5]) is the median element and 'Joy' (*tui*[6]) is one of the eight trigrams of the *I Ching*. Among the metals the former is associated with gold and the latter with silver (though that is not its only meaning in alchemy; see Sivin (1), pp. 194–5 n.). On the date of this work see Chhen Kuo-fu (1), vol. 2, p. 391.

[d] Sivin (1), p. 148, notes that 'as used rigorously *fu*[7] or *fu huo*[8] means "chemical treatment of a volatile substance so that it is no longer volatile under normal conditions"'; and that the terms are also used loosely to describe certain products merely earthy in appearance, or, when mercury is fixed, merely solid. *Chih*[9] (lit. 'restrain') is used alternatively for the same kinds of process, as is *ssu*[10] (lit. 'kill') though the latter is sometimes specialised to mean ridding of toxicity (see above, pp. 4ff., 187, 191, 198 and below, p. 263).

[e] See pt. 3, *passim*. [f] See pt. 5 below. [g] *TT*942, ch. 1, p. 4*b*, tr. auct.

[1] 混沌 [2] 太古土兌經 [3] 伏 [4] 點化 [5] 土
[6] 兌 [7] 伏 [8] 伏火 [9] 制 [10] 死

(ii) *Prototypal two-element processes*

Although ink will continue to be spilt over the question of precisely what chemical reactions the *Tshan Thung Chhi* is describing,[a] the general outline of the process is unambiguously cosmogonic. It is recapitulated in this rhymed passage:[b]

Cinnabar is the seminal essence of Wood;
When it encounters Metal, they unite.
Metal and Water conjoin,
Wood and Fire are partners.
These four the chaos (*hun-thun*[1]),
Aligning as dragon and tiger.
Dragon Yang, its number odd;
Tiger Yin, its number even.
Liver, caerulean, the father,
Lungs, white, the mother,
Reins, black, the son:[c]
Three substances, one family,
Reunited at the centre (*wu chi*[2]).[d]

The apparent obscurity of this text begins to dissipate as soon as we recall the correlation between the Five Elements and Yin and Yang. Fire and Water represent the maximal or mature phase of Yin and Yang respectively (Fig. 1515). Wood and Metal stand for the phase in which one of the polarities is becoming dominant but is not yet at its height—within the system of the year, naturally, the intermediate seasons of spring and autumn—and so on. Seen in another way, they are intermediate phases in the alternating dominance of the polar complements. To use a metaphor the cogency of which will shortly become clear, Wood (immature Yang) is the son of Water (mature Yin), from which it emerges, but it is also the father of the Fire phase (mature Yang) which succeeds it.[e] Chinese thinkers ordinarily referred to these emergent

[a] We do not raise again here the question of whether the *Tshan Thung Chhi* was originally meant as a work of laboratory or physiological alchemy or both (see above, pt. 3, pp. 50ff.). Our aim in what follows is simply to show how the book was understood by *wai tan* thinkers. *Nei tan* adepts had their own interpretations, which varied according to whether the treatise was being understood philosophically or in terms of respiratory or sexual practices; examples may be found throughout Vol. 5, part 3, especially pp. 150, 200.

[b] Ch. 2, p. 23*a*, tr. auct.; cf. Wu & Davis (1), p. 255. The lack of a critical edition is especially unfortunate here, for various versions differ as to the number of lines in this passage and their arrangement, as noted below. Our translation rejects all lines in which confidence is not fully warranted, but we must emphasise that it is based on a tentative reading of the text.

[c] At this point in the *Chou I Tshan Thung Chhi Fên Chang Chu Chieh*, our basic text, three additional lines occur: '(The trigram) Li,[3] scarlet, is the daughter, Spleen, yellow, is the ancestor; The motion commences on the north–south line (*tzu wu*[4]).' They appear also in the *Tshan Thung Chhi Shan Yu* of +1669 in a different order, but in Chu Hsi's *Khao I* of +1197 only the second line is found. The great commentator notes: 'The two lines "Heart, scarlet" and "Spleen, yellow" do not appear in the various editions; I do not know which version is the correct one' (pp. 20*b*–21*a*). The wording of this note indicates that versions available to Chu Hsi originally read 'Heart, scarlet' (*hsin chhih*[5]) rather than 'Li, scarlet' (*li chhih*[6]). We provisionally omit both lines partly because of their uncertainty and partly because they conflict with the idea of a triune family expressed in the next line.

[d] Literally, 'to the fifth and sixth of the ten celestial stems', which correspond to centre and Earth.

[e] We follow, as do the texts, the Mutual Production order. See also above, pp. 225, 229.

[1] 混沌 [2] 戊己 [3] 離 [4] 子午 [5] 心赤 [6] 離赤

phases as 'the Yin within the Yang', and vice versa. Earth is the neutral phase of balance in which, as we should put it, the polarities cancel out.

Read alchemically, Wei Po-Yang's verses begin by constructing the primordial Chaos out of the four 'unbalanced' elementary phases (in which either Yin or Yang predominates). Only one of the four, Wood, is explicitly identified with a substance, though it is natural enough to speculate that Metal stands for another. But we know already that the customary association of cinnabar is not with Wood but with Fire, which follows Wood in the Mutual Production succession order. We are constrained to allow for the possibility that 'cinnabar' is meant no more concretely than the dragon's odd number a bit further on, and that the first line may be asserting nothing more than the conventional genesis of the category Fire (as 'seminal essence')[a] from the category Wood. Be this as it may, Metal and Wood (immature Yin and Yang) unite, and also merge with Water and Fire (mature Yin and Yang) through affinity of like with like, to form the Chaos. What fills the functional categories Water and Fire—whether other substances or alchemical treatment with water and fire—is left open. Indeed the point may simply be that Wood and Metal mature within the Chaos in the direction of complete differentiation as Yang Fire and Yin Water, though this explanation would seem to be based on a rather confused notion of the Chaos.

Then in the course of the treatment the 'iron law of entropy' reverses itself, and the undifferentiated contents of the vessel segregate spontaneously into Yin and Yang components (tiger and dragon), which are thought of as spatially separate. These differ from the Yin–Yang components with which the process began in that their polarities are reversed. In the cosmological tradition the status of dragon and tiger as abstractions is ambiguous. They embody Yin and Yang emergent from their opposites, but early sources differ as to whether the dragon is Yang within Yin or Yin within Yang.[b] Here we can be reasonably sure that the dragon represents Yang emergent from Yin (its odd number is merely another Yang resonance), and the tiger the opposite.

The point is reinforced by the image of a family, in which the immature Yang, or Wood (identified by its visceral and colour associations) is the father, the immature Yin, or Metal, the mother, and the mature Yin, or Water, the son. This feminine son redeems his family through a return to the Centre, that is to say through his role as an intermediary in the formation of the Yellow Sprouts from which the Elixir is grown. The line 'Spleen, yellow, is the ancestor',[c] which appears in Chu Hsi's text, affirms

[a] See pp. 229ff.

[b] A commentary on the *Huai Nan Tzu* book, ch. 3, p. 2*b*, which appears in *TPYL*, ch. 929, p. 7*a*, refers to the dragon as the Yin within the Yang, or immature Yin. The opposite, however, is asserted in the apocrypal *Chhun Chhiu Wei Yuan Ming Pao*[1] (*Ku Wei Shu*, ch. 7, p. 8*b*). In the *Kuan Lo Pieh Chuan*,[2] another work also mostly lost, we are told that 'the dragon is the Yang seminal essence lying concealed within the Yin'. Both these passages are cited in the encyclopaedia *Chhu Hsüeh Chi*,[3] ch. 30, p. 22*a* (pp. 740, 738) respectively. Although the dragon is conventionally associated with water (as e.g. in *Lun Hêng*, ch. 29, tr. Forke (4), vol. 1, pp. 356–7, where the relation is specified as categorical affinity), in the trigram system of the 'Book of Changes' it is associated with the fiery *kua* Chên.[4] As for Kuan Lo, he was a famous geomancer and diviner of the San Kuo period (cf. Vol. 4, pt. 1, pp. 296, 302), and his biography was written in or before the Thang.

[c] Or, 'grandparent'.

[1] 春秋緯元命包 [2] 管輅別傳 [3] 初學記 [4] 震

this point while completing the family metaphor; the ancestor, corresponding to the medial Earth phase, is the neutral organising centre to which the son returns.[a] It is easy enough to find this metamorphosis delineated explicitly in later texts, as in this example from Chang Hsüan-Tê's 'Mental Mirror':

> The oral formula says: 'Use 8 oz. of lead, which is Yang, the Masculine, and the Tiger; and 9 oz. of quicksilver, which is Yin, the Feminine, and the Dragon. These two ingredients may metamorphose into a Lead which is also Yin. It corresponds to black, Water, and the number 1, and is Yin'.[b]

It is important to keep in mind that this concreteness closes many alternate avenues of opinion which the *Tshan Thung Chhi* leaves open, and which other alchemists later followed.

Thus summarised, the plot of the story incorporates the familiar separation of Yin and Yang out of the universal blend, which Wang Chhung[1] had amply expressed sixty years before Wei Po-Yang. We have already discussed the marriage of the masculine and feminine forces, which engenders the phenomenal world, as it is described in the *Huai Nan Tzu*[2] two centuries earlier still.[c] But here we see a new idea of great originality and religious depth: a double hierogamy, the first union resulting in complete undifferentiation and then complete differentiation, and the second union leading ultimately to the perfectly balanced and enduring organisation of the Elixir.[d] It would be tempting, though perhaps superficial, to point out a parallel with the basic spiritual process of Western alchemy, which unites the Stoic and Gnostic pioneers with the Christian magi of the Renaissance: the androgynous union as the Death of the Soul, and the perfect reconciliation of opposites in its resurrection.[e]

To return to our exploration of the alchemical level of meaning, in principle Yin and Yang may be brought to bear on the process in different ways and at different stages. First they can be represented by two reactants which are blended and sealed within the vessel, duality subsequently merging to constitute the Chaos. It is equally logical to apply Yin and Yang as cyclic phases which alternate in time, as the sealed vessel and its contents are subjected to the periodic variation of fire or some other

[a] One could hardly wish for a better instance of the functional character of alchemical thought. In the family image the immature elementary phases are considered the parents, which give birth to the mature Yin son, this son in turn completing them. The dragon and tiger, like the son, represent the post-Chaos stage, but they are conventionally associated with the immature polarities. The apparent contradiction disappears when we realise that the dragon–tiger image is meant to suggest not latency but emergence—in other words, to emphasise the evolution of the polarities from their opposites.

[b] *Tan Lun Chüeh Chih Hsin Ching* (*TT*928), probably Thang; p. 6*a*, tr. Sivin (5). It is not impossible that the oral formula ends just before the last sentence, which would thus be the author's comment.

[c] Pp. 224–5 above, and Vol. 2, pp. 371–4. Of course both these ideas may be found less distinctly expressed though fully fleshed before the Han. See, for the former, the Great Commentary of the Book of Changes (*Hsi Tzhu Ta Chuan*[3]), XI, 5, tr. Wilhelm (2), vol. 1, p. 342; and for the latter, *Lü Shih Chhun Chhiu*[4] (−239), ch. 5, sect. 2, (ch. 22); tr. Wilhelm (3), p. 56.

[d] For the *nei tan* interpretation of this same process, see below, pt. 5.

[e] Cf. pt. 2, pp. 22ff. above, p. 361 below, and again Vol. 5, pt. 5.

[1] 王充 [2] 淮南子 [3] 繫辭大傳 [4] 呂氏春秋

treatment. The separation of the Chaos yields a 'pure' Yin and Yang, of supramundane perfection and thus no longer embodied in the ingredients. The new pair bears the same relation to the original substances as an immortal does to an ordinary mortal. Their polarities are reversed to signify the realisation of potential. Later alchemists and annotators spoke of the pair as Realised Lead (*chen chhien*[1]) and Realised Mercury (*chen hung*[2]), or Realised Metal and Realised Water, and tended to think of them as actual substances, intermediates in the preparation of the Elixir.[a] Some, less interested in theoretical rigour than in results, simply took them as cover-names for ingredients.[b] Nevertheless, once the commentaries are set aside it is hard to see this second-stage Yin and Yang represented in the text as anything but functional categories.

The implication of many commentators that the original ingredients are lead and mercury is also far from unambiguously justified, even on the assumption that the book was written to make chemical sense. In an extremely arcane argument which introduces sons and mothers, white tigers and caerulean dragons, sun and moon, purely for their categorical associations, it is perfectly possible that the metal lead is merely meant to stand for the corresponding element Water. Let us examine the only mention of metallic lead in context.[c] There it is juxtaposed with the River Chariot (*ho chhê*[3]), which in later alchemy regularly refers to mercury. It would be poor method, of course, to assume the same specific identification in the *Tshan Thung Chhi*:

> Knowing the white, cleave to the black,
> And the spirits will make their appearance.
> The white is the essence of Metal,
> The black, the fundament of Water.
> Water is the pivot of the Tao;
> Its number is called One.
> At the inception of Yin and Yang
> The Dark (*hsüan*[4]) holds Yellow Sprouts in its mouth.
> It is the Master of the Five Metals;
> The River-chariot of the North.
> Thus lead, black outside,
> Holds in its bosom the floreate essence of Metal.[d]

[a] The outstanding prominence of 'true' or 'vital' lead (*chen chhien*) and 'true' or 'vital' mercury (*chen hung*) in *nei tan* physiological alchemy we emphasise in its appropriate place below (pt. 5). Although the terms occur more rarely in *wai tan* elixir alchemy they certainly do appear in that context (cf. pp. 258ff.), and can even be found in connection with chemical industry. An example of this last usage occurs in *Ling Wai Tai Ta* (+ 1178), ch. 7, pp. 11*b*, 12*a*, where Chou Chhü-Fei is discussing the cinnabar mines of Yungchow and Kuei-tê. He opines that mercury produced from cinnabar is not *chen hung* (thus contrary to Mêng Yao-Fu, p. 259 below), and suggests that the term should be reserved for the native mercury which could be collected in these mines. Free mercury does in fact sometimes occur disseminated in mercuric ore beds (Gowland (9), p. 348; Mellor (1), p. 341; Partington (10), p. 393). How much Chou Chhü-Fei knew about the terminological usages of *wai tan* and *nei tan* adepts is of course a moot point. He is clearly taking '*chen hung*' in its most literal sense as 'authentic mercury'.

[b] Especially in physiological alchemy; cf. pt. 5 below.

[c] Metallic lead is also mentioned, along with white lead, in an example of transformation in ch. 12, p. 25*b*; see above, pt. 3, p. 68.

[d] Ch. 1, p. 16*a*, tr. auct. Echoes of the *Tao Tê Ching* are very obvious here; cf. Vol. 2, pp. 57, 59.

[1] 眞鉛 [2] 眞汞 [3] 河車 [4] 玄

The mention of Yellow Sprouts establishes that these verses are about the Yin and Yang which have emerged from the Chaos, not those which went into it; even in the extant commentaries, none of which is committed to a *wai tan* interpretation, we find the white and black of this passage equated with Realised Metal and Realised Water.[a] 'The Dark' and 'lead' are thus arcane ways of referring to the Black Son encountered a few pages back—the Yang Water out of which the Yellow Sprouts (and thus, in the longer view, the Elixir) is prepared. The 'floreate essence of Metal' in the last line is an already familiar way of designating the element which precedes Metal in the Mutual Production order, namely Earth, to which the balanced Yellow Sprouts corresponds.[b] The emphasis on the black, on Water as the pivot of the cosmic process, is anything but rhetoric. Of the post-Chaos Yin–Yang pair, black Metal and white Water, it is the former which becomes pregnant with the Yellow Sprouts.[c]

The early alchemist who was more concerned with finding practical instructions in this gnomic text than with plumbing its philosophical meaning could take either of two basic directions. He could interpret it as concerned with some operation involving lead and mercury, perhaps in an amalgam.[d] But he might also understand the direct reference to lead as a mere illustrative example of how a substance can be one thing on the outside (or actually) and something else inside (or potentially). On this reading the text is concerned in a very theoretical way with the metamorphoses of mercury—or cinnabar, which as we shall see amounts to the same thing—alone. Many alchemical treatises which follow in one way or another the tradition of the *Tshan Thung Chhi* merely deal abstractly with the deeper meaning of its correspondences or images, or the further development of its hexagram phasing system; these require no commitment to particular amounts of specific minerals or metals. But any Taoist who aimed to carry out a two-element elixir process had to come to a concrete chemical understanding of the *Tshan Thung Chhi*, within the limits of his access to the alchemical and technological knowledge of his time.

The intellectual history of the various choices that were made will be one of the most interesting chapters in the history of Chinese alchemy when the time comes that it can be written. In the meantime a couple of examples of actual prototypal two-element processes must serve to illustrate the interplay of theory and practice in medieval alchemy. We are here concerned primarily with practical experimentation but in considering this one should always bear in mind how deep was the impress of the two-element processes upon physiological alchemy (cf. pt. 5.). Indeed the physiological adepts were, one might say, on the whole more faithful to them than the chemical alchemists.

The oldest mercury–lead process for which we have clear directions is in the 'Yellow Emperor's Canon of the Nine-Vessel Spiritual Elixir'. One of the sources of Ko Hung's *Pao Phu Tzu* (*Nei Phien*), the 'Canon' may indeed antedate the *Tshan*

[a] For instance, *Tshan Thung Chhi Shan Yu* (+1729), Sect. 7.
[b] See Vol. 2, pp. 255ff.
[c] See below, p. 259, where Realised Lead is called 'the ground of the Elixir'.
[d] See Vol. 5, pt. 2, pp. 242ff.

Thung Chhi. This is the 'Canon's' recipe for 'Black-and-Yellow' (*hsüan huang*[1]),[a] an intermediary in the preparation of the Nine Elixirs:[b]

Take ten pounds of quicksilver and twenty pounds of lead. Put them into an iron vessel, and make the fire underneath intense. The lead and the quicksilver will emit a floreate essence (*ching hua*[2]). This floreate essence will be purple, or in some cases may resemble yellow gold in colour. With an iron spoon, join it together and collect it. Its name is 'Black and Yellow', and it is also named 'Yellow Essence' (*huang ching*[3]), 'Yellow Sprouts' (*huang ya*[4]), and 'Yellow Weightless' (*huang chhing*[5]).[c] The medicine is then put inside a bamboo tube and steamed a hundred times. It is mixed with realgar and cinnabar solutions and volatilised.

The point of the final instructions becomes clearer subsequently, when the alchemist is directed to dissolve the Yellow Sprouts in a weak mineral acid mixture (*hua chhih*[6]),[d] recover it by evaporation, and subdue it in the fire (*fu huo*[7])[e] by heating for 36 days in a heavily luted vessel.[f] Then it is sublimed for another 36 days over an intense fire to yield the first of the series of nine canonical elixirs, 'Elixir Flowers' (or 'Floreate Essence of Cinnabar', *tan hua*[8]).

One can only guess once again at the chemical identity of Black-and-Yellow. Its colour is not necessarily yellow. It is not necessarily a sublimate, for there is no direction that the vessel be closed. Even if sublimation was involved, the product may have included the non-volatile portion of the reactants, for the instruction to 'join' (*chieh*[9]) the product while collecting it could conceivably refer to bringing together a sublimate and a residue. All sorts of helpful details are available in the late supplementary explanations (*chüeh*[10]), which, for instance, treat the 'joining' (rather implausibly) as the formation of the amalgam, but these reflect their own time and not that of the 'Canon'.[g] Chhen Kuo-Fu has suggested that the product was a mixture of

[a] In this case black and yellow do not correspond directly to the elements Water and Earth, but to Heaven and Earth. This equation comes from the *Wên Yen*[11] commentary to the 'Book of Changes' (*sub* hexagram Khun[12]); tr. Wilhelm (2), vol 2, p. 29. Cf. also the *Thai-Chhing Chin I Shen Chhi Ching*[13] (Manual of the Numinous Chhi of Potable Gold; a Thai-Chhing Scripture, *TT*875), which makes *hsüan huang* two distinct substances, Supernal Black (*thien hsüan*[14]) and Terrestrial Yellow (*ti huang*[15]). This text, which in its flamboyant imagery and emphasis on ritual resembles the texts directly associated with Thao Hung-Ching (see above, pp. 213ff.), also comes out of the Mao Shan milieu. Its third chapter is entirely devoted to records of visitations of Wei Hua-Tshun and her companion divinities. According to a private communication from Michel Strickmann, these records, almost all of which can also be found scattered through the *Chen Kao*[16] (*c.* +500), far antedate Thao Hung-Ching's collection. They can be identified as having been copied out by Hsü Mi's great-grandson Hsü Jung-Ti[17] (d. +435) at the end of his life, and thus make up the earliest surviving redaction of authentic Yang-Hsü manuscript materials from Mt. Mao.

[b] *TT*878, ch. 1, p. 3*b*, tr. auct., adjuv. Ware (5), pp. 78–9. This formula is also discussed above, pt. 3, pp. 83ff.

[c] It is also called *chen sha*,[18] which could mean either 'True, or Realised granules' but more probably 'True, or Realised cinnabar', in ch. 1, p. 4*a*.

[d] See pp. 171ff. [e] See pp. 4ff., 187, 191, 250. [f] Ch. 1, pp. 3*b*–5*a*.

[g] The supplementary explication for this recipe is found in ch. 17, pp. 2*b*–3*a*, where the canonical text as repeated incorporates what must once have been a footnote. The colour of the *hsüan huang* is described in the *Chüeh* in considerable detail: 'As for the regulation of the fire, if it is too hot the colour of the flowers will be yellow; if it is too cold the colour of the flowers will be virid or purple, and they

[1] 玄黃 [2] 精華 [3] 黃精 [4] 黃芽 [5] 黃輕
[6] 華池 [7] 伏火 [8] 丹華 [9] 接 [10] 訣
[11] 文言 [12] 坤 [13] 太清金液神氣經 [14] 天玄
[15] 地黃 [16] 眞誥 [17] 許榮弟 [18] 眞砂

yellow mercuric and lead oxides, which would be skimmed off the molten metal with the iron spoon.[a] This is possible, but oxides thus prepared would not form the good crystals which the name of the product implies. Also, the likelihood of obtaining the yellow form of HgO instead of the red under such loosely defined conditions could only be determined by experiment. An alternative possibility is that there was no sublimate, and that as the mercury was allowed to evaporate from the amalgam in an open vessel a dendritic crystalline growth of metallic lead, containing mercury in solid solution, formed on the surface. A modern chemist might not pay much heed to this phenomenon, but the alchemist, as we have seen,[b] tended to be intensely aware of subtle changes in crystalline structure and play of colour. The Yellow Sprouts might thus be a more or less oxidised form of lead. This possibility would, however, be ruled out if, as the instructions indicate, the temperature is kept above the melting-point of lead.

This procedure, or one like it, may have exerted some influence on the formation of the highly idealised type-process of the *Tshan Thung Chhi*, but cannot totally explain its operational basis. The 'Yellow Emperor's' Yellow-and-Black formula skips the crucial Yin–Yang segregation in the second stage, proceeding directly to a union of the opposites in the yellow element Earth, which represents their balance. It was much more usual in medieval alchemy to work out processes involving the conversion of two initial ingredients into Realised Lead and Realised Mercury.

By the Sung at the latest there is no difficulty about identifying the paradigmatic substances. The eclectic compendium *Chu Chia Shen Phin Tan Fa*[1] (Methods of the Various Schools for Magical Elixir Preparations), of the Sung or slightly later, includes one of the many explicit statements:

> The Realised Dragon is the quicksilver within cinnabar. It is born when the solar seminal essence (*jih ching*[2]) of mature Yang pours down and its realised *chhi* enters the earth. It is named mercury. The Realised Tiger is the white silver within black lead. It is born when the lunar floreate essence of mature Yin pours down and its realised *chhi* enters the earth. It is styled lead.[c]

To put this more prosaically, mercury and silver are the essences of cinnabar and lead because the former develop from the latter within the earth under the influence of the masculine and feminine *chhi* respectively.[d]

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will carry a *chhi* (= aroma?). If the fire is correctly adjusted, the colour of the flowers will be red or purple, or that of gold. But when it is (then) roasted until (the vessel) is the same colour as the fire (*c.* 900°), it resembles gold remarkably in appearance. When it is taken off the fire, it returns to its original substance (*pên chih*[3]).' The implication that the gold colour is merely a transient effect would not necessarily be shared by the author of the canonical text—but note the importance it gives to the alchemist's contemplation.

[a] (*1*), vol. 2, pp. 379, 385. [b] See pp. 244ff.

[c] *TT*911, ch. 1, p. 14*b*, tr. auct. Cited from a 'Gold Elixir Dragon and Tiger Manual' (*Chin Tan Lung Hu Ching*[4]). Even late writers on the enchymoma are explicit on this point. The *Nei Chin Tan*[5] (Metallous Enchymoma Within), in *Chêng Tao Pi Shu Shih Chung*,[6] *pên* 12, p. 8*a*, asserts that '"External" alchemists prepare the Gold Elixir from Realised Lead—silver—which they have extracted from lead.' See also *Ta Tan Chi*[7] (Record of the Great Enchymoma), *TT*892, p. 1*a*.

[d] It would be over-concrete to understand these *chhi* as mere sunlight and moonlight.

[1] 諸家神品丹法 [2] 日晶 [3] 本質 [4] 金丹龍虎經
[5] 內金丹 [6] 證道秘書十種 [7] 大丹記

The alchemist re-enacts this evolution when he distils or sublimes mercury from its sulphide, and extracts from crude lead the silver which often occurs in appreciable amounts as an impurity.[a] Therefore his products become the realised pair which serve as the basis of the Elixir. There is no Chaos in this practical interpretation; the Realised Lead and Realised Mercury are extracted directly and individually from the mundane ingredients. A quotation in the same compendium, from a book the title of which indicates that it was directly derived from the *Tshan Thung Chhi*,[b] connects the two perfected substances with Yellow Sprouts, after emphasising that additional ingredients, and miscellaneous processes of the kind so popular with pragmatically inclined alchemists, are to be avoided. Mêng Yao-Fu wrote:[c]

In 'using lead and mercury to make the elixir', most people erroneously take black lead for Realised Lead, or think that quicksilver[d] is Realised Mercury, or take yellow floreate essence of lead (*chhien huang hua*,[1] or massicot, PbO) for Yellow Sprout.[e] Some even boil down brine, or recrystallise salt and collect the essence (i.e. the cubic crystals), combining it with quicksilver, cinnabar, 'lead furnace' (*chhien lu*[2]),[f] and litharge, or the Two Caerulean Minerals, the Three Yellow Minerals, the Five Metals, the Eight Minerals, and that sort of thing. But the use of the Five Metals, the Eight Minerals, or any (merely) material substance (*i-chhieh yu chih*[3]) is no perfect method. As Yin Chen-chün[4] has said: 'The material is not fit to be taken as your companion; even if you succeed by force in such a preparation, when ingested it will cause damage.' It is imperative that gentlemen studying the Tao should take care.

[a] Whether what he got was actually silver remains very much an open question. Although the silver content of most Chinese lead ores is low, the content of zinc in some galena and blende is very high. See above, pt. 2, p. 218, and Collins (1), especially the analyses of Hunan lead ores on pp. 100–101 and the remark about the unfeasibility of a direct process for extracting silver on p. 239. On the idea of the actual conversion of lead into silver in relation to *nei tan* theory cf. pt. 5.

[b] *Chin Tan Pi Yao Tshan Thung Lu*[5] (Essentials of the Gold Elixir: Record of the Kinship of the Three) by Mêng Yao-Fu,[6] who was the main contributor to the *Chu Chia Shen Phin Tan Fa* collection.

[c] Ch. 2, pp. 4*a*–5*b*, tr. auct. Despite the cautions to avoid complex recipes, there are many formulae in the collection which use numerous ingredients, e.g. ch. 3, p. 6*b*. An example of just the sort of process the author warns against occurs in one of the few alchemical writings which can be assigned with confidence a pre-Thang date, *Thai-Chhing Chin I Shen Tan Ching*[7] (Manual of the Potable Gold Magical Elixir; a Thai-Chhing Scripture), *TT*873, ch. 1, p. 15*b* (partial text also in *YCCC*, ch. 65). A lead–mercury amalgam is prepared in a heated vessel and fired with lead carbonate (*hu fên*[8]), ground with vinegar, and sublimed with cinnabar, realgar, and orpiment. Maspero (7), pp. 97–98, dated this part in the first half of the +5th century, and Rolf Stein (5) has recently shown that the latter part of the work need be no later than the middle or even beginning of the +6th.

[d] I.e. commercial mercury, as distinguished from that distilled from cinnabar under proper ritual precautions and according to special procedures in the elaboratory. We use both 'mercury' and 'quicksilver' to refer to the ordinary article of commerce, corresponding to the purely verbal parallelism between *hung*[9] and *shui yin*.[10] The product of alchemical operations can similarly be referred to as 'realised (*chen*[11]) mercury' or 'realised quicksilver'.

[e] Note that here 'yellow floreate essence of lead' has entered ordinary chemical parlance as the appellation of massicot. This sort of transition has happened often enough in the Chinese language to call for caution in keeping the general and the particular unentangled. Another example is the philosophical term 'mature Yang' (*thai yang*[12]), which in lay speech was specialised to refer to the most obvious manifestation of the mature Yang, the sun. But to render '*thai yang*' as 'sunlight' when it occurs in the designations of the circulatory channels of the human body, as one translator has done, makes a simple and philosophically consistent system of nomenclature incomprehensible.

[f] We have not seen this term elsewhere, and the generally poor condition of the text of *Chu Chia Shen Phin Tan Fa* leads us to suspect corruption.

[1] 鉛黃華 [2] 鉛爐 [3] 一切有質 [4] 陰眞君 [5] 金丹秘要參同錄
[6] 孟要甫 [7] 太清金液神丹經 [8] 胡粉 [9] 汞
[10] 水銀 [11] 眞 [12] 太陽

The lead and mercury of which I mean to speak are universally kept secret in the alchemical classics. If one is not told directly, there is no way to understand what they are. 'Lead' is silver; that is to say, the silver is obtained from within lead. Therefore sagely silver is Realised Lead, which is born out of the stimulus of the essential *chhi* of the moon; it is the Water essence of mature Yin.[a] If a man be able to subdue it by art to form the Elixir, and ingest it, how could he not live forever? For Realised Lead one must definitely use silver; there can be no further doubt of this.... The mercury is quicksilver which has been obtained from cinnabar, with shape but without matter (i.e. a liquid). It imbibes the *chhi* of silver and congeals to form a body.[b] Thus it is styled Realised Mercury. It is born out of the essential *chhi* of the sun; it is the Realised Fire of mature Yang.... Among the myriad phenomenal things, only from lead and mercury can the Cyclically Transformed Elixir be made; all the rest have no place in the proper method. The lead has the *chhi*,[c] and the mercury is originally without shape. The lead is Yang inside and Yin outside, so it serves as the ground of the Elixir (*tan ti*[1]). It lends its *chhi* to engender the Yellow Sprouts. We know clearly that it is through getting the Realised *chhi* that the Divine Sprout is spontaneously born, after which the Realised Lead can be discarded.[d] Chhing Hsia Tzu[2] has said:[e] 'Lead is the mother of the Sprout, and the Sprout is the son of lead.' Once this golden floreate essence has been obtained, the lead is discarded and no longer used. Mercury is originally without shape, like the state (*chuang*[3]) of *chhi*. Its inborn nature is completely Yang, and its shape completely Yin (i.e. liquid). If a hundred *hu*[4] is put into a reaction-vessel it can be boiled until the pot is dry; thus is its immateriality made manifest. If it is planted within the lead it absorbs the essential *chhi* of the lead and metamorphoses its material substance, after which it is called Yellow Sprouts. Surely this is a going over from immateriality to materiality (*tsung wu erh yu chih*[5]).[f]

So lead, irradiated by the cosmic Yin *pneuma*, becomes silver. In this realised form it serves as the passive vessel which, impregnated by the Yang mercury, bears the Yellow Sprouts. The sexual imagery could hardly be more patent, but the *Tshan Thung Chhi*'s reversal of polarity in the realised substances is obscured. Just as the mercury is Yang here because it comes from cinnabar, the silver is still spoken of as lead, for Mêng Yao-Fu is thinking of the realised substances as functionally equivalent to their sources. The idea that a substance can be Yin outside (as shown, for instance, by its liquidity) and Yang inside (determined by its function or by a product of its metamorphosis) is one more application of the old idea that there is a potential Yang within every Yin and vice versa.[g]

[a] We have already pointed out that Water is the elemental phase which corresponds to mature Yin.

[b] Or 'It can imbibe the *chhi* of silver and congeal...', since this sentence clearly refers to the formation of a silver amalgam.

[c] I.e. the energy needed to impose on the mercurial substratum ('shape') the high level of organisation of the Elixir. This is analogous to the formative energy of semen which is responsible for forming a human embryo out of the passive Yin substance of the mother.

[d] Although it is not possible to enter into the non-alchemical levels of meaning of the *Tshan Thung Chhi* type-processes here, the parallel with the adept's use of female sexual partners for his own perfection through the Art of the Bedchamber is obvious.

[e] This is Su Yuan-Lang[6] (see above, pt. 3, p. 130).

[f] Our translation of the last sentence, which we do not fully understand, is tentative.

[g] See further in pt. 5.

[1] 丹地 [2] 青霞子 [3] 狀 [4] 斛 [5] 從无而有質
[6] 蘇元朗

The identification of the two realised substances does not settle the question of the choice of process, but rather opens it in new directions. Space permits only a single example of a process for preparing Yellow Sprouts from silver and mercury. The following procedure comes also from *Chu Chia Shen Phin Tan Fa*, which does not name its source or originator.

Take realised and balanced[a] 'mountain and marsh' silver, five ounces, and with an iron pestle beat it into a cake round as the shape of the sun. Then with the iron pestle beat it a thousand and more times until it is extremely firm, in order to prevent quicksilver from contaminating the Yellow Sprouts. Then put it in an earthenware tube.[b] Put three ounces of mercury inside, and then insert the silver cake into the earthenware tube, leaving a space of two inches or so between it and the mercury. Seat it firmly and lute all around with six-one lute as in the usual method, leaving no cracks. Above it put into place a vase of water to cover the mouth of the earthenware tube completely.[c] Below it use a fire made from three ounces of charcoal to heat gently and uninterruptedly day and night for seven days. When this time has passed, open it; the quicksilver will have gone up and the silver will have grown Yellow Sprouts, shaped like needles, countless in number and all of white silver. This is called the Yellow Sprouts of the First Cycle. Again add three ounces of quicksilver and apply a nourishing heat for seven days and nights. When this time is up open the vessel and examine its contents; they will resemble the colour of young sprouts from a cut tree (*nieh*[1]). Again add three ounces of quicksilver and apply a nourishing heat for seven days. When this time has gone by, open the vessel and examine its contents. The colour will be deep brown. Do not gather anything as yet. (The crystals) will be connected (*i-li*[2]), and will have grown as if what you had planted were sprouting. On (each) seventh day open the furnace and add three ounces of mercury until seven times seven days have passed. This will have been seven cycles, and a total of 21 ounces of mercury will have been added. The product is called Purple Gold Yellow Sprouts,...the Mother of the Cyclically Transformed Elixir. The quicksilver in the tube will still be inside the cover, and will be as red as vermilion. When it is collected there will be a couple of ounces. It is also named Son Become Mother (*tzu pien mu*[3]) or Single-bodied (*tu-thi*[4]) Vermilion.[d] This medicine, after being mixed with milk, steamed, and ground fine as flour, is made into pellets with jujube paste. Every day take three such pills with wine on an empty stomach as a tonic for the lower region of vital heat (*hsia yuan*[5]),[e] and to quiet the heart, pacify the animus, and still (*ting*[6]) the anima. It also cures cold disorders of the wind group (*fêng lêng*[7]) and other diseases. Its efficacy is so manifold that it cannot be described fully here. One can gather 12 ounces or more of the Yellow Sprouts which grow on the face (of the silver). There will be three or four ounces or more of the refractory mercury left under the silver cake.[f] That it has not been transformed is because this mercury has absorbed a sufficiency of *chhi*. It may be collected in another container, for it has its own

[a] This may be an over-philosophical translation, since *chen chêng*[8] in ordinary speech means simply 'genuine'.

[b] This must be visualised as like a test-tube or long narrow vase in shape.

[c] This cooling basin above is highly reminiscent of the upper condenser of the Mongol still; cf. pp. 62 ff.

[d] Both of these recondite names refer to the production of 'cinnabar' (actually mercuric oxide, which resembles it in colour) from mercury without the addition of sulphur.

[e] See pt. 5 below.

[f] The text is not clear as to whether the mercury is on the under-side of the silver cake or below it in the bottom of the vessel.

[1] 糵 [2] 迤邐 [3] 子母母 [4] 獨體 [5] 下元 [6] 定
[7] 風冷 [8] 眞正

utility when incorporated in medicines. The quicksilver and the Yellow Sprouts can be used as the elixir matrix (*tan mu*[1]), so they are called the Mother of the Cyclically Transformed Elixir. Cinnabar is called 'animus of the sun'; quicksilver and Yellow Sprouts are called 'anima of the moon'. There is a mnemonic verse which goes:

> 'The sage can rival the skill of the Shaping Forces;
> Raising his hand, he plucks the sun and moon from the sky
> To put in his pot....'[a]

Thus solid silver is attacked by the fumes of mercury in a sealed vessel over gentle heat for seven weeks (not, by alchemical standards, an imposingly long period). After formation of a massive beta phase, the silver gradually accumulates a needle-like crystalline growth called Yellow Sprouts. Surface oxidation of the silver 'sprouts' accounts for the gradual darkening of this colour. The formation of the red 'cinnabar' sublimate (HgO) inside the top of the vessel indicates that despite the careful closure and application of lute, the atmosphere within the vessel is oxidising, due to diffusion of air through the porous lute during the protracted firing.[b] Actually there is no vermilion inside the vessel. This alchemist was unable to distinguish red mercuric oxide from the sulphide.

The process just described makes use of a partly physical and partly chemical transformation to advance the elixir process one step, and the succeeding steps from Yellow Sprouts to Cyclically Transformed Elixir have rationales of their own (which are not germane here, but which invite investigation). An even more elegant conception is to base the whole elixir process on a single reversible chemical reaction. One might call this approach cosmological rather than cosmogonical, since it provides a model of the successive dominion of Yin and Yang in the cycles of the universe rather than of the stages in their definition out of the primal Chaos. As Chhen Ta-Shih puts it, 'That cinnabar should come out of mercury and again be killed by mercury: this is the mystery within the mystery.[c]

In the *Yin-Yang Chiu Chuan Chhêng Tzu-Chin Tien-Hua Huan Tan Chüeh*[2] (Secret of the Cyclically Transformed Elixir, Treated through Nine Yin–Yang Cycles to form Purple Gold and Projected to bring about Transformation),[d] one pound of mercury is distilled from three pounds of cinnabar in the presence of alum

[a] *TT*911, ch. 3, pp. 1*a*–2*a*, tr. auct. For a wet mercury–silver process, in which no strong heating is involved, see *Huan Tan Chung Hsien Lun* (*TT*230), pp. 16*b*ff. In pt. 5 we shall illustrate this verse by a photograph of a Szechuanese temple statue.

[b] In fact the protracted firings so usual in alchemy probably developed partly because many reactions involving oxidation would not have succeeded otherwise. The possibility that long periods favoured the formation of large crystals of sublimates should also be empirically tested. See Sivin (1), p. 183.

[c] In *Pi Yü Chu Sha Han Lin Yü Shu Kuei*[3] (On the Caerulean Jade and Cinnabar Jade-Tree-in-a-Cold-Forest Casing Process), *TT*891, p. 1*a*. This is an annotated series of poems with esoteric commentary, followed by instructions for a fundamentally two-element process using silver-bearing lead (*yin chhien*[4]) and mercury as well as ancillary substances. It belongs to the early + 11th century.

[d] *TT*888, which quotes the *Tshan Thung Chhi* often. There are parallel passages in the *Thai-Shang Wei Ling Shen Hua Chiu Chuan Tan Sha Fa*[5] (Methods of the Guardian of the Mysteries for the Marvellous Thaumaturgical Transmutation of Ninefold Cyclically Transformed Cinnabar; a Thai-Shang Scripture) *TT*885, a corrupt text based on a very similar process. This has been translated by Spooner & Wang (1) and Sivin (3).

[1] 丹母 [2] 陰陽九轉成粲金點化還丹訣 [3] 碧玉朱砂寒林玉樹賦
[4] 鉛鉛 [5] 太上衛靈神化九轉丹砂法

and salt, and then, in the second cycle,[a] heated with four ounces of sulphur to yield cinnabar. But the cycle does not merely repeat itself. It is essential that the product reach a higher state of perfection at each step. Thus in the third cycle mercury is obtained again, but subsequently it is 'congealed' by boiling with borax, malachite, salt and alum until it loses its volatility and becomes 'subdued' (*fu*[1]),[b] just as an immortal sheds his perishable body. The remainder of the process grows so complex chemically that one easily loses sight of the simplicity of its conception. To the alchemical theoretician the progressively more metallic products of each cycle were still in principle mercuries and cinnabars.

Just as the passage of recurrent time perfected minerals within the earth, the repetition of the simple mercury–cinnabar cycle was supposed to lead to a gradual metamorphosis, the product of which would be the Elixir of Immortality. The Chinese image of a cycle (*chuan*[2]) does not, in fact, convey the idea very adequately; since the outcome, whether geological or alchemical, is a substance both perfect and immune to decay. There is a linear component. In other words, the conception of the Tao thus implied was not a two-dimensional circle but a helix. That both cinnabar and Elixir are called *tan* does not signify their identity (the two senses were distinct in alchemy and medicine and not generally confused). Still, this sharing of a name could serve to support and preserve the idea of a genetic relationship. Some alchemists persuaded themselves that the maturation of the Elixir could be brought about by simple repetition of a cyclical treatment. This not very empirical notion appears, for instance, in the +8th-century *Ta-Tung Lien Chen Pao Ching, Chiu Huan Chin Tan Miao Chüeh*[3] (Mysterious Teachings on the Ninefold Cyclically Transformed Gold Elixir, Supplementary to the Manual of the Making of the Perfected Treasure; a Ta-Tung Scripture)[c] of Chhen Shao-Wei,[4] a sequel to the seven-chapter monograph on cinnabar quoted earlier.[d]

At one point in this treatise Chhen is discussing a basic cycle in which mercury and sulphur are first heated together in a covered and tightly luted porcelain vessel to form 'purple cinnabar' (*tzu sha*[5]), a mixture of the mercuric sulphides cinnabar and metacinnabarite. From this material, in the presence of lead and salt, mercury is recovered by sublimation (*fei*). As the process is repeated, each cinnabar develops greater powers, as indicated by the progressively exalted name. He wrote:

For instance, mercury used in the second recycling (in the chapter on Treasure Cinnabar)[e] is twice heated with sulphur to make it into cinnabar, and twice put into lead. The mercury is sublimed from (the intermediate cinnabar), added to the metal, and transformed into cinnabar. Mercury used in the third recycling (Effulgent Cinnabar) is thrice heated and sublimed before it is ready for use. Mercury used in the fourth recycling to produce Wondrous Cinnabar is sublimed and heated four times. Mercury used in the fifth recycling (Numinous Cinnabar) is sublimed and refined five times. Mercury used in the sixth recycling to produce

[a] In this treatise each 'cycle' (*chuan*[2]) is only half a cycle as ordinarily defined.
[b] See pp. 4ff., 187, 191, 250, 256. [c] *TT*884. [d] See pp. 237ff.
[e] I.e. in Chhen's other work, *Ta-Tung Lien Chen Pao Ching, Hsiu Fu Ling Sha Miao Chüeh.*

[1] 伏 [2] 轉 [3] 大洞鍊眞寶經九還金丹妙訣 [4] 陳少微
[5] 紫砂

Spiritual Cinnabar must correspondingly be heated and sublimed six times. Mercury used in the seventh recycling to produce Mysterious Realisation Crimson Cloud Cinnabar, just as in the previous cases, must be heated with sulphur seven times to form purple cinnabar, and lead used seven times, subliming to make it revert to Numinous Mercury. For each heating one uses three ozs. of sulphur; to reconvert it to mercury one uses one lb. of lead, heating and subliming cyclically, controlling the fire as specified earlier. In the course of these metamorphoses brought about by heating and subliming, (the Mercury) will maintain its inner essential *chhi* of Water and Fire. Once the numerical correspondences (*ta shu*[1]) of the Seven Chapters have been satisfied, the *chhi* of the three luminaries, Water, Fire and Metal, will naturally be united in the product. When the seminal essences meet, it is transformed and becomes numinous; it attains enlightenment and becomes Realised Mercury.[a]

To the experimentally minded this airy theorising cannot have been very satisfactory. In order to bring about progressive changes in practice, the purity of the mercury–cinnabar idea had to be compromised by the use of additional reagents. Indeed, the practical instructions given by Chhen himself in his seven chapters on Numinous Cinnabar use ancillary ingredients, but he does not regard this concession as in any way a failure. The supernumerary substances are, by implication, as external to the process as the ancillary drugs used in medicine to guide the 'effective' component of a prescription to the site of the illness. Even though the products of Chhen's cycles resembled mercury and cinnabar less and less, they still corresponded functionally.

Finally it is worth while to examine briefly a technique called 'irrigation' (*chiao lin*[2] or simply *chiao*), widely used in later alchemy.[b] It involves an interesting variant of the mercury–cinnabar cycle, a sort of compromise between the methods already described. First cinnabar is made from mercury and sulphur, then treated with other minerals to fire-subdue it (*fu huo*[3]). The product is superior to mundane cinnabar because it is no longer volatile, and thus invulnerable to erosion by the fire. The novelty involves sealing it with mercury in a special mineral-lined sublimation chamber. This chamber, commonly called the Bubbling Spring Casing (*yung chhüan kuei*[4]), is then heated for days or weeks. Even though no sulphur is added, what appears to be cinnabar forms at the top of the vessel. When more mercury is added to this product more 'cinnabar' is formed, grander after each cycle, its elixir qualities more patent. From the chemical point of view it seems most likely that the initial Subdued Cinnabar is inert. It is certainly no longer cinnabar after passing through most of the fire-subduing processes. The products of the successive cycles are not cinnabar but the very similar red mercuric oxide, formed by oxidation of the added mercury within a certain range of temperatures.[c] If the fire is too hot (above 500°), the mercuric oxide will break down. Whether

[a] Pp. 2*a*–4*a*, tr. auct. in summary form.

[b] Yüan Han-chhing (1), p. 209, defines *chiao* as 'to pour out a liquid product and let it cool slowly'. We have never seen a text in which this meaning would fit well, and suspect that it was only inferred from the non-alchemical sense 'to pour out a libation'. For a +13th-century inventory of 'irrigation' and related procedures, see above, pp. 18–19.

[c] The preparation of 'Seven-Cycle Cinnabar' by heating mercury alone was described by Sun Ssu-Mo in the middle of the +7th century. See Sivin (1), p. 191.

[1] 大數 [2] 澆淋 [3] 伏火 [4] 湧泉置

some property of the red sublimate varies from cycle to cycle to support the idea of its gradual perfection could only be determined in the laboratory, because of the complexity and variety of the procedures outlined by various alchemists.[a]

The use of reagents to embody Yin and Yang and re-enact their cosmic play was not enough. Yin and Yang are in their profoundest sense temporal phases. Creating a microcosm thus involved laboratory techniques for phasing time, and these we shall now examine.

(iii) *Correspondences in duration*

The postulate that one period of time can correspond to another has already made its appearance in an excerpt from *Tan Lun Chüeh Chih Hsin Ching*. The year required by the alchemist to prepare his elixir was likened to the 4320-year term of the natural cyclically-transformed elixir which forms within the earth.[b] Let us now return to that book as it proceeds to explain the correspondence:

Query: 'How is it that one year can correspond to the constant period (*shu*[1]) required by Nature to make a cyclically-transformed elixir?'
Reply: 'One day and night in the world above is one year in the human realm. Now among men one year is twelve months, of 360 days. One month is thirty days, and one day is twelve hours,[c] so one month is 360 hours. In sum, a year is 4320 hours, which corresponds to (the time needed by) Nature to produce the natural cyclically-transformed elixir.'[d]

What would be illogical and pointless in terms of the time metric of modern science makes perfectly adequate sense once we realise that here numbers are not measures. They are being used rather to mark members of a series of things which are qualitatively related, in the mode which Granet used to call 'emblematic'. We might say 'numerological'. That a year contains 4320 double-hours *proved* that it is functionally equivalent to the natural period of maturation.

We find the same set of correlations in the *Yü Chhing Nei Shu*:[e]

A month contains 360 hours. Calculating a correspondence on the basis of hours, a year of twelve months comes out to 4320 hours. Taking one hour as equivalent to (*tang*[2]) one year, we calculate (that the year is equivalent to) 4320 years, and corresponds to the (period

[a] Among the more important of the treatises concerned with 'irrigation' processes are the following, all of the Wu Tai, Sung or later: *Kêng Tao Chi* (*TT*946), dating from after +1144, a large collection in which many recipes appear to have been obtained from individuals rather than books, *Lung Hu Huan Tan Chüeh* (*TT*902), and *Chhien Hung Chia Kêng Chih Pao Chi Chhêng* (*TT*912). The preface of this last collection is dated in a *ping-chhen* year, which would correspond to +836, +896, +956 or another multiple of sixty years earlier or later. The book includes an oral formula clearly dated +808, but this may not be genuine because its cyclical characters are given wrongly. At least one work included used *fên* to refer to the weight unit next smaller than the *liang*, so the whole compilation may not have been assembled before the Sung. Particularly clear laboratory instructions are also found in the *Chiu Chuan Ling Sha Ta Tan* (*TT*886) and its neighbour the *Chiu Chuan Chhing Chin Ling Sha Tan* (*TT*887) which seems mostly to be paraphrased, rearranged and modified from the former, though it could equally well be a little earlier.

[b] See pp. 231 ff.

[c] I.e. Chinese double-hours (*shih*[3]). Cf. Vol. 4, pt. 2, pp. 439, 461. For further information on time units and measurements see Needham, Wang & Price (1).

[d] *TT*928, p. 13*a*, tr. Sivin (5). In the query we follow the *YCCC* edition, p. 13*a*, and emend 'five years' (*wu nien*[4]) to 'one year' (*i nien*[5]) as required by the sense and context.

[e] *TT*940, p. 19*b*, tr. auct.

[1] 數 [2] 當 [3] 時 [4] 五年 [5] 一年

of the) natural cyclically-transformed elixir. It is the conjugation of Yin and Yang, (the alternation of) winter cold and summer heat, which give rise to the correspondence.

Both of these books belong to the late tradition of dual cultivation, which made much use of time correspondences in phasing breath-control and even sexual techniques. The most elaborate scheme of time correspondences evolved in China is from an explicitly Interior Alchemy treatise, the *Huan Tan Nei Hsiang Chin Yo Shih*[1] (Golden Key to the Physiological Aspects of the Regenerative Enchymoma), written by Phêng Hsiao[2] in the middle of the + 10th century. This book develops in exhaustive detail the use of the hexagrams in the *Tshan Thung Chhi* to mark periods of time, and thus to provide a terminology for phasing the breath. Each hexagram is broken into its six constituent lines to make available a system of 384 fine divisions (360 in practice). Here is part of Phêng's argument for a whole repertory of correspondences, with a year of cosmic process equated to a month, five days, $2\frac{1}{2}$ days, and one day:

Thus one year of 360 days contracts (*tshu*[3]) into a month of 360 hours. Further, if within a month of thirty days, or 360 hours, we assign one hexagram to each morning and evening, we can then transfer these sixty hexagrams, with their 360 lines, collapsing them (*hsien*[4]) into five days, or sixty hours, so that this period again corresponds to a month. Two and a half days is thirty hours, which becomes thirty days, and (thus) also corresponds to a month. Having determined a hexagram for each morning and evening (in a month), again we assign 60 hexagrams, which comes to 360 lines, so that this again corresponds to a year, or 360 days. Again, if within $2\frac{1}{2}$ days, or 30 hours, we separate out a period of 15 hours, this responds to (*ying*[5]) a phase (*yung shih*[6])[a] of half a month, or 15 days. Again we take this half-month, from the first to the fifteenth day (inclusive), and collapse it into the 12 hours. To the period from the (beginning of the) second half of the first hour to (the end of the) first half of the sixth hour (i.e. midnight to noon) will be assigned 30 hexagrams, which comes to 180 lines. This period therefore corresponds to that from after the winter solstice to before the summer solstice, and responds to half a year, or 180 days....The 'Book of Changes' says that the Masculine Factor is 360.[b] When this number of days has passed the Yin will have arisen and the Yang gone down. For their cycle we use the the year of the sidereal circuit (of the sun), the great constant of the myriad phenomena. Now one year comes out to 360 days, or 4320 hours. If to the morning and evening of each day we assign two hexagrams (i.e. one to each), this will give a total of 60 hexagrams (per month). With six lines per hexagram, their entire number will amount to 360 lines.[c]

[a] *Yung shih* (lit., 'play a part in the affair') is not a noun compound, but refers to the periodic dominant activity of one agent among several within a cycle, for instance the ascendancy of Wood in the Spring of the year. Its meaning is thus close to that of 'phase'.

[b] Actually, it says nothing of the kind. This is a freely adapted reference to the Great Appendix (Hsi Tzhu[7]), I, 9, which gives the Masculine Factor as 216. See Wilhelm (2), English tr., vol. 1, p. 334, where the term *chhien chih tshê*,[8] which we translate 'Masculine Factor', is rendered 'creative total'.

[c] *YCCC*, ch. 70, pp. 3*a*–4*a*, tr. auct. Chhen Kuo-fu (*1*), vol. 2, p. 439, suggests that this is an abridgment of the original work of Phêng Hsiao, rather than a fragment. A very similar schema, using the same technical terms, appears in *Hsiu Tan Miao Yung Chih Li Lun*[9] (A Discussion of the Marvellous Functions and Perfect Principles of the Practice of the Enchymoma), *TT*228, pp. 2*a*–2*b*, which is definitely later since it refers to the Sung Taoist Master Sea-Frog (Hai Chhan Hsien-sêng[10]), Liu Tshao.[11] For another, more compressed, system of multiple time correspondences see the undated *Ta Tan Wên Ta*[12] (Questions and Answers on the Great Elixir), *TT*932, pp. 3*b*–4*a*.

[1] 還丹內象金鑰匙 [2] 彭曉 [3] 蜃 [4] 陷 [5] 應
[6] 用事 [7] 繫辭 [8] 乾之策 [9] 修丹妙用至理論
[10] 海蟾先生 [11] 劉操 [12] 大丹問答

This is only a sample of the relevant passage, but it is enough to convey the approach and the flavour. There remains only to reproduce an annotation which appears in the text at the end of the part we have cited:

> Again this appropriates (*to*[1])[a] a year. The 360 days, (as we see upon) calculating the number, appropriates the 4320 years that the balanced *chhi* spends within the Spirit Chamber (*shen shih*,[2] i.e. the reaction-vessel, or the *tan thien* in physiological alchemy).

This is numerology of the most extravagant kind, with its breathtaking transitions, its round number of sixty hexagrams, and its rounded-off sidereal year of 360 days.[b] In the literature of External Alchemy strictly defined we encounter nothing so elaborate, but multiple correlations are involved even if their rationale remains tacit. Phêng Hsiao's passage offers at least a hint as to why the normal quantum step in the fire-phasing cycles which we shall now examine was $2\frac{1}{2}$ days.

(iv) *Fire phasing*

Fire is the great agent that nourishes and matures the Elixir. Since the heat of the flame thus stands for the active forces, the re-creation of the cosmic process depends upon the binding of fire by time. The key to the success of the Work, the great test of laboratory skill and assiduity, particularly in the strain of alchemy concerned with ideal processes, was the technique of gradually increasing and decreasing the intensity of the fire (*huo hou*[3]) by the use of precisely weighed increments of fuel.

This is the closest thing we find in the ancient world to a quantitative conception of degrees of temperature. A constant increase in the weight of fuel does not cause a constant increase in the temperature of the thing heated, but that was beside the point before the thermometer provided a standard for testing the correlation.[c] The idea of fire control, in the sense of using an amount of fuel specified by weight, is an ancient one in the chemical arts, because to each weight of fuel, burnt in the same way, corresponds a set temperature and a predictable product. What the alchemists did was to make this concept of *huo hou* dynamic, varying the weight of fuel and thus the temperature in a regular way. They were bringing their processes under the control of one of the few exact measuring instruments at their disposal, the balance.[d]

Intensity of heat, controlled in this necessarily indirect manner, was the time-dependent variable, and the overall profile could be as precisely cyclical as the seasonal changes to which it corresponded point by point:

[a] This unusual use of *to*,[1] the primary meaning of which is 'to take by force or threat', very roughly parallels the widening of the meaning of the word 'abstract' in English. Cf. p. 234.

[b] The true value is of course 365·2564 days. Cf. Vol. 3, p. 181.

[c] On the beginnings of temperature measurement in East and West see Vol. 3, p. 466, Vol. 4, pt. 1, p. 63.

[d] It is not difficult to find processes in which even fractions of an ounce (*chhien*[4]) are used. See, for instance, the late *Hsiu Lien Ta Tan Yao Chih*[5] (Essential Instructions for Preparing the Great Elixir), *TT*905. Despite rather esoteric terminology, this collection of recipes using casing (*kuei*[6]) techniques (above, pp. 18ff.) reflects much practical knowledge. Take, as an example, the instructions for the lost-wax casting of a reaction-vessel (ch. 2, pp. 1*b*–2*a*).

[1] 奪 [2] 神室 [3] 火候 [4] 錢 [5] 修鍊大丹要旨 [6] 匱

The amounts of fuel to be weighed out are increased and decreased in cyclical progression according to the proper order of Yin and Yang. They must conform with the signs of the 'Book of Changes' and the 'Threefold Concordance',[a] tally with the four, eight, 24, and 72 seasonal divisions of the year, and agree with the implicit correspondences and pneumatic manifestations (*chhi hou*[1]) of the year, month, day and hour[b]—all without a jot or tittle of divergence.[c]

To see the beginnings of the notion of heat phasing we must return to the *Tshan Thung Chhi*. It devotes much space to the association of the trigrams and hexagrams of the 'Book of Changes' with temporal phases. As we have seen in a previous volume in connection with the fundamental ideas of Chinese science, six of the trigrams were used to mark off segments of the lunation cycle, and twelve of the hexagrams were assigned to the twelve double-hours of the diurnal cycle.[d] The correspondences are simple and schematic, for the diagrams were used as a kind of graphic representation of the interplay of Yin and Yang in each phase. For instance, the diurnal cycle begins with Fu,[2] Return, no. 24 in the normal order of the *I Ching*. Recalling that one reads the hexagrams from the bottom up, we see in the single solid line of Fu ䷗ the rebirth of Yang beginning when midnight, the point of mature Yin (Khun[3] ䷁, Receptor, no. 2 in the textual order) has passed. The third double-hour is represented by Thai[4] ䷊, Upward Progress (no. 11), in which the Yang has advanced a step. Halfway around the cycle, the mature Yang phase (Chhien[5] ䷀, Donator, no. 1), having had its dominion, is replaced at the seventh double-hour by Kou[6] ䷫, Reaction (no. 44), as the Yin begins to reassert itself, and so on.[e] The thesis behind this progression is simply that the six trigrams and twelve hexagrams, chosen to represent various stages in the endlessly repeated complementary growth and decay of Yin and Yang, can be assigned to the successive phases of any temporal cycle

[a] I.e. the *Tshan Thung Chhi*.

[b] On manifestations of *chhi* phased throughout the year, see Vol. 4, pt. 1, pp. 186–92, and Bodde (17).

[c] Anonymous; cited in *Chu Chia Shen Phin Tan Fa* (*TT*911), ch. 4. p. 1*b*, tr. auct. Cf. pp. 3, 257ff.

[d] See Vol. 2, pp. 329–34, especially table 17 (p. 332). Here the hexagram Fu was wrongly incorporated with the trigrams in the lunar cycle. Probably this mistake arose because the *Tshan Thung Chhi* does say (ch. 4) that the principle of the Fu *kua* establishes all first buds of new growth (cf. Bodde (4), p. 117). The chapter numbers given on p. 331 were those of Wu & Davis (1); they should be corrected to chs. 2, 4, 18 and 19 respectively. If one writes down the trigrams one can see clearly the wave of Yang or Yin rising and falling through them. For a detailed description of the alchemical applications of the *I Ching* diagrams, see above, pt. 3, pp. 60ff.; here we recapitulate summarily for convenience. Corrections are also required for the diurnal cycle in Table 17. The order should be Fu (24), Lin (19), Thai (11), Ta Chuang (34), Kuai (43), Chhien (1); then Kou (44), Thun (33), Phi (12), Kuan (20), Po (23) and Khun (2). Cf. Vol. 5, pt. 3, p. 61 above, and Ho Ping-Yü (16).

[e] This is a binary notation, but its order is not the same as that of modern binary numbers. First Yang lines increase from the bottom toward the top, and after the hexagram has become entirely Yang, Yin lines appear at the bottom and spread upward. The twelve hexagrams used in the diurnal cycle are those the inner lines of which are all connected to top or bottom by other lines of the same sign. See Table 14 in Vol. 2, p. 315. For the same reason the trigrams Khan and Li, so important otherwise in alchemy (cf. Vol 5, pt. 5), do not come in to the six of the lunar cycle, but *Tshan Thung Chhi*, ch. 2, connects them with the change-over point between the months and indicates that they govern the whole system (cf. Fêng Yu-Lan in Bodde (4), and Wu & Davis (1), pp. 232–3).

[1] 炁候 [2] 復 [3] 坤 [4] 泰 [5] 乾 [6] 姤

governed by the interplay of the opposites. In principle, the trigram and hexagram sequences are merely alternatives to the Five-elements phasing system, carrying rather different qualitative connotations.

There is no hint in the text of the *Tshan Thung Chhi* as to how these progressions are to be applied to laboratory operations. Looking at the text itself, all we can say for sure is that it is using the trigrams and hexagrams to divide the month and the day into qualitatively distinct phases which govern the alchemical process. The traditional view that this governance was exercised through alternate heating and cooling makes sense, but there is no evidence in the classic itself that the temperature of the furnace was graded through many steps, or controlled by weighing the fuel. Alchemists and commentators united in finding a heat phasing system in the passages on the mutational diagrams.[a] So, for that matter, did those who interpreted the book as respiratory or sexual alchemy, for they applied the *huo hou* concept to rhythmic cycles of breathing or sexual penetration.[b] These adepts would hardly have hesitated to read the sophisticated idea of heat phasing by weight into the ancient and obscure *Tshan Thung Chhi* if they had felt inclined to do so. They always found it natural to assume that the older a canonical book the deeper and more sophisticated were the ideas expressed in it. Generally, indeed, Taoists thought of the history of alchemy as a devolution rather than a progressive unfolding. They conceived the Art as something forced gradually downward by the inability of devotees to recover the austere and authentic revelations with which the tradition had begun, and by the credulity and bad faith of vulgar amateurs who contaminated the ancient doctrines.[c]

Ko Hung, early in the +4th century, maintained no more than the simple distinction between gentle and strong fires. The only securely datable early appearances of heat phasing techniques, shortly after his time, also take no notice of the *Tshan Thung Chhi*. These procedures, primitive by comparison with those popular from the Thang on, appear in the Mao Shan alchemical documents which passed through the hands of Thao Hung-Ching (*c.* +500).[d] The treatise on the 'Lang-kan Gem Floreate Essence Elixir' does not use weighings of fuel but rather varies the distance of the vessel from the chaff fire below it in the stove (*tsao*[1]). The alchemist is cautioned to keep the fire moderate, but no constant weight of fuel is specified. First the fire is maintained one foot from the vessel for 20 days, and then at distances of six and four inches for twenty days each. The flame is advanced to one inch from the vessel for ten days, and is adjusted so as just to touch it for another ten. Finally the flame is allowed to half-envelop the vessel for twenty days. A hundred days have passed and the first-stage

[a] See pt. 3, pp. 58ff.

[b] As only one early example for physiological alchemy, see the *Ta Huan Tan Chhi Pi Thu*[2] (no later than *c.* +1000), in *YCCC*, ch. 72. Chhen Kuo-Fu's suggestion (*1*), vol. 2, p. 287, that this is by the Thang alchemist Chang Kuo[3] is not supported by enough evidence. Other important documents are the *Huan Tan Nei Hsiang Chin Yo Shih* (*YCCC*, ch. 70) and the *Hsiu Tan Miao Yung Chih Li Lun* cited just above (p. 265).

[c] This veneration for antiquity did not rule out occasional recognition that the ancients were fallible; see, for instance, Sivin (*1*), p. 168.

[d] See pp. 213ff.

[1] 竈　[2] 大還丹契秘圖　[3] 張果

elixir is finished (Fig. 1517).[a] A similar scheme, with a more constant gradient applied over 120 days to a 28-ingredient elixir, is given in the 'Liquefied Gold Spiritual Chhi Canon.' Although this work is probably much later, its Mao Shan provenance is guaranteed by a chapter of revelations borrowed from Thao's *Chen Kao*.[b] A third example also comes from another of the very few texts clearly linked to the community of Mt. Mao, suggesting that heat phasing by distance was a traditional speciality of theirs.[c] The second of Thao's scriptures includes a method of the same

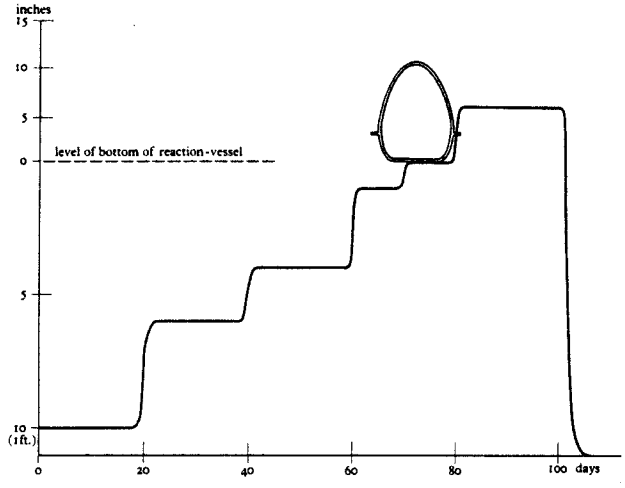

Fig. 1517. Fire-distances prescribed in the *Thai-Wei Ling Shu Tzu-Wên Lang-Kan Hua Tan Shen Chen Shang Ching* (Divinely Written Exalted Spiritual Realisation Manual in Purple Script on the Lang-Kan (Gem) Radiant Elixir; a Thai-Wei Scripture), a text of the late +4th century. The shape of the reaction-vessel derived from Needham & Ho Ping-Yü (3), p. 70.

kind, with a rather irregular gradient, but also a second technique called 'doubling the fire' (*pei huo*[1]), which ambiguously suggests quantitative regulation of fuel. Unfortunately the definition given is too opaque to allow us to judge whether this was a precursor of fuel weight regulation, or merely a sequence of timed stages (though

[a] *Thai-Wei Ling Shu Tzu-Wên Lang-Kan Hua Tan Shen Chen Shang Ching* (*TT*252), p. 4*b*. The phasing is repeated in the second stage (p. 5*a*).

[b] *Thai-Chhing Chin I Shen Chhi Ching* (*TT*875), ch. 1, pp. 4*b*–5*a*. Cf. above, pp. 245, 258.

[c] *Thai-Chi Chen-Jen Chiu Chuan Huan Tan Ching Yao Chüeh*[2] (Essential Teachings of the Manual of the Supreme-Pole Adept on the Ninefold Cyclically Transformed Elixir) *TT*882, p. 3*a*, presents a very complex scheme with irregular distance increments at nine-day intervals. The Mao Shan influence reveals itself in an account of five magic plants which grow on Mt. Mao, entitled 'Lord Mao's Formula (for Ingesting) the Five Kinds of Chih-jung' (*Mao Chün wu chung chih jung fang*[3]), pp. 6*b*–8*a*. Another schema too simple to be very significant appears in *Ling-Pao Chung Chen Tan Chüeh*[4] (*TT*416) p. 4*a*, which is evidently post-Thang because it specifies the 'large ounce' (*ta liang*[5]) measure. A vase containing reactants is heated for three days. On the first day the flame is kept two inches from the vessel; the second day, one inch; and on the third day, it must touch the vessel.

[1] 倍火 [2] 太極眞人九轉還丹經要訣 [3] 茅君五種芝茸方
[4] 靈寶衆眞丹訣 [5] 大兩

the times given in the distance-phasing schema, unlike this one, do not increase exponentially).

As for the doubling of the fire, first heat for one day, then heat to respond to (*ying*[1]) two days. After that, heat to respond to four days, and then to respond to eight days, and then to sixteen days. The constants for every period (*shih*[2]) should accord with these.[a]

The mature concept of phasing by fuel weight can be located among the handful of definitely pre-Sung works only in the writings of Chhen Shao-Wei,[3] probably not long after +713. There is no reason to believe that Chhen was its originator, since he applies the concept in a matter-of-fact way in his 'Numinous Cinnabar' treatise. But he is responsible for one of its grandest variants, found in his second work, on the 'Nine-cycle Gold Elixir'. Both are worth describing fully.

Simple *huo hou* systems involve a linear increase in fuel weight as a function of time. In order to complete the cycle, the fuel is then decreased at the same rate until the starting weight is again reached.[b] This use of two lines of constant slope (a 'zig-zag function')[c] to approximate a sinusoidal function is one of the most characteristic patterns of Chinese science. We perceive it in early figures for variation of sun shadow length with the seasons, the variation in respiration over the course of the day in breath disciplines, the rise and fall of Yin and Yang in the *Tshan Thung Chhi* series of *kua*, and so on.

Here are Chhen Shao-Wei's instructions for linear phasing as they appear in his treatise on the 'Numinous Cinnabar Seven Times Cyclically Transformed'. We are not able to comment upon the chemical reactions involved because of the large number of ingredients and, in a couple of cases, the uncertainty of their identification. They include malachite, halite, Epsom salt, *huang ying*[4] (probably a form of selenite) and *hua shih*[5] (which might be translated literally as 'fluxite', but we have been unable to determine what mineral it designates). In this particular process only the increase gradient appears, but the full cycle of increase and decrease will be reflected in a more elaborate system of Chhen's which we shall describe presently. Here he wrote:

Method of subduing by volatilisation. According to the supplementary instructions, five days is one phase (*hou*[6]); three phases is one *chhi* period.[d] In eight *chhi* periods, twenty-four phases, or 120 days, the subduing of the cinnabar is completed.[e] In the five days allotted for one phase of subduing by volatilisation, four days are governed by the *kua* Khan and one day by the *kua* Li. By 'the trigram Khan' is meant simmering in water for four days. By 'the trigram Li' is meant volatilisation over a Yang fire for one day. When the Yang fire is first laid, use seven ounces of charcoal, standing it on end below the reaction-vessel. One

[a] *Thai-Shang Pa-Ching Ssu-Jui Tzu-Chiang (Wu-Chu) Chiang-Shêng Shen Tan Fang* (*YCCC*, ch. 68), pp. 4*b*, 5*a*, 7*a*, tr. auct. Cf. p. 216 above.

[b] As we shall see, the return to starting weight is only approximate.

[c] See Neugebauer (9), pp. 110–113.

[d] In astronomical time-reckoning, the *chhi* or *chieh chhi*[7] are the 12 or 24 equal divisions of the tropical year. Thus one *chhi* is roughly $15\frac{7}{24}$ days. See Vol. 3, pp. 404–6.

[e] Cf. pp. 4ff., 187, 191, 262.

[1] 應 [2] 事 [3] 陳少微 [4] 黃英 [5] 化石 [6] 候
[7] 節氣

must see that there are seven ounces—no more, no less—of well-coked charcoal below the vessel at all times. After each cycle increase the amount of charcoal by one ounce and volatilise (the reactants again). Keep adding charcoal until after the fifth cycle, when suddenly a black *chhi* (= smoke) and a sublimate of mercury will come out (of the reactants). Collect the sublimate and again mix it with 1/20 ounce (*pan chhien*[1]) of previously fused halite (mineral NaCl) in a bowl. Grind lightly with a jade pestle until the mercury is completely absorbed. Then place the material in the reaction-vessel as before, and subdue by volatilisation using the Khan and Li trigrams until the twelfth cycle is completed. Add two ounces more of charcoal per cycle. Spread 1/8 ounce (*pan fên*[2]) of previously fused and powdered halite on top (before) closing (the vessel in the first place).[a] A total of two ounces or so of mercury sublimate will sublime. The void glow of the sublimate...[b] The residue in the vessel should gradually turn brown or purple. Collect the sublimate and the mercury (?), mix with 1/10 ounce of halite, and grind thoroughly in a bowl. Put the reagents into the reaction-vessel and subdue by volatilisation, phasing the heat as before until the eighteenth cycle has been completed. Increase the charcoal by three ounces (per cycle). The colour of the residue should be scarlet. Through the twentieth cycle, add four ounces of charcoal (per cycle). Only a half-ounce or less of mercury sublimate will sublime. It will be solid and hard as bronze chips (*phien*[3]), yellowish-white and lustrous. It is also to be mixed with mineral salt and ground in a mortar. Put into the reaction-vessel and subdue by volatilisation through the twenty-fourth cycle. The phasing of the cinnabar will be complete, the subduing by fire ended. (The residue) will be blazing red, lustrous and handsome; the cinnabar has been subdued.[c]

Thus one begins with a weighed amount of fuel and increases it at a rate which is kept constant for several cycles (Fig. 1518). The gradual increase in the increments is doubtless meant to accelerate the subduing of the cinnabar. The interaction of Yin and Yang is reinforced by alternately subjecting the cinnabar to wet and dry processes. The invocation of correspondences to the trigrams Khan ☵ and Li ☲ (immature Yin and Yang respectively)[d] suggests a debt to the *Tshan Thung Chhi*, which is confirmed by Chhen's habit of quoting apothegms from 'the Canon'.

The elaborate system in Chhen's second treatise (an elixir preparation for which the subdued Numinous Cinnabar was only a preliminary) not only models the ups and

[a] The text of *TT*883 specifies 1/4 oz. (one *fên*[4]) of halite. This sentence appears defective as a whole, and our translation of it should be considered tentative.

[b] The sense is not quite complete at this point; perhaps a few characters are missing.

[c] *Ta-Tung Lien Chen Pao Ching, Hsiu Fu Ling Sha Miao Chüeh*[5] (*YCCC*, ch. 69, under the title *Chhi Fan Ling Sha Lun*[6]), pp. 9*a*, *b*, translation from critical text in Sivin (4).

[d] These are the two trigrams omitted from the lunar sequence (see Table 109, pt. 3, p. 62). In addition to their use to designate wet and dry processes, Khan and Li stand in some writings for the Yin and Yang reactants in a two-ingredient process. The two functions are combined in a story told by Shen Kua[7] late in the +11th century about a Mr Li[8] who could make a Water Elixir (*shui tan*[9]) by boiling water until it congealed to resemble caerulean jade. Asked how the process worked, he replied 'I don't use anything, but merely regulate the powers (*li*[10]) of the water and fire. If they are the least bit unequal, (the Elixir) is transformed (into water) again and escapes (as steam). This is the refined essence of Khan and Li.' And he added: 'There are set degrees (*chieh tu*[11]) for increase and decrease both daily and monthly.' Shen interpreted Mr Li's success as due to the fidelity of his temporal correspondences. See *Mêng Chhi Pi Than, Pu* sect., ch. 3, para. 13 (Hu Tao-Ching (1) no. 582). In physiological alchemy Khan and Li came to assume outstanding importance (cf. pt. 5 below).

[1] 半錢 [2] 半分 [3] 片 [4] 分 [5] 大洞鍊眞寶經修伏靈砂妙訣
[6] 七返靈砂論 [7] 沈括 [8] 李 [9] 水丹 [10] 力
[11] 節度

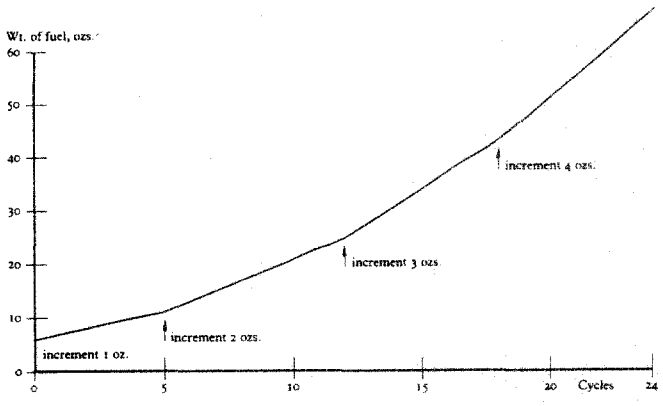

Fig. 1518. Chhen Shao-Wei's linear fire-phasing system, from his *Chhi Fan Ling Sha Lun* (On Numinous Cinnabar Seven Times Cyclically Transformed), *c.* + 713.

downs of cosmic cycles in the varying intensity of the fire, but by shifting successive cycles upward also manages to represent the gradual perfection of the Natural Cyclically Transformed Elixir in what we have no choice but to call a helical phasing scheme. Chhen begins by designing apparatus the shape and measurements of which are completely determined by cosmic correspondences. We shall study them in their place, taking note here only that the furnace of three tiers, standing for heaven, earth, and man (Fig. 1375), has in the central tier twelve doors which stand for the twelve double-hours of the day and night (*chhen*[1], to which the twelve Jupiter Stations were also functionally equivalent).[a] The fire-phasing instructions are so extended and repetitive that we shall quote only their beginning, and represent the rest schematically (Table 118). Chhen says:

Formula for fire control. The formula for the use of fire also corresponds to Yin and Yang, the twenty-four *chhi* periods, and the 72 five-day phases. Five days make up one phase, three phases make up one *chhi*, and two *chhi* make up one month. Seventy-two phases thus correspond to twenty-four *chhi*, making twelve months. Twelve months make a round year, in which the cycle of Yin and Yang reaches completion and the elixir is finished.

As for the time of firing the furnace, the fire should be applied at a midnight which is also a sexagenary hour 1, on a sexagenary day 1, in the eleventh month.[b] Begin by firing through door A for five days, using 3 *liang* of charcoal. There must always be three *liang* of well-coked charcoal (*shu than*[2]), neither more nor less, in the furnace. Then open door B and start the fire, firing for five days, using four *liang* of charcoal. Then open door C and start the fire, firing for five days, using five *liang* of charcoal. Then open door D and start the fire, firing for five days, using six *liang* of charcoal. Then open door E and start the fire, firing for five days, using seven *liang* of charcoal. Then open door F and start the fire, firing for five days, using eight *liang* of charcoal. These six doors are the Yang doors. The charcoal must be put in place vertically in order to bring the Yang *chhi* into play. Then proceed to door G and start the fire, firing for five days, using nine *liang* of charcoal. Then open door H and start the fire, firing for five days, using eight *liang* of charcoal. Then open door I and start the fire, firing

[a] Cf. the drawings of three-tiered eight- and twelve-door furnaces in Fig. 1375.
[b] The month containing the winter solstice, rebirth of Yang.

[1] 辰 [2] 熟炭

for five days, using seven *liang* of charcoal. Then open door J and start the fire, firing for five days, using six *liang* of charcoal. Then open door K and start the fire, firing for five days, using five *liang* of charcoal. Then open door L and start the fire, firing for five days, using four *liang* of charcoal. The charcoal must be put in place horizontally through these six doors, in order to maintain the correspondence with the phased alternation of Yin and Yang.[a] The fire has thus been started through door A and rotated through the twelve doors, using a total of seventy-two *liang* of charcoal in the furnace, corresponding to the seventy-two phases (in a year).

Thus four *chhi*, twelve phases, sixty days, and two months have passed; this is the first cycle.[b]

Table 118. *Chhen Shao-Wei's helical fire-phasing system*
(Based on *TT*884, pp. 12*a*–16*b*, and *YCCC*, ch. 68, pp. 19*b*–24*a*)
See also fig. 3 in Sivin (14).

cycle		Yang doors						Yin doors					
		A	B	C	D	E	F	G	H	I	J	K	L
1	Wt. of charcoal, ozs.	3	4	5	6	7	8	9	8	7	6	5	4
	Total wt. used Cosmic significance of wt.	72 pentadic phases (five-day periods) in a year											72
2	Wt. of charcoal, ozs.	5	6	7	8	9	10	9	8	7	6	5	4
	Increase in total wt. Cosmic significance of increase	12 nodal divisions of solar year (*chieh* 節)											12
3	Wt. of charcoal, ozs.	7	8	9	10	11	12	11	10	9	8	7	6
	Increase in total wt. Cosmic significance of increase	24 *chhi* divisions of solar year (*chhi* 氣)											24
4	Wt. of charcoal, ozs.	9	10	11	12	13	14	13	12	11	10	9	8
	Increase in total wt. Cosmic significance of increase	(as in cycle 3)											24
5	Wt. of charcoal, ozs.	11	12	13	14	15	16	15	14	13	12	11	10
	Increase in total wt. Cosmic significance of increase	(not stated)											24
6	Wt. of charcoal, ozs.	17	18	19	20	21	22	21	20	19	18	17	16
	Increase in total wt. Cosmic significance of increase	(as in cycle 1)											72

In this remarkable intellectual construction we see each cycle divided into a Yang phase of increasing intensity and a Yin phase of decrease. Even the vertical and horizontal orientations of the pieces of charcoal are meant to induce the proper action of Yin and Yang upon the reactants. Each of the sixty-day heating cycles begins at a higher level than the one before and results in a more exalted product.

The modern scientist naturally thinks of the exaltation as caused by the upward shift in the successive time–temperature curves. But resonance rather than physical

[a] Or: 'with Yin and Yang, the fifteen-day *chhi*, and the five-day phases (*yin-yang chhi hou*[1]).'

[b] *Ta-Tung Lien Chen Pao Ching, Chiu Huan Chin Tan Miao Chüeh*,[2] pp. 12*a*–13*a* (*YCCC*, ch. 68, under the title *Chiu Huan Chin Tan Erh Chang*,[3] pp. 19*b*–20*b*), translation from critical text in Sivin (4).

[1] 陰陽氣候 [2] 大洞鍊眞寶經九還金丹妙訣 [3] 九還金丹二章

causality is what would have been in the alchemist's mind as explaining the formation of the Elixir. Its gradual perfection was induced, he would have said, by the correspondences he had designed into the process. The rise and fall of heat, which was only one of many correspondences, paralleled the rhythmic shaping force exerted by the cosmic organism upon the Natural Elixir maturing in the bowels of the earth.

The overall symmetry of the system is not seriously compromised by minor asymmetries introduced in the interest of stronger cosmic correlations. In the first cycle only, the weight of fuel is maximal at door G, even though the transition from Yang to Yin was supposed to come after door F. This Chhen found necessary in order to correlate the total weight of fuel in the first cycle with the 72 annual pentads. The exceptionally large increment in the sixth cycle can be explained in a similar way.

In Yang Tsai's 'Pronouncements of the Immortals on Cyclically Transformed Elixirs' (*Huan Tan Chung Hsien Lun*[1]) written in +1052, such minor anomalies are unnecessary. The helical phasing system described there has attained perfect structural symmetry and regularity at the cost of a few correspondences. The alchemist is directed to choose the proper day and compass orientation, and then to build a furnace platform of pounded earth in three layers. The furnace is octagonal, with eight doors. Above the doors is a cover on which is placed the reaction-vessel, with a second vessel for cooling water resting above it. The basic cycle is an ideal month of 30 days, divided into six phases (*hou*[2]), each subdivided into two parts:[a]

First phase, first day: corresponding weight of fuel (*chih fu*[3]), 1 ounce. After $2\frac{1}{2}$ days (30 hours) increase to 2 ounces (until) 60 hours (have elapsed). Second phase, 3 ounces. After $2\frac{1}{2}$ days (30 hours) increase to 4 ounces (until) 60 hours (have elapsed)....

The total configuration over nine months is apparent from Table 119.

Table 119. *Yang Tsai's helical fire-phasing system*
(Based on *TT* 230, pp. 16*b*–17*b*)

Cycle	Fuel wt. per half-pentad, ozs.											
	1A	1B	2A	2B	3A	3B	4A	4B	5A	5B	6A	6B
1	1	2	3	4	5	6	6	5	4	3	2	1
2	2	3	4	5	6	7	7	6	5	4	3	2
3	3	4	5	6	7	8	8	7	6	5	4	3
4	4	5	6	7	8	9	9	8	7	6	5	4
5	5	6	7	8	9	10	10	9	8	7	6	5
6	6	7	8	9	10	11	11	10	9	8	7	6
7	7	8	9	10	11	12	12	11	10	9	8	7
8	8	9	10	11	12	13	13	12	11	10	9	8
9	9	10	11	12	13	14	14	13	12	11	10	9

[a] *TT*230, pp. 16*b*–17*b*, tr. auct. Cycles of this kind had considerable currency among seekers after the enchymoma, e.g. *Huan Tan Chou Hou Chüeh*[4] (*TT*908), mostly of the Sung or later, ch. 1, pp. 18*b*–20*a*; *Hung Chhien Ju Hei Chhien Chüeh*[5] (*TT*934), undated but late, pp. 3*a*–4*a*; and with wording very similar to that of the latter in *Yü Chhing Nei Shu*[6] (*TT*940), also late, pp. 11*a*–12*b*, and also pp. 14*a* and 18*b*–19*b*.

[1] 還丹衆仙論 [2] 候 [3] 直符 [4] 還丹肘後訣 [5] 紅鉛入黑鉛訣
[6] 玉清內書

Perhaps the last significant conceptual improvement in 'fire-times' (*huo hou*[1]) was two-variable phasing, in which the weight of both fuel and cooling water fluctuate to represent the dynamic interrelations of Yang and Yin. This we find in the 'Confidential Instructions on the Manual of the Heaven-Piercing Golden Flower Elixir' (*Chin Hua Chhung Pi Tan Ching Pi Chih*[2]), of Phêng Ssu[3] & Mêng Hsü,[4] a 'dual-cultivation' treatise of + 1225 which seems to be concerned with laboratory processes, albeit in a rather abstract way.[a] Mêng outlines a symmetrical 30-day schedule to be used with sealed vessels incorporating water reservoirs and cooling tubes of various designs.[b] The cycle begins at the new moon (the maximal Yin phase) with 1 ounce of charcoal and 14 ounces of water. Each day the fuel weight is increased by 1 ounce and that of the water decreased by the same amount, until on the 14th day the proportions are reversed. The weights remain constant for 3 days, doubtless to allow leeway for the precise moment of the full moon, the point of maximal energy. Then from the 17th to the 29th the weight of fuel is decreased, and that of water increased, so that the initial weights are in force for a total of 3 days (the 29th, 30th, and 1st) around the time of the new moon. The combined weight of fuel and water is always the same, 15 ounces, and this is explained as the sum of the numbers 6 and 9, which are used for the Greater (or mature) Yin and the Greater (or mature) Yang in the 'Book of Changes' and the *Tshan Thung Chhi*. Again, if for the moment we think of Yin and Yang as two sinusoidal functions out of phase by 180° (say curves representing the sine and cosine of $\theta/2$), we see them approximated here by two interdependent zig-zag functions (see Figure 1519*a*).[c]

From documents of the kind just cited one can see that number and measure were being used in a way only indirectly related to their employment in modern science. The use of measurement to control the time–temperature profile of, say, an organic synthesis is familiar enough today. In ancient and medieval alchemy the specification of quantities by which the process is to be controlled derived, by way of a theory, from prior observations and measurements, just as it does in contemporary chemistry. Its elaborate cosmic phasing aside, the alchemical process did have to transform one substance into another, and so at some point certain physical and chemical conditions had to be satisfied. It is obvious enough that alchemy and chemistry differ in the number and vagueness of the links between the control specifications and the theory, and those between the theory and the original observations. But if we were to stop there we should remain unable to account for the remarkable specificity, the over-

[a] The second chapter of this book (*TT*907), according to the author, was revealed to him by an avatar of Pai Yü-Chhan,[5] the sixth patriarch of the Southern School of Sung Taoism, which propagated 'dual cultivation'. This book might be called an imaginative meditation upon laboratory procedures and apparatus (see above, Vol 5, pt. 3, pp. 199, 203); but there are some signs, e.g. the easy mutations in the names of the two reactants, that nothing in it was meant precisely for practical application. Nevertheless it is important for the light it throws on the actual techniques of the time. On Pai Yü-Chhan, see pt. 3, p. 202.

[b] The presence of a cold water reservoir or condenser at the upper part of Yang Tsai's apparatus is of course very relevant to the early history of sublimation and distillation, on which see pp. 44ff., 62ff.

[c] *TT*907, ch. 2, pp. 20*a*–21*b*.

[1] 火候 [2] 金華冲碧丹經祕旨 [3] 彭耜 [4] 孟煦 [5] 白玉蟾

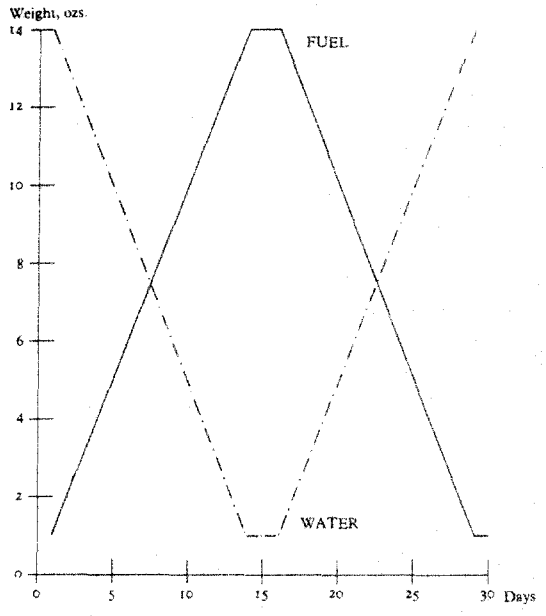

Fig. 1519*a*. Mêng Hsü's two-variable phasing system, from *Chin Hua Chhung Pi Tan Ching Pi Chih* (+ 1225).

determination, of the ancient formulas. The next step, therefore, is to realise that although in both alchemy and chemistry prior experience has to be shaped by a theory to evolve a new process, modern chemical theories are essentially mathematical while alchemical theories were numerological. The ancient adepts used numbers freely in a way which Granet in his classical study called 'emblematic'—ranking phenomena and things in a qualitative order which would also reflect their special qualitative values.[a] The numerals one to five could be used as strict equivalents for the Five Elements, and thus for the Five Spatial Orientations, Five Sapidities, Five Emotions, and so on.[b] Nine called up in the mind of the alchemist all the attributes and associations of the Greater or mature Yang, including such subtle notions as that of the inevitable inception of decay once the bloom of maturity is past. But Chhen Shao-Wei's use of a three-tiered furnace was not meant merely to symbolise, or allude poetically to, the classical triad of Heaven, Earth, and Man. It aimed actually to bring to bear on the process the synthetic unity which this triad embodied. The twelve firing doors (the basis of Chhen's combustion cycle) were placed in the middle tier because that tier had precisely the same significance within the system of the furnace as man had in his capacity as mediator between heaven and earth (Yang and Yin) within the cosmic Tao. The significance of a given number came from its order in a sequence, and that sequence as an organic whole derived its qualitative meaning from correspondences with other sequences. For instance, if 1 and 2 stood for primal Yin and Yang, 3, as their sum, stood not only for the synthesis which reconciled the antitheses but for the sentience of man which was capable of that synthesis. In another context,

[a] Granet (5), pp. 149–299.

[b] See Vol. 2, pp. 261 ff.

which energised another sequence, 3 might serve a different and even logically contradictory function. For instance, in the five-elements order 3, like 8, stood for the creative phase Wood, and carried all the immature Yang associations of East, Spring, and so on. It could be equated with, or used to mark, other things which carried the same associations, but that was no static classification into species. The Five Elements were functional phases of a dynamic cycle or configuration, not set qualities, and they could only be defined individually by relation to the total system. The Aristotelian approach, based on a rigidly structured biological taxonomy in which genera and species were individually defined, was not present here. One can find a few static definitions, but the only ones which had any standing were archaic.[a] Later Chinese taxonomy might be considered a kind of 'degenerate case' of functional and dynamic systems of correspondences,[b] just as efficient causation occurs in Chinese physics as a degenerate case of resonance interaction. Students of ancient Chinese biological ideas have worked so hard at digging out implicit taxonomies that they have had no time left to explain why explicit taxonomies were so unimportant.[c] Despite the appeal of static notions of the Five Elements and other phase-sequences to Western students of Chinese philosophy, in so far as such conceptions are specific they are inapplicable, and indeed their role in the historical development of the five-elements theory and its applications was negligible.

Now a fire-phasing system is also a dynamic sequence of numbers used to induce cyclic behaviour in a chemical process. The uniqueness of these particular systems is due, at first glance, to the fact that they were applied quantitatively as measures. But that can hardly be the whole story so long as Mêng Hsü feels free to define the constant total of fuel and water weights in his two-variable phasing system as the sum of the emblematic *I Ching* numbers 6 and 9; so we must look further. Another point which should not be ignored is that the established qualitative associations of individual numbers in a fire-phasing system need not come into play, though indeed latent. Some of these correspondences may be activated, as in Chhen Shao-Wei's use of the total weights of fuel per cycle to stand for the various divisions of the year. A third element is that the fire-phasing systems were *ad hoc*. If the usual correlations of individual numbers could be ignored, the alchemist was free to design his own system instead of accepting or building on an old one. He would have no such freedom if he were trying to explain some aspect of his process with a theory made up of five coordinate concepts, for he would be unable to avoid the customary five-element associations.

Once all these characteristics are put together, the contrast between a classical emblematic system such as the Five Elements and a fire-phasing system becomes much

[a] Even the best-known set of archaic definitions of the elements—'Water is called the soaking and descending', etc.—are clearly concerned with modes of action rather than formal qualities. See Vol. 2, pp. 242–6.

[b] Our 'symbolic correlations' of Vol. 2, pp. 261 ff.

[c] This does not mean, of course, that no impressive systems of botanical and zoological classification developed as the centuries went on. The process is clearly visible in the literature of lexicography and pharmaceutical natural history from the *Erh Ya* and the *Shen Nung Pên Tshao Ching* onwards (cf. Vol. 6). One of us (N.S.) doubts, however, that these classifications were primarily biological in any modern sense.

clearer if somewhat less absolute. To understand either, one has to be aware of two related kinds of emblematic significance. One is the mode of action or behaviour implied by the whole system seen as a sequence of phases. This significance Granet called 'hierarchical', for he thought of it as the construction of a hierarchy (in the case of the elements, a five-valued one) and the ranking of phenomena within it.[a] We prefer to use some such phrase as 'phase-sequential', in order to emphasise that the ranking was neither static, absolute, nor vertical, and that time was one of its most basic parameters. Spatial configurations were no less characteristic than temporal sequences, as we shall see;[b] but in place of a cycle, what they imply is a continuum.[c] The second kind of significance is determined by the qualitative associations of individual elements. These associations could be applied to phenomena on a one-to-one basis, even though they were functional and originally derived from the role of the element in the system. This is Granet's 'formal function' (*fonction protocolaire*).[d] We recognise it in the application of the number 5 to invoke the cosmic associations of Earth, which within the five-element system represents the phase of balance, neutrality, or undifferentiation.[e] In the classical systems, Yin–Yang, trigrams and hexagrams and the Five Elements, there is somewhat greater emphasis on the formal function in most theoretical applications, although both functions are generally in evidence and one tends rather clearly to imply the other. The ubiquity of qualitative associations sets a limit to the truly mensurational applicability of these systems. A fire-phasing system, on the other hand, is an *ad hoc* construction in which the formal function does not come into play unless the alchemist chooses in certain cases to assign cosmic significances. We have seen that such choices were responsible for the anomalies in Chhen Shao-Wei's schema, and that Yang T'sai achieved much greater simplicity without them. With a minimum of individual qualitative correlations, there is little in a fire-phasing system to make gravimetric applications confusing. The significance of such a system is almost completely concentrated in the sequential profile of its cycle.

Still, the metaphysical basis of a fire-phasing system was in no way different from that of, say, the Five Elements. Quantitative fire and heat control was a remarkable first step in the use of quantity to unite theory and practice, but somehow it did not carry within it the implication of further steps in the direction of mathematised science, and historically it was also the last stage of this kind in Chinese proto-science as such.[f] Nevertheless it was known and practised later in both Arabic and European alchemy, as Ben Jonson's 'Alchemist' may by itself sufficiently prove.[g]

> *Mammon:* Lungs, I will manumit thee, from the Furnace;
> I will restore thee thy complexion, Puffe,
> Lost in the Embers; and repair this Brain
> Hurt wi' the Fume, o' the Metals.

[a] Granet (5), p. 151. [b] Pp. 286ff. [c] Cf. Vol. 4, pt. 1, pp. 6ff.
[d] Granet (5), pp. 151, 566ff. *et passim.*
[e] Cf. Vol. 2, pp. 59, 106, 112, 114 on 'the uncarved block'.
[f] For a discussion of the idea of combining weights in alchemy and its connections with numerology, see below, pp. 301ff. [g] Act II, Scene ii.

Face: I have blown, Sir,
Hard for your Worship, thrown by many a Coal
When 'twas not Beech, weigh'd those I put in, just
To keep your heat still even; These Bleard-eyes
Have wak'd, to read your several Colours, Sir,
Of the pale Citron, the green Lyon, the Crow,
The Peacocks Tail, the plumed Swan....

(5) Cosmic Correspondences Embodied in Apparatus

The dearth of individual correspondences in fire-phasing did not hinder the alchemist much, for he had many other means at his disposal for bringing cosmic correspondences to bear on his process. As we have already looked at the choice of reagents in this light,[a] we can now proceed to consider cosmic correspondences in the alchemist's equipment. These were established by a variety of related means, including spatial orientations, analogical shapes, and numerologically defined dimensions of furnaces and reaction-vessels. Here we shall find many more data on the formal significance of measurements in Chinese alchemy.

Although the *Tshan Thung Chhi* is full of microcosmic correspondences, these are not developed much numerically. There is a chapter which has circulated separately under the title 'Song of the Reaction-Vessel' (Ting Chhi Ko[1]) and may indeed be later than the rest, on the canonical dimensions of the reaction-vessel;

Round three five,
Inch and a tenth,
Mouth four eight,
Two inch lips...'[b]

But the significance of these numbers, whatever it may be, remains entirely implicit. Nor is there anything of this kind in the 'Yellow Emperor's Nine-Cauldron Spiritual Elixir Canon' (late Han?), nor in the Inner Chapters of the *Pao Phu Tzu* book (*c.*+320). In the early Mao Shan documents (*c.* +500 at the latest) there are lucid instructions for centering the furnace in a space oriented by the cardinal points. A thatched elaboratory has to be built facing south. The furnace is set up precisely at its centre, and the reaction-vessel placed centrally within it.[c] But again the significance of this centering is not pointed out.

For explicit cosmic correlations we must return to the furnace and vessel within which Chhen Shao-Wei, probably in the +8th century, phased the firing of his 'Ninefold Cyclically Transformed Gold Elixir'. In *TT*884 we read:

The furnace and reaction-vessel for the Great Elixir must also be made in such a way as to incorporate (*ho*[2]) heaven, earth, and man (the Three Powers), and the Five Spirits

[a] See pp. 225, 251ff.

[b] *Chou I Tshan Thung Chhi Fên Chang Chu Chieh*, ch. 33 (ch. 3), pp. 7*a*–10*b*, tr. auct. Cf. above, Vol. 5, pt. 3, p. 71.

[c] *Thai-Wei Ling Shu Tzu-Wên Lang-Kan Hua Tan Shen Chen Shang Ching* (*TT*252), p. 4*a*; *YCCC*, ch. 68, p. 4*b*.

[1] 鼎器歌 [2] 合

Fig. 1519*b*. Two of the Twelve Hour-Presidents (Spirits of the Double-hours). On the left, the patron of the hour *mao* (5 a.m. to 7 a.m.); on the right, the precentor of midnight (the *tzu* hour, 11 p.m. to 1 a.m.). A pair of Han tiles in the Royal Scottish Museum, Edinburgh.

(*wu shen*[1] = the Five Elements).[a] The vessel must be made from 24 ounces of gold from the seventh recycling, in order to respond to the 24 *chhi* periods. Sixteen ounces of it is cast into a round (or, spherical) vessel with a capacity of nine liquid ounces (*ko*[2]); and eight ounces into a cover.[b] The use of 16 ounces to make the vessel incorporates the number of (ounces in) a pound. The capacity of nine ounces embodies the Three Origins (*san yuan*[3] = the Three Powers) and the maximal Yang (number, 9).[c] The 8 ounces of the lid responds to the Eight Nodes (the beginnings and midpoints of the four seasons). The vessel and lid are thus 24, incorporating these great constants. The vessel must be emplaced according to the Eight

[a] This meaning of *wu shen* goes back to the *Huai Nan Tzu* book, *c.* −120 (ch. 21, p. 2*a*): 'Astrology ... conforms to the correspondences of the temporal cycles, and models itself on the constancy of the Five Spirits.'

[b] The possible alchemical use of the ancient spherical *tui* vessels (Figs. 1392, 1393 above) has already been remarked upon.

[c] Cf. Granet (5), p. 150.

[1] 五神 [2] 合 [3] 三元

Trigrams and the Twelve Spirits (*shih-erh shen*[1] = the 12 hours)[a] before the mixed Purple Gold Granules are placed in it. It is tightly closed and luted so that no Yang *chhi* (i.e., vapour) can escape, and is put into the furnace.

Formula for building the furnace. On a 45th sexagesimal day falling in a 41st sexagesimal decad,[b] in a place oriented toward the southwest and the ninth duodenary branch,[c] take clean earth and begin by building it up to make a platform eight inches high and two feet four inches broad. On the platform make a furnace 2 feet 4 inches high, in three levels, with free access of *chhi* from bottom to top. The upper level, 9 inches high, is Heaven. Make nine openings in it, to correspond to the nine stars (of the old Great Bear).[d] The middle level, 1 foot high, is Man. Make 12 doors, which stand for the twelve hours of the day (*chhen*[2]). A fan (*shan*[3]) must be installed in each. The lower level, 5 inches high, is Earth. Open 9 passages (*ta*[4]), which correspond to the Winds of the Eight Directions (*pa fêng*[5]). The interior of the furnace must be 1 foot 2 inches in diameter.[e]

These correlations are all paradigms of the use of number to call up qualitative associations. Their referents are rather scattered—from the balance to the Great Bear—but images patently cyclical and temporal are in the majority. All of these influences operate upon the furnace and vessel, and contribute to the formation of the Elixir. Numerological correspondences of this sort become common in later alchemy, and can even be found in physiological alchemy and magic.[f]

(i) *Arrangements for microcosmic circulation*

In one of the basic collections on 'irrigation' processes, the *Chhien Hung Chia Kêng Chih Pao Chi Chhêng*[6] (Complete Compendium on the Lead–Mercury A–G Perfected Treasure),[g] incorporating generally Sung or later materials,[h] the effect theoretically induced within the reaction-vessel by bringing the cosmic forces to bear is clearly visualised.

[a] Cf. Forke (4), vol. 1, p. 534; vol. 2, pp. 406–407. See also for the double-hour presidents, our Vol. 4, pt. 2, p. 440 and Fig. 1519*b*.

[b] The practice of numbering ten-day periods (*hsün*[7]) sexagesimally was not at all common in China.

[c] According to the normal spatial associations of the duodenary series, the ninth branch is the southernmost of the three which correspond to West. See Table 34, in Vol. 3, p. 403.

[d] See Vol. 3, p. 250.

[e] *TT*884, pp. 11*a*–12*a*, and *YCCC*, ch. 68, pp. 18*b*–19*b*; tr. Sivin (4).

[f] For physiological alchemy see *Hsiu Tan Miao Yung Chih Li Lun*[8] (Sung or later, *TT*228), pp. 9*b* ff. As for magic, numerologically significant numbers appear without discussion, but correspondences of furnace shape are identified, in a Thang text on the preliminaries to the casting of three magic mirrors (which themselves embody cosmic dimensions), weights, and images. This is *Shen Hsien Lien Tan Tien Chu San Yuan Pao Ching Fa*[9] of +902 (*TT*856). The penultimate character is sometimes given as *chao*;[10] it was altered, probably by an early copyist, to avoid a Sung taboo on the character *ching*[11] and its homonym; see Chhen Yuan (4), p. 154.

[g] *Chia*[12] and *kêng*,[13] which here we translate as A and G in this book title, are two of the ten cyclical characters (*kan*,[14] 'stems') long used for designating members of a series; and, since the +17th-century Jesuits, for translating letters of the alphabet denoting parts on scientific and engineering diagrams. Since the stems are paired two by two with the Five Elements, *chia* and *kêng* correspond to the elements Wood and Metal (immature Yang and Yin) respectively, and that is their significance here. See Vol. 3, pp. 396–8, and Vol. 5, pt. 3, pp. 158 ff., 280 above.

[h] See pp. 294 ff.

[1] 十二神 [2] 辰 [3] 扇 [4] 達 [5] 八風 [6] 鉛汞甲庚至寶集成
[7] 旬 [8] 修丹妙用至理論 [9] 神仙鍊丹點鑄三元寶鏡法
[10] 照 [11] 敬 [12] 甲 [13] 庚 [14] 干

Upper and lower reaction-vessels (*ting*[1]). The body has a circumference of 12 inches to respond to the 12 months,[a] and is 8 inches long (i.e., high) to correspond with the Eight Nodes. The width of the body of the upper vessel is twice that of the lower vessel, in order to bring to bear (*an*[2]) the 24 *chhi*. The upper vessel is heaven, and the lower earth. In the upper there is ascension, so it is Yang; in the lower there is descent, so it is Yin.[b] The Yin *chhi* wants to ascend, and the Yang *chhi* wants to descend. This responds to the formative power (*thao yeh*[3]) of Yin and Yang. The length and breadth must be neither larger nor smaller than (the dimensions given). If larger, the *chhi* will disperse instead of collecting; if smaller, it will be forced to overflow. Thus (in neither case) can it be made to rise and fall equitably and harmoniously.[c]

The motion described here is unquestionably a circulation, although explained rather vaguely, apparently in terms of the automatic reversion of Yin and Yang once they have reached their limits. The author does not seem to be very concerned about the contradiction of a Yin *chhi* wanting to ascend when it is defined by its tendency to descend. Perhaps he would have explained such a movement by the urge towards creative union.

This apparent discrepancy is handled more overtly in a late text which envisions, at least for meditative purposes, a vessel with cooling water above and fire below. The explanation may not be chemical, but it is certainly physical. The writer says:

Now for the method of preparing the Elixir.[d] The reaction-vessel has three legs in order to respond to the Three Powers. The two containers, upper and lower, correspond to the Two Instrumentalities (*liang i*,[4] earth and heaven). The legs are 4 inches high to respond to the four seasons. The furnace is 8 inches deep in order to match the Eight Nodes. In the lower part 8 doors are opened to admit the Winds of the Eight Directions. The charcoal is apportioned in 24 pounds in order to arouse the 24 *chhi*.[e] Yin and Yang are inverted, with Water and Fire meeting and struggling. Above is Water, responding to the pure *chhi* of Heaven. Below is Fire, receiving the turbid *chhi* of Earth. The celestial *chhi* descends, while the terrestrial leaps upward: Heaven and Earth meeting in mutual stimulus, the primal *pneumata* (*yin yün*[5]) conjugating. They come together to form the Two *chhi* (Yin and Yang), which, once joined, blend to become one. (The product) is named the Great Elixir of the Two *chhi*, and its marvellous function depends upon these (correspondences). In a dozen hours (i.e. a day) the process asserts a power which it takes the Shaping Forces a thousand years to exert.[f]

If the task is to explain a cyclical motion within the vessel, the crux will lie in accounting for the half of the motion which is contrary to the customary sense of Yin and Yang. This tractate derives the reverse movement from the configuration of the apparatus, which from the viewpoint of Yin–Yang theory can be considered inverted, since the

[a] This refers to the lower vessel, and is given later (p. 5*a*) as diameter.

[b] This sentence may also be taken to mean simply 'Ascent is Yang, descent is Yin.'

[c] *TT*912, ch. 3, p. 4*b*, tr. auct.

[d] Even though the ultimate concerns of this treatise seem to be with the Enchymoma, the language of the process contemplated here is that of the Elixir, so we translate accordingly.

[e] I.e. the *chieh chhi* of the 24 fortnightly divisions of the year.

[f] *Chiu Chuan Ling Sha Ta Tan Tzu Shêng Hsüan Ching*[6] (Mysterious Sagehood-Enhancing Canon of the Great Ninefold Cyclically Transformed Cinnabar Elixir [or Enchymoma]), *TT*879, pp. 1*b*, 2*a*, tr. auct. This undated text, cast in *sūtra* form, of unknown authorship, incorporates many of the conceptions of *wai tan* (external, or chemical, alchemy), but its own rather obscure perspectives seem to be those of *nei tan* (internal, or physiological, alchemy).

[1] 鼎 [2] 按 [3] 陶冶 [4] 兩儀 [5] 氤氳 [6] 九轉靈砂大丹資聖玄經

fire (Yang) is below and the water (Yin) is above.[a] Since the two *chhi* are out of their proper static (or rather configurational) orientations, they must move to regain them.[b] What we might for the moment visualise as the kinetic energy of their collision, responsible for the exalted level of organisation of the Elixir, is accounted for.

But if the circulation is divided into two temporally distinct halves, it becomes nothing more nor less than an oscillatory cycle. This we find a bit further on in the *Chhien Hung Chia Kêng Chih Pao Chi Chhêng* (*TT*912), as the 'four seasons' heating

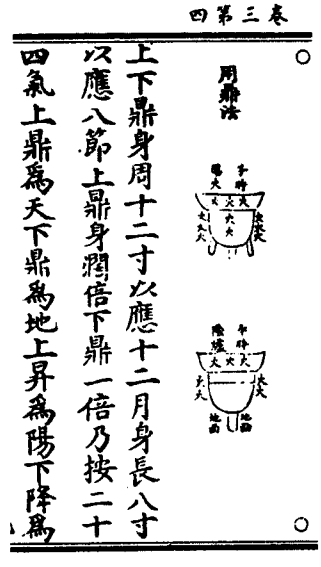

Fig. 1520. A page from Chao Nai-An's *Chhien Hung Chia Kêng Chih Pao Chi Chhêng* (Complete Compendium on the Perfected Treasure of Lead, Mercury, Wood and Metal), ch. 3, p. 4 *b*, showing the *Yang lu* and *Yin lu* furnaces. Perhaps Thang (+ 808) in date, but more probably Wu Tai or Sung.

technique (*ssu shih huo*[1]). The sealed vessel is moved back and forth each day between a 'Yang furnace' (*Yang lu*[2]), which is heated from below, and a 'Yin furnace' (*Yin lu*[3]), which has a container of water below it and is heated from above, in order to set up an oscillatory motion within the vessel (Fig. 1520). The text runs:

Use 'four seasons' heating for 7 days and nights, in order to develop the great power (*kung*[4]) (of the Elixir). Water, Fire, and the reactants: these respond to the Three Powers, heaven, earth, and man.[c] In this 'four seasons' heating the fire of spring should be mild, that of summer intense, that of autumn warm, and that of winter weak. For this method, select the first double-hour (11 p.m.–1 a.m.) of the first day of a duodenary cycle, place the vessel on its fitted three-legged support, and put it into the Yang furnace. Under the belly of the vessel pile (charcoal), extending it $\frac{3}{4}$ inch (*or* $\frac{3}{10}$ of the way, *san fên*[5]) up the body of the vessel. Use a gentle fire so that the contents conjugate for $1\frac{1}{2}$ hours. Next increase the fire,

[a] Note the parallel with the reversed polarity of Realised Lead and Mercury, seen earlier (p. 254).

[b] The implicit assumption—that the *chhi* of an Element will move spontaneously in order to regain the orientation proper to that element—is philosophically reminiscent of that doctrine of place on which Aristotle's physics of motion was based. See Vol. 4, pt. 1, p. 57.

[c] The reactants take the same intermediate position as does man with respect to earth and sky.

[1] 四時火 [2] 陽爐 [3] 陰爐 [4] 功 [5] 三分

piling the charcoal close to the vessel up to half its height for 1½ hours. Then make the fire intense with a full charge of charcoal, building it ⅔ of the way up the body of the vessel. After 1½ hours gradually decrease the fire. Use a weak fire, so that the contents of the vessel will be warm and the warm *chhi* remains controlled for 1½ hours until the sixth double-hour (11 a.m.–1 p.m.). Withdraw the vessel and start the Yin furnace, placing the belly of the vessel over the mouth of the small pot (of water which has been buried in the earth at the bottom of the furnace). Use ashes to bury the body of the vessel to ⅔ of its height. Then with a cloth wipe any water off the upper vessel. After it is dry put the fitted fire-pan (*ting phan*[1]) in place, and in it put one pound of burning fuel. This is called 'inserting the spring fire', which causes the mercury inside the vessel to descend slowly for 1½ hours. Only then may the charcoal be piled up above the ash layer and packed against the vessel as (the fire) is gradually increased for 1½ hours. Finally the full charge of burning fuel is packed about the vessel from the fire-pan to the ash layer. This gives a strong combustion, and the flame burns intensely for 1½ hours. Then gradually remove the fire above the vessel and heat weakly from below,[a] so that the Medicine within the vessel is kept at a controlled warm heat for 1½ hours until midnight, the first double-hour of the day. At that time the vessel is again shifted into the Yang furnace, and as before (the Medicine) is made to go through a cycle of ascent and descent in the *chi chi*[2] and *wei chi*[3] furnaces.[b] After 7 days and nights the power of the fire will have brought the process to completion.[c]

Thus although there are four major phases, which correspond to the four seasons beginning with Spring,[d] the transitions are not at all abrupt. The phasing is moderated and made gradual by finer variations of both fire intensity and area of vessel in contact with the burning fuel, but fuel weights are not prescribed. This particular process does not happen to maintain the symmetry of water and fire throughout the cycle, but depends on fire alone during the Yang phase. Since the 'Yang furnace' (which had no water vessel and was usually heated from all sides) and the '*wei chi* furnace' (with fire above and water below) both induced the Yang mode of action within the vessel, the alchemist was constrained in choosing between them only by his taste for abstract symmetries.

In another compendium of 'irrigation' methods, the *Kêng Tao Chi*[4] (Collection of Procedures of the Golden Art),[e] written some time after +1144, there is a 'Bubbling-Spring Perpetual-Life Casing' method (*yung chhüan chhang shêng kuei*[5]) in which 'water below and fire above' is alternated with 'fire below and water above' for 2½ days

[a] Or, punctuating differently, 'Then gradually remove the fire above the vessel and the lower fire.'

[b] On these pieces of apparatus see further the discussion on pp. 68ff. and the study of the meaning of the names, p. 70. The whole conception of the Yang and Yin furnaces in this text is inextricably connected with the ancient procedures of sublimation and *destillatio per descensum* (cf. pp 44, 55), as also with the later development of true distillation in its East Asian forms (pp. 62ff.). For Chao Nai-An and his anonymous colleagues who wrote this book the *chi-chi* and *wei-chi* apparatuses were probably not stills in any modern sense, but they may well have derived from apparatuses in artisanal or pharmaceutical use that were.

[c] *TT*912, ch. 3, pp. 5*a*–6*a*, tr. auct.

[d] The most common practice was to begin the process at the winter solstice, the moment of the ascendancy of mature Yin and thus of the rebirth of Yang in the cycle of the year.

[e] The title does not actually say 'gold' but '*kêng*',[6] the 7th of the decimal stems and thus the element Metal. But pragmatically oriented alchemists often used *kêng* as a cover name for gold, and it is possible that the compiler of *Kêng Tao Chi* meant nothing more abstract. Our rendering of the title is in any case tentative.

[1] 鼎盤 [2] 既濟 [3] 未濟 [4] 庚道集 [5] 湧泉長生匱
[6] 庚

each. The fuel is increased a day at a time from 1 ounce to 16, and then decreased to 1 ounce again. We are informed that 'this is the Bubbling-Spring fire phasing system (*yung chhüan huo hou*[1]) concealed within Master Wei (Po-yang's) *Tshan Thung (Chhi)*.'[a] Here as in the earlier examples, the two-reactant system, the heat phasing, and the correspondences of the apparatus are interdependent.

By good fortune we are not limited to verbal descriptions of the two types of fire–water apparatus. In the seventh cycle of the formula for the 'Nine-Cycle Potable Gold Great Cyclically Transformed Elixir' (*Chiu Chuan Chin I Ta Huan Tan*[2]) in the *Chin Hua Chhung Pi Tan Ching Pi Chih*[3] (Confidential Instructions on the Manual of the Heaven-Piercing Golden Flower Elixir) of +1225, detailed instructions are given for heating the reactants,[b] sealed within a golden 'chaos vessel', first with 'water below and fire above' for two months, then with 'fire below and water above' for one month.[c] Although the weight of fuel remains constant within each of the two phases in this particular process, a single apparatus is converted from one function to another by substituting parts (Fig. 1448). Although, as has been pointed out above (p. 73), the 'water below and fire above' apparatus somewhat resembles a still with two side-tubes, the text indicates that the water-container with its two arms is not open to the reactants, and that they remain sealed within the egg-shaped reaction-vessel. The arms could thus serve only to lead water into the reservoir and to let steam escape. It is not unreasonable to suppose, however, that this design was prompted by knowledge of water-cooled stills. In practice its effect would have been only to lower slightly the temperature in the vessel. On the other hand, the water reservoir in the 'fire below and water above' apparatus resembles a funnel and protrudes from the condenser head into the reaction-vessel, but its lower end is closed.[d]

With this in mind we are able to go back another 50 years in time and recognise the same alternation in two illustrations in the *Tan Fang Hsü Chih*[4] (Chymical Elaboratory Practice) of +1163.[e] The apparatus on the left in Fig. 1446, with the reaction-vessel and furnace above and the water reservoir with side-arms below, is labelled '*wei chi* furnace', while that on the right, with its water reservoir above, is marked '*chi chi* furnace', as in the Four Seasons heating technique which we have just examined.[f] In all these texts, as in others of less certain date and import,[g] we may

[a] *TT*946, ch. 7, pp. 16*a*–17*a*. The text is syntactically defective, and we read conjecturally *chih nei pi tshun*[5] for *pi chih nei tshun*.[6]

[b] Each cycle uses a different complex apparatus, basically a sealed gold reaction-vessel with cooling coils of various sorts; in later cycles the metal is made by transmuting mercury. For details see above, pp. 35ff. An apparatus which closely resembles the lower one in Fig. 1409 appears in ch. 2, p. 2*a*, with the superscription *chi chi*[7] (cf. Fig. 1446) as in *Tan Fang Hsü Chih* (see below).

[c] *TT*907, ch. 2, pp. 14*b*–16*a*.

[d] See above, p. 35, for an excerpt from this text which specifies that 'the lower end is closed and does not allow water to pass through'.

[e] *TT*893, p. 9*a*.

[f] See pp. 283ff.

[g] Another picture of the *wei-chi* apparatus occurs in the *Chih-Chhuan Chen Jen Chiao Chêng Shu*[8] (Technical Methods with Critical Annotations by the Perfected Immortal (Adept) Chih-Chhuan (Ko Hung), *TT*895), p. 1*b*. We reproduce it in Fig. 1447. Despite the attribution, the authorship and date of this little tractate are unknown. Nor is it critically annotated. Moreover the text is not at all oriented towards practical proto-chemical alchemy.

[1] 湧泉火候 [2] 九轉金液大還丹 [3] 金蕚冲碧丹經秘旨 [4] 丹房須知
[5] 之內祕存 [6] 祕之內存 [7] 既濟 [8] 稚川眞人校證術

be seeing landmarks in the history of distillation transmuted into instruments of microscosmic induction. They and their background will require much further study.

(ii) *Spatially oriented systems*

The paramount importance of time in alchemical processes has led us to give much emphasis to the significance of phased cycles. But spatial orientation was also regularly used by some alchemists in their models of the Tao. Since the Tao is the organic totality of space and time, it cannot be apprehended in its wholeness except by a mystical intuition which not every Taoist could hope to summon up at will. The adept who wanted to find his way to enlightenment through knowledge and contemplation used abstract correspondences and partial visualisations. He could concentrate on the temporal aspect of the Tao, turning his attention to the cyclical behaviour of the cosmos or one of its sub-systems. Another alternative open to him was to hold time constant, apprehending the organismic pattern as reflected in a momentary configuration. In other words, as we have suggested in passing a few pages earlier, a configuration of several organically related elements plays the same role in spatial correspondences as a cycle (a special time configuration) plays in temporal correlations. The two modes are interdependent and functionally interchangeable. As the great systematiser of five-element correspondences, Tung Chung-Shu, put it about −135, 'Thus Wood has its place in the east and has authority over the *chhi* of spring. Fire has its place in the south, and has authority over the *chhi* of summer', and so on.[a] What held spatial east and temporal spring in their equation was the sun's annual motion, of which they both represented a quarter.[b] Each of the temporal sub-systems based on the year (the 72 pentadic phases, 24 *chhi* periods, 12 months, 8 nodes) which we have seen invoked above had similar correspondences—to each *chhi* belonged $\frac{1}{24}$ of the sun's annual path,[c] and so on—which the alchemist could make explicit if he wished.

From the birth of alchemy to its demise, the Five Elements were used to characterise locations throughout space, dividing it into the four cardinal directions and a centre at which opposite modes were neutralised and harmonised. The Five Elements categorised places and at the same time organised them into a system.[d]

Examples of spatial orientation have already appeared in several of the documents above.[e] Alchemical specifications of location were so tied conceptually to temporal correspondences that they are practically never found in isolation. One of the very

[a] *Chhun Chhiu Fan-Lu*, ch. 42, tr. Hughes (1), p. 294. See Vol. 2, p. 250. The attribution and date of this book have recently been questioned by Prof. G. Malmqvist, but the text must be an ancient one.

[b] The relation is not so simple as it may seem but we have discussed it in Vol. 3, p. 240.

[c] Cf. Yabuuchi's definition of the *chieh-chhi*[1] (the 24 *chhi* divisions) as the 'time required by the sun to move through each 15° on the ecliptic'; (9), p. 462.

[d] So far the classical account of Chinese conceptions of space lies with Granet (5), pp. 86–114, but there is urgent need for a less exclusively anthropological approach.

[e] The reader will also recall the alchemical planting of the Five Grains, each in the direction corresponding to its colour, within the precincts of Wang Mang's palace in +10. See above, Vol. 5, pt. 3, p. 37.

[1] 節氣

few exceptions is particularly interesting because it is early, its context is medical, and it is concerned implicitly but unmistakably with emplacing the reactants within the reaction-vessel in such a way as to create a microcosmic configuration. This is not an alchemical elixir but a 'Panaceal Sublimed Yellow Powder' (*kuang chi fei huang san*[1]), prescribed for sores and ulcerations in one of the great medieval compendia of medical prescriptions, Wang Thao's[2] *Wai Thai Pi Yao*[3] (Important Medical Formulae and Prescriptions revealed by a provincial governor) of +752. That its ultimate source was alchemical is more than likely. Yoshida Mitsukuni has pointed out[a] similarities to a recipe in the *Thai-Chhing Shih Pi Chi*[4] (Records of the Rock Chamber; a Thai-Chhing Scripture—before +806), a practical collection of alchemical and iatrochemical formulae with Mao Shan associations. What Wang Thao says is as follows:

Take: Laminar malachite (*tshêng chhing*) Magnetite (*tzhu shih*)
Orpiment (*tzhu huang*) Realgar (*hsiung huang*)
Fibrous arsenolite (*pai yü shih*) Cinnabar (*tan sha*)

one ounce of each. Grind the above six ingredients to fine powders, and emplace them according to the colour correspondences of the directions: laminar malachite to the east, cinnabar to the south, white arsenolite to the west, magnetite to the north, and realgar in the central position. Two earthenware urns (*wa wêng*[5]) are coated inside with yellow clay two or three times in order to make (a lining) five- or six-tenths of an inch thick. Then place powdered orpiment in the bottom. Combine and sieve[b] the other ingredients and put them on top, afterwards laying (the other) half of the orpiment on top as a cover. Spread clay closely on the joint (between the two vessels, the mouths of which are now joined); and do not allow any of the *chhi* to leak out.[c]

Here the five-element correspondences are organised conventionally:[d]

Substance	Colour	Direction	Element
Laminar malachite	caerulean	east	Wood
Cinnabar	red	south	Fire
Arsenolite	white	west	Metal
Magnetite	black	north	Water
Realgar	yellow	centre	Earth

[a] (5), p. 220, referring to *Thai-Chhing Shih Pi Chi* (*TT*874), ch. 1, pp. 13*a*–14*a*. This recipe also emphasises directional correspondences, but the similarity is not quite as close as Yoshida suggests. The alchemical text has *pai fan shih*,[6] white kalinite alum, instead of arsenolite, *pai yü*[7] *shih*. Since the characters are similar, it is not impossible that one passage is corrupt, but we dare not assume it. Yoshida also adduces another similar passage. Cf. (7), pp. 227ff.

[b] The direction to combine the ingredients seems expressly to countermand the specification that they be emplaced directionally. The separation of the two instructions does not necessarily mean that they apply to two separate procedures, for the opening instruction seems to have been attached originally to the list of ingredients rather than to have been the first of several consecutive steps in the actual process. We suggest very tentatively that 'combine and sieve' (*ho shai*[8]) may be a misreading of the visually similar 'sieve separately' (*fên shai*[9]). The editor of the recent Jen-min Wei-shêng edition suspects (textual notes, p. 65*b*) that this recipe is incomplete, and suggests other emendations.

[c] *Wai Thai Pi Yao* (*Fang*), ch. 30 (p. 818.2), tr. auct.

[d] See above, p. 225, Table 117.

[1] 廣濟飛黃散 [2] 王燾 [3] 外臺秘要 [4] 太清石壁記 [5] 瓦甕
[6] 白礬石 [7] 雄 [8] 合篩 [9] 分篩

This microcosm transcends the two-dimensionality of the five-element concept by adding a higher and a lower plane. Orpiment serves for both, its yellow colour indicating the bond of the up and the down to the centre, and thus their neutrality in the scheme. If the originator of this process had wanted to bring the Yin–Yang correlations of 'up' and 'down' to bear, he would have used two different substances to represent them.[a]

Another preparation (unfortunately more confused) given by Wang Thao employs a vertical stack of five reactants in addition to the five which are horizontally emplaced:

> Take cinnabar and place it to the south in an earthenware basin (*wa phên*[1]). Orpiment is placed in the centre, magnetite to the north, laminar malachite to the east, and quartz (*pai shih ying*[2]) to the west, with arsenolite above, talc (*shih kao*[3]) next in order, and stalactite (*chung ju*[4]) on the bottom. Realgar is the cover, and muscovite mica (*yün mu*[5]) is spread thinly beneath. (Use) 2 ozs. of each, first pounding and sifting into the basin. Cover it with another basin....[b]

The wording is not exact enough to determine where the horizontal and vertical axes intersected, or even the precise order of the vertical ingredients. Reasoning from the way formulae are usually worded, we might suggest the most probable order (from the top down) to be realgar, arsenolite, calcite, stalactite, and muscovite. All are white except the realgar, which the Chinese associated closely with orpiment (as does modern chemistry), and which took the central place in the other configuration.

If we trace the idea of alchemical colour associations as far back as we can, we find them being applied along with other cosmic associations not to the contents of the reaction-vessel but to the lower of the three regions of vital heat ('Fields of Cinnabar', *tan thien*[6]) in physiological alchemy.[c] The *Lao Tzu Chung Ching*[7] (The Median Canon of Lao Tzu) is a pre-Thang treatise on the physiological microcosm and its gods which maintains the pre-Mao-Shan tradition (based on a prone meditation position) with respect to the location of the *tan thien*.[d] Before noting that the divinity resident in the *tan thien* is named Confucius (*hsing Khung ming Chhiu tzu Chung-Ni*[8]), it states that

> the interior of the *tan thien* is scarlet in the centre, caerulean on the left, yellow on the right, white above, and black below. It goes from square to round within (a length of) 4 inches. The reason that it is located 3 inches below the navel derives from (the triad of) Heaven, Earth, and Man. Heaven is 1, earth 2, man 3, and the seasons 4; thus it is said (that the length is) 4 inches. Based on the Five Elements, there are the 5 colours.[e]

[a] Exactly what Wang Thao ended with would be anybody's guess, but if he took the sublimate it was presumably a mixture of mercuric and arsenical compounds. Repetition in the laboratory today could alone decide what happened.

[b] Ch. 24 (p. 664.1), tr. auct. The Chhing xylograph which the Jen-min Wei-shêng edition reproduces is badly mispunctuated, jumbling the directional associations. The formula is attributed to one Fan Wang.[9]

[c] See pt. 5 below.

[d] Early Taoist traditions of internal cosmography and *nei tan* techniques are being studied by our colleague Prof. K. M. Schipper, to whom we owe this reference.

[e] *YCCC*, ch. 18, pp. 13*a*, *b*, tr. auct. It is curious that since in this case red had to be central the other colours had to be peripheral, but it is not easy to see why they were arranged as stated.

[1] 瓦盆 [2] 白石英 [3] 石膏 [4] 鍾乳 [5] 雲母
[6] 丹田 [7] 老子中經 [8] 姓孔名丘字仲尼 [9] 范汪

In this passage there is no attempt to assign a function to the array of colours, or to account for the fact that their directional associations are not those of the five-element convention. It may be, therefore, that the Five Colours were introduced for the simple numerological purpose which becomes plain in the final sentence of our excerpt. Still, this highly regarded treatise existed thenceforth as a precedent for deeper speculations.

Between Wang Thao's sophisticated and abstract configurations laid out within the confines of a sealed reaction-vessel and the simple centering of the vessel within a directionally oriented elaboratory in the earliest Mao Shan documents lies a great gulf.[a] In the latter we can still glimpse the ritual origin of the organisation of space. Even after the idea of configuration had been transmuted philosophically into chemical techniques, the demarcation of inviolate sacred spaces in Taoist rituals continued alongside. The following example of a rite for the protection of the alchemical furnace, included in Wu Wu's[1] *Tan Fang Hsü Chih*[2] (Chymical Elaboratory Practice) of +1163, uses at least three of the same colours and directions as Wang Thao's formula, though they are represented by different materials. It runs:

To the south, one foot from the furnace platform, bury 1 pound of crude cinnabar,[b] formed into a 5-inch long 'wire' (*hsien*[3]) after being mixed with vinegar. To the north bury 1 pound of lime; to the east, 1 pound of cast iron; and to the west, 1 pound of white silver. Above, three feet from the reaction-vessel, hang an ancient mirror, and set out lamps for the 28 lunar mansions and the Five Planets. In front set up a fine sword. Before the furnace provide a basin of water from a previously unused well, refilling (the basin) once every seven days. Use a bench of peach-wood on which to place the incense burners. Put them in every location and keep them charged day and night. By the fourth cycle the elixir will be in contact with the gods and spirits (*shen ming*[4]), and there is danger that demons (*mo*[5]) will come and encroach upon it. Guard it therefore tranquilly, saying these words of prayer:

'I respectfully call upon the Emperor of the Abscondite Origin, the Most High Ancient Lord (Hsüan-yuan Huang-ti[6]) and Thai-shang Lao-chün,[7] (an emanation of the Tao) to

Cycle and combine the Creative and the Receptive,[c]
Ward off invasions by diabolical beings
Trying to touch our Perfect Medicine.
Venerable Creative (= lead)[d] has safe refuge,
Iron buried to the east,
Ardent fire in the south,
A man hidden in the west,
A barbarian standing in the north.
Above hangs a mirror;
Where the Five Elements are matched
The Ghosts and Spirits will not come.
Let this place be tranquil,

[a] See pp. 216ff.

[b] Or vermilion, artificial mercuric sulphide (*chu*[8]).

[c] I.e. the *I Ching* Chhien and Khun *kua*, which stand for Yang and Yin here.

[d] The text of this line apparently telescopes two complex associations. 'The Creative', the name of the first hexagram of the *I Ching*, is a homonym for 'lead' (*chhien*[9]), of which *chin kung*[10] is a variant. The Creative is also Yang, a symbolic correspondence of lead in two-element processes (p. 253). Note that in a story quoted earlier (Vol. 5, pt. 3, p. 26), Huan Than's pun depended upon taking *kung* in its alternate sense 'grandfather'.

[1] 吳悞 [2] 丹房須知 [3] 線 [4] 神明 [5] 魔 [6] 玄元皇帝
[7] 太上老君 [8] 硃 [9] 鉛 [10] 金公

Let the Realised Immortals protect me
As I hold firmly to the Perfect Tao.
Urgently, urgently, as by lawful order!'[a]

Again let us transpose these correspondences into a table:

Substance	Colour	Direction	Element
Iron	caerulean	east	Wood
Cinnabar	red	south	Fire
Silver	white	west	Metal
Lime	grey?	north	Water

Fig. 1521. Tshao Yuan-Yü's reconstruction of a mediaeval Taoist alchemical laboratory in a cave (*1*).

There is no fifth element, because the point of the ritual is to put the furnace and its contents in the place of Earth and thus induce the state of undifferentiation and harmonisation of opposites which Earth implies. The centering simultaneously protects the Elixir, of course, from malicious spirits.

The idea of furnishing the microcosm with its own firmament lies midway between rite and metaphysics (at a point where the distance between them is particularly

[a] *TT*893, pp. 5*b*–6*a*, tr. auct. This work is as important for its rites and ceremonies as for its practical instructions and illustrations of apparatus. The prayer, and especially its ending, is strongly reminiscent of the Taoist liturgies already briefly described (pt. 2, pp. 128ff. above, with references to more detailed studies). The whole scene evoked by the passage recalls the picture sketched by Tshao Yuan-Yü forty years ago, when it appeared as the frontispiece to vol. 17 of *Kho Hsüeh*, and often afterwards reproduced, as by Barnes (1), Li Chhiao-Phing (*1*), Thaiwan ed. p. 27, (1), opp. p. 26. We reproduce it in Fig. 1521, leaving its evaluation to the judicious.

short). Only a post-Enlightenment man would maintain a hard distinction in principle between the ritual function of hanging up 28 lamps and the theoretical point of working the number 28 into a weight or dimension. The only practically relevant difference is that the rite, however directly derived from the Five Elements and other physical conceptions, was primarily and directly meant to produce an effect upon the Unseen World—negative upon the riff-raff of that realm, positive upon its functionaries going about their business—rather than upon the ingredients of the Elixir.

There is no reason to assume a corresponding difference in the level of abstraction of the correspondences in ritual acts and in the alchemical Work. None of the alchemist's convictions about the universe and his Art forbade even the actual depiction of earth and sky on the floor and ceiling of the elaboratory, on the furnace, or on the reaction-vessel. Given the preference of most adepts for abstraction, we can hardly expect anything so literal to be common, but one text suggests that it was not unheard of. This is the *Shang-Tung Hsin Tan Ching Chüeh*[1] (An Explanation of the Heart Elixir Canon: a Shang-Tung Scripture), undated but probably long before the middle of the +15th century when the *Chêng-Thung Tao Tsang* was printed. Despite the suggestion of the enchymoma conveyed by the title (which was meant concretely, as we shall see anon), this treatise provides clear instructions for laboratory preparations.[a] It has this to say about the design of the furnace:

If you use the Ninefold Cyclically Transformed Magical Elixir (technique just given) to treat the Three Yellow Minerals (i.e. sulphur, realgar and orpiment), the result will be equivalent to the Yellow Emperor's Nine-Vessel Sublimed Elixir. The method (is as follows). Set up the furnace platform (*than*[2]) as above,[b] carry out the purification rites, and then display the Nine Palaces and the Eight Trigrams.[c] Use a tortoise-shaped combustion-chamber (*kuei hsing lu*[3]), with the top made according to the pattern of the sky and the bottom according to the configuration of the earth (*shang an thien wên, hsia an ti li*[4]). The Three Yellow Minerals are placed on top of the cinnabar (i.e. the elixir), and covered with the 'sky-plate'.[d] After this is done sublime the ingredients with fire above and water below. Brush the Arcane Frost down, and take a dose the size of a millet grain.[e]

[a] There is in fact a section on Internal Alchemy (ch. 2, pp. 7*b*–10*a*), largely adapted from *PPT/NP*, ch. 8, but it is clearly stated that this technique is to be used just before and after taking the Outer Elixir.

[b] See pp. 10ff.

[c] This is evidently a ritual procedure meant to demarcate a sacred space. In a detailed ceremony for the previous elixir preparation (ch. 2, p. 13*a*) the adept is told somewhat more clearly, 'set out the Nine Palaces; the one who is compounding the Elixir (*ho tan chê*[5]) places himself in the central palace keeping watch over the combustion-chamber.' There is no doubt that these are the nine palaces of the Hall of Brightness (*ming thang*[6]), and thus of the old Lo Shu[7] magic square with its nine cells, three on a side. See Vol. 3, pp. 57–58, 542.

[d] It is not entirely clear whether the 'tortoise-shaped combustion-chamber' was a furnace in any ordinary sense. The combustion-chamber used for heating the casing in the preceding formula (ch. 2, p. 6*a*) was made by plastering over a wooden framework, and the casing was elevated on a short tripod over the flame. No sky-plate is mentioned. Here it is not possible to tell whether the sky-plate was a movable partition between the sealed reaction-vessel and the fire which was built above it within the combustion-chamber, or whether it was the figured lid of the chamber itself, on top of which the fire was burning. One is reminded of the 'heaven-plate' and 'earth-plate' of the Han diviner's board (*shih*[8]); cf. Vol. 4, pt. 1, pp. 262ff.

[e] *TT*943, ch. 2, p. 14*b*, tr. auct.

[1] 上洞心丹經訣 [2] 壇 [3] 龜形爐 [4] 上按天文下按地理
[5] 合丹者 [6] 明堂 [7] 洛書 [8] 栻

This could conceivably be the furnace with a round top and square base often used in similar cases,[a] but the choice of words here definitely suggests decoration, whether painted or moulded. *Thien wên*[1] in astronomy refers not to the shape of the celestial vault but to its constellations and planets,[b] and *ti li*[2] in geomancy and cartography to the lay of the land.[c] Thus images in two or three dimensions may well have been used at some point in the history of alchemy to stimulate the action of the cosmic forces upon the microcosm of the furnace.

(iii) *Chaos and the egg*

If the furnace was the Cosmos in little, the reaction-vessel was the Chaos out of which the Elixir was differentiated, the womb in which it was nourished. We have already cited in passing images like these which described the Elixir container,[d] and it is only necessary here to emphasise that for the alchemist they were not so much metaphors as identities, brought into play by the resonance of analogous configurations. In order to think of the vessel as a womb, some alchemists even took the trouble to mould it about a sphere of wax which was subsequently melted and poured away through an aperture. This sphere was called, in fact, a womb (*thai*[3]).[e]

The Chinese conviction that correspondences implied functional identity is perhaps best illustrated by another universal organic image of Chaos, namely the egg. It was common in alchemy so to denominate the reaction-vessel. Mêng Hsü,[4] for instance, in the *Chin Hua Chhung Pi Tan Ching Pi Chih*[5] (Confidential Instructions on the Heaven-Piercing Golden Flower Elixir) of +1225, speaks of it as the 'Chaos Egg and Spirit Chamber' (*hun-tun chi-tzu shen shih*[6]),[f] noting that it was often made in the shape of an egg.[g] Phêng Ssu[7] in the same book, in a passage already quoted, did not hesitate to

[a] See, for instance, *Chiu Chuan Ling Sha Ta Tan* (*TT*886), p. 1*b*. On furnaces and combustion-chambers in general see above, pp. 11ff.

[b] See our translation (Vol. 2, p. 326) of *thien wên* as 'the forms exhibited in the sky', where the term appears in the Great Appendix of the *I Ching*.

[c] See Vol. 2, pp. 359ff., Vol. 4, pt. 1, pp. 239ff.

[d] See pp. 16ff.

[e] See the alchemical miscellany *Ling-Pao Chung Chen Tan Chüeh*[8] (after +1101), *TT*416, p. 7*a*, and clearer instructions for the reaction-chamber on p. 12*b*. Presumably this technique had some close connection with the ancient *cire perdue* process in bronze metallurgy (see Sect. 36).

[f] 'Spirit Chamber' was a widespread term for sealed reaction-vessels. See above, p. 22, where we translated *shen shih* as 'magical reaction-chamber'; here our rendering reflects the ritual meaning intended in the texts we cite below. But in other texts *shen shih* is a matter-of-fact technical term; e.g., in *Kêng Tao Chi* (*TT*946, ch. 7, p. 18*b*), where it is defined as 'a silver casing'. For the *nei tan* meaning of the term, see Hsü Ming-Tao's[9] *Huan Tan Pi Chüeh Yang Chhih-Tzu Shen Fang*[10] (Wondrous Art of Nourishing the Naked Babe (i.e. the primary vitalities) by using the Secret Formula for the Regenerative Enchymoma) probably of the late + 12th century, *TT*229, pp. 1*b*, 2*a*; and a possibly pre-Sung discussion in *YCCC*, ch. 73, p. 7*b*.

[g] *TT*907, ch. 2, pp. 2*a*, *b* and 13*b*. The relevant passage is translated in full above, p. 35. The shape of the Spirit Chamber is also likened to that of an egg in *Yü Chhing Nei Shu* (*TT*940), p. 10*b*; and a silver reaction-vessel is said to 'correspond to an egg, white outside and yellow inside' in *Thung Yu Chüeh* (*TT*906), p. 8*b*.

[1] 天文 [2] 地理 [3] 胎 [4] 孟煦 [5] 金華冲碧丹經秘旨
[6] 混沌雞子神室 [7] 彭耜 [8] 靈寶衆眞丹訣 [9] 許明道
[10] 還丹祕訣養赤子神方

speak of the ingredients within the reaction-vessel as the 'elixir embryo' (*tan phi*[1]).[a] Similarly, a book of much earlier date, ascribed to the Chin but more probably Thang, the *Chih-Chhuan Chen Jen Chiao Chêng Shu*,[2] follows the same thought. After speaking of gold, lead, white frost of lead, potable gold, etc. it goes on to say:

> Union and maternity bring completion, so that bones and flesh are formed, and the foetus or the embryo comes to the birth. In this way the potentialities of the Shaping Forces are determined, and there is the glorious manifestation of the conquest of the element Wood by the Metal element—that is the whole idea of it.[b]

Another interesting occurrence of cosmic egg images is found in that very philosophical work on the *chhi* techniques of physiological alchemy, the *Yuan Chhi Lun*[3] of the mid-Thang. Detailing the steps in its pneumatic cosmogony, it says that

> before the *chhi* (of Yin and Yang in the Thai Chi[4] phase) separated, they had the configuration of a young foetus (*phi*[5]) like in shape to an egg. The original *chhi* was quite round, its shape perfect, so it is called the Grand Unity (Thai I[6]).[c]

Wu Wu,[7] writing in +1163, tells us that for success the reaction-vessel (*ting*[8]) must be as round as a hen's egg (*chi tzu*[9]).[d] A little further on he cites a shadowy predecessor as follows:

> Chhing Hsia Tzu[10] says: 'The chemicals in the reaction-vessel are like the chick embryo in the egg, the child within the womb, or the fruit upon the tree;[e] when once they have received fully the requisite *chhi* they ripen and develop and come to perfection of themselves. But when the chemicals have been placed in the 'womb', it is always necessary to seal it firmly and securely for fear that any leakage of the perfected *chhi* (*chen chhi*[11]) may occur.' He also says: 'That the sealed "womb" (*ku chi thai*[12]) may not leak, and that change and transformation may proceed, it is necessary to insist that it be made spherical like heaven and earth at their beginning. If there should be any crack or seam in the vessel it must be so tightly luted that not the most minute trace can escape of the numinous cyclical evolutions (*shen yün*[13]) going on inside.'[f]

This is reminiscent of what Wang Chhung[14] had had to say about developing eggs towards the end of the +1st century. The 'formless mass' (*hung-jung*[15]) of yolk and white at the beginning was regarded by him as a harmless liquid homogeneity, organised only by Yang *chhi* during the warmth of incubation.[g]

[a] *TT*907, ch. 1, p. 1*a*; the full text is given in translation on p. 35 above.
[b] *TT*895, pp. 1*b*, 2*a*, tr. auct.
[c] *YCCC*, ch. 56, p. 1*a*, tr. auct., adjuv. Maspero (7), p. 207.
[d] *TT*893, p. 8*b*.
[e] Or, 'unformed as yet within the tree'.
[f] *Tan Fang Hsü Chih*, +1163 (*TT*893, p. 10*b*), tr. auct. Chhing Hsia Tzu was the Taoist appellation of the historical Su Yuan-Lang[16] (see above, pt. 3, p. 130), but one must still consider the questions of whether Su actually wrote the words attributed to him in many later sources, and whether this passage refers primarily to internal or external alchemy, entirely open.
[g] His argument was that human death and dissolution were nothing but a return to the state of formless chaos—how therefore could malevolent or dangerous ghosts and spirits exist? The relevant passage from *Lun Hêng*,[17] ch. 62, has been given in translation already (Vol. 2, p, 370).

[1] 丹胚 [2] 稚川眞人校證術 [3] 元氣論 [4] 太極 [5] 胚
[6] 太一 [7] 吳悅 [8] 鼎 [9] 雞子 [10] 青霞子
[11] 眞氣 [12] 固濟胎 [13] 神運 [14] 王充 [15] 頑溶
[16] 蘇元朗 [17] 論衡

Not long after Wu Wu's time someone who was trying to reason out the best possible way of making a container represent an egg hit upon the unsurpassable solution—he used a hen's egg itself.[a] This may have come earlier, as early as the +9th century, but more probably it was a little later, in the Southern Sung. The 'Complete Compendium on the Lead–Mercury A–G Perfected Treasure' (*Chhien Hung Chia Kêng Chih Pao Chi Chhêng*[1]) by Chao Nai-An,[2] cites 'Secret Directions for the Yellow Sprouts Great Elixir' (*Huang Ya Ta Tan Pi Chih*[3]). One stage of the preparation goes as follows:

Orpiment, ½ ounce
Sal ammoniac, and
White arsenic, ¼ ounce each

First grind the orpiment; then grind the arsenic and sal ammoniac separately, fine as flour. Take an egg and make a hole in it. Get rid of the yolk but keep the white.[b] Spread half the arsenic and sal ammoniac on the bottom inside the egg; put the orpiment in the middle, and half the arsenic and sal ammoniac to cover it. Take somewhat less than half an egg-shell to cover the hole, and seal it on with iron oxide solution (*chiang fan shui*[4]) which has been mixed (with the egg-white?).[c] Then take a pound of minium (*huang tan*[5]) and an iron reaction-vessel (*ting*[6]). Put half the minium into the vessel and place in its centre the medicines in the egg. Then cover them with the rest of the minium, applying a little pressure. Fill the vessel with lime (*shih hui*,[7] evidently raw) and lute it tightly. Using half a pound of charcoal, heat it gently in an ash bath.[d] When it is taken out it will be finished. For each ounce of *pai hsi*[8] (zinc or tin)[e] use a piece the size of a red mung bean (*hsiao tou*[9]).[f] First melt the metal, and when it is liquid project the medicine upon it. Pour it out and wait for it to cool. It will then be the colour of gold.[g]

The porosity and fragility of the egg rule out its serving both the metaphysical function of the cosmic egg and the practical function of a sturdy and impregnable container, so the two functions are separated and the latter assigned to an iron vessel. The white

[a] For this there were ancient precedents. Ko Hung, about +300, knew of a way of incubating mercury and its compounds inside an egg sealed with lacquer; see Table 111 above, no. 36 (*PPT/NP*, ch. 4, p. 13*b*; Ware (5), p. 89). He also in another formula used the blood of black crane or stork embryos; Table 111, no. 20 (*ibid.* p. 12*o*, p. 86). See Vol. 5, pt. 2, pp. 91–2.

[b] An alternative translation, 'Remove the yolk but leave the white inside', would imply a rather sophisticated technique, and it is more likely that the separation took place in a bowl, the albumen being reserved for later use in sealing the shell.

[c] Punctuated differently, the second half of this sentence might be rendered 'and seal it on with iron oxide which has been mixed (into a paste) with water'. Such a paste would be so deficient in adhesive qualities that this would be an obvious application for the reserved egg-white. A similar method which we cite shortly specifies the use of egg-white as a sealing agent (p. 296). We take 'red alum' to be the ferric oxide produced by the roasting of ferrous sulphate ('green alum' or melanterite).

[d] A bed of ashes, like the water-bath, was used under or about the reaction-vessel as a means of diffusing and moderating heat. For Chinese water-baths, see above, p. 32.

[e] See pt. 2, pp. 214ff.

[f] For the red mung bean (*Phaseolus mungo*) as a metrological standard in pharmacology and alchemy, cf. Sivin (1), p. 254. We have already encountered the use of black millet-grains in acoustic metrology in Vol. 4, pt. 1, pp. 200ff.

[g] *TT*912, ch. 5, pp. 12*a*–12*b*, tr. auct. We have already encountered a vaguer mention of an egg-shaped silver container in a work which may be earlier, *Chen Yuan Miao Tao Yao Lüeh*[10] (later than mid-seventh century, *TT*917); see above, pt. 3, p. 78, and Fig. 1394.

[1] 鉛汞甲庚至寶集成　[2] 趙耐庵　[3] 黃芽大丹秘旨　[4] 鋒霜水　[5] 黃丹
[6] 鼎　[7] 石灰　[8] 白錫　[9] 小豆　[10] 眞元妙道要畧

arsenic and sal ammoniac and the reddish-yellow orpiment represent the albumen and yolk.

Since all three of the primary reactants were volatile, there was some danger that their vapours might explode the egg. The text is not entirely clear about whether or not the albumen was removed at some point; its presence would surely have complicated the placing of the inorganic substances and the course of the reactions. If it was there (which is unlikely), complex organo-metallic compounds might have been formed. If not, the vapours of the ingredients might have diffused gradually outwards and reacted with the lead and calcium, depending on the tightness with which the minium and lime were packed around the egg and the gentleness of the heating. The specifications given do seem designed to minimise the danger of explosion. That the procedure given by Chao Nai-An is workable we have no reason to doubt, pending a laboratory trial. At all events, it is extremely improbable that an egg would have been chosen as an inner reaction-vessel for any practical motives.

Exactly what form of aurifaction was taking place here is not immediately obvious. The reagents heated together were arsenic trisulphide, ammonium chloride (or carbonate), arsenic trioxide, ferric oxide, lead tetroxide and calcium oxide, with or without, as the case may be, a protein as source of carbon, nitrogen and hydrogen. Whether or not the tin or zinc was tinged golden only superficially is not clear from the description: if so, arsenical and other sulphides might have done just as well by themselves (cf. pt. 2, p. 252 above). If, on the other hand, copper was meant though tin or zinc actually stated, then a uniform-substrate golden alloy of arsenical copper could easily have been produced by projection as described (cf. pt. 2, p. 223 above). It will be remembered, too, that in the medieval lists of 'golds' which we studied earlier, a *pai hsi chin*[1] regularly appears (pt. 2, p. 275), which supports the practicality of what was described here, but our conclusion again has to rest upon whether after all copper was present. This is on the face of it unlikely. As for whether the metal meant to be transmuted was zinc or tin, it is difficult to see how any possible product of this formula could tint either yellow. Zinc oxide would of course be yellow when hot, but the instructions specify that the golden colour is visible after cooling. We leave this as a problem to be solved in some future laboratory devoted to the investigation of medieval alchemical procedures.

There can be no more fitting climax to this sub-section than a remarkable passage in the *Shang-Tung Hsin Tan Ching Chüeh*, even though we are unable to establish whether it is earlier or later than Chao Nai-An's collection of formulae. In it the egg as reaction bomb (*shen shih*,[2] lit., 'spirit chamber') is clearly linked with the subterranean growth of the Natural Cyclically Transformed Elixir. At the same time, the organic character of this application is emphasised by correlation with the human heart. These leitmotifs, together with an allusion to the abiding of the spirits, constitute almost a recapitulation of the chief themes of all alchemical thought.

In this process for the Heart Elixir, cinnabar which has been digested with other substances is divided among four 'spirit chambers' made by emptying eggs and

[1] 白鍚金 [2] 神室

coating them with thickly ground Chinese ink.[a] The author of the supplementary instructions (*chüeh*[1]) continues:

When I make the caps (for the holes in the eggs) I use a shoe-soling needle to pierce seven holes at equal intervals around the circumference of four eggs. These holes correspond to the seven apertures of the heart. The four egg-shell caps are also coated with ink as already specified. Eggs are white, so the spirits cannot abide there. But if they are tinted black with a black pigment, the spirits can remain secure inside. That is why the vessel is called 'the spirit chamber'.[b]

Once the appropriate rites have been carried out and the eggs have been charged,[c] they are placed in a bed of lime, arsenic and other white minerals, within a 'Five-Elements Jade Casing' (*wu-hsing yü kuei*[2]). Then to this ambiance of white material are applied the very technical terms which Su Ching[3] had used in the middle of the +7th century for the matrix out of which large cinnabar crystals grow:

Where cinnabar grows, beneath it there are white substances; above a white bed there is a white jade 'shrine' (*khan*[4]).[d] In the preparation of this elixir both the medicines used to seal the 'spirit chamber',[e] and those within the casing which serve as the ground in which (the eggs) are planted, are white. This is in order that they may correspond to the jade bed and jade shrine of the cinnabar (growth). It is like the pericardium in human beings (because the vessel corresponds to the heart).[f]

Here one cannot forbear from a comparative glance at similar ideas in other cultures. Probably all of them have seen in the development of the cleidoic egg of fowls, so sharply bounded off from all external things, a model of the creation or evolution of Cosmos from Chaos. As is well known, the cosmic egg was a notable theme in Greek mythology,[g] but similar ideas may have been current much earlier in Babylonia.[h]

[a] The supplementary instructions specify that before the eggs are pierced and emptied they are to be soaked in vinegar, but how long and for what object is not made clear. The shells would certainly be softened by solution of the lime.

[b] *TT*943, ch. 1, p. 9*b*, tr. auct.

[c] Here the adept is explicitly instructed to seal the caps to the shells with egg-white (p. 10*a*).

[d] The text does not read very well at this point. If *pai pai chhuang*[5] were emended to *pai shih chhuang*,[6] it would be much improved, and the translation would read: 'Where cinnabar grows, below it there is a bed of white mineral and above it a white jade "shrine".'

[e] I.e. the egg-white.

[f] *TT*943, ch. 1, pp. 10*a*–11*a*, tr. auct.

[g] Cf. Needham (2), pp. 8ff., 50–1, with references there given.

[h] Half a century ago Zimmern (1) and Campbell Thompson (5), pp. 50, 70–1, studying cuneiform texts on the making of glass, frit and enamel, from the library of King Ashurbanipal (r. −668 to −626), reported several mentions of 'foetuses' or 'embryos' in connection with the furnaces, to which sacrifices and libations had to be made. Thompson at least was inclined to think that these were aborted foetuses which had to be propitiated as representatives of all natural processes fated not to come to term. Eisler (4), on the other hand, urged that the 'embryos' were the actual ores and other mineral ingredients themselves. The question, not yet settled, is discussed impartially by Eliade (5), pp. 43, 68ff., 75ff. On the basis of this Eisler propounded a theory of the origin of all alchemy in the Mesopotamian cultures; it caused some stir at the time but has never been generally accepted, though favoured now and again, as by Forbes (31).

What relation, if any, such practices had with the 'true and secret fertility amulets' (*chung thai chen pi fu*[7]), which Ko Hung recommended taking with one when entering the wilds of forest and mountain (*PPT/NP*, ch. 17, p. 11*b*, tr. Ware (5), p. 295), might admit of a wide solution.

[1] 訣 [2] 五行玉匱 [3] 蘇敬 [4] 龕 [5] 白白牀
[6] 白石牀 [7] 中胎眞祕符

Certainly the parallelism of the reactants-and-vessel with the foetus *in utero* was prominent in European alchemy, with its oft-pictured *vas philosophorum* or Philosopher's Egg of glass, 'Hermetically' sealed.[a] And we have already quoted the parallel between the chick's incubation and the development of gold in the earth (or in the elaboratory), as stated in Ben Jonson's play.[b] Sometimes, finally, the analogy was reversed, as in the *Secretum Secretorum* of Pseudo-Aristotle translated by Roger Bacon (on which see p. 368), where on physiognomy we read:

> Thou knowest that the womb is for the embryo as the pot is for the food. Therefore whiteness, or blueness, or extreme redness (of the face) indicates imperfect coction in the matrix....Therefore beware, etc.[c]

The remarkable practice of using eggs as models for Chaos outlasted the heyday of laboratory alchemy in China, surviving like so many other alchemical methods in iatro-chemistry. We see it last in the +17th century, in Fang I-Chih's[1] collection of notes *Wu Li Hsiao Shih*[2] (Small Encyclopaedia of the Principles of Things). Fang, one of the first Chinese to pay serious attention to the whole spectrum of European knowledge then being introduced by the Jesuit missionaries, refers to the ultimately literal method of maturing inorganic medicines recorded by Ning Hsien Wang[3] (+1390 to 1448) Prince of the Ming, Chu Chhüan,[4] an amateur of every sort of arcane knowledge:[d]

> *Incubating medicinal eggs* (*fu yao luan*[5]). For any medicine, make an egg of silver which can be opened and closed with a small cover.[e] Insert the medicine and seal it with lacquer. Put it in a nest of eggs and let the hen incubate it for exactly seven weeks [some people rotate it among several hens].[f] Its effects upon the circulation of *chhi* (in the patient's body after ingestion) are marvellously beneficial. It may also be irradiated by sunlight or nurtured over a warm fire for a hundred days. Its special virtues are due to changes stimulated when it is incubated by the female of the species. This is also the point of the procedure given by the Emaciated Immortal (Chhü Hsien[6]): 'Raise separately white cocks and hens. Take an egg (from one of the hens), extract the yolk and white, take cinnabar, grind and blend them, and put the mixture into (the shell). Seal the opening with wax. Then let one of the white hens incubate it along with its own eggs. When the chicks hatch from the others, the medicine is finished. Take it mixed with honey. Or mix realgar with the egg-contents, seal it, and heat it over a feeble fire for three days and nights.'[g]

[a] On this see Read (1), pp. 104, 149ff., 217–18, etc.; Ploss *et al.* (1), frontispiece and pp. 138–9, 202–3; Mahdihassan (58). Sherwood Taylor (3), pp. 44–5 has suggested that the distillation of eggs by the Hellenistic aurifactors was probably inspired by some similar symbolism. For psychological interpretations of the alchemical egg see Jung (1), Germ. ed. pp. 103, 276ff., 281, 325ff., 461; Eng. ed., pp. 192–3, 227. Finally, mem. *Corp.* I, iii.

[b] See p. 243 above.

[c] Steele (1), fasc. 5, p. 166, Ar. version, p. 219. One text runs: 'Scias ergo quod matrix est embrioni sicut olla ferculo decoquendo. Albedo ergo cum livido colore et flavus color nimis est signum diminute decoccionis embrionis in matrice.'

[d] Often encountered before, cf. Vol. 5, pt. 3, pp. 210ff. N.S. prefers *Chih* in the title.

[e] Cf. the silver egg-shaped aludel of Thang date shown in Fig. 1394 above.

[f] This is a note in the text.

[g] Ch. 4, p. 18*a*, *b*, tr. auct.

[1] 方以智 [2] 物理小識 [3] 寧獻王 [4] 朱權 [5] 伏藥卵
[6] 隱仙

(6) Proto-Chemical Anticipations

Our understanding of alchemy places it in the mainstream of traditional Chinese scientific thought, heterodox though it was (unlike mathematics and astronomy) for conventional scholars. In its theoretical aspect it was a deductive proto-science on quite the same level as medicine, acoustics or magnetic geomancy, based on the same general laws and the same natural rhythms, its essential difference lying in the selection of phenomena which it set in order. Each of these sciences was determined by an original demarcation of a field of observation and experience, defined by imposition of the common natural philosophy, and developed partly by working deductively through the various permutations of particular facts. But if alchemy consisted wholly of this special application of an organicist philosophy of Nature on the one hand, and eclectic compendia of elixir recipes (with no indication that the reactions were understood) on the other, it would be necessary to conclude that nothing in Chinese alchemy was truly relevant to the pre-history of chemical thought.

Such a view would badly underestimate the ability of the alchemist to respond to his experience.[a] A more direct appreciation of the fact of chemical change can be documented at least as far back as Ko Hung's dictum that minium (Pb_3O_4) and white lead ($2PbCO_3.Pb(OH)_2$) are transformations of lead.[b] If only early craftsmen had been literate, we could doubtless trace that same appreciation back to the beginnings of chemical technology in China. Even at this initial stage of research, in which our greatest accomplishment is to gauge what we do not know, it is possible to discern attempts to develop theories of substantial change. Generally these theories reflect the lack of clear distinction between physics and chemistry, inevitable so long as the language of quality and function was used for both. For example, the *Thien Kung Khai Wu*,[1] that great technical encyclopaedia of +1637, offers a physical explanation of substantial change: 'Cinnabar, mercury, and vermilion are originally the same substance. The difference in name corresponds to a difference in fineness and degree of coction (*ching-tshu lao-nun*[2]).'[c] There is every reason to believe that this idea was first worked out in an alchemical context.

Our study has given us grounds for hope that a broad and consistent theoretical picture of substantial change—though certainly very different in its definitions and assumptions from modern chemistry—can be drawn together from data scattered through the surviving literature of external alchemy. An enormous work of collation and intellectual reconstruction will be necessary, but the potential contribution to a comparative history of chemistry would more than justify it. In the meantime we can only offer a couple of clues on the approach toward chemical reasoning which we

[a] It would also, incidentally, ignore the great contribution of Chinese as well as Western alchemy to the development of apparatus and techniques still used daily in modern chemistry (cf. pp. 44, 101 above).

[b] This may well go back to the −4th rather than the +3rd century if the *Chi Ni Tzu* book is near the beginning of the story (cf. pt. 3, pp. 14–5 above). As for Ko Hung's understanding of chemical change, see the sub-section above on his attitude to aurifaction (pt. 2, pp. 62ff., esp. p. 70).

[c] Ch. 16, p. 1*a*, mistranslated euphemistically in Sun & Sun (1), p. 279.

[1] 天工開物 [2] 精粗老嫩

hope eventually to see delineated out of the Chinese sources. We shall return briefly below to the role of number in alchemical thought, first concentrating on gravimetric ideas, the use of the balance, and finally take up the development of category theories to explain the reactivity of one substance with respect to others.

Further pursuit of the sprouts of early chemical thought in China should not neglect the less obvious sources, such as for example the Neo-Confucian literature. In the thought of Chhêng I[1] (+1033 to +1107)[a] there are interesting things to be found. At one place he says:[b]

> The physicians do not sufficiently consider organic pattern-principles (*li*[2]); when compounding drugs in prescriptions they do not exhaustively investigate their natures (*hsing*[3]). They know only the therapeutic uses of each, and not what happens when the substances form combinations; how then can they understand their (real) natures? For instance, myrobalan (*ho tzu*[4])[c] is yellow, and alum (*pai fan*[5]) is white, yet when they are mixed together the mixture is black. When what is black appears, that which was yellow and that which was white have disappeared. If we put *a* and *b* together we get *c*, so that *c* manifests itself, and *a* and *b* are no longer visible. But if we get back *a* and *b* again, then *c* disappears. If we have *c* and continue to look for *a* and *b* in it, if we have black and persist in looking for yellow and white in it, then we are failing to understand the nature of things. (This is why) the ancient (sages) investigated to the utmost the organic pattern-principles of things (*chhiung chin wu li*[6]); they studied tastes, smelt odours, differentiated between colours, and acquired knowledge of what substances will mix or combine together (*chih chhi mou wu ho mou*[7]).

What he was talking about here was the production of the deep blue-black pigment formed when tannins are brought into the presence of salts of iron; the metal combines with the polyhydroxy-benzoic acid derivatives to give the colours still to this day used for inks. Chhêng I seems to have realised half-intuitively that something essentially new had been formed in the reaction. But as usual with the Neo-Confucians, he did not systematically pursue this line of enquiry. Elsewhere, however, he said:[d]

> Sound, colour, smell and taste, are all alike, in themselves empty, yet full of meaning. Every thing that has corporeal form has to have these four qualities, and out of them arise significance, appellations, images and numerical values.

These, no doubt, were numerological still, rather than quantitative in our sense. But the one could slide into the other.[e] In a third passage, directed evidently against that metaphysical idealism to which his equally eminent brother was rather addicted:[f]

> The Master said: 'To investigate exhaustively the organic pattern-principles of things is to investigate how they come to be as they are. The height of the heavens, the thickness

[a] Cf. Vol. 2, pp. 414, 457, 471, 479; and Forke (9), pp. 100ff.

[b] *Hsing Li Ching I*,[8] ch. 9, pp. 2*a*ff., tr. auct.

[c] Myrobalan is the black fruit of *Terminalia Chebula* (R247), full of tannins, like those of all members of this genus of Combretaceae (Burkill (1), vol. 2, pp. 2134ff., 2139). More properly named *ho li lê*,[9] and by origin Indian and Burmese, it first appears in the *Hsin Hsiu Pên Tshao* (+659). The leaves and bark also tan.

[d] *Honan Chhêng Shih I Shu*, ch. 18, p. 13*b*, tr. auct.

[e] Cf. p. 304 below.

[f] *Honan Chhêng Shih Tshui Yen*, ch. 2, p. 59*b*, tr. auct.

[1] 程頤 [2] 理 [3] 性 [4] 訶子 [5] 白礬 [6] 窮盡物理
[7] 知其某物合某 [8] 性理精義 [9] 訶黎勒

Fig. 1522. Drawings of native cinnabar from the *Chêng Lei Pên Tshao* of + 1249 (ch. 3, p. 2*b*). The upper sample from Chhenchow, the lower one from Ichow. The headings on the right are the latter part of the contents table of the chapter in question (ch. 3).

of the earth, the appearance and disappearance of expansion or disaggregation, and of contraction or agglomeration, all must have some manner of coming into being. If it be said that all these things are just our way of talking about the world, and no more, then how and why did they come into existence?

In the literature of Neo-Confucian philosophy we may well find many further speculations upon distinctively chemical examples of coming-into-being and passing-away.

(i) *Numerology and gravimetry*

From the standpoint of the comparative development of chemistry, one of the most cogent themes to emerge from the study of early Chinese alchemy is its concern with quantitative factors. This is not a mere matter of the specification of amounts in formulae; Sumerian medicine had reached that point by −2500.[a] But we find evidence of a truly gravimetric application of number in the following excerpt from Chhen Shao-Wei's[1] great monograph on the alchemy of cinnabar, *Ta-Tung Lien Chen Pao Ching, Hsiu Fu Ling Sha Miao Chüeh*[2] (Mysterious Teachings on the Alchemical Preparation of Numinous Cinnabar) written, it seems, not long after +712. At this point Chhen is discussing, in descending order of purity, natural crystalline varieties

[a] Levey (7), pp. 61–70.

[1] 陳少微 [2] 大洞鍊眞寶經修伏靈砂妙訣

of cinnabar (Fig. 1522), and their substitution for each other in an elixir preparation. He says:

Now from 1 lb. of lustrous cinnabar (*kuang ming sha*[1]) one can distil 14 ozs. of mercury, lustrous white and free-flowing. This indicates that lustrous cinnabar of the highest quality contains only 2 ozs. of mineral *chhi*. From 1 lb. of white horse-tooth cinnabar (*pai ma-ya sha*[2]) one can distil 12 ozs. of mercury; it contains 4 ozs. of mineral *chhi*. From 1 lb. of purple numinous cinnabar (*tzu ling sha*[3]) one can distil 10 ozs. of mercury; it contains 6 ozs. of mineral *chhi*. From 1 lb. of superior translucent (commercial) cinnabar (*shang sê thung ming* [*sha*])[4] one can distil only 7 ozs. of mercury; it contains 9 ozs of mineral *chhi*.[a] Mineral *chhi* is the void *chhi* of Fire and rock (*huo shih chih khung chhi*[5]).[b] After the mercury has been extracted there will be about an ounce of Mineral Embryo (*shih thai*[6]), a greyish ash.[c]

Thus some alchemists twelve and a half centuries ago knew that 13 or 14 ozs. of mercury can be distilled from 16 oz. of the best native cinnabar. A more exact figure, according to modern calculation, would be 13·8. Chhen had learned the importance of experimentation with weighings, on principles which must at some point have come from metallurgists (unless a mercury-smelter furnished him with the figure).[d] Not only that, but he knew that this ratio must vary with the purity of the cinnabar, so that a cinnabar of lower quality will contain less mercury and more 'mineral *chhi*'—resolved by the treatment into irrecoverable *pneuma* and a residue of Mineral Embryo.[e] What is perhaps most significant, and certainly most original, is Chhen's assumption that when each kind of cinnabar is broken down into its constituents they always total 16 ozs. in weight. This was only a hypothesis, for there was no way of collecting and weighing the *chhi* which had presumably escaped, but it was just the sort of hypothesis which in much more recent times pointed the way to a chemistry based solidly on measure and number. In this way Chhen seems far ahead of his time.

But it is not quite so simple as that. Where did Chhen get his figures for the yields of mercury from different types of cinnabar? First we must ask how different in fact the four varieties were. This question can be answered, at least in a rough way. All four are, first of all, exceptionally large and rare crystalline forms, far superior to the ordinary article of commerce. It is obvious from their descriptions that they did not normally contain perceptible quantities of admixed earth and stone.

Lustrous cinnabar fits the description of translucent, nearly vitreous, rhombohedral

[a] These are the weights given in *YCCC*, ch. 69, pp. 18*a*, *b*. The corresponding text in *TT*883, p. 14*b*, gives the yields as 8½ and 7½ ozs. respectively. In both cases the sum is 16 ozs.

[b] Or, 'of minerals which belong to the element Fire'.

[c] *YCCC*, ch. 69, pp. 18*a*, *b*, tr. Sivin (4).

[d] A corollary of the argument which we develop below is that, if the various figures had been furnished him by an artisan, they would not have varied over so wide a range. Lustrous cinnabar and the other varieties mentioned were too precious to be used for distilling mercury; in fact transparent cinnabar crystals were often set in Chinese jewellery. On the history of gravimetry in assaying and cupellation, see above, pt. 2, pp. 36ff., 65ff.

[e] There is a parallel passage in the much later *Ling Wai Tai Ta* (+1178), ch. 7, p. 10*b*. But Chou Chhü-Fei was no chemist, and reported (unless the text is faulty) that 8 lbs. of the best cinnabar would yield 10 lbs. of mercury. He was presumably garbling information received from the mercury workers of Kuei-tê and other southern places.

[1] 光明砂 [2] 白馬牙砂 [3] 紫靈砂 [4] 上色通明砂
[5] 火石之空氣 [6] 石胎

crystals of cinnabar, such as are still used in China, whole as semi-precious stones, and pulverised as the pigment in very high grades of seal ink (*yin ni*[1]). White horse-tooth cinnabar, despite its designation, is not white in colour. Su Ching, in the mid-seventh century, points out its suitability for artist's vermilion pigment, and describes it concretely enough to allow its identification as small tubular crystals rather than granules (which are not usually translucent):

> The next quality comes from within rocks or from streams, and occurs in pieces of which the largest are the size of a thumbnail and the smallest the size of apricot stones. It is lustrous and without admixed rock mineral. It is called 'horse-tooth cinnabar', and another name is 'undoubled mineral' (*wu chhung shih*[2]). It is excellent for use in drugs and also for painting, but (like lustrous cinnabar) not much of it finds its way into the possession of ordinary people.[a]

The white is explained as the colour of its lustre in the supplementary instructions to the 'Yellow Emperor's Nine-Vessel Spiritual Elixir Canon' (probably early Sung):

> There are also tablets coarse as horses' teeth or like small rolls (*hsiao chüan*[3]), brilliant with radiant depths, their matter compact and their white lustre dazzling to the eye—they are styled cinnabar.[b]

This is less ambiguous than the statement of Chhen Shao-Wei earlier in his treatise that it 'shines with a radiant white light the colour of mica.'[c] Thirdly, there is nothing in the sources to deter us from considering purple numinous cinnabar as a true cinnabar of darker colour than normal.[d] Last, superior translucent cinnabar is, unlike the other varieties, a common article of commerce, although still of very high grade. The specification of translucency indicates that it is still a crystalline (and thus tolerably pure) form of mercuric sulphide. To sum up, although disparities in crystal size and transparency could have convinced the alchemist that the four varieties of cinnabar differed sensibly in their places on the hierarchic scale of maturation, their chemical purity can hardly have been very unlike. Impurities might occur from time to time in the form of mechanical admixtures, but the proportions would be random rather than constant within each type.

Since the four varieties of cinnabar do not apparently differ greatly or consistently in chemical purity, all the numbers except the first must be based, not on laboratory experience, but on the conviction that a difference in kind must be associated with a difference in number, and the further assumption that these differences must form a series of rather regularly graded steps which reflect, by implication, steps on a hypothetical mineral maturation curve.[e]

[a] Cited in *CLPT*, ch. 3, p. 3*b*; tr. auct.; cf. also Okanishi (5), pp. 99–100.
[b] *Huang Ti Chiu Ting Shen Tan Ching Chüeh* (*TT* 878), ch. 13, p. 3*b*, tr. auct.
[c] *YCCC*, ch. 69, p. 2*b*, tr. Sivin (4).
[d] Though we might note in passing that Brelich (1), observing Chinese mining methods seventy years ago, noted that a dark opaque red form, called 'black cinnabar' by the Kweichow miners, almost invariably contains small quantities of antimony.
[e] Another suspiciously regular gradation, based on a lower maximum yield, is attributed to the legendary Hu Kang Tzu[4] (see Sivin (1), p. 159) in the *Huang Ti Chiu Ting Shen Tan Ching Chüeh*

[1] 印泥 [2] 無重石 [3] 小捲 [4] 狐剛子

The same frame of mind shows itself in other asseverations of Chhen Shao-Wei; for instance:

One oz. of lustrous cinnabar, when taken orally, is equal in potency to 4 oz. of white horse-tooth cinnabar. One oz. of white horse-tooth cinnabar, when taken orally, is equal in potency to 8 oz. of purple numinous cinnabar. The potency of creek cinnabar (*chhi sha*[1]) or earthy cinnabar (*thu sha*[2]) is not of an order comparable with these.[a]

Yet the intensity of the physiological reaction to a dose of any of these varieties (with the probable exception of earthy cinnabar, which might contain much gangue impurity)[b] would have been very much the same. Even if it were different, it is not easy to imagine an experimental arrangement for determining the precise comparative dosage required to metamorphose experimental subjects into immortals soaring in the empyrean. There was indeed an objective verifiability of alchemical immortality, in a certain sense, but hardly the possibility of its operational quantifiability.[c]

The figures we have just seen applied to the mercury yield of cinnabar also appear metamorphosed in a discussion concerned with yields of elixir and of the intermediate 'subdued cinnabar' (*fu huo* [*tan sha*][3]):

Furthermore, when 1 lb. of lustrous cinnabar is subdued in the fire, 14 ozs. of subdued (cinnabar) are obtained, which when heated in a furnace urged with bellows yields 7 ozs. of the 'Perfect Treasure'. When 1 lb. of white horse-tooth cinnabar is subdued in the fire, 12 ozs. of subdued (cinnabar) are obtained, which when heated in a furnace urged with bellows yields 6 ozs. of the 'Perfect Treasure'. When 1 lb. of purple cinnabar is subdued in the fire, 10 ozs. of subdued (cinnabar) are obtained, which when heated in a furnace urged with bellows yields 3–5 ozs.[d] of the 'Perfect Treasure'. When 1 lb. of creek cinnabar, earthy cinnabar or other cinnabars of diverse kinds is subdued in the fire, it is possible to obtain 6 or 7 ozs. of subdued (cinnabar), which when heated in a furnace urged with bellows yields 1 or 2 ozs. of the 'Perfect Treasure'. So it is quite clear that the *chhi* with which creek cinnabar and earth cinnabar are endowed is impure—sluggish, turbid, and heterogeneous. In order to succeed in making Sevenfold-recycled (Cinnabar) or Ninefold Cyclically Transformed (Gold Elixir), a lofty and enlightened gentleman must first choose the proper cinnabar and then correctly phase the fire, regulating it to accomplish the desired end.[e]

If we look at all these quantities together (Fig. 1523), it is not hard to tell where Chhen got them. They can only be *a priori*, generated by numerological reasoning in order to construct three hierarchies—mercury yield, physiological potency, and Elixir yield—based on the fundamental hierarchy of cinnabar quality. That the first of the three was anchored to a number derived by measure out of chemical experience

(*TT*878), ch. 11, p. 4*a*: 'From 1 lb. of good vermilion one can get 12 ozs. (of mercury); from 1 lb. of medium-grade vermilion one can get 10 ozs.; from 1 lb. of inferior vermilion one can get 8 ozs.' In the same chapter (p. 2*a*) a method is given which, it is claimed, will extract a pound of mercury from a pound of cinnabar if the latter is sufficiently pure. But this is not credited to the same source.

[a] *YCCC*, ch. 69, p. 2*a*, tr. Sivin (4).

[b] According to Huang Chu-Hsün (*1*), pp. 106–7, the non-translucent type of cinnabar mined in China in the early twentieth century usually also contained some antimony.

[c] On incorruptibility, mummification, etc. see the discussion in pt. 2, pp. 249ff. above.

[d] The text has 6 ozs., we amend to expectation.

[e] *YCCC*, ch. 69, pp. 2*b*, 3*a*, tr. Sivin (4).

[1] 溪砂 [2] 土砂 [3] 伏火丹砂

reminds us of the interpenetration of the two functions of number—mathematical and numerological—in all ancient and medieval Chinese minds. This is only one more instance of the way in which the 'advanced' aspects and the 'retrograde' or 'unscientific' aspects of early science (which once led a distinguished positivist historian to call research in alchemy, astrology, and related areas 'the study of wretched subjects') turn out to be not only balanced, but so intimately connected as to be inseparable.

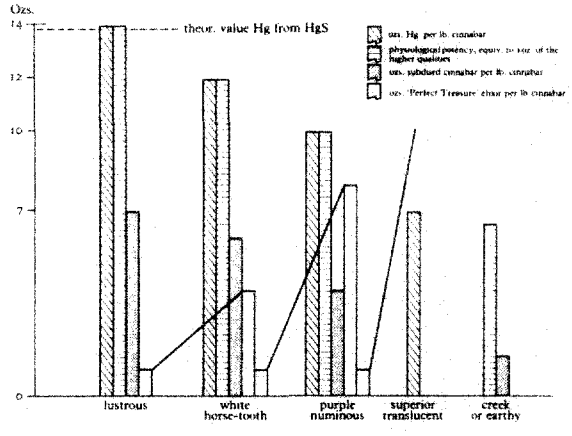

Fig. 1523. Chhen Shao-Wei's mercury yields from different varieties of cinnabar. Explanation in text.

Actually, in the case of Chhen Shao-Wei we see an important early stage in the definition of gravimetry. It is beginning to define itself out of an almost Pythagorean faith in number as a reflection of underlying reality on the one hand, and out of the metal-workers' use of the balance to control manufacturing processes on the other.[a] In the alchemical literature there are many other specifications of yield, potency, and ability to transmute base metals which must be closely examined, and if possible experimentally tested, before the history of the concept of combining weights in ancient China can fall into place.[b]

[a] Perhaps the most classical instance of the borderline between numerological and gravimetric quantification would come from the Arabic world; the *Kutub al-Mawāzīn* (Books of the Balances) in the Jābirian Corpus (+9th century) have far more to do with a theoretical assignment of elements in the composition of substances than with any real weighings (cf. p. 459). But weighings were certainly made, as in the famous mercuric oxide experiment of the *Rutbat al-Ḥakīm* (Sage's Step), attributed to Maslama ibn Aḥmad al-Majrīṭī (d. +1007); cf. Sarton (1), vol. 1, p. 669; Holmyard (1), p. 71, (11), p. 302; Leicester (1), p. 71, etc. And al-Jildakī in the +14th century maintained that substances only react according to definite weights (Holmyard, 10).

Arabic weights themselves were sometimes of remarkable accuracy; the same author gathered data showing that in the +8th century glass dinar and dirham weights had an average error of only 4 mgs. and some series agreed within ±0·3 mg. The subject is of course bound up with the history of weighing in general in the different civilisations. For Europe on this there is the book of Moody & Clagett (1); outstanding figures were Blasius of Parma (d. +1416) and Nicholas of Cusa (*d.* +1464), cf. Thorndike (1), vol. 4, pp. 75ff., D. Singer (1), p. 55. Unfortunately we have so far no general history of the balance and its use in Chinese culture, beyond the histories of metrology as such, and what has been said in Vol. 4, pt. 1, pp. 19ff. On the gravimetric principle in the history of chemistry there is the remarkable monograph of Walden (1), but it deals only with Europe.

[b] No less to the point is the resonance with the Daltonians' confidence in simple combining ratios, as Cyril Stanley Smith has remarked.

At this point we can only suggest that the strength and integration of numerology in Chinese thought did much to encourage truly mathematical approaches to natural phenomena, but at the same time it was difficult to see that such approaches were something different from numerology.[a] In Europe the application of a mathematical physics to earthbound experience was inevitably revolutionary, for it undercut the most fundamental metaphysical assumptions of the traditional way of looking at the universe. Since mathematics, according to Aristotle, dealt with perfect and eternal bodies and their relations, it could only be rigorously applied to astronomy, for nothing below the orb of the moon was perfect and eternal. The very success of the Aristotelian synthesis at imposing reason and coherence upon most of man's concerns over two millennia gave it a strength which could be overcome only by that total confrontation which we call the Scientific Revolution.

In China there was no such tension. The basic system of natural concepts—Yin and Yang, the five elements, and so on—were at bottom no less qualitative than Aristotle's, but number was one of the established ways of expressing quality, and no one denied that its application to terrestrial measure reflected deep realities too.[b] Thus since the +1st century a truly mathematical approach to acoustics, a human artifact, was thought of as parallel to mathematical astronomy; indeed most of the dynastic histories discuss the two together. But while the prevalent natural philosophy easily accommodated both numerology and mathematics, it did little to encourage their separation, or even to keep in view the distinction between them. In alchemy, numerologically derived quantities were treated as though they were observational; in mathematical astronomy, observational constants for periods of revolution were often metaphysically accounted for by 'deriving' them numerologically.[c] We suggest then, as a hypothesis which only many more case-studies could establish or disprove, that this very ease of accommodation meant less tension of the kind that might have led to an autonomous definition of exact science.

(ii) *Theories of categories*

About the interaction of substances and things there existed in ancient and medieval China a coherent body of doctrine springing from philosophical ideas first apparent in the writings of the famous Han scholar and thinker, Tung Chung-Shu[1] (−179 to −104).[d] In this world-order every thing and being belonged to a category (*lei*[2]), and

[a] That Chhen Shao-Wei and his friends did make many weighings in the late+7th and early +8th centuries can hardly be doubted. As our collaborator Tshao Thien-Chhin noticed long ago, this is suggested by the expression often used by them regarding chemical conversions—*fên hao wu chhien*,[3] 'there is not a grain or a scruple of loss'. In *TT*884 this is applied both to the making of mercuric sulphide (*tzu sha*[4]) from the two elements, and to the making of lead sulphide from lead metal and mercuric sulphide. This recalls Maslama al-Majrīṭī three centuries later, though the Andalusian failed to note the increase of weight on calcination. For Chinese statements about weighing in gold refining, going back to the +2nd century, cf. Vol. 5, p. 2, pp. 56–7.

[b] One thinks of the quantitative computations essential for the great works of hydraulic engineering (cf. Vol. 4, pt. 3), so closely associated since the earliest times with the fortunes of dynasties and rulers.

[c] See, for instance, Sivin (9), pp. 8–9.

[d] See Vol. 2, pp. 248–9 and *passim*.

[1] 董仲舒 [2] 類 [3] 分毫無欠 [4] 紫砂

events took place by mutual resonance between entities in the same category.[a] These classical theories took shape at the very general conceptual level of Yin and Yang and the Five Elements, so that they could be applied to the whole range of man's experience of natural transformations and natural phenomena; and their extension led to an early form of what after the Scientific Revolution were to become theories of chemical affinity. Hence though they may not have played a very large part in the detailed planning of laboratory processes they deserve close comparative study. The context of most systematic alchemical writing on categories was in fact not laboratory alchemy but rather the art of the enchymoma, which is comprehensible enough, for we have already seen by a number of indications how greatly systematic theoretical speculation flourished in physiological alchemy.[b] Perhaps the adept's experience of his own bodily and psychical states limited intellectual freedom to create order and symmetry less than his experience of chemical and physical changes in the external world. But he saw the inner and outer realms as similarly constituted, so that knowledge of one would illuminate the other.

Let us proceed by reviewing the hypotheses upon which category thinking was based. Chinese natural philosophy was given form by certain sets of concepts which could function dynamically as phases of a cyclical process, or statically as categories, that is to say as divisions within a continuum or configuration. The most universally applied of these sets of concepts were the binary Yin and Yang[c] and the Five Elements. With these five elements were aligned and associated, in symbolic correlation, everything else in the universe which could be got into a fivefold arrangement.[d] The keyword in the old Chinese thought-system was Order, but this was an order based on organic pattern, and indeed on a hierarchy of organisms. The symbolic correlations or correspondences all formed part of one colossal pattern. Things behaved in particular ways not necessarily because of prior actions or chance impulsions of other things, but because their position in the ever-moving cyclical universe was such that they were endowed with intrinsic natures which made that behaviour inevitable for them. If they did not behave in those particular ways they would lose their relational positions in the whole (which made them what they were), and turn into something other than themselves. They were thus organic parts in existential dependence upon the whole world-organism. And they reacted upon one another not so much by mechanical impulsion or causation as by a kind of mysterious resonance.[e]

Nowhere are such conceptions better stated than in the fifty-seventh chapter of

[a] Later on we shall suggest that this idea was perhaps originally not unconnected with the perpetuation of likeness in fermentation and generation (pp. 364ff. below), biological phenomena on which man must have meditated from very early times. Chinese alchemists and Alexandrian proto-chemists alike were wont to appeal to these in support of the view that similar things react with, and produce, similar things (cf. the quotation on p. 313).

[b] The theory of physiological alchemy is fully discussed in pt. 5 below.

[c] 'When the Yin and Yang unite in harmony the myriad things are begotten', *Li Chi*, ch. 11, p. 27*a*; Legge (7), vol. 1, p. 420. 'When Heaven and Earth combine their generative forces the changes and fermentations of the myriad things (are completed); when male and female mingle their seminal essences the transformations and births of the myriad things (are accomplished)', *I Ching* (Great Appendix), Pt. 2, ch. 5 (ch. 3, p. 33*a*), Baynes tr., vol. 1, p. 368; cf. Granet (5), p. 138.

[d] Cf. Vol. 2, pp. 261ff.

[e] For a full account of this nature-philosophy see Vol. 2, pp. 279ff., 291ff.

Tung Chung-Shu's[1] *Chhun Chhiu Fan Lu*[2] (String of Pearls on the Spring and Autumn Annals), written about −135, which is entitled 'Thung Lei Hsiang Tung',[3] i.e. in Hughes' translation (1) 'Things of the Same Genus Energise Each Other'. We read:

> If water is poured on level ground it will avoid the parts which are dry and move towards those that are wet. If (two) identical pieces of firewood are exposed to fire, the latter will avoid the damp and ignite the dry one. All things reject what is different (to themselves) and follow what is akin. Thus it is that if (two) *chhi*[4] are similar, they will coalesce; if notes correspond, they resonate. The experimental proof (*yen*[5]) of this is extraordinarily clear. Try tuning musical instruments. The *kung*[6] note or the *shang*[7] note struck upon one lute will be answered by the *kung* or the *shang* notes from other stringed instruments. They sound by themselves. This is not due to spirits (*shen*[8]) but because the Five Modes are in relation; they are what they are according to the constant relations (*shu*[9]) (whereby the world is constructed).
>
> (Similarly) lovely things summon others among the class of lovely things; repulsive things summon others among the class of repulsive things. This arises from the complementary way in which a thing of the same class responds (*lei chih hsiang ying erh chhi yeh*[10])—as for instance if a horse whinnies another horse whinnies in answer, and if a cow lows, another cow lows in response...[a]

Similar passages occur elsewhere in the same book. In this instance one can see how each element was associated with a particular musical note and a particular animal, and in general how things of the same category (*thung lei*[11]) were conceived to act as receptors only to disturbances originating within the same category.[b]

Thus the classifiability of which Tung Chung-Shu speaks is the capacity of the various things in the universe to go into the fivefold categorisation, or others of different numerical values. Chinese thought was particularly fond of such categorisations: Mayers (1) could list 317 of them from the Two Primary Forces to the Hundred Officials. No less than eleven chapters of the *Thu Shu Chi Chhêng* encyclopaedia (+1726) are consecrated to this subject in its calendrical-mathematical section.[c] Bodde (5) has devoted a special paper to Chinese 'categorical thinking' in which he analyses the curious tabulation in the twentieth chapter of the *Chhien Han Shu* (History of the Early Han Dynasty), where nearly 2,000 historical and semi-legendary individuals were arranged in nine grades according to their virtue.

Tung Chung-Shu was elaborating a philosophy quite widespread among the scholars of the Han:[d] the idea that actions and reactions in the natural world come

[a] Tr. auct., cf. Vol. 2, pp. 281–2.

[b] Cf. p. 316 and p. 319.

[c] *Li fa tien*,[12] chs. 129–40.

[d] The expression *thung lei* turns up in all kinds of contexts, e.g. in a speech by Ssuma Hsiang-Ju to the emperor about bear-hunting (*CHS*, ch. 57B, p. 8*b*). Perhaps food-chains were at the back of his mind, for certain animals could be killed only by certain others. See also *Han Shih Wai Chuan*, ch. 1, p. 2*a*. It is also, as one would expect, prominent in the ancient medical texts; see, for example, *Huang Ti Nei Ching, Su Wên* (Pai-hua version), ch. 81 (p. 521)—*thung lei hsiang kan*.[13] We shall have more to say on this subject fundamental to physiology and medicine in Sect. 44 (Vol. 6).

[1] 董仲舒 [2] 春秋繁露 [3] 同類相動 [4] 氣 [5] 驗
[6] 宮 [7] 商 [8] 神 [9] 數 [10] 類之相應而起也
[11] 同類 [12] 曆法典 [13] 同類相感

about by specific stimulus and specific response of one organism upon another according to their intrinsic natures as classifiable in schemas of correspondences and categories. Of course this systematisation was based on a minimum of critical observation and no systematic experiments. And for the effects it was not necessary that the bodies should be in contact: action at a distance made no difficulty for the Chinese mind, which visualised a sort of wave-motion transmissible almost infinitely through the aetheric *chhi*.[a] Yet bodies (organisms, whether animate or inanimate) influenced one another not at random but always in accordance with their positions in the perpetually moving cyclical universe. Thus just as the astronomer had to follow the motions of his celestial bodies through the cycles of month and year, the alchemist had to pay attention to the proper alternation of the Yin and the Yang within his microcosmos. It will be clear from this that the intellectual obstacles inhibitory to a proper understanding of chemical combination in China were rather different from those in Europe. For in the West the Greek atomic theories were always waiting in the wings ready to take the centre of the stage when the time was ripe, while in China the atomic theories of the Indians, though often brought in, never seduced Chinese thinkers from their instinctive adhesion to what was essentially a prototypal wave-theory, the reciprocally dependent rise and fall of the Yin and Yang forces or the analogous succession of the five elemental phases. Thus it came about that in spite of the relatively advanced scientific character of medieval Chinese physical theory, and in spite of the numerous empirical discoveries and inventions of medieval Chinese alchemy and chemical technology, modern chemistry (like the rest of distinctively modern science) originated in Europe, and passed to China only in the later + 18th and nineteenth centuries.

The deep analysis of ancient and medieval Chinese ideas on causality has hardly yet begun,[b] but the original and interesting papers of Leslie (2, 7) have been clearing the way. Using many texts from Wang Chhung, Hsün Chhing, Chuang Chou and Tung Chung-Shu, all of the Warring States and Han periods, he summarises the situation by saying that three kinds of causation were recognised: (*a*) by contact, usually of like category with like, a phenomenon in temporal succession,[c] (*b*) by action at a distance, mostly of like category with unlike, also a phenomenon involving succession in time, and (*c*) by natural harmony or 'resonance', a simultaneous or co-incidental effect resulting from the pre-established harmony or pattern of the world, and not a sequence of events in time.[d] So far as alchemy and early chemistry were concerned most of the

[a] Cf. Needham & Robinson (1), as also at length in Sect. 26(*b*) above (Vol. 4, pt. 1).

[b] We have oftentimes glimpsed various aspects of the matter at earlier stages, as in Vol. 2, pp. 280ff., 288ff., Vol. 3, pp. 415, 483ff., Vol. 4, pt. 1, pp. 135, 233, and *passim* in all Sections. We hope to bring it all together in a compendious statement in Vol. 7 (Sect. 46).

[c] Thought of more like 'infectivity' or 'contagion', one might say, than any mechanical impulsions of particulate entities. The idea remained unanalysed. We shall consider its European parallels in Vol. 6 with a medical context.

[d] Clearly this was an ancient formulation of the synchronicity or 'acausal connecting principle' developed in our own time by C. G. Jung. Resonance could also be thought of as 'simultaneous causality', neither event of the two being distinguishable as cause or effect, but both being changes due to a higher overall dynamic pattern-principle. This is certainly not causality in any ordinary sense, and Jung thought of it more as a world-principle of 'meaningful co-incidence' working in a *mundus unus*. See Jung (2, 11);

changes would doubtless have been regarded as due to the contact of the reactants, though many other influences of a more distant, cosmic, character would be operating, or could be mobilised to operate, as well.

Though it has received almost no attention from sinologists, the ancient and medieval Chinese category theories gave rise to a literature which is of much historical interest. It forms the wider background of the book which led to the first recognition of the importance of alchemical category theory when studied and discussed by Ho Ping-Yü & Needham (2) some twenty years ago. The oldest tractate which we have now in mind derives from the early Chin period, at which time Chang Hua[1] (*fl.* +232 to +300) wrote the *Kan Ying Lei Tshung Chih*[2] (Record of the Mutual Resonances of Things). Chang Hua is better known of course for his *Po Wu Chih*[3] (Record of the Investigation of Things), a miscellany of scientific interest datable *c.* +290. Then at some point probably in the third to the seventh centuries was written the most important of these treatises from the alchemical point of view, the *Tshan Thung Chhi Wu Hsiang Lei Pi Yao* (Arcane Essentials of the Fivefold Categorisation based on the 'Kinship of the Three').[a] It was presented to the throne with a commentary by Lu Thien-Chi in +1114, or at any rate between +1111 and +1117.[b] Unlike most members of the genre, which drew their examples of transformation and interaction from the whole range of human experience, this work dealt almost exclusively with chemical changes familiar to the alchemist.[c]

Jung & Pauli (1); and an interesting recent work by Abrams (1). To what extent ancient Chinese scientific and medical thought was dominated by this conception is discussed by Needham & Lu Gwei-Djen (9) in a critique inspired by the book of Porkert (1).

[a] This was the text translated with its commentary and discussed in detail by Ho & Needham (2). All the traditional bibliographies attributed it to Wei Po-Yang of the +2nd century (e.g. *Thung Chih Lüeh, I Wên*, ch. 5; ch. 43, pp. 6*b*, 23*b*), but this was true of many other books such as the *Chhi Fan Ling Sha Ko*, and the attribution is not acceptable today without further evidence of dating. There is no intrinsic ground for denying that it is a text of the Later Han, but no positive evidence in favour either.

[b] At some time in the same period Lu also presented to the throne a tractate on psycho-physiological alchemy, the *Chih Chen Tzu Lung Hu Ta Tan Shih*[4] (Song of the Great Dragon and Tiger Enchymoma of the Perfected Master), *TT*266. Although the last character of Lu's name has been lost from the superscription, the detailed specification of his official titles is exactly the same as in the work which interests us more here. The reason for fixing the date of these presentations exactly at +1114 is that an imperial edict in that year appealed for the collection of all Taoist books (*Sung Shih*, ch. 21, p. 3*a*). This was brought to our attention by Dr James Zimmerman of Yale University.

[c] It may not have been the only one of this character. Certain other books with similar titles may prove relevant when they have received closer examination, though their date and authorship remain quite obscure. For example, the *Chin Pi Wu Hsiang Lei Tshan Thung Chhi*[5] (Gold and Caerulean Jade Treatise on the Similarities and Categories of the Five (Substances) and the 'Kinship of the Three'), *TT*897, is attributed to Yin Chhang-Shêng[6] (perhaps +120 to +210) the oldest commentator on the *Chou I Tshan Thung Chhi*. Our collaborator Tshao Thien-Chhin was inclined to think that the versified text could well be as early as the +2nd or +3rd century, while the prose commentary would be of the Liu Chhao, Sui or early Thang, thus contemporary approximately with the *Tshan Thung Chhi Wu Hsiang Lei Pi Yao*. The whole work, which has been given a preliminary study by Ho Ping-Yü (12), is distinctly *nei tan* in feeling, and though it does mention some substances and even apparatus these look like cover-names for physiological processes and techniques. Unfortunately, in its present form it contains nothing on category theory, and neither text nor commentary has an archaic air.

The other book here in mind is much more interesting for our present theme; it is called *Yin Chen Chün Chin Shih Wu Hsiang Lei*[7] (Similarities and Categories of the Five (Substances) among Metals

[1] 張華 [2] 感應類從志 [3] 博物志 [4] 至眞子龍虎大丹詩
[5] 金碧五相類參同契 [6] 陰長生 [7] 陰眞君金石五相類

Later, in the early Thang, the astronomer Li Shun-Fêng[1] (*fl.* +620 to +680) followed on with his *Kan Ying Ching*[2] (On Stimuli and Responses in Nature).[a] And we must also mention two small books deriving from the writings of the Sung monk and lover of natural curiosities (Lu) Tsan-Ning[3] (+919 to +1001). The *Wu Lei Hsiang Kan Chih*,[4] subject of a recent study by Yamada Keiji (*1*), has often been attributed to the great poet and scholar-official Su Shih[5] (+1036 to +1101), since he and Tsan-Ning shared the literary appellation Tung-Pho.[6] The present version is an abridgement in one chapter produced (probably with some additions) by the late Ming;[b] about the same time as another book of a like kind, the *Ko Wu Tshu Than*[7] (Simple Discourses on the Investigation of Things), also put together from Tsan-Ning's work and similar materials.[c] This is far from exhausting the available literature which deals with categories and resonances in nature-philosophy, but we shall discuss these books sufficiently as representative.

Before proceeding further, however, we must make mention of a text which might be regarded as the *fons et origo* of the whole group. We refer to the *Huai Nan Wan Pi Shu*[8] (Ten Thousand Infallible Arts of the Prince of Huai-nan). This strange work dates mostly from the time of the prince of Huai-nan, Liu An[9] (*d.* −120), that great patron of alchemists and other naturalists.[d] It is supposed to have formed a complement to the existing, and very well known, *Huai Nan Tzu*[10] book, a compendium of natural philosophy the authenticity of which is quite unquestioned.[e] A clear tradition

and Minerals, by the Deified Adept Yin), *TT*899, of date and authorship so far impossible to determine. It consists of twenty sections each headed *phei ho . . . hsiang lei*, 'the pairing and combining category of . . .'. Each one gives synonyms somewhat in the manner of the *Shih Yao Erh Ya* but with more detailed explanations. The first eleven sections are very chemical, dealing with (1) lead, (2) mercury, (3) laminar copper carbonate, (4) sulphur, (5) realgar, (6) silver (the essence in lead), (7) white cinnabar, (8) gold, (9) sal ammoniac, (10) saltpetre (*hsiao shih*,[11] also known as *chhiu shih*,[12] cf. pt. 5), and (11) nodular copper carbonate. The remaining nine, however, are much more difficult to understand, including, for example 'the *hun* (animus) of minium' (no. 13), or 'the male and female of the uterine palace' (no. 15), and—a strange entry—"the Persian essence" (no. 18). This last might help to date the work, which Tshao Thien-Chhin thought might be as old as the +3rd century but with later additions. The writer says that all the 72 metals and minerals can be classified into Yin and Yang substances, and presumably also into one or other of the twenty categories enumerated. This little treatise requires, and truly deserves, further study.

[a] See p. 314.

[b] Probably by Chhen Chi-Ju[13] for inclusion in the third collection of his *Pao Yen Thang Pi Chi*[14] (printed in +1615). On the history of the text and its chapter divisions see Su Ying-Hui (*1*, *2*). The question is rather complex. Sung records give Tsan-Ning as the compiler and 10 chapters as the structure, mentioning a quadripartite organisation very different from that of the current version, which thus cannot be taken as a simple condensation from the original work.

[c] See the comments in the 18th-century imperial analytical catalogue, *Chhin-Ting Ssu Khu Chhüan Shu Tsung Mu Thi Yao*, ch. 130, which suggests that the 18-chapter version also available at that time was a later expansion of the 1-chapter version. Chhang Pi-Tê (*1*), p. 263, however, has noted that since quotations in early sources correspond to the 18-chapter version, the inverse process is more likely. The *Ko Wu Tshu Than* contains numerous passages which agree verbatim with the current text of Tsan-Ning's other book, so it may be simply another abridgement of the original recension.

[d] For an account of what is known of the genesis and bibliography of this book, see Kaltenmark (*2*), p. 32. On its position in the history of practical proto-chemistry and alchemy cf. Vol. 5, pt. 3, pp. 24ff. above.

[e] Cf. Vol. 2, pp. 36 *et passim* above.

[1] 李淳風 [2] 感應經 [3] 錄贊寧 [4] 物類相感志 [5] 蘇軾
[6] 東坡 [7] 格物麤談 [8] 淮南萬畢術 [9] 劉安 [10] 淮南子
[11] 硝石 [12] 秋石 [13] 陳繼儒 [14] 寶顏堂祕笈

among Chinese scholars going back to the +1st century asserts that much of the *Huai Nan Wan Pi Shu* was concerned with alchemy (*shen hsien huang pai shu*[1]—the Holy Immortals' Art of the Yellow and White, i.e. elixirs and the making of gold and silver).[a] We now have only fragments of this book, but it is reasonable to look on it as the forerunner of the whole class of proto-scientific literature which we are discussing. In this connection we may recall that its date is very close to that of the *Chhun Chhiu Fan Lu*, since Tung Chung-Shu was a younger contemporary of Liu An. Broadly speaking, in this sort of literature, the later the text the less the admixture of magic and the stronger the practical technological element.

Modern scholars such as Yeh Tê-Hui[2] and Sun Fêng-I[3] have collected together the fragments of the *Huai Nan Wan Pi Shu* from numerous sources—mainly encyclopaedias and pharmacopoeias. Of 115 entries, 56 are concerned with charms and omens, but there are 32 which deal with medicine, pharmaceutics, nutrition and animal lore, while 13 involve physical phenomena and 12 alchemy or chemistry. Thus side by side with a charm to make people tell the truth by giving them insects from the bamboo plant to eat, or hanging up a piece of lodestone in a well to draw back a runaway person, one finds a clear statement of the precipitation of metallic copper from copper-containing waters[b] or a prescription for a longevity elixir using copper carbonate. Of sympathies and antipathies there are plenty—roasting crab-meat attracts rats, and horn is burnt to keep away leopards and tigers in the mountains.[c]

Ho Ping-Yü & Needham found a remarkable parallelism between this text and the *Peri Sympatheiōn kai Antipatheiōn* (*περὶ συμπαθειῶν καὶ ἀντιπαθειῶν*), also called the *Physica Dynamera* (*φυσικὰ δυναμερά*) of Bolus of Mendes, not till then pointed out. Bolus, who lived at Mendes in Egypt between −200 and −150, has generally been regarded as the initiator of that long line of Western proto-chemical literature which begins with Pseudo-Democritus and Mary the Jewess in the +1st century and runs on continuously through Syriac and Arabic into the late Latin books.[d] Since colouring processes were so important for these practitioners of aurifaction it may be significant that the title of one of Bolus' lost books was *Baphica*, *βαφικά* (On Dyeing), while that of another, which we have just mentioned, was similar to the title of the truly chemical-metallurgical work of Pseudo-Democritus *Physica kai Mystika* (*φυσικὰ καὶ μυστικά*). Besides these there was a *Cheirokmēta* (*χειρόκμητα*, Prescriptions based on Sympathies and Antipathies). Bolus of Mendes, as the first Western theorist of natural phenomena in their chemical and technological aspects, applying Greek ideas perhaps

[a] Cf. *Chhien Han Shu*, ch. 44, p. 8*b*. [b] Cf. p. 201 above.

[c] *PPT/NP*, ch. 3, p. 5*b*, quotes Lao Tzu to the effect that the ability of 'wildcat's head' (which is also the name of a gourd) to cure the 'rat ulcers' of lymphadenitis, and that of woodpecker's flesh to protect the teeth against cavities, can both be understood in terms of categorical resonance (*lei*[4]); cf. Ware (5), p. 61; Feifel (1), pp. 196–7. But the statement is actually a condensation of one from *Huai Nan Tzu*, ch. 16, p. 14*b*.

[d] See Berthelot (1), pp. 156ff.; Festugière (1), pp. 197ff., 219ff., 229ff.; and p. 325 below. On the social background of Hellenistic Egypt see Cumont (4). The real Democritus of Abdera, so renowned for his atomic materialism, died in −375. Bolus may have called himself 'the Democritean' (cf. pt. 2, pp. 17, 25 above).

[1] 神仙黃白術 [2] 葉德輝 [3] 孫馮翼 [4] 類

to the interpretation of Egyptian techniques, occupies a position similar to that of Tsou Yen[1] in China, though perhaps an even more shadowy figure than the great systematiser of Five-Element theory.[a]

The reconstructed book[b] of Bolus on sympathies and antipathies is much smaller than the *Huai Nan Wan Pi Shu* but the similarity is obvious. Of its 34 items, 20 concern natural antipathies, 3 tell of sympathies, and the rest have to do with marvellous properties of animals, plants or minerals. Thus with the same juxtaposition of magic and science as in the Chinese text, we find a charm to make a person tell the truth by laying the tongue taken from a live frog upon her sleeping breast, or a notice of the antipathy of serpents for the saliva of a fasting man, side by side with information about the attractive powers of amber and lodestone or about poisonous fruits. On the whole there is relatively more magic in the Greek than in the Chinese text.[c]

The significance of this whole train of thought can well be seen in an epigram which appears several times among the Greek proto-chemical writings.[d] At the beginning of the book of Pseudo-Democritus, the author relates how, being tormented by the desire to know 'how substances and natures unite and combine themselves into one substance', he invoked the shade of his master Ostanes the Mede, who had died before transmitting all his chemical learning. The answer was that the books were all hidden in a temple, but they could not be found there, and no illumination came until upon a festival evening one of the columns spontaneously split open revealing the marrow of the doctrine in an inscription: 'One nature is charmed by another nature, one nature conquers another nature, one nature dominates over another nature.'[e] Here then,[f] within the field of the metals and minerals, is just the same principle of sympathies and antipathies about which not only Bolus of Mendes but also the adepts of the Prince of Huai-nan had so much to say. However far removed this may seem from the history of chemistry, it is actually one of the most important roots of chemical thinking, for antipathies and sympathies are nothing but the prehistoric ancestors of reactivities and affinities. Tabulation of affinities according to categories was of course another and considerably later development.[g]

[a] On Tsou Yen (−4th century) see Vol. 2, pp. 232ff..

[b] See the learned contribution of Wellmann (2). On Bolus' possible Persian sources see Bidez & Cumont (1), vol. 1, pp. 203 ff., 244 ff.; vol. 2, pp. 311ff., 320.

[c] The whole realm of the Hellenistic magical papyri is of course relevant here. Some are bilingual, having Greek side by side with hieratic Egyptian, as in Leiden Pap. 65 and 75 discussed by Berthelot (1), pp. 82ff. There is also a marked overlap with the proto-chemical papyri (pt. 2, pp. 15ff. above), some of the magical ones containing chemical recipes.

[d] Berthelot & Ruelle (1), vol 2, pp. 42ff.; vol. 3, pp. 44ff., *Corp. Alchem. Gr.* II, 1, retranslated by Festugière (1), pp. 228ff. The aphorism recurs repeatedly in Pseudo-Democritus, cf. vol. 3, pp. 47ff., 50, 51, 52, 55; as also in Synesius, p. 61. Cf. Bidez & Cumont (1), vol. 1, pp. 203ff., 244ff.; vol. 2, pp. 311ff., 320. Similar thoughts recur in Ptolemy, *Tetrabiblos*, 1, 3.

[e] It is difficult not to be reminded, in this formulation, of the Principles of Mutual Conquest and Mutual Production in Chinese Five-Element theory (see Vol. 2, pp. 253ff.), at least contemporary, indeed in some respects going back to the −4th century. To be sure, those principles were more strictly concerned with ordered succession in cycles of change. But one also senses a connection with the 'love and hate' of the pre-Socratic philosophers, especially Empedocles. This, too, has striking Chinese parallels (Vol. 2, p. 40).

[f] As Festugière (1), p. 231 acutely pointed out.

[g] Without enlarging on a matter which gets separate treatment elsewhere (pp. 324ff.), we cannot refrain from pointing out here the far-reaching parallels which are being revealed in the development of

[1] 鄒衍

One can also say that the ideas of groups, classes, categories and affinities are to be found embryonically within the writings of the Hellenistic proto-chemists, if not perhaps in the oldest texts.[a] One attributed to Zosimus, at any rate, speaks of mercury 'and its analogues', as we might say, or the substances similar to it (*kai ta homoia*, καὶ τὰ ὅμοια): and it uses the same expression for pyrites, magnesia and chrysocoll.[b] Almost in the next breath, it goes on to talk about the affinity or relationship, literally 'consanguinity' (*syngeneia*, συγγένεια), which certain substances have for others.[c] Thus magnesia and magnetite are said to have a congenital relationship, presumably an attraction, for iron, mercury for tin (obviously because of amalgamation), copper for pyrites, and lead for the Etesian stone (less obvious, but the identifications are uncertain). All this was rather unorganised thinking and it does not seem to have been followed up among the Greek writers. They also shared with the ancient and medieval Chinese (cf. pp. 317, 319) the closely related idea, derived from primitive biological observation, that like only comes from like. As is said in the tractate attributed to Isis, 'corn is engendered only by corn, man alone sows man, and only gold can give a harvest of gold', in general like generates (*genna*, γεννᾷ) like.[d]

One might wonder what happened to the lore of sympathies and antipathies apart from the stimulus which it gave to affinity theory in chemistry. In the West it petered out in the bestiaries and books on talismanic magic of the late Middle Ages and the early Renaissance, one element, at least, of considerable importance in the genesis of modern science;[e] and it may be that some of the old Chinese beliefs became incorporated, through Arabic intermediation of course, in the eventual magma. About + 1056 someone in Spain put together a book on magic which bore the title *Ghāyat al-Ḥakīm* (The Aim of the Sage),[f] and this, under the name of *Picatrix*,[g] enjoyed a great success in the Latin world during the following four or five hundred years. Derivations from Arabic, Hebrew and Syriac sources, as from Greek, Sanskrit and Pehlevi, have been acknowledged, but when one finds in many of the manuscripts lists of the twenty-eight lunar mansion constellations accompanied by drawings or diagrams of them exactly in the Chinese style (the 'ball-and-link' convention)[h] one is inclined to suspect that further study would reveal sympathetic beliefs which had come down

chemistry in Mediterranean and Chinese antiquity. Not only does Bolus of Mendes parallel in time and nature the school of Liu An, but Liu Hsiang and Wei Po-Yang bracket the + 1st-century developments, and then the two great synthetic writers Zosimus of Panopolis and Ko Hung appear at about the same time (*c.* +300). To say nothing of the Thang and Arabic alchemists, we end by finding the Chinese alchemical corpus first going into print in + 1019, just about the date when the writings to which all our knowledge of Hellenistic proto-chemistry is due were being copied and compiled into the codices.

[a] As was pointed out by Hammer-Jensen (2), p. 24.

[b] *Corp. Alchem. Gr.*, III, xxviii, 9 (Berthelot & Ruelle (1), vol. 3, p. 192).

[c] *Corp.*, ibid., 10 (Berthelot & Ruelle, ibid., p. 193). Cf. p. 360.

[d] *Corp.* I, xiii, 8 (Berthelot & Ruelle, op. cit., vol. 2, pp. 30, 34, vol. 3, p. 34).

[e] Cf. Yates (2), who eloquently pleads for the thesis (which must be at any rate partly true) that the Renaissance 'magus' was the immediate ancestor of the + 17th-century scientist.

[f] Cf. Ritter (1, 2); Plessner (1, 2); Yates (1), pp. 49ff. and *passim*; translation by Ritter & Plessner (1). On account of an attribution sometimes found, the writer is often called Pseudo-al-Majrīṭī. We discuss the book further below, pp. 427ff.

[g] From Buqrāṭīs, i.e. Hippocrates, the supposed writer.

[h] Cf. Vol. 3, pp. 276ff. Similar diagrams are found, as we learn from our friend Mr M. Destombes, on some Arabic astrolabes, MSS, and even Latin treatises on astronomy of the + 12th and + 13th centuries. Cf. the illustration on p. 428 below.

all the way from the *Huai Nan Wan Pi Shu*. If so, they would have had a share in the liberating Renaissance current of thought which restored to man that conviction of the possibility of dominion over Nature which the Middle Ages had minimised or deprecated,[a] and strengthened the assurance that fundamental effects could be brought about by manual operations.[b] Magic and science were still difficult to distinguish in the early days of the Royal Society, but the 'multiplication of real experiments' was already on foot to bring its ineluctable consequences.

Setting aside the *Tshan Thung Chhi Wu Hsiang Lei Pi Yao* for separate consideration presently because of its specifically chemical import, we must now briefly describe the books in the line of literary descent already adumbrated. Chang Hua's +3rd-century tractate[c] contains some matters of genuine scientific interest, set down more or less at random alongside a good deal of magical and superstitious material. Among the former we may mention his descriptions of fish poisons and of the charcoal hygrometer,[d] and his account of the optical phenomena of reflection in plane mirrors. Both this and some of the magical recipes[e] are almost identical with what is found in the *Huai Nan Wan Pi Shu*.

Chang Hua's other book also has some interesting passages. From one of them we can see that in the +3rd century 'category (*lei*[1]) was sometimes thought of as determined by the 'state' of matter, liquid, solid, gaseous, etc. He says:[f]

When lead (*chhien-hsi*[2]) is heated to make white lead (lead carbonate), (these substances) are similar in category (both being solids) (*yu lei yeh*[3]). But when cinnabar in converted into mercury there is no longer any categorical similarity (one being a solid and the other a liquid), (*tsê pu lei*[4]). (These are examples to show that) things of similar category (*thung lei*[5]) can change into categories that differ from one another.

In his +7th-century *Kan Ying Ching* Li Shun-Fêng again describes the charcoal hygrometer and has something to say on strange animals, the generation of insects from grain and of fireflies from rotting grass.[g] He says that swallows have a sense of direction, for apart from migrations their nests always face north. Unfortunately his treatise is available today only in fragmentary form.[h]

The books based upon Tsan-Ning's writings are much more advanced (though magic is not entirely absent), and each is well classified into subjects. Significantly, both mention magnetic attraction.[i] The *Ko Wu Tshu Than* opens with weather forecasting and continues with miner's lore concerning signs of ore beds, including plant indicators.[j] Tsan-Ning (or his editors) knew of poisoning by the fumes of burning coal and recommend a remedy for it. In both books there is mention of the

[a] The full argument should be read in Yates (1, 2).

[b] Cf. Vol. 2, pp. 34, 83, 89ff. 'However strange his operations may seem to us, it is man the operator who is glorified in the (Hermetic) *Asclepius*' (Yates (2), p. 257). The accent was on power, and that was just what the merchants of early capitalism also wanted. Did the magus go hand in hand with the entrepreneur? If so, we might have a piercing side-light on the origins of modern science.

[c] In *Shuo Fu*, ch. 24, pp. 18*b*ff.

[d] Cf. Vol. 3, p. 471.

[e] E.g. charms for getting a runaway person to come back.

[f] *Po Wu Chih*, ch. 4, p. 3*a*, tr. auct.

[g] The metamorphosis lore of animals and plants will be discussed in Sect. 39 below (Vol. 6).

[h] In *Shuo Fu*, ch. 9, pp. 1*a*ff.

[i] But curiously not the polarity, though it was well known in his time in China. See Vol. 4, pt. 1, Sect. 26(i).

[j] See further on this Vol. 3, pp. 675ff.

[1] 類 [2] 鉛錫 [3] 猶類也 [4] 則不類 [5] 同類

use of lime as a dehydrator for preventing iron and steel implements from rusting. Corrosion of bronze and brass, on the other hand, can be removed by vinegar. Another interesting reference is to the so-called wet method of copper production where copper-containing mine waters are led over waste iron and the copper metal is precipitated as a powder: this technique, mentioned already, as we have just seen, in the −2nd century in the *Huai Nan Wan Pi Shu*,[a] was becoming a standard industrial process by Tsan-Ning's time.[b] One encounters all kinds of things; for example: 'For the Floating Elixir, mould camphor and vermilion into a cake; when you put it on water it will rush to and fro.'[c] Or on disinfection: 'When an epidemic comes, put the clothes of the first person falling ill in a steamer and steam them well, then the whole household will escape the infection.' On invisible ink: 'Write characters with a solution of (iron) alum, allow it to dry, then to make the writing visible wet it with an extract of gall-nuts.'

As for the *Wu Lei Hsiang Kan Chih*, more certainly Tsan-Ning's, it tells how tung oil spread on the water kills lotuses, how liquids can be clarified by filtration through sand, how spots can be bleached by the uric acid in bird droppings, how grease can be absorbed on finely powdered charcoal or talc, and how sterilised salt should be added to vinegar to prevent the formation of a white pellicle by moulds.[d]

Lastly we may refer to another Sung book, dating from the +12th century, the *Hsü Po Wu Chih*[1] (Continuation of the Record of the Investigation of Things) by Li Shih.[2] In this, Li quotes the (*Shen Nung*) *Pên Tshao Ching*[3] as follows:[e]

When the tiger roars, the wind rises.[f] When the dragon gives tongue the clouds gather.[g] The lodestone attracts needles. Amber attracts bits of straw (literally mustard seeds).[h] After coming into contact with crabs lacquer will not concrete.[i] Lacquer added to hemp (-seed oil) makes it bubble.[j] Treated with the *tshung*[4] onion, cinnamon (bark? wood?) softens. Cinnamon causes (certain) trees (or plants) to wither.[k] Crude salt preserves piles of eggs.[l] The

[a] In *Thai-Phing Yü Lan*, ch. 988, p. 5*a*.

[b] Cf. Vol. 2, p. 267. More detailed information has been given above, pp. 201 ff.

[c] Cf. pt. 2, p. 170 above.

[d] A complete translation of these two small books would be rewarding, especially with a commentary to bring out the widespread role of the applications of empirical science in the daily life of medieval China.

[e] Ch. 9, p. 5*a*.

[f] A parallel statement of Han date occurs in the *Huai Nan Wan Pi Shu* (*Thai-Phing Yü Lan*, ch. 89, p. 5*a*).

[g] For representations of dragon–tiger resonances in ancient literature and art cf. Hawkes (1), p. 133; Riddell (2), a circular lacquer dish of +69; Chavannes (9), a rubbing of +171.

[h] The development of knowledge of magnetism and electrostatics in China is fully dealt with in Vol. 4, pt. 1, Sect. 26(i).

[i] On this *locus communis*, which involved an ancient empirical discovery of a powerful laccase inhibitor, see pp. 207 ff. above.

[j] It has in fact been the practice for centuries past to add tung oil to lacquer latex as an adulterant; as Li Shih-Chen pointed out (*Pên Tshao Kang Mu*, ch. 35, p. 20*a*), this makes it very poisonous. The bubbling could have been disengagement of CO_2 because of an acidity difference.

[k] *Pên Tshao Kang Mu*, ch. 34, p. 15*b*, quotes the *Lü Shih Chhun Chhiu* (−239) as saying, 'Under the branches of the cinnamon tree no other saplings will come up.' This passage does not appear to be in the *Lü Shih Chhun Chhiu* now, but there is no reason for doubting its antiquity. The *Phao Chih Lun*[5] (*c.* +470) of Lei Kung[6] is also quoted in the same place as saying that if you drive a peg of cinnamon wood into the root of another tree the latter will wither.

[l] A parallel statement of Han date occurs in the *Huai Nan Wan Pi Shu* (*Thai-Phing Yü Lan*, ch. 865, p. 5*a* and ch. 928, p. 6*b*).

[1] 續博物志 [2] 李石 [3] 神農本草經 [4] 葱 [5] 炮炙論 [6] 雷公

gall of the otter cracks (literally divides) wine-cups. (All these phenomena occur because) the *chhi* (*pneumata*) of these things are in sympathy (*chhi chhi shuang chih*[1]) and thus bring about mutual resonance (*hsiang kuan kan yeh*[2]).[a]

If this is what it purports to be it could date from the – 2nd century, but the passage is not found in the version of the *Pên Ching* reconstructed by modern scholars such as Mori Tateyuki (1845).[b] Thus although the consciously chemical content of these texts is not great, they form a corpus cognate with the specifically alchemical theories worked out in the *Tshan Thung Chhi Wu Hsiang Lei Pi Yao.*

For the oldest application of the theory of categories in alchemy we have to go back to Wei Po-Yang who in his *Chou I Tshan Thung Chhi*[3] speaks as follows:[c]

Lead carbonate (*hu fên*[4]), being placed on the fire, becomes discoloured and changes back to lead. Mixed with hot liquids ice and snow melt into water (*thai hsüan*[5]). The Gold (Elixir) is mainly derived from cinnabar ([*tan*] *sha*[6]) which is naturally endowed with mercury. Transformations depend on the true nature (of the substances)—beginnings and ends are mutually related. The way to become an immortal (*hsien*[7]) through taking drugs lies in the use of substances of the same category (*thung lei*[8]). Grains are used for raising crops, hen's eggs are used for hatching chicks. With substances of (similar) categories as the assistants of natural spontaneity the formation and moulding of things is easily accomplished. Fish eyes cannot replace pearls, neither can weeds be used for timber. Things of similar category go together (*lei thung chê hsiang tshung*[9]): precious substances cannot be made from the wrong materials. This is why swallows and sparrows do not generate the *fêng*[10] (male phoenix), this is why foxes and rabbits do not suckle the horse. Flowing water does not heat what is above it, and a fire does not wet what is underneath it.

And elsewhere he says:[d]

In the activities of Nature there is never anything sinister or illusory. The *chhi* of the mountains and marshes distils into the heavens forming clouds and returns as rain. The muddiest lane becomes a dust-dry path in time, and after the fire is out all turns to dead earth-ash. Shavings of *nieh*[11] wood[e] or bark dye yellow, but if blue (indigo) be added green

[a] We should like to draw attention to the fact that the whole passage partakes grammatically of the nature of a sorites, each statement beginning with an agent which was the patient of the previous statement. This can be seen in the fifth and sixth, and the seventh and eighth, statements. On the sorites as a logical form see Welton (1), p. 393; Maspero (9), and Granet (5), pp. 337, 443, 487. But here the whole content is empirical, and one cannot help being reminded of the successive dominances in the Mutual Conquest Principle of the Five-Element Theory (see Vol. 2, pp. 257ff.).

[b] As Prof. A. F. P. Hulsewé points out, the dating of this passage might hinge on the time at which cinnamon bark first became well known in China; on this see Vol. 6 (Sect. 38).

[c] *Tshan Thung Chhi Fên Chang Chi Chieh* ed., ch. 12 (ch. 1, p. 25*b*); *TT*990, ch. 1, p. 37*a*, *b*; cf. *Ku Wên Tshan Thung Chhi Chien Chu Chi Chieh*, ch. 6, p. 1*a*. We differ here from the translation by Wu & Davis (1), p. 241.

[d] Ch. 32 (ch. 3, p. 5*a*); *TT*990, ch. 3, p. 6*b*. On this the +3rd-century commentary of Yin Chhang-Shêng says that when mercury–lead amalgam is made the 'yellow sprouts' appear, and that when these are added to more mercury the cyclically-transformed elixir spontaneously develops. This is because the species are right. But trying to make gold from aqueous solutions of various minerals and drugs will effect nothing, for the categories are not congruent. Labour and skill will be vain, and success will not follow. Here also the translation of Wu & Davis (1), p. 259, misses the point.

[e] This is probably the leguminous *Pterocarpus indicus* (= *flavus*), on which see R405, CC1035 and Schafer (8). *Huang po*[12] may have been a synonym anciently, but *po* is properly the name of another plant; cf BIII 315.

[1] 其氣爽之 [2] 相關感也 [3] 周易參同契 [4] 胡粉 [5] 太玄
[6] 丹砂 [7] 仙 [8] 同類 [9] 類同者相從
[10] 鳳 [11] 檞 [12] 黃檞

girdles can be made. Cooking leather and skins gives glue; mould-leaven (*chhü*[1]), malt and yeast (*nieh* [2,3]) transform mash into wine.[a] If the categories are the same (*thung lei*[4]) it is easy to perform the work, but with discrepant species (*fei chung*[5]) difficulties will defeat the greatest skill. On this depend all the marvels of men's craft.

These words were written, we suppose, in the neighbourhood of +140. Within a few centuries thereafter, in the *Tshan Thung Chhi Wu Hsiang Lei Pi Yao*, we find a much more mature application of category theory. A large number of the common reagents are classified in categories with reference to their use in elixir processes. At one place the writer says:[b]

> Now the *Tshan Thung* (*Chhi*), by means of the Five Elements, the inner and outer (aspects), and the six acoustic pitches (*liu lü*[6]), allows one to determine the proper quantities and to know (which substances are of) the same category (*thung lei*[7]).
>
> [Comm.] Now (in the making of) the Great Elixir, success will never be attained if the Yin and Yang principle and the Five-Element theory are not followed to classify substances into categories (*kho ting thung lei*[8]).
>
> Now according to the Five-Element theory just explained, (one can determine) the substances which are of the same category as 'Red Marrow' (*chhih sui*[9]).
>
> [Comm.] The Red Marrow of Thai Yang is Thai Yang quicksilver; it is mercury extracted from cinnabar. Another name for it is *Thai Yang hung*.[10] Thai-yang is a synonym of cinnabar.[c]
>
> The Greater, or mature, Yang, realgar, because of its male essence, contains and receives it; the Greater, or mature, Yin, orpiment, as a coagulated liquid (*ning chin*[11]) is categorically similar to it.[d] This is the great Tao of the Cyclically Transformed Elixir.
>
> [Comm.] Male Essence is realgar, Yin Liquid is orpiment. Ta Huan Tan (Great Cyclically Transformed Elixir) is another way of saying it.
>
> Furthermore, realgar is of the same category as sal ammoniac (*nao sha*[12]).
>
> [Comm.] When realgar and sal ammoniac are heated together in the same pan a blood-coloured liquid will be formed after a short while. Heating must then be continued for a day and a night in a closed vessel to effect the subduing. From this we know that the statement is true.[e]
>
> Without sal ammoniac, realgar will not develop the proper colour...

With the aid of Lu Thien-Chi's commentary Ho & Needham were able to recognise more or less confidently in the text mentions or descriptions of the following operations:

(*a*) Interconversion of the metals and their sulphides (mercury and iron).

(*b*) Amalgamation of mercury in a variety of different ways with gold, silver, copper, tin, iron, zinc and lead; in one case seemingly involving organic copper compounds, and frequently in the presence of the sulphides of arsenic.

[a] Cf. pp. 132 ff. above.

[b] *TT*898, p. 2*b*, tr. auct. adjuv. Ho Ping-Yü & Needham (2), p. 180.

[c] *Shih Yao Erh Ya*, ch. 1, p. 1*b*, gives Thai-yang as a synonym of mercury as well as of cinnabar.

[d] In Five-Element theory the Greater, or mature, Yang, and the Greater, or mature, Yin, correspond of course to Fire and Water respectively.

[e] Perhaps the chloride acted to prevent oxidation of the fused arsenic disulphide.

[1] 麴 [2] 蘗 [3] 酵 [4] 同類 [5] 非種 [6] 六律
[7] 同類 [8] 刻定同類 [9] 赤髓 [10] 太陽汞 [11] 凝津
[12] 硇砂

(*c*) Formation of the acetates of mercury and silver.
(*d*) Sublimation of the chlorides of mercury, and preparation of lead carbonate.
(*e*) Formation of sulphides and sulphates of mercury by treatment with alum.
(*f*) Treatment of arsenic disulphide with ammonium chloride.
(*g*) Association of arsenic trisulphide with alkaloid-containing liliaceous corms.

Thus some of the processes discussed were of a quasi-metallurgical nature reminiscent of the Western developments from the chemical technology of the Leiden papyri and the Hellenistic proto-chemists. But others were more characteristically Chinese.

Thus the writer of the *Wu Hsiang Lei Pi Yao* clearly believed that for two things to react there must be something similar about them. But this seems at first sight to conflict with the expectation that if all things in the universe belonged either to the Yin or the Yang, reactions might more naturally occur between things of opposite sign in this sense. And that indeed was the ground on which the late Tenney L. Davis based his favourite theory (by no means necessarily erroneous)[a] of an identity of principle in the foundations of Chinese and Western alchemy.[b]

Davis and his collaborators had no difficulty in finding occidental comparisons for the mating of contraries in the Great Work, the marriage of Sol and Luna, of sophic sulphur and sophic mercury, under a hundred synonyms; nor did they lack Western texts which emphasised the maleness and femaleness of the fundamental essences in a strangely Chinese manner.[c] Though few would now subscribe to Davis' belief that the sulphur–mercury theory occurs already in the Hellenistic proto-chemists (+1st to +4th centuries), it is certainly flourishing in the Jābirian corpus (+9th and +10th centuries), perhaps derived (as some think) from the two mineral exhalations of Aristotle,[d] perhaps rather from the antitheses of China.[e] Then it continues to flourish in the Geberian books (late +13th and +14th centuries) and so comes down to Paracelsian times. On the other hand statements of sexual type undoubtedly occur in the Greek writings. In Zosimus we find the fundamental aphorism twice—'Above what is heavenly, below what is earthly; by the male and the female the work is accomplished,'[f] and again 'Mary said: "Join the male and the female and you will find what you are seeking"'.[g] These quotations were made early in the +4th century and the latter is ascribed to the +1st. Then there is another epigram attributed by Olympiodorus (*c.* +420) to Mary (+1st century): If you do not make corporeal substances incor-

[a] Cf. pp. 454ff. below, 491, and pt. 2 above, pp. 6–7.

[b] See especially Davis & Chhen Kuo-Fu (2), and the discussions in Davis (2, 3, 4, 5). Davis (6) has been untraceable by us.

[c] Davis brought under contribution, e.g. Basil Valentine, the *Speculum Alchemiae*, *Le Texte d'Alchymie*, and Norton's *Catholicon*.

[d] Cf. Vol. 3, pp. 636ff.

[e] We leave on one side for the present the fascinating question of Chinese influence on the Shi'ite and Isma'ilite writers of the Jābirian books. It would have taken at least two forms, the emphasis on immortality and longevity elixirs as opposed to chrysopoiesis as such, and a powerful reinforcement of chemical dualism. See further, pp. 457ff.

[f] Berthelot & Ruelle (1), vol. 3, p. 147. This aphorism also occurs as a kind of caption below a picture of alchemical apparatus in the +11th-century Paris MS. 2327, f. 81v; see vol. 1, pp. 161, 163. *Corp. Alchem. Gr.*, III, x, end.

[g] Berthelot & Ruelle (1), vol. 3, p. 196. Berthelot considered this text as due to a Pseudo-Zosimus of the +7th century but Sherwood Taylor (2) accepted it as genuine. *Corp. Alchem. Gr.*, III, xxix, 13.

poreal and vice versa, and if you do not turn two bodies into a single one, none of the results you hope for will be produced.'[a]

But whatever may be the case with the Western alchemists this was always only half the story for the thought of the Chinese. Besides something like the marriage of contraries there was the firm conviction that *similia cum similibus agunt*. These two principles were combined in the thought that substances of opposite sign will react only if they belong to the same category (*lei*[1]). This is most clearly explained in the *Wu Chen Phien*[2] (Poetical Treatise on the...Primary Vitalities), written in +1075 by Chang Po-Tuan[3] (+983 to +1082), patriarch of the Southern School of Sung Taoism and one of the most authoritative exponents of internal alchemy.[b] It was from this work that Davis drew particular support for his theory, though the book is concerned not with laboratory operations at all but with physiological and sexual disciplines.[c] As Chang Po-Tuan put it, 'Yin and Yang (things), if they are of the same category, respond and interact with each other.'[d] On this Chhen Chih-Hsü[4] (Shang Yang Tzu[5]), two and a half centuries later,[e] commented:

> What is meant by 'categories' is the partnership of Heaven and Earth, the complementarity of the moon and sun, and the mutuality of female and male; hence it follows that mercury must require lead as its category partner.

Later on Chang Po-Tuan says in homely analogy:[f]

> For repairing something made of bamboo, bamboo must be used. If you want a hen to hatch chickens, they must come from eggs. No matter what you are doing, if it is not based upon the classification of things by category (*fei lei*[6]) it is a complete waste of energy.

And the commentators elaborate the point at length. Thus the Chinese alchemists had in their minds a kind of table divided one way into Yin and Yang signs and the other way into a series of categories.[g]

It only remains to construct such a chemical table according to the explicit statements of the *Wu Hsiang Lei Pi Yao*. No less than fifteen of these *thung lei* categories are given in the main text, and five further statements can be collected from other parts of the work.[h] All are shown in Table 120. When the sign of a substance is not

[a] Berthelot & Ruelle (1), vol. 3, p. 101; *Corp. Alchem. Gr.* II, iv, 40. Elsewhere, p. 124 (III, iv), the first part of the aphorism is attributed to Hermes, who is placed in the +2nd century by Sherwood Taylor (2). Cf. Festugière (1), p. 242; and further, below, pp. 360ff.

[b] See Vol. 5, pt. 3, pp. 200 ff. [c] See pt. 5 below.

[d] Ch. 8; cf. Davis & Chao Yün-Tshung (7), p. 104. We may remember, moreover, the pregnant statement of the +11th- or very early +12th-century commentator of our own text, the *Wu Hsiang Lei Pi Yao*, given on p. 317 above. [e] See pt. 3, pp. 206ff.

[f] Ch. 25. Cf. Davis & Chao Yün-Tshung (7), p. 106.

[g] An elaborate +14th-century table of this kind, constructed with the concepts of physiological alchemy by Chhen Chih-Hsü, is given in Ho & Needham (2). We shall reproduce it and discuss it in pt. 5.

[h] It will be remembered that the *Chin Shih Wu Hsiang Lei* lists twenty categories (p. 310 above). The entries and definitions are not by any means all the same, but the near coincidence of the total number may not be entirely fortuitous.

[1] 類 [2] 悟眞篇 [3] 張伯端 [4] 陳致虛 [5] 上陽子
[6] 非類

clear from the text itself, it may follow from the substance with which it is paired, or it may be obtainable from other texts. We wish to remark only on two especially interesting entries, nos. 8 and *b*, which indicate clearly there was a graduation of Yang-ness and that while mercury might be female to sulphur it would act as male to silver. Hence further vistas of complication open up, and we may expect to find in course of time due explorations of them in other medieval Chinese texts. After all, this would have been only a natural development from an idea of great antiquity, embodied to this day in the well-known Yin–Yang symbol, familiar everywhere, with a Yin heart to the Yang and a Yang heart to the Yin (cf. p. 379). It would have been related to a doctrine of the inseparability of the Yin and the Yang, the idea that there could hardly be anything in the phenomenal world so Yang as not to have some Yin within it and vice versa.[a] Bodies thus ascended to a quasi-quantitative plane, at least in theory, taking their places on a hierarchical scale in accordance with their Yin–Yang *mistio* or *krasis* (κρᾶσις), so that a given substance might act as Yin in one relation and Yang in a second, forming a succession intuitively analogous to the electrochemical series of the elements, the order in which they displace one another from their salts.[b]

Table 120. *Chemical categories from the 'Wu Hsiang Lei Pi Yao'*

Lei	Yang	Yin	Neutral
1	cinnabar	mercury	
2	realgar	orpiment	
3	realgar	sal ammoniac	
4	honey and fritillary corms[c]	orpiment	
5		arsenious acid	clay
6	sulphur	magnetite	
7	sulphur	mercury	
8	mercury	orpiment	
9	cinnabar	vinegar	
10	lead	mulberry ashes	
11	litharge	tin	five coloured clays
12	cinnabar	bronze coins	
13	Persian brass fragments[d]	mercury	
14	copper carbonate	mutton fat	
15	blue copper carbonate	red haematite	
a	lead	calomel	
b	mercury	silver	
c	red salt	alum	
d	copper carbonate	silver	
e	red salt	calomel	

[a] Cf. on this Vol. 2, p. 276 and Fig. 41; and Davis (5), p. 85.

[b] Strangely reminiscent, too, of the series of intersexes found in many invertebrates, especially molluscs, and some micro-organisms.

[c] *Pei mu*,[1] almost certainly *Fritillaria Roylei* (R678). This plant contains a number of active alkaloids and is still used in Chinese medicine; cf. Chang Chhang-Shao (*1*), pp. 78ff.; Lu Khuei-Shêng (*1*), pp. 95ff.

[d] Cf. pt. 2, p. 202, pt. 3, p. 136 above.

[1] 貝母

The question may now be asked, is there any representative in modern chemical theory of the doctrine that 'things of similar category go together'? Transmuted into terms of the deeper insights of today the doctrine in some sense still persists, for valencies in chemical combination have to be equivalent. A trivalent atom for instance will not combine wholly with a univalent one, and in so far as atoms can be octavalent there are eight categories to consider. Combining atoms also have to be similar in that they are both in a position to share an electron; some elements such as the inert gases, with their fully filled shells, are unable to co-operate in this way. The doctrine of 'similar categories' seems to have joined its opposite in the higher synthesis of modern chemistry, for while many examples of ionic bonds, some very strong, exist, there are also many examples of covalent bonds between atoms of the same kind.

At the beginning of the eighteenth century modern chemistry set out, as Metzger has so well shown, from the proposition that like attracts like.[a] This was one of the great watchwords of Stahl[b] and his disciples such as Juncker,[c] who preferred it to the Cartesian 'mechanical' system of a union of opposites. They applied their notion of affinity to the assumed indwelling 'earthy', 'aqueous', 'mercurial', or 'sulphurous' (phlogistic) principles rather than to the chemical substances themselves.[d] Newtonian gravitational attraction was then brought in to explain these affinities, and the rest of the century was occupied with the establishment and then the destructive criticism of the doctrine.[e] It thus ended with a dominance of the opposite point of view, represented, for example, in the *De Attractionibus Electivis* of Torbern Bergman (+1775);[f] not only the idea of which, but the very name, was translated back to the human sphere in the title of Goethe's famous novel *Wahlverwandtschaften*, the 'Elective Affinities'.[g]

In the nineteenth century it was only with the greatest difficulty that the prejudice against envisaging combinations of identical atoms was overcome. The tradition of Davy and Berzelius was that only atoms with opposite electrical charges could form compounds together. Thus Canizzaro had great labour in convincing chemists of the truth of Avogadro's law because it involved double molecules such as O_2, N_2, etc., i.e. combinations of like with like.[h]

But of course there is something artificial in stretching the vague conceptions of antiquity on the Procrustean bed of modern scientific theory, and it is best not to push such comparisons too far. Moreover, as we have already said, the doctrine of 'similar categories' was built up on fancied resemblances and imaginative classification, not on critical observation and experiment. Yet in its two-dimensional or 'matrix' character it did find room for both theses of the perennial contradiction—that only opposites unite, and that similar things alone react together.

[a] (1), esp. pp. 139ff.

[b] Cf. Partington (7), vol. 2, p. 665 (+1660 to +1734). The most relevant passages are in his *Specimen Beccherianum* (+1738 ed.), p. 13, and *Traité des Sels* (+1783 ed.), p. 304.

[c] Partington, *op. cit.*, p. 688 (+1679 to +1759).

[d] In Stahl, mercury forms amalgams because metals contain 'mercury', metals dissolve in nitric acid because both contain phlogiston; acids unite with bases because both are 'salts', etc.

[e] Cf. Metzger (1), p. 52.; Dobbs (4), pp. 209 ff.

[f] Cf. Carlid & Nordström (1), containing the biography by Olsson.

[g] Cf. Walden (3), pp. 56, 115; and the special study of Adler (1).

[h] The history of the modern concept of chemical composition and combination has been written in

Looked at in another way, the old Chinese theory of categories is a hitherto unrecorded chapter in the prehistory of the conception of chemical affinity. According to Partington (3) the word *affinitas* was first employed with chemical meaning by the great Dominican scholar-naturalist Albertus Magnus (+1206 to +1280), a contemporary of Phêng Ssu[1] and Mêng Hsü,[2] the writers of the famous book on the 'Golden Flower Elixir'.[a] It is evident from reading over the list of 'similar category' substances given by the *Tshan Thung Chhi Wu Hsiang Lei Pi Yao* that although the writer had no way of distinguishing between chemical reaction and physical change or mixture, he did put together pairs or groups of substances which he observed to react in one way or another. Was he not thus the ancestor of E. F. Geoffroy, whose first affinity table of +1718 served as the model for so many others,[b] preparing the way for the synthesis of Lavoisier? Men such as Guyton de Morveau (from +1772 onwards)[c] were still struggling with essentially the same problems as the writer of our text.

Again, the old Chinese theory of categories seems to take its place in the linear ancestry of the idea that things can be arranged in chemical classes the members of which are susceptible of chemically similar processes. These words are Sherlock's, in his acute study (1) of the contribution of the *Archidoxis* of Paracelsus (+1526), a book which described the preparation of a series of coloured chlorides and nitrates of the metals. Here the great advance was the first conception of a generalised method for making a number of analogous preparations.

The idea that things which belonged to the same class, or to the same phase of a cyclic process, resonated with, or energised, each other, though so characteristic of Chinese thought, was not without parallels in ancient Greece.[d] Cornford (2) has detected these in what he calls the maxims of popular belief accepted by the philosophers from 'common sense' without scrutiny. Take Aristotle's three kinds of change. Movement in space was explained by asserting that like attracts like; growth, by asserting that like nourishes like; and change of quality, by asserting that like affects like. To quote from Aristotle, 'Democritus held that agent and patient must be the same or alike; for if different things act upon one another, it is only accidentally by virtue of some identical property.'[e] But there was also an opposite set of maxims that like things repelled one another—'Everything desires, not its like, but its contrary' to quote from Plato.[f] All this has an evident relationship with the ideas of the pre-Socratics about 'love' and 'hatred' in natural phenomena, and it would be easy to see the origin of it in social practices, exogamy or endogamy, sympathetic magic, and so on.[g] Among the Chinese philosophers of the Warring States period closely similar

a classical monograph by Ida Freund (1). Benfey (2) has reprinted a selection of the most important papers on the subject.

[a] See Ho & Needham (3), and here, pp. 35, 44, 275, 285.

[b] Cf. Duncan (1, 2, 3). For Bergman's Tables of Affinity see Freund (1), pp. 114ff.

[c] Cf. Smeaton (1).

[d] That 'like things have an affinity for one another' is in Hippocrates, *De Morbis*, IV, 7. Cf. p. 360.

[e] *De Gen. et Corrupt.* 323*b* 10. His own views were complex, subtle and difficult, cf. the study by Stephanides (2).

[f] *Lysis*, 215c. But in *Tim.* 57c he puts just the opposite view, the Hippocratic, inconsistent as usual.

[g] The interesting book of Lloyd (1) on polarity and analogy in Greek thought, now available, appeared too late to be of help to us.

[1] 彭耜 [2] 孟煦

conceptions were current.[a] The point to be emphasised here is that while Greek thought moved away from these ancient ideas towards concepts of mechanical causation foreshadowing the complete break of the Scientific Revolution, Chinese thought developed their organic aspect, visualising the universe as a hierarchy of parts and wholes suffused by a harmony of internal necessities.[b] In this development the Chinese alchemists participated according to their lights, though their contributions to chemical discovery and invention, certainly not less than those of other civilisations, remained until the end of a typically pre-Renaissance character. Yet after all, the dimensional analysis of current scientific concepts[c] is showing how again and again in many different fields the two thought-patterns 'unlikes attract', and 'birds of a feather flock together', underlie the most recondite and sophisticated theories. Perhaps, as categories of thought itself, they always will.

(*i*) COMPARATIVE MACROBIOTICS

It seemed impossible to conclude this part of our work without some account of the general course of events throughout the Old World civilisations, for neither Chinese nor any other culture can usefully be thought of in total isolation. But do we yet know enough to demonstrate, or even to suggest, that the great intellectual adventure of proto-chemistry and alchemy, aurifiction, aurifaction and the elixir, was really one single movement, even with separate foci of origin, during the past three thousand years? Many scholars (even some among our own group of collaborators) would be inclined to say that it is too soon to attempt this, and that a good few decades must yet pass before sufficient understanding of the different traditions has been attained, and enough information is in. Nevertheless, I feel that there is already something to be said, chiefly by way of a comparative prospect of Chinese alchemy, Hellenistic proto-chemistry, and Arabic and Latin alchemy; and this is what the following pages contain.

The subject has been on the agenda for quite a long time. Theophilus Spizel, in one of the earliest European sinological books, *De Re Literaria Sinensium* (+1660), noting the ubiquity of the search for material immortality in Chinese culture, and the harm done by dangerous elixir preparations, as also the widespread belief in argentifaction,[d] agreed with H. Conring's view of +1648 (*De Hermet. Med.*, ch. 26) that they had probably got all these ideas from the Saracens.[e] As we now know, the case was just the opposite. Bernard Varenius, too, in his description of Japan and Siam, published at Cambridge in +1673, gave an account of the Taoists and their Pope of the Ciam (Chang) family, remarking how many of them worked and wrote on elixir alchemy.[f] Isaac Vossius, for his part, admired in +1685 the chemical knowledge of the Chinese, which he said had been growing for two thousand years if not the four thousand six hundred which some claimed for it; and he knew that the activities of their numerous

[a] Cf. Vol. 2, p. 39.

[b] Anthropomorphically, a harmony of wills, the spontaneous co-operation of all individual beings and things.

[c] Cf. Benfey (1).

[d] Cf. Francis Bacon on this, Vol. 5, pt. 2, p. 33 above.

[e] Pp. 259ff.

[f] Pp. 260ff., esp. p. 262. This was the Varenius whose *Geographia Generalis* had been edited and published by Isaac Newton in the previous year.

alchemists were directed not so much to the making of gold as to the pursuit of long life and immortality, even if the longevity of the most ancient men had been due to other causes, and the alchemists could never benefit themselves from what they so liberally promised to others.[a] Yet he joined with the new, or experimental, philosophers, in reproving the secrecy which the alchemists, both in East and West, maintained about their arcane mysteries.[b]

A century later, de Pauw devoted a whole chapter of his *Recherches Philosophiques*... (+1774) to a discussion of the state of chemistry among the Egyptians and the Chinese.[c] De Pauw did not know the Alexandrian Corpus from Pizzimenti's edition (+1572, +1717) as he might have done, so he thought of Egypt purely in terms of the technical arts such as glass and gilding, denying at the same time to the Chinese anything more than empirical industries such as gunpowder and porcelain. He believed, on the other hand, that the idea, or 'folly', of the elixir of life had come to them from the 'Tartars' their ancestors, by which he meant the Scythians and the Persians, whose *haoma* (*soma*) he knew of. As we have already seen (pt. 2, p. 121) there was a grain of truth, if only a grain, in this. Like J. C. Wiegleb, a few years later (+1777), whose *Historisch-kritische Untersuchung der Alchemie* was the book which more than any other gave the death-blow to the belief in aurifaction in Europe,[d] de Pauw knew of the attribution of alchemy to Lao Tzu.[e] But none of them had any idea of the wealth of real Chinese alchemical experimenters and writers contemporary with the Graeco-Egyptian proto-chemists, and even prior to them.

(1) China and the Hellenistic World

(*i*) *Parallelisms of dating*

It has not so far been generally appreciated by historians of chemistry that the succession of Greek-speaking proto-chemists in the Mediterranean region was closely paralleled by a line of proto-chemists, or, strictly speaking, alchemists (cf. pt. 2, p. 12) in China. This is the first point which needs to be examined. And the first problem which presents itself is that of the identity and date of the oldest writer of the Greek

[a] *De Artibus et Scientiis Sinarum*, in *Variarum Observationum Liber*, ch. 14, p. 77. The passage runs: 'Chemiam jam a bis mille annis apud Seras in usu fuisse constat. Quod si ipsos audiamus Chemicos, illi jam a sexcentis supra quater mille annis ejus arcessunt antiquitatem; nec aliunde primorum hominum longaevitatem quam hujus scientiae beneficio provenisse affirmant. Doctiores tamen Medici id genus hominum cum omnibus suis figmentis arcanis, in apertam non audentibus prodire lucem, strenue contemnunt. Nusquam plures invenias Chemicos quam apud Seras, non divitias tantum, sed et immortalitatem quoque promittentes, eaque aliis liberaliter spondentes, quae sibi ipsis praestare nequeunt.'

[b] Recently Rossi (2), in an interesting paper on the 'equivalence of intellects', has emphasised the importance of a democratic estimate of human capacities, and a conviction of the universal accessibility of truth, in the Scientific Revolution; as opposed to the aversion of the learned magi in all previous civilisations to revealing their knowledge to the *promiscuum hominum genus*. Hence the 'plain, naked, natural way of speaking' exacted by the early Royal Society (cf. Lyons (1), p. 54).

[c] In his vol. 1, pp. 376ff. Cf. pt. 3, pp. 227ff. above. The work was intended partly to explode the earlier thesis that 'the Chinese were a colony of the Ancient Egyptians' (de Guignes, +1760, J. T. Needham, +1761; cf. Vol. 1, p. 38). Partly also it was anti-Jesuit propaganda.

[d] Cf. Ferguson (1), vol. 2, p. 546.

[e] Wiegleb (1), pp. 184, 211–12, de Pauw (1), vol. 1, p. 431.

proto-chemical Corpus, Pseudo-Democritus;[a] a question which we have touched upon already at two places in the preceding sub-sections.[b]

There is no doubt that the man who stands at the head of the tradition which in due course gave rise to Hellenistic proto-chemistry is Bolus of Mendes, a city in the Nile delta. Almost certainly he called himself Bolus the Democritean,[c] a circumstance which helped to confuse him with the later proto-chemical writer. Although not one of his books has survived, he was a prolific author,[d] producing works on agronomy (*Georgica*, γεωργικά), medicine (*Technē Iatrikē*, τέχνη ἰατρική), prodigies (*Thaumasia*, θαυμάσια), entertaining magic (*Paignia*, παίγνια), military science (*Tactica*, τακτικά), morality (*Hypomnēmata Ethica*, ὑπομνήματα ἠθικά), and even a book on the history of the Jews. More important for us were his treatises on sympathies and antipathies (*Physica Dynamera*, φυσικὰ δυναμερά, or *Peri Sympatheiōn kai Antipatheiōn*, περὶ συμπαθειῶν καὶ ἀντιπαθειῶν) and on artificial sympathetic remedies (*Cheirokmēta Dynamera*, χειρόκμητα δυναμερά); these we have already compared with the *Huai Nan Wan Pi Shu*[1] in China (pp. 311 ff.). Still more important is it that Bolus wrote something on dyeing and tinting (*Baphica*, βαφικά), that subject so vital for the first proto-chemists. It may even have been in four books, like those *biblous tessaras baphicas* (βίβλους τέσσαρας βαφικάς) which Synesius in the +4th century ascribed to Ps.-Democritus,[e] dealing respectively with gold and silver colourings, the tingeing of 'gems' and glasses, and textile dyeing, especially purple. Thus some trace of incipient proto-chemistry can certainly be ascribed to Bolus of Mendes—exactly how much we may well never know.

In the −1st century Bolus was regarded as an authority of equal rank to Aristotle and Theophrastus. He must be of the −2nd century, and probably of the first half of it, for his agronomic fragments have reached us through Cassius Dionysius (−88), the botanical ones through Krateuas (*c.* −100), the zoological ones through Juba of Mauritania (*c.* −50 to +50), and the philosophical ones through Poseidonius of Apamea (−135 to *c.* −51).[f] From the +1st century a great number of writers mention and quote him. This being established, could he have been the same person as the Ps.-Democritus who heads the series of writers in the Corpus? The question has been a controversial one, and we must be content with referring to a few of the arguments on either side which have been brought forward.[g] Those who plead for

[a] Oldest because he quotes no one (except Ostanes and Pammenes) and is quoted by everyone. He is always called pseudonymous because no question arises of identifying him with the pre-Socratic philosopher of the early −4th century.

[b] Pt. 2, p. 17, pt. 3, p. 48. [c] Festugière (1), p. 197.

[d] The abundant literature on the subject is discussed by Festugière (1), pp. 42ff., 187ff., 196ff. See also Partington (7), vol. 1, pt. 1, pp. 211ff.

[e] *Corp. Alchem. Gr.*, II, iii, 1. Ct. Bidez & Cumont (1), vol. 2, p. 311.

[f] The best attempt to fix his date as near as possible is that of Wellmann (3), who studied the *Georgica* minutely and collected its fragments. No one quotes Bolus earlier than Skymnos of Chios (*fl.* −185), and a recipe from the *Paignia* appears in a text of the physician Menander (*fl.* −197 to −159). The most probable conclusion is that Bolus of Mendes was a close contemporary of Aristophanes of Byzantium, a grammarian who was also interested in the sciences (d. −180), and that both of them worked in Alexandria.

[g] The state of the case has been well reviewed by Festugière (1), pp. 220ff., 230ff., 237ff. Those in favour of identity have included Diels (1), pp. 127ff.; von Lippmann (1), p. 329. Those against:

[1] 淮南萬畢術

the identity have to face the awkward fact that the name of Bolus never once appears in the writings of the Corpus; always the references are just to the name Democritus. Perhaps the true name of this first author of the group was lost because, like Bolus, he called himself 'the Democritean'. Next, from internal evidence his Corpus texts cannot be earlier than the +1st century. For example there is mention of a gold-like brassy alloy called *claudianon* (κλαυδιανόν), and this must be a reference to the emperor Claudius (r. +41 to +54).[a] So also the red dye from India called lac (*laccha*, λακχά) is referred to,[b] and this could hardly be before the first decades of the Christian era. Ps.-Democritus also complains to his colleagues (*symprophētai*, συμπροφῆται) about the young operators (*neoi*, νέοι) not wanting to follow the scriptures, but presumably to experiment on their own,[c] and these earlier writings might indeed have been those of Bolus or his time. Some of the axioms or epigrams which we shall consider a little more fully below occur in Ps-Democritus texts, e.g. 'One nature is charmed by another nature, one nature triumphs over another nature, one nature dominates over another nature';[d] and it has been argued that these crystallise exactly the doctrine of Bolus in his sympathies and antipathies of natural things,[e] but X the Democritean could have been his follower or reader, extending and applying his ideas to chemical phenomena. He certainly never mentions Bolus, ascribing his illumination rather to his master Ostanes the Mede. All in all, therefore, it seems best to place Ps.-Democritus firmly in or at the beginning of the +1st century,[f] just conceivably towards the very end of the −1st, and to conclude that his *Physica kai Mystica* (φυσικὰ

Wellmann (2) and Bidez & Cumont (1), vol. 1, p. 198, who all placed Ps.-Democritus in the +2nd century; also W. Kroll (1) and Hammer-Jensen (2), whose +5th-century date is much too late for him; Preisendanz (in Pauly–Wissowa, vol. 18, pt. 2, col. 1629); Partington (7), vol. 1, pt. 1, p. 214, and priv. comm. 1959. Festugière, *op. cit.*, gave most of the arguments (which we can only briefly summarise here) but inclined to believe that the Ps.-Democritus texts were due to Bolus, at any rate in an earlier form. Berthelot (1), p. 99, (2), p. 201, also hesitated, but he always put Bolus too late, in the −1st century.

[a] *Corp.* II, i, 7.

[b] *Corp.* II, i, 2. This is not absolutely decisive by itself, for as Filliozat (5) pointed out, pepper (albeit with a Persian form of the name) is mentioned in the Hippocratic Corpus ('On the Diseases of Women', Littré ed. vol. 8, p. 394). But it still has some weight. *A fortiori* the +3rd-century chemical-technological papyri show evidence of Indian connections; these have been particularly studied by Hammer-Jensen (1). In considering the numerous recipes for false gems in the Stockholm papyrus, it should be remembered that Pliny says (*Hist. Nat.* XXXVII, 79) that the art began in India, though this may well have been a confusion with the real gems of Ceylon. He also says (XXXVII, 197) that there were manuals for making such coloured glasses, bearing the specific names of authors. The *tabasios* (ταβάσιος) in the Stockholm papyrus is taken to be tabasheer, i.e. the silicic acid concretions in bamboos, which would certainly have come from India. The indigo recipes, the rice decoctions, and the use of several different kinds of milk, are all suspiciously Indian, as also the use of a basket in a steambath (like the ancient steamers so characteristic of China, cf. p. 27). All the material on pearls, Hammer-Jensen thought, is probably Indian, and Pliny certainly believed that they were the first to make artificial or imitation pearls (cf. Vol. 4, pt. 3, pp. 674ff.). Finally Flavius Vopiscus, writing about +300, says that Aurelian, Probus and Diocletian all sent dyers to India to learn how to make the false purple, in three or four expeditions, but they could never get the secret. Since the three reigns covered the period +270 to +305, he may well be worthy of belief.

[c] *Corp.* II, i, 14.

[d] *Corp.* II, i, 3. Cf. p. 360 below. When the axiom is quoted again by Synesius in II, iii, 1, it is attributed directly to Ostanes, whose principles Ps.-Democritus adopted.

[e] Festugière (1), p. 231.

[f] Leicester (1), p. 40, concurs, though placing Bolus of Mendes also in the +1st century, which is impossible.

καὶ μυστικά) the fragments of which we still have in the Corpus, was a text quite different from anything written by Bolus of Mendes.

This being once decided, and the *floruit* of Bolus at *c.* −175 being accepted, the rest of the Corpus falls reasonably into place.[a] The period down to +200 is filled by a number of names, none of which can be earlier than Ps.-Democritus but none much later—Comarius, Pseudo-Cleopatra,[b] Mary the Jewess, Pelagius, Pebechius, Petasius, Petosiris,[c] Pammenes, Panseris, etc.[d] To the following, +3rd century, belong probably a number of fragments bearing the names of Hermes, Agathodaemon,[e] Iamblichus[f] and Isis; those of Africanus certainly, for he was a perfectly historical character who died in +232 (cf. pt. 2, p. 16). This was also the time, it will be remembered, of the chemical-technological aurifictive papyri (pt. 2, p. 20 above), the connections of which with the Corpus we have already discussed. With Zosimus of Panopolis (a city up the Nile to the south) we are again on firmer ground, for this great codifier was certainly writing between +280 and +320; a historical position strangely close, as we shall see in a moment, to the first great codifier of alchemy in China. The next century brings Synesius,[g] whose writings must have been completed before +389; while a hundred years later there follows the Neo-Platonic chemist Olympiodorus, whose work must date from the close neighbourhood of +500. Late in the +6th century there is the Philosophus Christianus, whose personal name has been lost, and then in the +7th there was more intense activity. For it is to this time that another great proto-chemical writer is to be ascribed, Stephanus of Alexandria (*fl.* +620, under the emperor Heraclius),[h] as well as the Philosophus Anonymus,[i] the chemical poets Heliodorus, Theophrastes and others,[j] and in all probability whoever it was that wrote the 'Domestic Chemistry of Moses' (cf. p. 345).[k] By this time we are past +700.[l] Exactly a century later comes the historian Georgius Syncellus, an important witness, as we shall see (pp. 339, 341); then during and after the +9th century the tradition is in full

[a] Cf. Berthelot (1), pp. 98ff., 127ff.

[b] Berthelot (1), pp. 111, 173. In the view of Hammer-Jensen (2) the texts of these two are the earliest parts of the Corpus, but that has not been generally accepted.

[c] Berthelot (1), p. 168.

[d] 'Ostanes' (Berthelot (1), p. 163) would come in this group, but of him more later.

[e] This name fluctuates between a god or spirit, a mythical or sacred animal, and a mortal human writer; cf. pp. 344–5, 375.

[f] Not the same as the Neo-Platonic philosopher who lived under Constantine the Great (+306 to +337).

[g] Probably not the same as the famous bishop of Ptolemais (Festugière (1), p. 239; Berthelot (1), p. 188).

[h] Berthelot (2), p. 287.

[i] The apocryphal fragments attributed to John the Archpriest also belong probably to this time.

[j] Possibly in fact a single writer; Festugière (1), p. 239; Hammer-Jensen (2), pp. 30ff.

[k] This by no means exhausts the list of names, some of which are curious (cf. Berthelot (1), pp. 121, 125), but these must suffice. Moses reappears in Ben Jonson's *Alchemist* (+1610), where Mammon says (p. 373):

> Will you believe Antiquity? Records?
> I'll shew you a Book, where Moses, and his Sister,
> And Solomon have written of the Art;
> Aye, and a Treatise penn'd by Adam. *Surly:* How?
> *Mamm.:* O' the Philosophers Stone, and in High Dutch.

[l] This is the point at which, plus or minus half a century or so, the first collections of the Corpus writings were made.

decay, preserved only by commentators and quoters like Photius or the great lexicographer Suidas (*c.* +98). There were one or two minor and muddle-headed writers to follow, such as Michael Psellus (*c.* +1050) and Nicephoras Blemmydes, but by this time the Corpus had been collected into forms very like those which we still have, and in the +11th century the oldest of our extant MSS were written out.[a] Such was the course of the linguistically Greek tradition of proto-chemistry. It has to be taken as representative of the Europe of those ages, for there was nothing corresponding to it in the Latin West until the period of the practical chemical-metallurgical manuals.

Of these the oldest seems to have been the *Compositiones ad Tingenda Musiva*... (Preparations for Colouring Mosaics, etc.),[b] translated into Latin by some Lombard not earlier than +750, indeed nearer +780, from an Alexandrian Greek text of *c.* +600, the time of Stephanus of Alexandria. Then came the *Mappae Clavicula* (Little Key to Painting),[c] written in Latin in the early +9th century, perhaps about +820. A work attributed to one Heraclius may again have been Greek in its first recension; this was the *De Coloribus et Artibus Romanorum* (On the Colours and Arts of the Romaioi, i.e. the Byzantines), the first Latin version of which dates from about +1050, though its final form was not reached until the end of the +12th century.[d] Fourth comes the very Latin *De Diversis Artibus* (On Various Techniques) by a monk whose name in religion was Theophilus Presbyter, almost certainly Roger of Helmarshausen;[e] this work is not as early as was once thought, but belongs to the close neighbourhood of +1130. It is important to notice how the tradition taken up by the practical Latin West direct from the Hellenistic world was the technological one of the papyri (which might involve aurifiction but was not concerned with aurifaction) —not at all the mystical one of the Corpus. This latter found its way only indirectly to the Latin West after the beginning of the great era of translations from the Arabic, and that took place, as it happened, just during the lifetime of Roger of Helmarshausen. Only thereafter did the concentration on the practical problems of gilding, dyeing, and working glass and metals, yield to the wilder, more exciting, dreams of actually succeeding in making gold from something else, and of preparing, in connection with it, an elixir medicine of at least extreme longevity.[f] Looking back on the Hellenistic proto-chemical tradition it is very striking that the collapse of pagan Mediterranean culture did not harm it at all. Even the destruction of the Library and Museum at Alexandria in +389, the Serapeum, centre of science and learning in the ancient world, failed to do it much damage. Presumably this was because the concept of aurifaction presented vistas of utility to anybody who accepted it, whether pagan or Christian, while there could be no question about the usefulness of the practical chemical-

[a] They first saw print in the Latin translation of D. Pizzimenti (Padua and Cologne, 1572, 1573); cf. Ferguson (1), vol. 1, p. 205 on the reprint of +1717. This was doubtless how they became known to R. Bostocke, one of the first to attempt a history of medical chemistry, in his *Difference between the Auncient Physicke...and the Latter Physicke* (London, 1585). On this see Debus (12, 19), Pagel (13). Bostocke's book was also one of the first to defend Paracelsian theories in England, so the Alexandrians came in handy.

[b] Hedfors (1); Burnam (1); Johnson (2).

[c] Phillips (1); Johnson (1).

[d] Merrifield (1); Ilg (1).

[e] Ilg (1); Dodwell (1); Hawthorne & Smith (1).

[f] Cf. pt. 2, p. 30 above, and p. 493 below.

technological arts—and the fact that they continued on their way of slow development is shown by the first successful production of 'Greek fire' (low boiling-point petroleum fractions) by Callinicus at Byzantium in the middle of the +7th century, just after the time of Stephanus.[a]

Having thus passed in review the European line of evolution of proto-chemistry we can set beside it what took place in China.[b] At the head of the list stands the natural philosopher Tsou Yen,[1] not because of any detailed alchemical writings which have come down to us, but because of the evidence that among the techniques possessed by his school was one for 'prolonging life by a method of repeated transmutation'. The chemical thaumaturgists of the −2nd century certainly traced back their filiation to him and his disciples. Thus he challenges comparison with Bolus the Democritean, though the dates differ, for Tsou Yen undoubtedly lived within the period −350 to −270.[c] If, as is widely believed,[d] Bolus of Mendes and his *symprophētai* provided a chemical 'theory', in the form of Aristotelian philosophy, for the empirical practices of the temple and palace artisanate of Egypt, Syria and Greece; so also Tsou Yen may be thought to have supplied a Taoist theory of Yin–Yang and the Five Elements for the growing Chinese conviction that material immortality was attainable, and for the empirical operations of the palace and temple artisans whose works were recorded in the Khao Kung Chi[2] chapter of the *Chou Li*.[3] Only he was about a century and a half earlier than Bolus in his activity. The relevant parts of the 'Artificers' Record', which in a way correspond to the Hellenistic chemical-technological papyri, are also relatively much older than these, for instead of the +3rd century they may be traced to the early Han period (−2nd), if not indeed to the State of Chhi in the late−4th, when Tsou Yen was a young man.[e] From him the line runs straight to Li Shao-Chün, Shao Ong, and Wei Po-Yang, but first we must pause for a moment in the first springtime of empire, the dynasty of the Chhin.

The earnest, almost desperate, searches of the first emperor, Chhin Shih Huang Ti, for the herbs or substances of immortality, and the concoctions that could be made from them, is a matter of common knowledge. Since he was reigning (as universal monarch) from −221 to −209 he and his proto-alchemical advisers (if so we might call them) again preceded the time of Bolus. We need not here recall the names of all

[a] This is discussed in Sect. 30; meanwhile Partington (5) is to be consulted. Greek fire was in China by +850 or so (cf. p. 158).

[b] In the following paragraphs cross-references will be omitted, for the persons mentioned will be readily found at their appropriate places in the historical sub-section, or by means of the general index.

[c] A more precise *floruit* might be taken as −323 to −298 (Dubs (5), pp. 75, 83).

[d] See pt. 2, pp. 21, 26 above, evidence almost over-emphasised (with racialist undertones) in Festugière (1), pp. 218–19, 222–3, 237–8. For him, Bolus added Greek *theōria* (θεωρία) to 'oriental' *praxis* (πρᾶξις). Matters, we think, were not so simple.

[e] Another link with the −4th century arises in connection with Mo Ti[4] (*fl.* −480 to −380), the philosopher of universal love, pacifism and scientific logic. Berthelot remarks in one place, (1), p. 153, how strange it was to see a man like Democritus of Abdera, a naturalist philosopher, agnostic and free-thinker *par excellence*, transformed as Pseudo-Democritus into a magician and alchemist. But that happens everywhere—the *San Kuo Chih* bibliography lists a *Mo Tzu Tan Fa*[5] (Alchemical Preparations of Master Mo). And the *Mo Tzu* book got into the *Tao Tsang*. Probably belonging to the same period is the still extant list of minerals and alchemical substances in the *Chi Ni Tzu*[6] book (cf. pt. 3, p. 14).

[1] 鄒衍 [2] 考工記 [3] 周禮 [4] 墨翟 [5] 墨子丹法 [6] 計倪子

those in charge of the searches, but there were others in his time (i.e. the Chhin) who became known as elixir-makers,[a] such as Chiang Shu-Mao,[1] Liu Thai-Pin,[2] Thang Kung-Fang[3] and Li Pa-Pai.[4] Almost nothing is known of what they did but tradition associated cinnabar and other minerals with their names.

The time of Bolus of Mendes coincided with the first decades of the Han dynasty (from −206 onwards), and here already we have firm evidence of aurifaction from the wording of the anti-coining edict, a point to which we shall return in a moment. During the first half of the −2nd century elixir-makers abounded, e.g. Huang Hua,[5] Yin Hêng,[6] Liu Jung[7] and Li Hsiu,[8] some of whom were very chemical indeed judging from expressions such as *yün shuang tan*[9] (frosty sublimate elixir) which occur in connection with them. More irrefragable evidence historically is provided by the physician Shunyü I[10] (−216 to −147), whose case histories of −167 and −154 include firm proof of the excessive taking of metallic and mineral drugs and elixirs (pt. 3, pp. 46–7). Immediately after his death there occurred events which constitute nodal points in the development of Chinese alchemy. From the official history we know that the thaumaturgical alchemist Li Shao-Chün,[11] the first in any civilisation to associate artificial gold with immortality, was at the height of his influence in −133; and when his ascendancy at the court of Han Wu Ti came to an end, he was quickly succeeded by Shao Ong.[12] This man in turn fell from grace just about the time of the judicial suicide or disappearance of Liu An[13] (−122), that Prince of Huai-nan who had gathered about him a company of scholars and adepts, the writers doubtless of the compendium of natural philosophy known as the *Huai Nan Tzu*[14] book.[b] The names of all eight of his Pa Kung[15] have in fact come down to us, eight 'venerable experts' of a strongly alchemical flavour.[c] There are besides other alchemists, such as Wang Hsing[16] and Wang Than,[17] who may have to be placed in the reign of Han Wu Ti.[d]

The −1st century was also very important in Chinese alchemy and proto-chemistry. It saw the extraordinary government-supported programme of aurifaction in the imperial workshops (−61 to −56) under the leadership of Liu Hsiang;[18] as also the first accounts of 'projection' (i.e. the use of a small amount of a chemical substance to convert a large quantity of base metal into gold or silver)[e]—one in the story of Chhêng Wei[19] and his wife, the other in traditions about Mao Ying.[20] This last, with his younger brothers Mao Ku[21] and Mao Chung,[22] exerted an incalculable influence on Chinese alchemy by their posthumous patronage of the great school of Taoism

[a] I.e. to later generations, for in most cases contemporary evidence about them has not been preserved. Another adept of the same name lived in +7 (pt. 2, pp. 125–6).

[b] And also of the *Huai Nan Wan Pi Shu* just now referred to. As will be remembered from pp. 311 ff., there are close parallels between this and the 'sympathies and antipathies' of Bolus of Mendes and his successors.

[c] Cf. p.168. We also have the name of Liu An's other chief chemist, Wang Chung-Kao.[23]

[d] Cf. *TT*293, ch. 9, pp. 11*b* ff.

[e] We shall return to this in the adjacent sub-section.

[1] 姜叔茂 [2] 劉太賓 [3] 唐公房 [4] 李八百 [5] 皇化
[6] 陰恆 [7] 柳融 [8] 李修 [9] 雲霧丹 [10] 淳于意
[11] 李少君 [12] 少翁 [13] 劉安 [14] 淮南子 [15] 八公
[16] 王興 [17] 王探 [18] 劉向 [19] 程偉 [20] 茅盈
[21] 茅固 [22] 茅衷 [23] 王仲高

associated with the abbey on Mao Shan.[a] Among other elixir-makers were Su Lin[1] (*d.* −60) and Chou Chi-Thung,[2] while at the end of the century, during the Hsin interregnum, Su Lo[3] was prominent. These were the kind of men who corresponded in time with Anaxilaus of Larissa (*fl.* −40 to −28).[b]

This brings us to the probable date of Pseudo-Democritus himself, the +1st century, corresponding to the Later Han. Perhaps the *Kêng Hsin Ching*[4] (Book of the Realm of Kêng and Hsin, i.e. the noble metals),[c] though we do not have any of it now, should be put side by side with the *Physica kai Mystica*, and we know only the philosophical name of its author, Chiu Yuan Tzu,[5] but it would coincide closely in date.[d] From this time onwards commence those genealogical tables so characteristic of Chinese alchemy, tracing the descent of chemical secrets from master to disciple as the decades wore on. Thus Wang Wei-Hsüan[6] begat Han Chhung,[7] and Han Chhung begat Liu Khuan[8] (+121 to +186); often, as in this case, the dates of several can be estimated if those of one member of the series are known. The earliest may sometimes be of doubtful historicity, as in the sequence which leads from Ma Ming-Shêng[9] (*fl. c.* +100) to Yin Chhang-Shêng,[10] the putative master, or first commentator, of Wei Po-Yang.[11] With Wei we reach the oldest extant Chinese alchemical text, the *Chou I Tshan Thung Chhi*,[12] datable at +142, and already considered in detail by us;[e] this is entirely historical, and falls between the dates of Pseudo-Democritus and Zosimus.

Henceforward the clear chronological lead of the Chinese developments fades out, and the two traditions are fully under way, with striking coincidences of date between the greater representatives. Thus it is curious that Ko Hung,[13] author of the *Pao Phu Tzu*[14] book (+283 to +343), should have been so exact a contemporary of that other great systematiser, Zosimus of Panopolis. Similarly, Thao Hung-Ching[15] (+456 to +536) closely parallels in time Olympiodorus; while Sun Ssu-Mo[16] (+581 to +682)[f] was active just at the same time as Stephanus of Alexandria. After this the tradition continued uninterruptedly in China, declining much later than in the world of Greek culture, for while by +1000 little or nothing was left of the latter, the former was still in animated life (and not at all uncreatively so, because of the iatro-chemists) until the middle of the Chhing dynasty, about +1700. Admittedly also the Chinese tradition has preserved many more names of alchemists and records of their doings between the time of Ps.-Democritus and Stephanus than can be found in the West, and indeed the golden age of Chinese alchemy followed rather than preceded the time of

[a] Cf. pp. 213ff. [b] See Wellmann (2).

[c] Cf. pt. 3, p. 43. For *kêng* as gold and *hsin* as silver see the tabulation in *Tshan Thung Chhi*, ch. 34, p. 11*a*.

[d] Much can often be told about a movement from its opponents, so it is relevant to be reminded that much of the book of the great sceptic Wang Chhung,[17] the *Lun Hêng*,[18] finished in +83, is directed against the belief in material immortality, hence implicitly against alchemy, which indeed from time to time is mentioned in it (cf. Vol. 2, pp. 368ff., 376).

[e] Cf. pt. 3, pp. 50ff., and pp. 248ff. above [f] On his life-span see Sivin (1).

[1] 蘇林 [2] 周季通 [3] 蘇樂 [4] 庚辛經 [5] 九元子
[6] 王肆玄 [7] 韓崇 [8] 劉寬 [9] 馬鳴生 [10] 陰長生
[11] 魏伯陽 [12] 周易參同契 [13] 葛洪 [14] 抱樸子 [15] 陶弘景
[16] 孫思邈 [17] 王充 [18] 論衡

Stephanus. Strange is it too, that while our oldest extant MS. of the Hellenistic proto-chemical writings dates from *c.* + 1000, definitive collections of the *Tao Tsang* books were made in + 990 and + 1019, their printing being actually accomplished in + 1115.[a]

There remains the matter of the anti-coining edicts directed against aurifiction. Here again Chinese culture seems to have had a considerable lead, since one naturally tends to contrast the Diocletian proclamation of + 292 (or + 296)[b] with the Han edict of − 144, so important, as we have seen,[c] for the problem of the origins of the aurifactive idea. But there were certainly earlier attempts in Europe to put down falsification, notably the Cornelian Law passed at Rome in − 81, forbidding the making of deceitful alloys (*fingere*), the addition of superficial layers (*flare*) and the tincturing or production of superficial coloured films (*tingere*).[d] A particular study devoted to the earliest laws against metallic counterfeiting would be very useful,[e] but for the time being we seem to have a definite Chinese date older than anything in the West. This only bears out the general conclusion arising from the foregoing paragraphs, namely that in aurifiction and aurifaction both, China seems to have had a couple of hundred years' advantage over the Mediterranean region. This brings us face to face at last with the fascinating problem of possible ideological contacts and transmissions between China and Europe. What exactly these ideas could have been we must leave for the next sub-section, but first it will help to set the scene by recalling certain undoubted historical facts.

As will be remembered, the activities of the explorer Chang Chhien[1] in Greek Bactria and the neighbouring lands, with their effects, occurred broadly within the decades − 140 to − 110, and at the latter date approximately the first caravans of silk began their traffic over the Old Silk Road.[f] The other important Chinese traveller of those days was Kan Ying,[2] who reached the Persian Gulf in + 97,[g] but by that time there were many visits of Gandhāran, Parthian and Roman-Syrian envoys, often more or less traders, to China (− 120, − 30, + 87, + 101, + 120, + 134, + 166 and + 284). The particularly well documented An-Tun[3] embassy[h] to the Han court, bearing its ivories and tortoise-shell, took place in + 166. All these were possible channels of communication, and there certainly must have been a good many more the details of which have not come down to us. We even know the Chinese name of one of the leaders of these missions, Chhin Lun,[4] a Roman-Syrian merchant-envoy, who reached the Wu State (of the San Kuo period) in + 226.[i] When one considers how intense the traffic on the Old Silk Road was during the − 1st century and the first two centuries of our era, quite apart from the considerable use of the shipping

[a] For the full account, see pt. 3, pp. 113 ff.

[b] See further p. 340 below. [c] Pt. 3, pp. 26 ff. above. To say nothing of the earlier edict of − 175.

[d] *Corp. Jur. Civil.*, Digest, bk. 48, tit. 10, paras. 1, 8. Cf. von Lippmann (1), p. 286.

[e] There is already, for Rome, the interesting paper of Grierson (2).

[f] Vol. 1, pp. 173 ff. It is therefore strictly correct to say that Europe and its culture was discovered by China and not the reverse. Yet the Philistine view continues to dominate, as in the following example (1971): 'The Europeans roamed the world, as the Greeks had done already, and discovered India, China and the rest of the world; the inhabitants of those parts stayed at home and contemplated their navels' (Hutten, 1).

[g] Vol. 1, p. 196. Cf. Dubs (5), p. 81. [h] Marcus Aurelius Antoninus.

[i] On this see Vol. 1, p. 198; and on the whole subject pp. 191 ff., as also Hirth (1), pp. 35 ff.

[1] 張騫 [2] 甘英 [3] 安敦 [4] 秦論

lanes to and from Indo-China and South China round India and Malaya, it would almost be surprising if no ideas connected with the chemical art travelled along them.[a] Some of its products certainly did, for example the artificial gems so prominent in the Graeco-Egyptian papyri.[b] Very soon we must look into the question of ideological parallels, but first the intermediate realm of Iranian culture demands attention.

It is a disturbing fact that Pseudo-Democritus lauds as his greatest teacher and master no Greek, no Egyptian either, but Ostanes the Mede. Uštana was a perfectly good Elamite name,[c] that is to say, characteristic of the south-western part of Persia sometimes called Susiana, region of the cities of Susa and Persepolis. Media was one of the greatest and oldest of the Persian provinces, roughly that part of northern Persia west of modern Teheran and south-east of Armenia and the Caucasus; Ecbatana (mod. Hamadhān) was its traditional capital. The original form of the name Ostanes was resumed in Arabic and later Persian, Uṣtānis, and thus he appears in the quite undatable texts which have come down to us in Arabic as his.[d] Historical geography throws much light on this Bolus–Pseudo-Democritus–Ostanes link, for as any atlas of ancient history will explain, the empire of Alexander the Great at his death in −323 constituted a vast L-shaped area, the long arm being formed by Sogdia, Bactria, the Indus Valley, Parthia, Media, Armenia and Anatolia, while the shorter one comprised Palestine and the Nile Valley. Although this was soon divided between Seleucus, Antigonus and Ptolemy, the middle of the −2nd century saw a great intensity of trade and much flow of ideas along these axes, connecting Alexandria and Rhodes in the west with Antioch, Seleucia (near Babylon), Rayy (near Teheran), Khiva, Merv, Balkh, and (after −110) all points east. Ptolemaic Egypt became a Roman protectorate after −102, and part of the empire after −45, but trade and travellers still continued as before.[e] In short, the exchange of ideas along an east–west line of communication has to be reckoned with as a very real probability from about −300 onwards, and if this is once visualised, men such as Li Shao-Chün, Liu An and Liu Hsiang on the one hand may not have been so impenetrably sundered from people like Ps.-Democritus, Comarius and Pebechius on the other as has usually been supposed, even allowing for the obvious barriers of perhaps several intervening languages.[f] At any rate, it clears the decks for an objective examination of possible contacts. As for Ostanes, he was many things, certainly a legendary character but also probably one or more living men. For the best discussion of him you turn to Bidez & Cumont.[g]

[a] At the time of elaboration of the Hermetic and Gnostic literature, wrote Filliozat (5), we should expect to find many traces of exchanges between the East and the West. On the lines of communication across Central Asia the papers of Herrmann (2, 3, 5, 6) are still authoritative. As early as 1917 Holgen (1), p. 471, drew attention to the importance of the Old Silk Road for ancient contacts of chemical thought, and later on Huang Tzu-Chhing (2) re-affirmed this.

[b] The evidence is collected in Vol. 1, p. 200.

[c] It was the name of an eminent artisan in the period −509 to −494, as Dr I. Gershevitch has informed us, in discussions on this subject for which we render our best thanks.

[d] See Berthelot & Houdas (1), pp. 116ff., cf. Festugière (1), p. 391.

[e] On daily life in Hellenistic Egypt Cumont (4) should be read; he describes the arrival of Chinese silks, and the manufacture of *ersatz* gems for export (pp. 91, 96).

[f] Cf. Vol. 1, p. 150.

[g] (1) vol. 1, pp. viff., 167ff. See also Festugière (1), pp. 42ff. and of course the encyclopaedia article of Preisendanz (1).

The 'magi' whom the Greeks knew were not the real Mazdaeans of Persia who after the Zoroastrian reform worshipped only the god of good (Ahura-Mazda) and not the god of evil (Ahriman), but *magousaioi* (μαγουσαῖοι), priests of earlier Mazdaean colonies established in Achaemenid times (−6th cent. onwards) west of Iran from Mesopotamia to the Aegean, lasting down to the end of the −1st century and continuing still the ancient Persian tribal system of worshipping both gods.[a] Hence all kinds of theurgy and apotropaic magic, divination and astral lore, hence too connections with earlier Chaldaean science and pseudo-science which were taken over, just the sort of manual-operations medium in which mystical aurifaction could be expected to arise. The language of this 'Mazdaean Diaspora', as it has been called, became gradually Aramaic, so that the 'magi' of the Greeks could not read Avestan texts and probably had no Zend or Pehlevi sacred books, but they made up for this by acting as clearing-houses for the magical arts of all the peoples;[b] and if anyone deserved the name of *fang shih*[1] during the last three centuries of the −1st millennium it was they.

Our Ostanes was one of them. The first of the name was supposed to have accompanied Xerxes (*r.* −485 to −465) to Abdera and taught Democritus when young;[c] this may be considered legendary. A second was said to have accompanied Alexander the Great in all his travels and conquests.[d] Someone of the name was referred to as the 'Prince of Magi' by Pseudo-Damigeron (himself a mage), the writer of a verse lapidary *c.* −200. Pliny himself never saw any books attributed to Ostanes, but Bolus certainly did,[e] on magic, divination, pharmaceutical natural history and 'sympathies and antipathies'.[f] Philon of Byblos reports a work in eight volumes, *Oktateuchos* (ὀκτάτευχος), which must have been in existence by *c.* −250 at the latest. All in all, there is no reason why Pseudo-Democritus, whatever his real name and cultural background was, could not have had a Persian teacher with the name (true or adopted) of Ostanes; and this conclusion opens gates throughout the length of Asia. Though we shall probably never know much more about him, his name does strikingly symbolise that continuity of east–west intercourse, and that general powerful Persian influence on Mediterranean culture from at least the −4th century onwards and especially after the end of the −2nd.[g] It certainly had some strange effects in the Graeco-Egyptian milieu, for example, as Bidez & Cumont wrote:[h] 'Thus Democritus, the pure representative of Greek philosophy, became, by a characteristic fiction, at one and the

[a] Cf. Benveniste (3). Some regarded infinite time (Zervan-Akarana) as the greatest god, whence the other two proceeded.

[b] Apocrypha attributed to Zoroaster circulated in Greek after −270, for example a book on natural phenomena entitled *Peri Physeōs* (περὶ φύσεως), and there is evidence that this was used by Bolus of Mendes. See Bidez & Cumont (1), pp. 107ff., 111. It seems to have contained a lot of botany, evoked by the complex rules for liturgical rites and ceremonies.

[c] Cf. Pliny, *Hist. Nat.* XXX, ii, 8, spelling Osthanes. Cf. Bidez & Cumont (1), vol. 2, p. 267.

[d] Pliny, *loc. cit.* 11.

[e] Pliny, *Hist. Nat.*, XXIV, cii, 160, calls him *Magorum studiosissimus*. Cf. Festugière (1), p. 198.

[f] Ostanes books of various kinds are often quoted by later writers such as Tatianus, Pamphilus of Alexandria, Dioscorides, Pseudo-Apuleius, etc. For the details see Bidez & Cumont (1), vol. 2, pp. 293, 299ff.

[g] The point has been well put by Ganzenmüller (2), p. 32.

[h] (1), vol. 1, p. 204.

[1] 方士

same time the prophet of Chaldaeo-Iranian wisdom and the true chief and inspirer of the priestly colleges of Egypt.'

After all that has been said earlier in this volume we need hardly rehearse the parts played by Ostanes and Ps.-Democritus in the Corpus. The basic filiation of Ps.-Democritus centres round the vision in the temple (Ostanes, son of Ostanes, being one of the characters), when the spirit of the master is invoked[a] and a secret door in a column spontaneously opens, disclosing writings containing some of the basic proto-chemical aphorisms.[b] This scenario was the model for many later descriptions of the same kind; there is a Syriac version in a 'Letter of Pebechius to Osron'.[c] The apparatus of underground repositories of secret chemical data, with seven gates each one of a different metal etc., was much appreciated by the later Arabs, and a version in that language can be read in a 'Book of Uṣtānis' preserved in a *Kitāb al-Fuṣūl*.[d] Hence the myths of the *Tabula Smaragdina* in later times, and the *Tabula Chemica*.[e] In the Arabic story there are three such stele inscriptions, one in Egyptian, one in Persian, and one in 'Indian', thus emphasising again, though at a relatively late date, the continuity of Old World culture.

The only attributed writing of Ostanes in the Corpus is the 'Letter of Ostanes to Petasius' on the calcium polysulphides.[f] But in one of the Zosimus texts certain aphorisms or gnomic sayings are ascribed to him,[g] and in the 'Letter of Ps.-Democritus to Ps.-Leucippus' emphasis again is laid on Persian knowledge transmitted to the ancestral kings of Egypt, then confided to Phoenicians (or Mages).[h] As for Petasius, a work called 'Memoirs of Democritus' (*Dēmocriteia Hypomnēmata*, Δημοκρίτεια ὑπομνήματα) is attributed to him,[i] and in another place he is called King of Armenia,[j] a country after all eastern, and adjacent to Media. Lastly, we have already referred to that difference between Persian and Egyptian metallurgical techniques which appears to arise from the Corpus,[k] namely that the former specialised in surface films and layers while the latter worked mainly with uniform substrate alloys, and we gave reasons for thinking that there was not much reality behind it.[l] After discussing this matter, Bidez & Cumont went on to say:[m] 'Although the idea that alchemy was born in Egypt continues to spread everywhere and gain acceptance, in spite of the hesitations of specialists, what remains of our apocrypha [Ps.-Democritus in particular] serves only to show that however current this opinion, born in the shadow of the pyramids, may be, it owes its prestige to nothing more than a prejudice.'

[a] It is explained that the master had died by poison, either purposely or accidentally. Could we dare to understand this as the consumption of a dangerous elixir, in the Chinese style? That would indeed be an 'hypothèse hardie mais attirante', counter-indicated only by the lack of macrobiotics in Alexandrian proto-chemistry.

[b] *Corp. Alchem. Gr.*, II, i, 3.

[c] Tr. Berthelot & Duval (1), pp. 309ff. It will date any time between the +2nd and the +6th centuries.

[d] Tr. Berthelot & Houdas (1), pp. 116ff., cf. Berthelot (2), p. 216.

[e] Cf. pp. 373, 401 below.

[f] *Corp. Alchem. Gr.*, IV, ii, cf. Bidez & Cumont (1), vol. I, p. 208.

[g] *Corp.* III, vi, 5. Cf. also II, iii, 1, 2.

[h] *Corp.* II, ii, 1.

[i] *Corp.* V, vii, 16.

[j] In the alternative title of *Corp.* II, iv.

[k] *Corp.* II, ii, 1 and more explicitly in the 'Letter of Synesius to Dioscorus', *Corp.* II, iii, 2.

[l] Pt. 2, pp. 253–4 above.

[m] (1), vol I, p. 205.

At all events, we must be prepared to keep an open mind about possible exchanges of ideas in these early times between East and West.

In order to give a little more life to this picture of cultural continuity, and perhaps to take off any impression that the borrowings were only westwards, we may look at a few instances of things that the Chinese heard about the West. First, it is a well-known fact that Indian medical ideas began entering China towards the end of the Han or soon afterwards, accompanying of course Buddhism, and in this flow there came some constituents from further West. In view of the obvious dominance of Five-Element theory in China, the existence of 'four primes' (*ssu ta*[1])[a] in some medical writings, including those of Thao Hung-Ching in the late +5th century, struck a foreign note, as was observed already by Hsü Ta-Chhun[2] in his history of medicine, *I Hsüeh Yuan Liu Lun*,[3] written in +1757.[b] Among the translations of early Buddhist medical texts into Chinese, Sen (1) has studied and englished the *Fo Shuo Fo I Wang Ching*,[4] a *sūtra*[c] which entered the *Ta Tsang* through the hands of Chih-Chhien[5][d] and an Indian collaborator in +230. This explains all the 404 diseases as caused by imbalances of the elements Earth, Water, Fire and Wind. Thus the Empedoclean and Aristotelian elements had entered Chinese thought by the San Kuo period, and if they played thereafter only a very small role relative to the indigenous theories of natural philosophy it was at any rate a striking example of cultural contact.

Still more interesting for our present theme is the information about Alexandrian aurifaction which was preserved in one of the commentaries on the *Shih Chi* (−90). There, in the chapter on Western countries,[e] Ssuma Chhien tells us about An-Hsi[6] (Parthia), saying, among other things, that the people use silver money with the face of the king stamped on it, this being changed when a new king succeeds to the throne.[f] West of the country lies Thiao-Chih[7] (Mesopotamia), and north of it Yen-Tshai[8][g] and Li-Hsien[9].[h] The commentator,[i] taking the last at least of these places to be more or less the same as Ta-Chhin[10] (Roman Syria, Palestine and even Egypt),[j] proceeds to quote the well-known passage in the *Hou Han Shu* on the gold and silver

[a] I.e. four primary or elementary constituents (*ssu ta yuan su*[11]), Skr. *catvarī-mahābhūtanī*. Further details are given in Jen Ying-Chhiu (1), pp. 42ff.

[b] According to our colleague Nathan Sivin (priv. comm.).

[c] N1327, TW793.

[d] It may not be irrelevant to note that his ethnikon shows him to have been of 'Scythian', i.e. Indo-European 'Tocharian' stock, a descendant of the Yüeh-chih who overran Greek Bactria about −130 and then went on to found the Śaka kingdom in India. Cf. Vol. 1, p. 173.

[e] Ch. 123, p. 5*b* (p. 53), tr. Watson (1), vol. 2, p. 268.

[f] He also says that they write horizontally on strips of leather (parchment?) for their books and records.

[g] We would conjecture for this Chorasmia (Khwarizm), and its city of Khiva.

[h] Watson takes this to be Hyrcania, i.e. the parts of Persia just south of the Caspian Sea, the modern province of Mazendaran with the Elburz mountains, just north of mod. Teheran. But Hirth (1) believed that Li-Hsien (with variant orthography, Li-Kan,[12] Li-Chien[13]) was an older name for the whole of Ta-Chhin, perhaps derived from Rekem (= Petra), an *entrepôt* on the trade routes (pp. 169ff., 180). The commentator must have thought so too, or he would not have attached so much material about Ta-Chhin to the passage. Cf. Vol. 1, p. 174, where the equation with Alexandria is discussed.

[i] Chang Shou-Chieh,[14] writing in +737.

[j] See Hirth (1), p. 180.

[1] 四大 [2] 徐大椿 [3] 醫學源流論 [4] 佛說佛醫王經 [5] 支謙
[6] 安息 [7] 條枝 [8] 奄蔡 [9] 黎軒 [10] 大秦
[11] 四大元素 [12] 黎軒 [13] 黎靬 [14] 張守節

deposits, asbestos, coral and amber of that region,[a] but then goes on to cite some sentences from the *Wu Shih Wai Kuo Chuan*[1] (Records of Foreign Countries),[b] a lost book by the traveller and ambassador of Wu State, Khang Thai,[2] written about +260. He again says that the people of those parts use gold and silver money, and have jewels of rock-crystal in five colours,[c] adding, however, that there are many clever craftsmen among them, who can transmute silver into gold.[d] It is quite an unexpected thing that such a rumour of Hellenistic aurifaction and aurifiction should have found its way into Chinese literature in the +3rd century.

One more example. In +1347 Chu Tê-Jun,[3] a distinguished literary scholar interested in scientific subjects, was sitting talking with two friends not racially Chinese (as was so common under the Yuan dynasty), the officials Yo-Hu-Nan[4] and San-Chu-Thai.[5] The former, Johanan, was probably a Christian Uighur,[e] the latter, Saljidai, a Mongolian. During their service in the imperial guard between +1314 and +1320 they had had discourse with an embassy from the West, and they retailed to Chu an alchemical fable which they had heard from the members of this embassy. Their land, they said, had a lake of mercury (*shui yin hai*[6]), from which the metal was collected in the following way. Men and horses covered with gold leaf ride along its shores, whereupon a great wave of mercury arises and pursues them, but they successfully flee away and the metal falls into pools made ready beforehand, whence the local people collect it in due course. What is more, they heat it with certain aromatic herbs so that it all turns to silver. Such was the story which Chu later recorded in his *Tshun Fu Chai Wên Chi*[7] two years later.[f] The implicit reference to Au–Hg amalgamation needs no emphasis, but the origin of the embassy is slightly puzzling. The country mentioned, Fo-Lin,[8] sounds like a variant of the standard name for Byzantium,[g] but Fuchs (7), who has gone into the matter, brings evidence that the envoys came really from Moorish Granada, and that the mercury story emanated from the famous mines of Almadén located between Toledo and Cordoba.[h]

This was only one of a series of fables with the same motif cropping up in many Old World languages. Another is found, whether concerned with tin or mercury is not quite clear, in the Syriac versions of Zosimus or Ps.-Zosimus, but in this case the glittering metal is induced to come out of its pool by a beautiful naked girl who walks past it, then runs quickly away, while young men attack it with hatchets and cut it up

[a] In ch. 118, tr. Hirth (1), p. 41.

[b] We have several times had occasion to refer to this, Vol. 3, pp. 511–12, 610, 658, Vol. 4, pt. 3, pp. 449–50, 472. For further details see Fêng Chhêng-Chün (1), pp. 11ff.

[c] Interesting in connection with the false gems and coloured glasses of the papyri.

[d] *Jen min to chhiao nêng hua yin wei chin.*[9]

[e] Possibly one of the family recorded in *Yuan Shih*, ch. 134 (tr. Saeki (2), pp. 489 ff.).

[f] Ch. 5, pp. 11*b*, 12*a*, tr. Fuchs (7). Through various intermediaries it got into *PTKM*, ch. 9, (p. 56) and appears twice in *TSCC* (*Khun yü tien*, ch. 22, *hung pu hui khao*, p. 1*a* and *Pien i tien*, ch. 60, *Ta-Chhin pu chi shih*). Also in *STTH*, whence *Wakan Sanzai Zue* (de Mély (1), tr., p. 73, text, pp. 70–1) and the remarks on it in de Mély (6), p. 333.

[g] Vol. 1, p. 186.

[h] That the embassy of +1317 or thereabouts was from Muslim Spain is argued partly on the ground of the very long time they took on their journey. Also they brought with them Islamic prayer-carpets, woollen cloth, brocades, etc.

[1] 吳時外國傳 [2] 康泰 [3] 朱德潤 [4] 岳忽難 [5] 散竺台
[6] 水銀海 [7] 存復齋文集 [8] 佛郎 [9] 人民多巧能化銀爲金

Fig. 1524. A representation of the 'gold-digging ants' of Asia, from the +1481 Augsburg edition of Mandeville's 'Travels' (Pollard ed., p. 209).

into bars.[a] A third, the most famous, is the story of the gold-digging ants (Fig. 1524), launched originally by Herodotus with reference to some Central Asian region north of India.[b] The gold particles are in the sand which they dig up to form their burrows, then when they are sheltering down below from the noontide heat, men rush to the spot with camels, fill up bags that they have with them, and make their escape even though the ants, which can run extremely fast, pursue them. Since Herodotus' time (−440) this has generated quite a literature.[c] Everybody talked about it—Strabo (−25),[d] Pliny (+75),[e] and of course Solinus (+3rd cent.);[f] and it is in the Corpus, mentioned by Olympiodorus (*c.* +500).[g] Thus it comes through to Vincent of Beauvais[h] and Sir John Mandeville.[i] Tibetan and Mongol versions have been published (Laufer, 41) and those of living Ladakhi folklore (Francke, 1), but so far no

[a] Berthelot & Duval (1), p. 245. The text would be of the +4th to +6th centuries. Amalgamation is involved again, for the mercury comes apparently from tin. The parallel was noticed long ago by de Mély (6), pp. 332ff., who added a note of a place-name in Syria, Bir al-Zeibaq, Quicksilver-Well.

[b] III, 102–105. In Vol. 1, p. 177, we mentioned Megasthenes' account, *c.* −300.

[c] Like the Golden Fleece of Jason and the Argonauts itself. This legend is supposedly of the −13th century (cf. J. R. Bacon, 1) but an invention of the −7th may account for it (Vol. 4, pt. 3, p. 608). Strabo already (XI, ii, 19) explained the fleece reasonably enough as referring to the placer gold of Colchian streams caught in fur or blankets. Agricola (ch. 8, Hoover & Hoover ed., p. 330) agreed. By the time of Suidas (+1000) the fleece had become a parchment (vellum) book of *chēmeia* which taught how gold could be made (*Lexicon*, vol. 1, p. 525). On both legends see Adams (1), pp. 483ff. For a Chinese reference to the placer technique see *PTKM*, ch. 8, (p. 3), quoting Chhen Tshang-Chhi (+725) on 'bran' gold washed out on felt (tr. Schafer (13), p. 251). Cf. pp. 60, 81.

[d] XV, i, 57.

[e] *Hist. Nat.*, XI, XXXVI, 111.

[f] Cf. Vol. 3, pp. 505ff.

[g] *Corp. Alchem. Gr.* II, iv, 43.

[h] *Speculum Naturale*, XX, ch. 134.

[i] 'Travels', ch. 33 Pollard ed., p. 198. On the whole legend cf. also Druce (1); Marshall (1), p. 14; Bevan (1), pp. 396, 404.

close Chinese equivalent has been found. In +1799 von Veltheim suggested as the basis of the tale the miners of the Altai or the Gobi and the burrows of the Tartary fox; Schiern (1) a century later thought the miners were Tibetan. Boni (3) scented an allegory of the levigation process for separating alluvial gold.[a] The term 'ant-gold' (*pipīlika*) occurs in the *Mahābhārata* (*c.* +1st century),[b] perhaps referring to the size of the alluvial grains, and some think that this was the origin of the story (Rickard, 3). Laufer, however, suggested a confusion between the name of a Mongolian clan, the Shiraighol, and the Mongol word for ant, *shirghol*. The last word has certainly not been said on the subject, but in the meantime it would hardly be possible to find a better example of the East–West cultural continuity in ancient times than these strange mining stories of the men pursued and the thing pursuing.

(ii) *The first occurrence of the term 'Chemistry'*

On this subject a great deal has been written during the last century or two, and any assured conclusion takes some digging out, but if one drives one's adit fair and true it is possible to reach the facts of the matter. The work is inescapable because of the delicate question of conceivable East Asian influence upon the Alexandrian proto-chemists. From the following pages it will emerge that the word 'chemistry', in the form of '*chymeia*', '*chēmeia*' or even '*chimeia*' (χυμεία, χημεία, χιμεία), with its enigmatic root, does not appear in the Mediterranean region before about +300. Anyone impatient of Western classical detail would be well advised to proceed directly to the next item on the agenda, but those who are willing to follow the argument closely may find some very peculiar things on the way.

The first outstanding fact is that the word is never found in the early parts of the Greek 'alchemical' Corpus, e.g. in the writings ascribable to Pseudo-Democritus, nor does it ever appear in the papyri dealing with chemical technology (cf. pt. 2, pp. 15ff. above, on aurifaction and aurifiction). Next there are certain early references which have been claimed but must be discarded. For example, Julius Africanus wrote a book of thaumaturgical technology called *Kestoi*[c] about +230, and this was described as dealing with the 'powers of chemical preparations' (*chymeutikōn periechousan dynameis*, χυμευτικῶν περιέχουσαν δυνάμεις).[d] But that was only what was said about it in later times, by George Syncellus in his *Chronographia* (*c.* +800),[e] and even if he got the phrase, as he seems to have done, from the Egyptian monk Panodorus, that will not take it earlier than about +40c—certainly not to the date of the original writer.

[a] Because Herodotus says that the male camels tire and fall victims to the ants, while the female ones, determined to regain their foals, bear the Indians and the gold swiftly to safety.

[b] II, 1860.

[c] The title was taken from the magic girdle of Aphrodite. The extant fragments are available in the edition of Thevenot (+1693). The book is important for its description of early military incendiary preparations (cf. Partington (5), pp. 7–8). The later chapters are additions made between about +550 and +800.

[d] As Hoffmann (1), p. 521, pointed out. This was an altogether remarkable study, as Hoffmann was working in the pre-Berthelot period, and went to the original MSS of the Corpus. Ruska much admired it, (11), p. 325.

[e] Goar ed., p. 359, Dindorf ed., vol. 1, p. 676.

A similar, if grosser, instance occurs in the astrological handbook of Julius Firmicus Maternus, written by +336, where the printed editions have *scientiam chimiae* as the gift of those born under the influence of the moon in the house of Saturn.[a] But it is now known that the extensive passage containing these words was inserted whole by Johannes Angelus in +1488, just in time for the first printings.[b]

Possibly admissible, however, is the traditional account of the proscription of aurifictors in +296 (or +292) by the emperor Diocletian, a measure taken, supposedly, lest the Egyptians should raise funds in this way and start a rebellion against the Roman rule.[c] The classical citation of this occurs in the *Lexicon* of Suidas (*c.* +976),[d] where we read that 'the order was given to burn all the books written in olden times on the chēmy (or chymy) of gold and silver (*ta peri chēmeias chrysou kai argyrou tois palaiois gegrammena biblia*, τὰ περὶ χημείας χρυσοῦ καὶ ἀργύρου τοῖς παλαιοῖς γεγραμμένα βιβλία).' The sources for this, of course, go further back, though not as far as we should like, for a similar text appears in the 'Acts of St Procopius' (early +8th cent.)[e] and earlier in the writings of John of Antioch (*fl.* +610),[f] who may possibly have copied from Panodorus, though this is uncertain. Nevertheless one may be inclined to accept the transmitted text of the edict as valid for the Diocletian date,[g] partly because of the parallel occurrence of words ancestral to 'chemistry' in fragments attributable to Zosimus (cf. pp. 327, 365) who was writing between +280 and +320.

These lead us into very strange country. The essential passage occurs in one of the letters of Zosimus to his sister (or *soror mystica*) Theosebeia, and runs as follows:

> The holy scriptures set forth in books record, O Woman, that there was a race of daemons which coupled with the daughters of men. Hermes also says this in his *Physica*,[h] and nearly every exoteric and esoteric text reports the same. Now the ancient and divine writings say that certain angels fell in love with human women, came down (from heaven) and taught them all the operations and works of Nature, on account of which, we are told, [great offence was taken],[i] and they were excluded for ever from the celestial realms; because they had taught to mankind all things evil, and unprofitable for the soul. [From the commerce of these angels and these women, the writings also say, a race of giants was born.][j] And the first account of all these arts and techniques was that of Chēmēs (Χήμης), which is why it is called the 'Book of Chēmēs (or Chyma, Χύμα)', and why the art is called Chēmeia (χημεία, or Chymeia, χυμεία). [This book is composed of 24 sections, each having its proper name or a designatory letter. They are explained by the voices of priests. One is called Imos, another

[a] *Astron.* III, 5, ix.

[b] Diels (1), pp. 121–2; cf. von Lippmann (1), p. 288. Berthelot (1), p. 74, Schorlemmer (1) and Hoffmann (1), p. 522 still accepted this reference as ancient, though the usual printing was 'alchemiae'.

[c] As noted elsewhere, this date is to be compared with that of the Chinese edict against aurifiction, −144.

[d] Vol. 3, p. 669. Suidas' definition is: 'Chēmeia is the fabrication of silver and gold' (*chēmeia hē tou argyrou kai chrysou kataskeuē*, χημεία ἡ τοῦ ἀργύρου καὶ χρυσοῦ κατασκευή).

[e] *Acta Sanctorum* (Bollandists), Julii, II, 557 A. This uses the second form of the word in the text as given above.

[f] In Valesius (1), pp. 834–5, where silver precedes gold in the text, and the spelling is *chēmias*.

[g] Von Lippmann (1), pp. 288ff. accepted this.

[h] Otherwise unidentifiable, and certainly more than semi-legendary. Festugière, it is true, suggests that our present 'Epistle of Isis to Horus' (*Corp.* I, xiii) was part of it. Cf. pp. 326–7.

[i] Not in the Syriac version.

[j] Also not in the Syriac.

Imuth,[a] another 'Face', as we might translate it. One section is called 'Key', another 'Seal', a third 'Manual', a fourth 'Epoch'; each has its own name. One finds in this book the arts and techniques explained in thousands of words. Those who followed wrote as much by way of commentary, but nothing good. They not only spoilt the books of Chēmeia, they made a mystery of them...].[b]

Hence Zosimus' present book, addressed to Theosebeia. For it was a book, almost certainly entitled *Cheirokmēta* (χειρόκμητα) or 'Manipulations',[c] though very little of this is left now, and nothing, needless to say, of the 'Book of Chēmēs' itself. The Greek version of the passage is preserved only in the *Chronographia* of George Syncellus (*c.* +800),[d] and the Syriac version only in MSS of much later date,[e] but there is no compelling reason for placing either of them later than the +6th century,[f] and it is not unreasonable to believe that they come from the pen of Zosimus himself.[g]

Can we trace the 'Book of Chēmēs' any further? The obvious background to Zosimus' account of the fall of the angels is the passage in the Book of Genesis (6, 1–12) which relates how the sons of God saw that the daughters of men were fair and came down to woo them; thus the mighty men of old were born and much evil ensued, so that God repented him of his creation and sent the Flood tod estroy it, only Noah with his family escaping. We are here in the presence of a corpus of legend which filtered down from Jewish sources to Essenes, Gnostics and Christians suggesting to religious minds that all the sciences and techniques were really diabolical in nature, and perhaps especially chemistry, the sources indeed of all evil, this traceable not so much to the 'sin of Adam' as to the disobedience of the 'Promethean' angels.[h] And so we are led back to the apocryphal 'Book of Enoch', one of the most interesting of the Jewish writings rejected from the canon, datable in its relevant parts at about −165, and preserved for us only in a number of Ethiopic versions. What it says is this:[i]

VI. 1 And it came to pass when the children of men had multiplied that in those days were born unto them beautiful and comely daughters.

2 And the angels, the children of heaven, saw and became enamoured of them, and said to one another: 'Come, let us choose wives from among the race of men, and beget us children.'

[a] = Imhotep, say Berthelot & Duval (1), p. xxx.

[b] The part in square brackets here is only in the Syriac version.

[c] Cf. Sherwood Taylor (8). It is said to have had 28 sections, and the passage comes in sect. VIII on tin. Why twenty-eight? Surely, Filliozat (5) suggested, because of the 28 lunar mansions (Chinese *hsiu*, Indian *nakshatra*) along the equatorial band (cf. Vol. 3, pp. 242ff., 252ff.). Here would be another remarkable instance of idea-sharing among the ancient civilisations.

[d] Goar ed., p. 13, Dindorf ed., vol. 1, p. 24. A world history from Adam onwards.

[e] Tr. Berthelot & Duval (1), p. 238. Cf. Berthelot (1), p. 9. Part of what we now have must certainly be considered Pseudo-Zosimus, for 'elixir' is mentioned on p. 258, but that does not invalidate the whole.

[f] Von Lippmann (1), p. 294 agrees.

[g] The passage was used in one of the first histories of chemistry, the *De Ortu et Progressu Chemiae* by Olaf Borrichius, printed at Copenhagen in +1668.

[h] A Chinese parallel might be found in the story of the old man in *Chuang Tzu* who would not use a swape because he felt that all ingenuity leads to evil-doing (Vol. 2, p. 124). But this anti-technology complex was never dominant in China. Of course, the problem is still with us. Cf. pp. 125–6.

[i] Tr. Charles (1), pp. 13ff., mod. auct. adjuv. Beer (1), in Kautzsch, vol. 2, pp. 238ff.; Migne (1). vol. 1, pp. 395ff. This text, written partly in Hebrew, mostly in Aramaic, but extant as a whole only in Ethiopic (Amharic), is known as 1 Enoch. The Slavonic version, which we shall mention presently, is

3 And Semjāzā, who was their leader, said unto them: 'I fear that you will not in fact perform this deed, so that I alone shall have to pay the penalty of great sin.'
4 But they answered him one and all, saying: 'We shall swear an oath, and bind ourselves by mutual imprecations not to abandon this plan but to carry it through.'
5 Then sware they all together, and bound themselves upon it.
6 And they were in all 200, who descended in the days of Jared on the summit of Mt. Hermon, and by this name it was named because they swore and bound themselves by mutual imprecations upon it.
7 And these were the names of their leaders, Semjāzā their commander, Arakiba, Aramael, Kokabael, Tamael, Araqael, Danael, Ezekael, Baraqael, Azazael, Armaros, Batarael, Ananael, Zaqael, Shamshael, Satarael, Turael, Jomjael and Sarael.
8 These were their decarchs.

VII. 1 And all the others together with them took unto themselves wives, each choosing for himself one, and they began to go in unto them and unite themselves with them, and they taught them spells and enchantments, and the lore of plants (lit. the cutting of roots),[a] and showed then the (healing properties of) herbs.

VIII. 1 And Azazael taught men to fabricate swords and knives, shields and breastplates, making known to them the metals (of the earth) and the arts of working them. He also showed how bracelets and all kinds of ornaments could be made, teaching the use of cosmetic black, and the painting of the eyes, and the knowledge of all precious stones and of all colouring tinctures.
3 Semjāzā taught enchantments and the knowledge of plant drugs (lit. the cutting of roots),[a] Armaros taught exorcism and the breaking of spells, Baraqael and Kokabael taught astronomy and astrology, Ezeqael prognostication by the clouds, Araqael prognostication by the signs of the earth, Shamshael by the sun and Sarael by the moon.[b]
2 And there arose much godlessness, and fornication, and men were led astray, and became corrupt in all their dealings.

VII. 2 And the women became pregnant, and bore great giants, whose stature was three thousand ells,
3 And who consumed all the acquisitions of men. And when men could no longer sustain them,
4 The giants turned against the men and women and devoured them.
5 So men began to sin against the birds and beasts, the reptiles and the fishes, and to feed upon one another's flesh, and to drink the blood.[c]

VIII. 4 And as men perished, they cried out, and their cry went up to heaven...

VII. 6 Then the earth laid accusation against the lawless ones.

actually a quite different text, though parallel in many ways; it is called 2 Enoch. The latest parts of the former date from about −65. In the translation we give here the order of the verses has been somewhat rearranged so as to present a more continuous story. The Aramaic and Hebrew fragments from the Qumran scrolls (*c.* −200 to *c.* +70) have been edited and translated by Milik (1). Cf. Eissfeldt (1), pp. 617ff., 622–3.

[a] The 'root-cutters' (*rhizotomoi*, ῥιζοτόμοι) was the classical Greek term for the early herbalists and pharmaceutical proto-botanists.

[b] In a later and different version (*c.* −75), reported in ch. LXIX, the fallen angels are regarded as a set of Shaitans, their names are given again, and we learn that Gadrael demonstrated weapons and Kasdeja poisons, while Penemue instructed mankind in writing with ink on paper, 'which had not been intended by the Creator'.

[c] For the Jews this was a particularly horrible thing.

The general result of all this was that Michael, Uriel, Raphael and Gabriel brought the case before the Most High, significantly saying (IX. 6) that Azazael 'hath taught all unrighteousness on earth and hath revealed the eternal secrets preserved in heaven, which men were striving to learn...' Orders were accordingly issued for the arrest and eternal imprisonment of Semjāzā, Azazael and the others. Here is where the prophet Enoch comes in. He is sent to read the sentence to the fallen angels (or 'Watchers', as the text now calls them), and is asked by them to intercede for them in heaven; this he does, but unsuccessfully, and once again has to declare the irrevocable condemnation. Part of the address to the angels says (XVI. 3): 'You were in heaven, but all the mysteries had not yet been revealed to you, only worthless ones you knew, and now these in the hardness of your hearts you have made known to the women; and through these mysteries women and men work much evil upon the earth.'[a]

The whole legend is of extraordinary interest, combining, as it does, a terrifying parable of the evils which the uncontrolled use of science and technology can bring upon mankind, with the age-old fear of sex and sexual relations unauthorised by religion, i.e. by the social organisation and knowledge of the period.[b] Are not the societies for social responsibility of scientists still in the field against the giants today? But for our present purpose the value of the 'Book of Enoch' is a negative one, for the Hamlet of the piece is missing—Chymēs or Chēmēs is not one of the angels, nor is anything known in this apocryphal literature of him and his book on their teachings; there is no trace of him therefore in the −2nd and −1st centuries; we have to look later.[c] It can be said at once that outside the Greek 'alchemical' Corpus no mentions

[a] The Slavonic 'Book of Enoch' (2 Enoch), preserved only in Russian and Srb (see Vaillant (1); Morfill & Charles), is quite a different text from the Ethiopic, though in some places paralleling it closely. It was originally written mainly in Greek, a little in Hebrew, probably by Alexandrian Jews, −30 to +50, certainly in Egypt. The account of the fall of the angels occurs in chs. VII and XVIII, but there is little emphasis on their teaching of the arts and sciences.

[b] Some of the patristic embroideries, all in the neighbourhood of +200, are interesting. Clement of Alexandria only has a passing mention (*Stromata*, v, i, Wilson tr., vol. 2, p. 226); but Tertullian has more, attacking astrology taught by the angels, allowing metallurgy and pharmaceutical botany as useful, but emphasising the evils of gold, silver, gems, and all feminine adornments and cosmetics (*Apologeticus*, ch. 22, *De Idolatria*, IX, *De Cultu Feminarum*, I, ii, iii, II, X; Thelwall & Holmes tr., vol. 1, pp. 97, 152, 305ff., 327). In Pseudo-Clement of Rome the angels actually transform themselves into gems, pearls, purple, gold, etc., as also beasts and reptiles, in order to tempt men and women—then resume human form to reproach them. Instead of this, however, they are themselves overcome with desire, and mate with the women, after which they leave with them the black arts of magic and metallurgy, astronomy, dyeing and plant knowledge, 'and whatever was impossible to be found out by the human mind'. The giants follow. *Homilies*, VIII, 12–18, Smith, Peterson & Donaldson tr., pp. 124ff. In connection with an argument which will develop a page or two below, it is of interest that this pseudepigraphic work says the angels brought 'the working of gold and silver and all smelting and melting' (*chrysou kai argyrou kai tōn homoiōn chysin*, χρυσοῦ καὶ ἀργύρου καὶ τῶν ὁμοίων χύσιν, VIII, 14). Further material on the Enoch legend will be found collected in Partington (7), vol. 1, pt. 1, pp. 173ff.

[c] In his suggestive attempt to apply some of the methods of biblical text-criticism to the Lü Hsing chapter of the *Shu Ching*, Fehl (1) has compared the rebellious angels in 1 Enoch with Chhih-Yu, Kung-Kung and others in Chinese myth (cf. Vol. 2, pp. 115, 117, the 'legendary rebels'). Strangely enough there may well have been a Chinese translation of one version of the 'Book of Enoch', namely that which was incorporated as one of the seven canonical scriptures of the Manichaeans under the title 'Book of the Giants' (*Graphē tōn Gigantōn*, γραφὴ τῶν γιγάντων); cf. Henning (3, 4). These scriptures were enumerated in an account of the Manichaean religion: *Mo-Ni Kuang Fo Chiao Fa I Lüeh*[1] (Compendium of the Doctrines and Styles of the Teaching of Mani, the Buddha of Light), prepared in the

[1] 摩尼光佛教法儀畧

have been found. While aurifaction itself is spoken of in various early texts, as in the words of Aeneas of Gaza (+484) already quoted (pt. 2, p. 23), none has anything to say about Chymēs or *chymeia*.

In the writings of Zosimus of Panopolis, however (or in texts plausibly attributed to him) there are four further references to the eponymous hero.[a] 'Chimēs (Χίμης) the Prophet, speaking of projection, says...';[b] 'Chimēs often proceeds by burning...';[c] 'All the writers, especially Chymēs (Χύμης) and Maria, say...';[d] or 'As Chymēs has rightly declared...' and there follows one of the proto-chemical aphorisms (cf. p. 359).[e] This evidence comes from about +300. Olympiodorus, writing about +500, has one mention: 'So also Chēmēs (Χήμης) follows Parmenides, saying...', and another form of the same aphorism follows.[f] Olympiodorus and his successors have many other related words and phrases, such as a reference to Agathodaemon, 'who wrote the book on chemistry (*biblon chēmeutikēn*, *βίβλον χημευτικὴν*)';[g] or, 'the chemical art (*chimmōtikē technē*, *χιμμωτικὴ τέχνη*)', or, 'the first of the chemists (*prōtou chimmeutou*, *πρώτου χιμμευτοῦ*)'.[h] Chimēs the man appears again in Stephanus of Alexandria (*c.* +620),[i] and his name occurs regularly in the lists of 'oecumenical philosophers' (cf. pt. 2, p. 17) given in the extant proto-chemical manuscripts,[j] as also in the *Fihrist al-'Ulūm* of Ibn al-Nadīm al-Warrāq (*c.* +985), where he appears twice, under the guises of Kīmās and Shīmās.[k] We need follow him no further, for it is clear that the root and its derivatives were firmly planted, even if with several variant spellings, in the +5th century, and probably first appeared, partly as a personal name, towards the end of the +3rd. It may be, as Ruska thought,[l] that some real proto-chemist wrote under this name between the time of Pseudo-Democritus and Zosimus—perhaps he was a contemporary of Mary the Jewess—but whether he took his name from the germinating word for the subject, or gave his name to it, remains entirely in the dark. In either case the etymological origin remains open. Although no book with this name has survived, either in the Corpus or outside it, the supposition would not be

College of All Sages (cf. Vol. 4, pt. 2, pp. 471–2) in +731, though the MS. (Stein collection, no. 3969) is more probably of about +930; cf. Haloun & Henning (1). The Chinese title of the book about the giants was *Ta Li Shih Ching*.[1] No Chinese text is known, but Henning (2) has transcribed and translated fragments from several Central Asian languages. None of them mentions the 'Book of Chēmēs'. Thanks are due to Dr Liu Nan-Chhiang for bringing these strange facts to our knowledge.

[a] On all these loci see Hoffmann (1), p. 520; Berthelot (1), pp. 167, 193, 200, 256, 260, (2), p. 111.

[b] *Corp. Alchem. Gr.* III, xxiv, 7.

[c] *Corp.* III, xxiv, 4.

[d] *Corp.* III, xx, 2.

[e] *Corp.* III, xviii, 1.

[f] *Corp.* II, iv, 27.

[g] *Corp.* II, iv, 18.

[h] *Corp.* VI, xv, 15 (Philosophus Anonymus). Half a dozen of these are collected by Hoffmann (1), p. 525.

[i] 9th Lect.; not in Sherwood Taylor (9), only in Ideler (1), vol. 2, p. 246. A strange rhetorical passage in the same author (*op. cit.*, vol. 2, p. 217) seems to call upon the help of chemical deities: 'Fight, copper! Fight, quicksilver! Unite the male and the female!...Fight, copper! *Chemoi* (*χεμοί*), help!'.

[j] Berthelot (2), p. 111.

[k] See Flügel ed., vol. 1, p. 353, and Fück (1), pp. 92, 118. Cf. Berthelot (1), p. 131. He also makes an appearance in an anonymous Arabic alchemical work of the previous century, the *Kitāb al-Ḥabīb*, not part of the Jābirian Corpus; where he is mentioned as 'Chymes the Sage' in a quotation purporting to be from Theosebeia, the friend or sister of Zosimus, and concerning aurifaction (Berthelot & Houdas (1), p. 114). See also Dodge (1), vol. 2, p. 849.

[l] (11), pp. 322–3.

[1] 大力士經

unreasonable that Zosimus did actually have in his hands a 'Book of Chymēs', yet what there was to connect it with the Enoch-legends remains still in deep obscurity.

To etymology we shall shortly return, but here a word should be said about the first 'chemist' of the Western world, and the first book with the title of 'chemistry'. That the root was well implanted by the end of the +5th century appears from the story of an aurifictor named Johannes Isthmeos, who appeared in the time of the emperor Anastasius Silentiarius (+504) and was consigned to prison by him.[a] Here the art is termed *cheimē* (*tēs cheimēs technōn*, τῆς χείμης τεχνῶν) and the adept appears as *cheimeutēs* (χειμευτής), the first of his line. As for the oldest book, whatever Agathodaemon's was, that Olympiodorus mentioned, it must have been earlier than this time, yet it has often been rivalled by a book in the Corpus with that strange title usually translated 'Domestic Chemistry of Moses' (*Mōuseōs oikeia chymeutikē taxis*, Μωυσέως οἰκεία χυμευτικὴ τάξις).[b] Though unquestionably reflecting the Jewish element in Alexandrian proto-chemistry,[c] it cannot be earlier than Zosimus, as has sometimes been thought, and is probably as late as the +7th or even +8th century.[d] Consequently Agathodaemon's remains the first, though nobody knows what was in it.[e] Nor can we tell the date of its remaining fragments.[f]

The upshot of all this is that the use of the root 'chem-' for what we now broadly call chemistry seems to have started with Zosimus, or a little before him in the +3rd century, the time of the chemical technology papyri (though words based on it never occur in them), and distinctly later than the first writings of the Corpus (Pseudo-Democritus, Cleopatra, Pebechius, etc.).[g] Clearly it was well established by the late +5th century. The question then arises, what could have been its origin? This has been quite a controversial matter, and even today each one of the proposed solutions has grave disadvantages. Let us see what they are.

[a] The usual authority here is Cedrenus, in his *Historiōn Archomenē* of +1059, Bekker ed., vol. 1, p. 629. The Enoch story is given on pp. 19–20, but without mention of the Book of Chēmēs. Older sources are Theophanes, *Chronographia* (*c.* +800), Classen ed., vol. 1, p. 231 (the spelling is *chymeutēs*, χυμευτής, under +499); and best of all John Malalas, *Chronographia*, Dindorf ed., p. 395, where the spelling is again *cheimeutēs*. As this historian died in +577, he was quite close to the event. One may remind oneself that Johannes Isthmeos was a contemporary of Thao Hung-Ching.[1]

[b] As Stephanides (4) pointed out, the proper translation should be 'Suitable Classification for Chemical Substances (or Preparations), by Moses'. But the book (*Corp.* IV, xxii), though aurifactive, is very metallurgical and practical. It has been analysed by Ruska (11). The full form of the Greek title is found only in *Corp.* V, vii, 10 (an anonymous late manual on the tincture of gems): *Mōusēs ho prophētēs en tē oikeia chymeutikē taxis*. Other references (*Corp.* III, xxiv, 4, 5, xliii, 6) cite a *Hē Mōseōs Maza*, which is considered an alternative title. We shall return to this strange word later, p. 365. Cf. also Vol. 5, pt. 2, p. 74.

[c] Later Jewish alchemy can be followed in the valuable encyclopaedia articles of Gaster (1); Suler (1, 2) and Rom (1). But as these scholars were Hebraists rather than historians of science, critical reading is necessary.

[d] This was Ruska's final conclusion (pp. 425ff.). It agrees with that of Festugière (1), p. 239.

[e] Apart from the writer who covered himself with the name, Agathodaemon was some kind of god or fabulous creature, later taken as one of their patrons by the Ṣābians of Ḥarrān (cf. p. 426, and Partington (7), vol. 1, pt. 1, pp. 330ff.).

[f] Berthelot guessed contemporary with Zosimus or a little earlier (1), pp. 136–7, (2), p. 202. This would mean the time of Ko Hung,[2] a century and a half later than the book of Wei Po-Yang[3] (pt. 3, pp. 50, 75).

[g] As Kopp saw clearly just over a century ago, (2), pp. 69, 82. Singer also, (8), p. 48.

[1] 陶弘景 [2] 葛洪 [3] 魏伯陽

(iii) *The origins of the root 'Chem-'*

The first idea which has to be considered is that it was simply part of a personal name. Even though Halen in +1694 attempted to write a biography of Chemes, 'the first author of the sciences',[a] it must be evident from what has so far been said that Chemes or Chymes is far too shadowy a figure on whom to base anything certain;[b] and in any case the nature of the root which formed his name remains to be determined. However, we cannot dismiss persons so easily, for there is someone else in the field, someone whom most chemists have totally forgotten about since they were introduced to the O.T. in their early youth—Ham the son of Noah, brother of Shem and Japheth.[c] In Greek his name was spelt with a *ch* (Χαμ), hence his possible connection with 'chem-'.

But not only this; there was an ancient corpus of legend about him recalling that concerned with Enoch and the angels. According to John Cassianus, who was writing about +428, Cham was expert in all the arts and sciences of the antediluvian generations, and wished to save this accumulated natural knowledge of mankind.[d] However, Noah and his two other sons were so holy that it was not possible for Cham to bring into the Ark any handbooks on the ancient 'superstitious, wicked and profane arts', so he inscribed them on metal plates and buried them underground. After the flood waters went down he succeeded in finding them again, and thus 'transmitted to his descendants a seedbed of profanity and perpetual sin'. In Pseudo-Clement of Rome (fictional material written about +220),[e] Cham figures as the first great magician, handing down his technical knowledge to his sons, especially Mizraim, ancestor of the Egyptians,[f] Babylonians and Persians,[g] and finally being burnt to death by his own conjured star-sparks. Nor is the sexual element lacking, for it will be remembered that after the flood Cham was cursed because he had seen his father's nakedness, Noah being drunk and the weather doubtless hot.[h] That there were books about Cham, or purporting to have been written by him, is not in question, for at a still earlier date Clement of Alexandria, writing just before +200,[i] quotes the Gnostic Isidorus, son of Basilides, as saying (in order to exemplify Greek indebtedness to Hebrew origins) that 'Pherecydes drew on the 'Prophecies of Ham' (*Cham Prophēteias*, Χαμ προφητείας)'.[j] Book-titles deduced from several other patristic references were listed by J. A. Fabricius, when drawing up his censuses of biblical apocryphs and pseudepigraphs at the beginning of the +18th century;[k] but virtually nothing is known of their content.

[a] *De Chemo Scientiarum Auctore*, an Uppsala monograph.
[b] As Kopp also saw, (2), p. 77.
[c] See the flood story in Gen. 7. 1ff.
[d] *Conlationes*, VIII, 21; Petschenig ed., xiii (2), p. 240; Gibson tr., p. 384. Cassianus' dates were +360 to *c.* +435.
[e] *Recognitiones*, IV, xxvii; tr. T. Smith, p. 297.
[f] Cf. the Arabic name for Egypt, al-Miṣr.
[g] Hence a confusion in later writers with Zoroaster.
[h] Gen. 9. 20–27.
[i] *Stromata*, VI, vi; Wilson tr., vol. 2, p. 335. Cf. Hilgenfeld (1), p. 215; Grant (1), p. 139.
[j] For the general background of this, see the interesting study of Pherecydes and his book by West (1), esp. pp. 3, 39, 43, 45.
[k] Apart from the 'Prophecies of Cham' (*Vet.* no. XCII, in vol. 1, pp. 291ff.), there are also 'Treatises of Cham' on magic and astrology (the *metallorum laminis* in fact) mentioned, besides Pseudo-Clement,

It seems to have been S. Bochartus in +1692 who first launched the idea that *chēmeia* was derived from Cham;[a] he knew the Zosimus passage but believed (wrongly) that the first use of the name of the art had occurred in Firmicus Maternus (p. 340 above). The association, however, was doubtless much older. The great drawback of it is that there is no direct statement in any ancient author that the arts which Cham transmitted were chemical or metallurgical in character. Though Reuvens found the whole story an 'absurd fable'[b] and Kopp a mere 'fantasy',[c] such Victorian scholars' opinions could not discredit the fact that ancient legends are themselves historical data, and Hoffmann was perhaps nearer the mark when he opined that 'chem-' was the mother of Chymes, and Cham his father.[d] But this only leads us back to square one, faced again by the problem of the origin of 'chem-' itself.

If personal names do not solve our problem, could the root have come from the name of a country? That this country was in fact Egypt is a suggestion which has had quite a long run, ever since it was first put forward in relatively modern times by Hermann Conring in +1648.[e] The idea has always rested on one single text, the statement of Plutarch (*c.* +95) in his book on Isis and Osiris that 'Egypt itself, by reason of the extreme blackness of the soil, is called by them [the Egyptians, or the priests] Chēmia (Χημία), the very same name which is given to the black part or pupil of the eye.'[f] The truth of this, confirmed by modern Egyptology during the past century and a half, cannot be questioned. For example, Champollion affirmed that Chēmi, Kēmī or Kimī (dialectal variations) was 'the veritable and only Egyptian name of Egypt' also meaning black—the people were *rem-chmé* or *reman-chimi*, the black of the eye was *pichēmi ambal*, the Nile was *Ou-chamé*, and so on.[g] In other works he gave the hieroglyphic character, a pictograph of a crocodile's tail, 'emblem of obscurity and darkness', as also the versions in hieratic and demotic.[h] Conring's suggestion was popularised by von Humboldt,[i] adopted by the weighty philologist Pott in 1876, and smiled upon by Hoffmann[j] and von Lippmann,[k] but it has almost insuperable objections, one being that such a derivation of *chemeia* is given by no ancient author. Moreover, as Ruska pointed out,[l] Egypt is never known in Greek literature as

by Epiphanius, in *Haeres.* XXXIX (*Vet.* nos. XCIII and XCIV, in vol. 1, pp. 294, 297). One can ignore Fabricius' numerous late non-patristic authorities. His 'Book of Cham' on chemistry and alchemy (*Vet.* no. XCV, in vol. 1, p. 301) was simply another incarnation of the 'Book of Chemes' already discussed. It is curious that Fabricius listed a 'Book of Mirjam', sister of Moses, on chemistry (*Vet.* no. CLXV, in vol. 2, p. 869); this was a common confusion with Alexandrian Mary the Jewess, the chief reference being to George Syncellos, *Chronographia*, p. 248, who of course knew the Corpus well. The 'Domestic Chemistry of Moses' seems not to have been included. A condensed list of all these presumed texts is given in Migne (1), pp. xliv, xlv.

[a] *Phaleg*, IV, 1, in *Op. Omnia*, vol. 3, pp. 203ff. The book was posthumous, Bochart having died in +1667.

[b] (1), pp. 69–70, in the 3rd letter. [c] (2), pp. 66–7.

[d] (1), p. 521, cf. pp. 517–18. He meant, presumably, that by a convergence of sound the Cham epic became accreted with the 'chem-' root. [e] *De Hermetica Medicina*, p. 19.

[f] *De Iside et Osiride*, ch. 33, Parthey ed., p. 58; cf. Squire (1), text, p. 83, tr. pp. 43–4; Gwyn Griffiths (1). Khme (Coptic) is derivative.

[g] (1), vol. 1, pp. 101ff. Cf. Erman & Grapow (1), vol. 5, p. 123, no. 1, (2), p. 196, no. 1.

[h] (2), p. 152, (3), pp. 62, 178. [i] (1), 1847 ed., vol. 2, p. 451.

[j] (1), p. 524. [k] (1), p. 295. One can add Gundel (4); Forbes (32).

[l] (11), pp. 319ff.

Chēmia but always as *Aigyptos* (Αἴγυπτος). And this is also true specifically of the Corpus, where all mentions of 'the holy art of Egypt' or 'the techniques of the Egyptians' use the Greek name, not the Egyptian one,[a] just as we normally say Finland rather than Suomi. Favoured though it has been by popular books on the history of chemistry, this derivation is too weak to stand.

But suppose we retain the notion of 'blackness'? The Alexandrian proto-chemists of the Corpus certainly had a lot to say about 'blackening' (cf. pt. 2, p. 23), and taking up Plutarch's hint one might be disposed to think of *chēmeutēs* as 'blackener' or '*black-maker*', and *chēmeutikai bibloi* as 'books concerned with blackening'. This was Hoffmann's favourite theory,[b] but it strikes the uncomfortable fact that the normal Greek word for blackening was *melan* (μέλανσις) or *melasmos* (μελασμός).[c] Worse still, the Corpus generally speaks of *melanōsis* (μελάνωσις).[d] The word is not in what is left of Pseudo-Democritus, who has only *leucōsis* and *xanthōsis*,[e] but starts with Zosimus,[f] and when Olympiodorus comes to speak of a 'black preparation' he says *melana zōmon* (μέλανα ζωμόν).[g] The fact is that 'blackening' is never called *chēmi* or *chēmeia* in the Corpus (or the papyri either), and so in spite of fancied resemblances with the 'black art' of medieval times, there is simply no ground for deriving the 'chem-' root from the notion of blackness.[h]

But was there no other word in the Ancient Egyptian language embodying the phoneme 'km-' which could be relevant to the origin of 'chem-'? One at least has been suggested, in an ingenious and interesting but hardly convincing theory. The verb *km* meant 'to complete, achieve, attain, execute' or 'bring to a close', and in pyramid texts it was indeed applied to the making of ointments or metalwork.[i] From it was derived (so it is thought) the title of a book of the −3rd millennium, *Kmj.t* (Book of Completion), some fragments of which have survived to this day. This was not a 'wisdom-book',[j] nor a religious text, nor a fictional work, but a compendium of excerpts from the best accepted writings intended to teach sound grammar to the youthful scribe, and a good style of composition.[k] It was probably being put together already by about −2300, for it must have been widely current and in standard use by −1970, in the time of Sesostris I of the XIIth Dynasty,[l] since Kheti the son of Duauf quoted it in his 'Satire on the Trades', the most famous example of what became a characteristic genre of Ancient Egyptian literature.[m] These texts exalt the

[a] See for example *Corp.* I, xiii, 1 and II, ii, 1.

[b] (1), pp. 525, 529.

[c] Ruska (11), *loc. cit.*

[d] The spelling varies. *Melanōsis* occurs in Comarius (*Corp.* IV, xx, 5) and Moses (*Corp.* IV, xxii, 47), but *melansis* (μέλανσις) in Zosimus and Olympiodorus, *passim*, as also *Corp.* III, xliv, 5 = VI, xv, 5 bis, anonymous texts.

[e] Cf. Vol. 5, pt. 2, p 23.

[f] Berthelot & Ruelle (1), vol. 2, pp. 107–252.

[g] *Corp.* II, iv, 40.

[h] Von Lippmann (1), pp. 301–7 notwithstanding, who supported Hoffmann in this.

[i] Erman & Grapow (1), vol. 5, p. 128, no. 12, (2), p. 195, no. 12.

[j] As some lexicographers tentatively defined it; Erman & Grapow (1), vol. 5, p. 130, no. 12.

[k] It was assuredly the book *Qemi* which Berthelot (1), p. 10, heard about from G. Maspero (2), p. 125. Chinese parallels will come up for discussion in Vol. 6, Sect. 38 on botany.

[l] *Kmj.t* is known to have been very popular also in the XIXth and XXth Dynasties (*c.* −1320 to −1160, contemporary with Shang times in China).

[m] See the general survey of van de Walle (1).

scribal function according to the general theme that 'a clever scholar is worthy to stand before rulers',[a] and they warn the student to keep his nose well into the book *Kmj.t* if he wishes to avoid the miserable lot of all those manual workers—potters, builders, weavers, dyers, brewers, smiths and metal-smelters, sailors and farmers—men of aching backs and stinking hands.[b] This genre is familiar to many of us because a typical excerpt from it was given by Wallis Budge in his classical introduction to Ancient Egyptian,[c] and several other translations have appeared.

Now A. Hermann (1), to whom we are indebted for much of the foregoing information, has suggested that the name of the 'Book of Chymes', so vital for us, was derived from nothing other than the *Kmj.t*.[d] It is not claimed that there was ever anything at all in that ancient book about metallurgy, chemistry or other techniques, simply that it was quoted by Kheti son of Duauf in a text which had something to do with them. Admittedly, again, his text was written precisely in disdain of those techniques,[e] nor do any extant versions of the 'Satires' actually describe any of the details of the operations.[f] Hermann however felt that by the Ptolemaic period labour conditions had eased with rising technological invention, so that chemical-metallurgical work, especially with the precious metals, became more attractive to intellectuals. But it seems to us bizarre that the Hellenistic proto-chemists should have drawn the name of their holy proto-bible (or unholy, according to your point of view), from an ancient book which never had any connection with the chemical arts, except in so far as it was quoted in satires against them. We conclude that it would be quixotic to derive the root 'chem-' from this source.

Perhaps the most obvious source of it would be a group of Greek words with the general sense of liquid and pouring—verbs like *cheein* and *chōneuein* (χέειν, χωνεύειν), to melt or pour, and *epicheein* (ἐπιχέειν), to pour on or off—nouns like *chyma*, *cheuma* (χύμα, χεῦμα) meaning fusion or the molten state, *chymos* (χυμός) juice or liquid (cf. chyme, p. 366),[g] finally *chytra*, *chytridion* (χύτρα, χυτρίδιον) and many similar forms,[h] signifying crucibles of different kinds. There is no question that these occur very frequently both in the Corpus[i] and the papyri, and the derivation is a good deal more attractive than

[a] Cf. Prov. 22. 29. Ecclesiasticus 38. 24 to 39. 11 reproduces closely a version of the trades-satire literature, but although it debars the manual workers from high political leadership, it is highly appreciative of their work. This is more than can be said of the classical Greek attitude to 'banausic' occupations.

[b] The descriptions, of brutal frankness or abusiveness, are often very exaggerated.

[c] (5), pp. 212ff., where it appears as 'The Proverbs of Ṭuauu-f-se-Kharthâi'.

[d] R. J. Forbes, after having adhered to Egypt as such (32), rallied to Hermann's proposal, as we know from letters published by Mahdihassan (15), pp. 94–5.

[e] Indeed it is one of the most ancient extant statements of the differentiation of social classes, contrasting the learned scribe sitting at ease with those who sweat under the sun or by the fires of forge and furnace.

[f] This greatly weakens Hermann's suggestion that by the time of Zosimus, the *Kmj.t* was just confused with the 'Satire on Trades'.

[g] This was the preference of Mahn (1), but for a bad reason. Though he called in (Skr.) *rasāyana* (cf. pp. 352, 498) to his support, he believed that the earliest phase of Mediterranean chemistry was primarily medical and herbal, which is just the opposite of the truth.

[h] E.g. *chōnos*, *chōnon*, *chōnē*, *chythra*, *chōstra* (χῶνος, χῶνον, χώνη, χύθρα, χώστρα).

[i] See for example III, xli, 2, xlii, IV, xxii, 38, V, i, 1, 16, VI, xiv, 6, 8, 15, xv, 4, 8. Also Stephanus of Alexandria (Ideler ed.), pp. 202, 210, 212.

others so far considered. It goes back to Rolfinck's *Chimia*[a] and Vossius' *Etymologicon*,[b] both of +1662, and has had impressive support, e.g. from Hoefer,[c] Gildemeister (1) following Cl. Salmasius (+1588 to +1653),[d] and Diels (1, 4), to say nothing of Stephanides (3) and Hammer-Jensen (2); and it was the considered conclusion of Ruska (11). Ruska felt that the identification was particularly convincing when he found the words of the Philosophus Anonymus (late +7th cent.):[e] 'The present book is called the "Book of Metallurgic and Chymeutic (Art)" (*μεταλλικὴ (καὶ) χυμευτικὴ (τέχνη)*), dealing with the fabrication of gold and silver, and the fixation of mercury, with vapours, with tinctures prepared from living things,[f] with the making of green gems and shining gems and all other colours, with pearls and the dyeing red of skins (leather) fit for princes; all this with the help of brine and eggs[g] and the metallurgical art'. Thus it was certainly a chemical compendium. But even this solution is subject to a serious criticism, namely that most of the words mentioned had been in use in classical Greek long before. Why should *chymeia* and *chēmeia* have waited till the +3rd or 4th century before making their appearance? Among the Greek inscriptions *chyma* or *cheuma* in the sense of ingot can be found in −170 or −70, and *chytra* even earlier.[h] Similar forms occur in Aristotle's *Historia Animalium* (*c.* −350) and even in the Hippocratic Corpus, evidence for the second half of the −5th century.[i] Hoffmann added other arguments—*chēmia* or *chēmeia* never applies in Greek to a preparation or a substance, as later Arabic *kīmiyā'* certainly does; *chymoi* in the Corpus means bodily humours only; liquids as such are usually called *zōmoi* (*ζωμοί*)[j] or *chyloi* (*χυλοί*); and the word which might most logically be expected, *chymateia* (*χυματεία*) is never found. In sum, the derivation from 'pouring' and 'molten' is much less convincing when closely considered than it seems at first sight.[k]

The only other well-known proposal was the paradoxical one of Lagercrantz (2) that by a process common in Indo-European linguistics *chymeia* was derived by an inversion of consonants from *moicheia* (*μοιχεία*), i.e. adultery, falsification, counterfeiting, deception.[l] But this was completely demolished by Ruska (11), chiefly on two grounds, first that *dolos* (*δόλος*) is the word always used in the papyri and the Corpus

[a] *Chimia in Artis Formam Redacta*, p. 19. Werner Rolfinck (+1559 to +1673) was the first professor of chemistry at Jena; cf. Partington (7), vol. 2, pp. 312ff.

[b] P. 17. Ruhland in his *Lexicon Alchemiae* (+1661) held the same: 'Chymia *apo to chuo* fundo. Unde *chymē* succus et chymia ars succum faciens, seu res solidas in succum resolvens...' (p. 149).

[c] (1), 1842 ed., vol. 1, p. 219, 1866 ed., vol. 1, pp. 226, 275.

[d] The idea can even be traced back to Ermolao Barbaro (d. +1493), *In Dioscoridem Corollariorum Libri Quinque* (Cologne, +1530). Cf. Kopp (2), p. 74, followed by Schorlemmer (1).

[e] *Corp.* III, xliv, 7.

[f] *Murex* purple for example.

[g] Cf. pt. 2, pp. 73–4, 253.

[h] See Boeckh (1), *Corpus Inscriptionum Graecarum*, no. 161 (vol. 1, p. 286), no. 1570 (vol. 1, pp. 750–3).

[i] For the *De Arte*, 12, is of genuine Hippocratic date, though perhaps Cnidian rather than Coan.

[j] Cf. *Corp. Alchem. Gr.* III, xxxix, 6.

[k] Naturally von Lippmann (1), pp. 295ff.; Pott (1); and others, on account of their different preferences, agreed with this.

[l] The idea seems to have arisen in part from what may be one of the earliest texts in the Corpus (I, xiii, 1), the 'Epistle of Isis to Horus'. Here Isis is visited by exalted angels, notably Amnael, who seek to lie with her, but in return she successfully obtains from him the great secrets of proto-chemistry (gilding, leucosis, etc.). The text (which may be of the +1st century) clearly echoes the Enoch myth; though the word *moicheia* does not in fact occur in it.

for falsification, and secondly, more important, that it is a wholly erroneous idea of Hellenistic proto-chemistry to think of it only or even primarily as falsification. Readers of this volume will be well aware from pt. 2, pp. 21 ff. that in the Hellenistic world there was not only aurifiction but also aurifaction—and very numinous at that—the 'holy and divine art'. Lastly, the Arabic authorities quoted by Lagercrantz were carefully dissected by Ruska, no man being better qualified to do it, and he showed that although the meaning of falsification does attach to some extent to *al-kīmīyā*, it is always far from the whole story.

If Egyptian and Greek do not help, what about returning to Hebrew? There is a word *chometz* (or *chāmetz*) which means leavened bread, hence leaven itself, or fermentation, though the technical term for yeast is *sē'or*; thus forming a parallel with *maza* and *zymē* (p. 365 below). Since there was a clear association between Hellenistic and Jewish proto-chemists earlier than the first appearance of the word *chēmeia* itself,[a] this possibility of origin must be taken seriously—especially as *maza* and *massa* came to be synonymous with alchemy in later times. The same Semitic root appears in Arabic and Aramaic as *khamir* (leaven, leavened bread). *Al-kīmiyā'* would hardly have derived direct from that, however, but rather as the offspring of *chēmeia* (pp. 355, 481) by way of Syriac. Such a derivation of 'chem-' from *chometz* derives its force from the prominence of the idea of fermentation in the process of projection by the philosopher's stone (p. 367 below). Projection was in fact a kind of fermentation. But here the difficulty is that the fermentation concept was only one among many multifarious thoughts and techniques envisaged in aurifaction and aurifiction, not universally applicable, and competing with colour-change, death-and-resurrection, dilution, distillation, reflux distillation, etc. Still, of all the proposals for explaining the prophet Chemes and his book, this one seems among the more attractive.[b]

If then it must be concluded that none of the classical and Western derivations of the root 'chem-' are entirely satisfactory, room should be left open for other suggestions, and one there is which particularly concerns us.

In 1946 I suggested that 'chem-' should be equated with Ch. *kim*,[1] i.e. *chin*,[1] as in *lien chin shu*,[2] the commonest expression for 'the art of transmuting metals (or gold)', generally implying aurifaction or aurifiction.[c] I remarked that this phrase would have been pronounced in Cantonese *lien kim shok*; but actually a more correct transcription of that kind would be *lin kêm*[d] *shut*.[e] The idea then in mind was that Canton was the terminus for so long a time of the sea route to and from China frequented by the Arabs, but since we know that the term *chēmeia* (*chimeia*, *chymeia*) was in use by the

[a] Cf. pt. 2, pp. 17, 19, 74, 253.

[b] We are indebted to Mr Ronald Hassett and Prof. E. Wiesenberg for suggesting and perpending this possibility. Yet another derivation could be drawn from (Heb.) *ḥokhmah*, wisdom, since the initial guttural of a root like *ḥkm* tended to disappear in transliterations (Wright (1), pp. 48 ff.; Brockelmann (3), pp. 120 ff., (4), pp. 48 ff.; Moscati (1), pp. 39 ff.). This could have given *chi* or *k* and *m* for the consonants, the vowels being, as we saw, very variable. Cf. Job 28, and obvious links with *sophia* and *logos*, but nothing about gold or anything operative, so the connection would have been very abstract.

[c] Needham (58), Fr. ed., p. 209, Eng. ed., p. 216.

[d] Near *gêm* or *gum*, with hard *g*.

[e] Or *ssu(t)*, as spoken by my friend Chhen Fei-Hua.

[1] 金 [2] 煉金術

+3rd century, an overland route such as the Old Silk Road would seem a more likely channel of communication—and transmission, if such there was. Hence it is important that the key word, *chin*,[1] was (and still is) pronounced *kim*, *kin*, *king*[a] in many other dialects and related languages, not only Hakka, Amoyese and Fukienese,[b] but also Korean, Japanese and Annamese. What is much more important is that the ancient pronunciation throughout China would have been something like *lien kiem dzhiuet* (*lien kịam dź'ịuĕt*),[c] so that a root 'kem-' could conceivably have come Westwards.

Unknown to me at the time, a similar suggestion had been put forward earlier in the same year by Mahdihassan (14). According to present recollection my proposal had originated during the war years in many conversations with chemical friends in China, such as Huang Tzu-Chhing, Li Hsiang-Chieh and Chang Tzu-Kung. Mahdihassan on the other hand had been led to it in the course of his studies on words of possible Chinese origin in other languages such as Arabic, Persian, Turkish, Urdu, Hindustani and English,[d] pondering especially (38) the case of *kincob*,[e] a Hobson-Jobson word for brocade, gold damask, and cloth of gold.[f] There was already good authority[g] for tracing this to *chin hua*[2, 3];[h] whence Persian *kimkhwā*, Hindi *kimkhwāb* and—most significantly—Byz. Greek *kamchanē*, *kamouchas* and *chamouchas* (*καμχανή*, *καμουχᾶς*, *χαμουχᾶς*),[i] current from the end of the +13th century onwards. Mahdihassan first attempted (14) to derive *chēmeia*, *kīmiyā'*, from *chin mi*,[4] 'gold deception' or 'infatuation',[j] and then from *chin mi*,[5] 'gold secret';[k] but a few years later, perceiving that the middle consonants were tautologous, proposed (9)[l] *chin i*,[6] 'gold juice'

[a] Always with the hard *g*, approximating *k* but not aspirated.

[b] Fuchow in particular.

[c] K185*j*, 652*a*, 497*d*. Again the *k* definite though probably spoken as a hard *g*. Karlgren used a date around +600 as his 'ancient' *point de répère*, and −700 for his 'archaic'; the latter forms are conjectural and we need not consider them for our present purpose.

[d] See, e.g. (1) on monsoon, (2) on turquoise and jade, (3), (5) on porcelain, (6) on carboy, (11) on dijinn, (35), (36) on godown, (37) on plague, (49) on paper, (50) on kutcherry and tussore.

[e] Current in English from +1712 onwards.

[f] The meaning could include all kinds of polychrome drawloom flowered or patterned silks, but gold thread was prominent in the conception. Cf. the confusion referred to in Vol. 1, p. 6.

[g] Yule & Burnell (1), p. 368.

[h] The pronunciations of these characters vary respectively only in tone.

[i] For the first of these forms the reference is to the 'Letter of Theodorus the Hyrtacenian to Lucites, Protonotary and Protovestiary of the Trapezuntians', written in +1300; the other two are in du Cange's glossary of late Greek, defined as 'pannus sericus, sive ex bombyce confectus'. A reference of +1330 is in Yule (2), vol. 3, pp. 99, 155, vol. 4, p. 17.

[j] Apart from the fact that the phrase is practically unknown in Chinese, this suffered from the same defect as the theory of Lagercrantz (2) just discussed.

[k] Also unknown in Chinese, a pure construct. The second character in the phrase would certainly have been pronounced *pi* in ancient and medieval times anyway. Mahdihassan realised this, but did not think of *mi*,[7] the easy way out—but, as ancient Chinese phraseology, equally poor.

[l] And often afterwards asserted (13, 15, 20, etc.). We are not able to follow him in all his suggestions. For example in (15), so far as we can understand it, he made a sharp separation of (Gk.) *chymeia* from *chēmeia*, though we believe the spellings were indiscriminate. The former he took to have been a translation from (Skr.) *rasāyana*, 'the way of the juices', and that in turn a direct translation from (Ch.) *i tao*,[8] though this is an expression we have never encountered in that language (cf. (12), p. 90, (21), p. 173). *Chēmeia* on the other hand he derived from (Ar.) *kīmiyā'*, rather than the reverse (cf. (25), p. 40), this being itself derived from (Ch.) *chin i*;[9] but he also left room for its being purely Egyptian, i.e. from the

[1] 金 [2] 金華 [3] 錦花 [4] 金迷 [5] 金秘 [6] 金液
[7] 密 [8] 液道 [9] 金液

or 'liquid', the ancient pronunciation of which would have been *kiem iak* (*kiem i̯äk*).[a]

Mahdihassan found this phrase in one of the translations of Wu & Davis,[b] who rendered it 'gold fluid'; but it was the same as Ware's 'potable gold' or 'gold exudate'[c] in the *Pao Phu Tzu* book.[d] Indeed Ko Hung often mentions a *Chin I Ching*[1] (Manual of the Potable Gold),[e] not now identifiable. In the present volume we have frequently used the phrase 'potable gold' (pt. 3, pp. 40, 49, 82–3), though we have also been obliged to recognise the quite different meaning of 'metallous fluid' in physiological alchemy (pt. 2, p. 90). Ware tentatively fixed the proto-chemical sense of the term as mercuric oxide,[f] though the *Shih Yao Erh Ya* gives it as a synonym of mercurous chloride (calomel, cf. pt. 2, p. 152);[g] probably it was a phrase with many meanings, varying with schools and periods. Mahdihassan liked to think of it as 'gold-making plant-juice',[h] linking this up with Ayurvedic *bhasmas* and his theory (discussed above, pt. 3, pp. 48–9) of the ancient use of organic acids in the surface-enrichment of gold-containing alloys.[i] However that may be, there is no dispute about the ubiquity of the phrase *chin i*, and it goes back quite a long way, for apart from the *Pao Phu Tzu* book and its long antecedent tradition, it occurs in those versions of the *Lieh Hsien Chuan* (Lives of Famous Immortals)[j] which contain the biography of Ma Ming-Shêng[2] (*fl. c.* + 100).[k] It is also mentioned in one of the poems of Shen Yo[3] (+441 to +513). There is little doubt that it was current early enough to have travelled Westwards in Han times, though one may well feel that the word *kiem* (*kim*, *chin*) itself was sufficient, without any companion word.[l] Mahdihassan's equation was afterwards accepted by Dubs (34), Schneider (1) and others, while many have found it attractive.[m]

What arguments present themselves as favourable for such an unexpected, and (at first sight) unlikely, transmission? First it has been well observed that none of the

book *Kmj.t* discussed in the note on p. 349 above. Subsequently, however, Mahdihassan saw the improbability of *chēmeia* being derived from *kīmiyā'*, and boldly suggested that it might have come from *chin i*[1] directly (cf. (21), p. 174, (30), p. 43, (32), p. 340, (33), pp. 102ff. and (22), (19), p. 4), though he clung to the idea of pre-Islamic Arabs, perhaps sailors or sea-merchants, as the intermediaries who carried it to Alexandria.

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[a] K800*n*. [b] (2), p. 250. [c] (5), pp. 64, 68–9, 89ff., 112.

[d] Ch. 3, p. 7*b*; ch. 4, pp. 1*a*, *b*, 14*a*, *b*, 16*a*, *b*; ch. 6, p. 3*a*.

[e] Ch. 4, pp. 2*a*, 15*a*; ch. 18, p. 2*a*; Ware (5), pp. 70, 91, 303. Several book titles beginning with this phrase will be found in our bibliography.

[f] We know of no justification for this (cf. RP44). Stannic sulphide is far more likely (cf. pt. 3, p. 103, pt. 2, p. 271).

[g] Ch. 1, p. 1*b*. Cf. RP45, 46. [h] (9), p. 120.

[i] Unfortunately, so far as we know, *chin i* in Chinese never refers to the juice or extract of a plant.

[j] The material in this dates from −35 onwards, stabilised finally by about +400. Cf. Dubs (34), pp. 33–4.

[k] See also that in *YCCC*, ch. 106, pp. 20*b*ff. The historicity of this character is in doubt (cf. Sivin (1), p. 58) but that does not affect the argument.

[l] Mahdihassan (9), p. 115, (15), p. 82, drew support for his doublet from the lexicographer 'Abdallāh al-Ṣafadī (+1297 to +1363, cf. Mieli (1), 2nd ed., p. 268) who averred that *kīmiyā'* had two syllables only. This confirmed his view that *kīm-* was indissoluble. But it did not prove that more than one word had been transmitted.

[m] E.g. Prof. H. B. Collier (priv. comm. 1952), Prof. B. Farrington (priv. comm. 1961), Prof. Guido Majno (priv. comm. 1968).

[1] 金液經 [2] 馬鳴生 [3] 沈約

usual derivations of 'chem-' from Greek, Hebrew or Egyptian origins have any connection with names for gold, though aurifiction and aurifaction constituted the central pivot of ancient proto-chemistry in so far as the elixir theme was missing from it.[a] 'Chem-' would thus have a built-in connection, as it were, with *chin i* (i.e. *kiem ịäk*),[b] or more simply with *chin* (*kiem*) alone. This is a consideration of real weight. The fact that another *chin* (*kiem*) derivative could generate a *chi* (χ) in Byzantine Greek (p. 352 above) is also very relevant here. The Old Silk Road began to function soon after -110 (cf. Vol. 1, p. 176), and if any one thing would have interested the merchants who handled its cargoes through Central Asia more than anything else it would have been gold. If just after the time of Li Shao-Chün (-133) it became common knowledge that Chinese adepts and technicians had ways of fabricating gold artificially,[c] talk about 'the goldery', 'the gold art' or 'liquid gold' would almost naturally have been expected to spread over the rest of the Old World. Whoever were the real Persians who stood behind the name Ostanes (cf. p. 334), so revered by Pseudo-Democritus and his successors, might they not have brought with them among their semi-mystical impedimenta the Chinese name for a Chinese technique, whether or not in fact the manipulations of the Persian and Graeco-Egyptian thaumaturgists closely resembled it? There is much evidence of contact between China and the Eastern Mediterranean both by land and sea between the -1st and $+3$rd centuries, Parthian middlemen and Roman-Syrian traders being prominent in the picture.[d] Indeed the dates are even consistent with a seed sown by Chang Chhien[1] himself, who was away in Western Central Asia between approximately -136 and -126, or by one of his followers, or by some members of the other slightly later Chinese expeditions to that region of Sino-Iranian contact.[e] He and they had plenty of time to talk about their ideas and beliefs, explaining thaumaturgical Taoist metallurgy to some sympathetic Hun or Bactrian Greek, for example, and no doubt they also carried with them scrolls and other material objects. Two historical facts which make this kind of conversation very plausible come at once to mind. We know that iron-casting was introduced to Ferghana and Bactria by Chinese technicians in the neighbourhood of -110.[f] And we have a striking example of the kind of thing that Chinese travellers used to like to talk about, in the account of the interview of the Buddhist pilgrims Hui-Shêng[2] and Sung Yün[3] with the King of Udyāna, when they expatiated upon the palaces of silver and gold of the holy immortals, and many other aspects of Taoism, medical and proto-scientific.[g]

[a] Mahdihassan (15), p. 81.

[b] Mahdihassan (14*b*), (21), p. 174, (22), (30), p. 43, (32), p. 340, (33), pp. 102ff.

[c] And this is to say nothing of the preceding aurifiction (cf. pt. 3, pp. 26ff.), going back to -144 for certain, and probably half a century earlier than that.

[d] See Vol. 1, pp. 150, 155, 157ff., 177ff., 181ff., 191ff., 197ff., 199ff. and Vol. 4, pt. 3, pp. 422ff. Some scholars have not hesitated to assert their belief that scraps of Chinese alchemy, if not more, were transmitted to the eastern Roman world during the $+1$st century; cf. Wang Chi-Min (*1*), p. 10. On Indian–Alexandrian contacts at this time see the reviews of Frend (1, 2).

[e] See Vol. 1, pp. 173ff.

[f] Vol. 1, pp. 234–5. We have discussed this further in pt. 2, p. 219 above.

[g] Vol. 1, pp. 207, 209. This was in $+520$ or thereabouts, but the instance is a striking one, for although the two were Buddhists, they were also patriots, and Taoism (with its corollary of alchemy) was a constituent of the national culture.

[1] 張騫 [2] 惠生 [3] 宋雲

If some have found an influence of *chin* (*kiem*) on *chēmeia* (*chimeia*, *chymeia*) difficult to accept, there has been less desire to question its influence on *al-kīmiyā'*.[a] No Arabic etymologist ever produced a plausible derivation of the word from Semitic roots,[b] and there is the further point that both *chin i* and *kīmiyā'* could and did mean an actual substance or elixir as well as the art of making elixirs, while *chēmeia* does not seem to have been used as a concrete noun of that kind.[c] We are left then with the possibility that the name of the Chinese 'gold art', crystallised in the syllable *chin* (*kiem*), spread over the length and breadth of the Old World, evoking first the Greek terms for chemistry and then, indirectly or directly, the Arabic one.

(iv) *Parallelisms of content*

We have now reached the point when we can ask in what sense there was a community of interest between the proto-chemistry of the Hellenistic world and the alchemy of China. Clarification of this will raise in a natural way the further question of whether or not we ought to think of transmissions at this early time, and if so in what directions. A natural division presents itself—things, methods and ideas—so let us pursue it.

Before doing this, however, we must just recall that fundamental distinction which we were obliged to make in Vol. 5, pt. 2. The reason why we wrote 'proto-chemistry' for the Graeco-Egyptian world in the preceding paragraphs, and 'alchemy' for China, was because macrobiotics (longevity or material immortality attained by the aid of chemical knowledge) played hardly any part in the former culture but was central for the latter. The papyri described aurifiction,[d] and the adepts of the Corpus visualised aurifaction,[e] but the 'drug of immortality' was primarily a metaphor in the Greek context and primarily a real material thing for the Chinese.[f] There seem to be no exceptions to this rule,[g] and it needs bearing in mind during the sub-sections that follow.

[a] The initial consonant here is definitely *kāf*, not *kh*. This alone would exclude a possible derivation from *khamir* (leaven, yeast, ferment), as my friend Dr Said Durrani has pointed out. We are grateful also to Professor R. B. Serjeant and Professor D. M. Dunlop for advice on this subject.

[b] For example, the derivations of al-Ṣafadī, and Muḥ. al-Khwārizmī al-Kātib (+976), from *kama*, to conceal, and (Heb.) *Yahwé*, God, could not today be taken seriously. Cf. Mahdihassan (9), p. 115, commenting on Wiedemann's article, *s.v.* in the 'Encyclopaedia of Islam' (30). On this al-Khwārizmī see Mieli (1), 2nd ed., p. 94, and Wiedemann (7). About the same time (+980), Bar Bahlul, in his Syriac lexicon, connected *chēmeia* with Kīmā, the Pleiades, eight mixtures being governed by eight stars (cf. Berthelot & Duval (1), p. 133; Ruska, 13). The same work also confused it with *kémélaya* (*chameleon*, *χαμαιλέων*), because of the colour changes in chemistry (cf. Hoffmann (1), p. 530; Berthelot & Duval, *loc. cit.*).

[c] Reiterated in his usual way by Mahdihassan (9), p. 109, (15), p. 83, (17), p. 67, (25), p. 40. Arabic has to say *ṣan'at al-kīmiyā'*, *'ilm al-kīmiyā'*, 'the craft of...', or 'the science of...', chemy.

[d] Vol. 5, pt. 2, pp. 18ff. [e] *Ibid.*, pp. 16ff., 21ff.

[f] *Ibid.*, pp. 72ff.

[g] Occasionally something suspicious turns up, but it tends to evaporate on analysis. Almost a century ago, Draper wrote: 'Ptolemy II, Philadelphus (r. −285 to −246) was haunted towards the close of his life by an intolerable dread of death, and spent much time in the discovery of an elixir, devoting himself to this with great assiduity. There was a chemical laboratory (in the Museum at Alexandria) to which people flocked from all countries', (1), p. 20, (2), vol. 1, pp. 189–90, conflated. Justification for this statement has never been forthcoming; there is nothing to be found in the works of the standard historians such as Mahaffy (1) and Bevan (4), though we learn that he was an enlightened monarch, interested in Egyptian religion, doing much for commerce and industry, a benefactor to the Museum and Library, and devoted to mistresses both Egyptian and Greek after the death of Arsinoe II. Only in

On the substances known and used there is not much to say, for as far as one can see they were quite similar in East and West. The two noble metals and all the ancient base metals were known to everyone, as also mercury and its sulphide, cinnabar, together with the two sulphides of arsenic naturally occurring. Besides these there were a number of crude ores and minerals, a variety of salts and alums, and the oxides of the metals.[a] In nomenclature there was of course no similarity, with a few exceptions; lead was 'black lead' and tin was 'white lead' in China as in the West,[b] while it is somewhat eyebrow-raising to find that the epithet 'male' was applied at both ends of the Old World to one of the sulphides of arsenic. However, *hsiung huang*,[1] the 'male yellow', was the disulphide, realgar, while *arsenicon* (ἀρσενικόν) was *auripigmentum*, orpiment, the trisulphide.[c] It would not be wise to build very much upon this curious fact, in the absence of any other evidence of contact, which remains to be seen. It is also noteworthy, however, that the greatest achievements of ancient chemistry (apart from metallurgy) both concerned sulphides, the calcium polysulphides among the Greeks and stannic sulphide in China. And while we are upon the subject of colours,[d] there is always that disturbing fact that both in Hellenistic Alexandria and in China purple was of such great importance. Among the Greeks it was the highest stage of the transmutation of other metals into gold, the *iōsis* in the *chrysopoia*, while among the Chinese 'purple sheen gold' was the most wonderful of the forms of gold, and purple was the colour of Taoist ineffability.[e]

Lists of names and cover-names[f] occur in both civilisations.[g] The greatest in China was probably the *Shih Yao Erh Ya* compiled just after +800 (cf. pt. 3, p. 152), corresponding quite reasonably to the *Lexicon of Chrysopoia* contained in the Corpus, which may date from the end of the +10th century.[h] Parts of this are doubtless much

Athenaeus (*Deipnosophists*, XII, 51) do we get a clue: 'Phylarchus, in the 22nd book of his Histories, tells us that "Ptolemy of Egypt, the most admirable of all princes, and the most learned and accomplished of men, was so beguiled and debased in his mind by his unseasonable luxury that he actually dreamed that he should live for ever, and said that he alone had found out how to become an immortal".' This however could have been theurgic, or something like the deification of Roman emperors—certainly it is not in itself enough foundation for attributing alchemical elixirs to Ptolemaic Alexandria. If the account had referred to the +3rd century rather than to the −3rd, it might have been tempting perhaps to see in it a remote echo of Chinese Taoist alchemy, especially in the light of what has been said in the previous pages about contacts and transmissions, but Ptolemy Philadelphus is really rather too early for this. It was Dr S. Mahdihassan who first noticed this passage in Draper and brought it to our attention.

[a] Further similarities in mineral materials are fairly obvious—stalactites and stalagmites for calcium carbonate (Vol. 3, p. 605), aetites with its legends (Vol. 3, p. 652), and 'thunder-axes' (Needham (56), p. 34). On all these things de Mély (6) is is still worth reading.

[b] Cf. Berthelot (1), p. 230, and Bailey (1), *s.v.* for Pliny. In China lead was also 'black tin'.

[c] Berthelot (2), p. 210. De Mély (6), p. 328, saw this coincidence (if such it is) long ago, but confused the two sulphides.

[d] Cf. the interesting and learned discussion of Dronke (3).

[e] Vol. 5, pt. 2, pp. 23, 253, 262ff., pt. 3, pp. 173, 194.

[f] One of the frankest statements on the usage of cover-names occurs in the Jābirian 'Book of the Western Mercury', tr. Berthelot & Houdas (1), p. 214. Here cf. Siggel (3).

[g] And both tended to poetical fancies such as the blood, semen, horn or other parts, of mythical or coloured animals.

[h] *Corp. Alchem. Gr.*, I, ii. See also Berthelot (1), p. 24, (2), pp. 10–11; Festugière (1), pp. 220–1; von Lippmann (1), pp. 11, 325–6.

[1] 雄黃

older, though some versions betray their date by giving Arabic terms in Greek,[a] but Mei Piao's work was certainly not the first in China. What is more startling, in view of the universal Chinese use of the expression *huang pai chih shu*,[1] 'the art of the yellow and the white', for aurifiction and aurifaction, is that Ps.-Democritus is said to have prepared a 'Catalogue of the Yellow and the White'. So Synesius,[b] but Zosimus also refers to his 'Books of the White and the Yellow'.[c] Of course, such expressions referring to silver and gold would be natural enough, and could have arisen, one supposes, quite independently.

Passing to the methods used, we need say little about apparatus, since this is discussed in detail elsewhere (pp. 83ff.), and we have given attention also to the fundamental types of operation used (pp. 8ff.), showing that there was little or nothing to choose between China and the West in this particular.[d] Of outstanding interest here, however, is the fact that 'projection', i.e. great chemical change (often from base to noble metal) brought about by the addition of only a small amount of some other chemical substance, occurs early at both ends of the Old World, with China perhaps slightly leading. *Tien*[2] in Chinese was *epiballein* (ἐπιβάλλειν) in Graeco-Egyptian circles. It seems to have been present in −1st-century China, judging from the reports concerning Mao Ying *c.* −40 and Chhêng Wei, whose *floruit* was either −95 or *c.* −20; later on, after Yin Kuei about +300, it becomes exceedingly common.[e] In spite of attempts to deny the fact,[f] there can equally be no doubt that it is fully developed in the Hellenistic Corpus, occurring not only in Olympiodorus[g] and Synesius[h] but in Zosimus[i] and even in Ps.-Democritus himself;[j] this means from the +1st century onwards.[k] So also transmutation (*hua*[3]) is represented by several words —*diabasis* (διάβασις), *strepsis* and *ecstrepsis* (στρέψις, ἔκστρεψις), *strophē* and *ecstrophē* (στροφή, ἐκστροφή), while *cataspaō* (κατασήπάω) seems to have meant the pulling away of the previous nature or form (cf. pt. 2, p. 22).[l] Even the philosophers' stone is there, the 'stone that is not a stone' (*lithon ou lithon*, λίθον οὐ λίθον),[m] and the powder (*xērion*, ξήριον) of projection.[n] Presumably it is conceivable that all this should have developed

[a] Berthelot & Ruelle (1), vol. 3, p. 18.

[b] *Corp.* II, iii, 2; cf. Berthelot (1), pp. 155–6. [c] *Corp.* III, xxv, 2, 3.

[d] At any rate, in general principle. Distillation and reflux distillation seem to have started earlier in the Hellenistic world than in China, where there was more skill anciently in steaming techniques; and when distillation developed in China it was with a logically antithetical design. Cf. pp. 62ff. above.

[e] For the details see pt. 3, pp. 38–9 *et passim*.

[f] E.g. Dubs (5), p. 81, in answer to which the late Prof. J. R. Partington supplied us most kindly with Corpus references (priv. comm. 1959).

[g] *Corp.* II, iv, 12; 'project the powder', he says, very rightly, being engaged in the making of arsenical copper. [h] *Corp.* II, iii, 2; 'the projections of the Egyptians'.

[i] *Corp.* III, vii, 1; III, x, 2; III, xiii, end; III, xxiv, 7 'the prophet Chimes exclaimed with enthusiasm: "After projection, etc."'; III, xxviii, 2, 3 quoting Mary, 'project the yellow sandarac (realgar) in cloth bags'; III, lvi, 1.

[j] *Corp.* II, i, 4, 24; perhaps also making arsenical copper.

[k] The word *epiballein* or similar forms is found also in the +3rd-century papyri.

[l] Hence again the origin of the word 'spagyrical'.

[m] The two titles, *Corp.* IV, xx, tit. (Comarius to Ps.-Cleopatra), and III, xxix, tit. (Zosimus), may be later additions, but the stone is in the text at any rate in two places, III, vi, 6 and III, xxix, 21, both Zosimus. [n] *Corp.* III, xxix, 24 (Zosimus). Cf. p. 473 below.

[1] 黃白之術 [2] 點 [3] 化

twice over, but if one is resolutely determined to reject any influences from the East, it must give a somewhat uncomfortable feeling to know that aurifiction and aurifaction were going on in China a couple of centuries earlier than the first evidence we have of the techniques in the Mediterranean region.

As for the fundamental chemistry, mostly rather simple, that gave rise to the idea of projection in the first place, we now have a number of reasonable explanations. An idea common, it seems, to all the Old World civilisations, it has kept on cropping up throughout this Section (pt. 2, pp. 18, 195, 223, 225). Besides the mere debasement of the noble metals in *diplōsis*, Western Asia and the Mediterranean region had zinc compounds with which to make the gold-like brasses, and arsenic to turn copper silvery or golden, while to these East Asia added nickel for the production of the really silvery cupro-nickel. There were also always of course the amalgams, where 'all the mercury was turned to silver', and other possible uniform-substrate alloys which have been discussed in the metallurgical-chemical introduction (pt. 2, pp. 242ff.). But this was only half the armamentarium of the aurifictors and aurifactors, for striking results could be achieved by mere surface-films, whether quite coarse as in the case of the classical gilding and silvering processes, or rather fine, as when base metals were treated with sulphurous and arsenical vapours. Indeed if projection was made with very small amounts of substance relative to the mass to be transmuted, it is probably only to be explained in terms of oxidation and deoxidation. Cadmium or antimony in lead gives oxide films of striking colours on cooling, and such films can even be dyed with organic colours (as in the case of the anodised aluminium oxide films so commonly used on metal objects at the present day); and this was very probably known both to the Alexandrians and the Chinese. Again, high-tin bronzes are liable to 'sweat', crystals of pure tin growing out at the surface by segregation during solidification, and this can produce a highly silvery appearance. Many effects of that kind could have been produced. And finally, though it was probably not usually thought of as projection, there was the clever—and very ancient—technique of leaching out base metals from the alloy surface, leaving a thin layer of almost pure gold or silver. A great deal must always have depended on what use for the aurifactive 'gold or 'silver' was in mind, for re-casting would destroy surface-films, and uniform-substrate alloys would therefore be required if this was to be done. With all such possibilities before us, one can feel fairly ready to diagnose any case of aurifaction in the literature, either Eastern or Western, provided always that the description is sufficiently full.

Also under the heading of methods two further aspects should not be forgotten, the importance attached to secrecy and oral instruction (*khou chüeh*[1])[a] both in East and West, and the accompaniment of chemical operations by magic, exorcisms, talismans, etc. (*fu*[2]).[b]

How now to organise the realm of ideas? As it happens, there is a quite convenient way, for the Hellenistic proto-chemists were fond of certain sayings which they called

[a] *Corp.* II, i, 3, 29 (Ps.-Dem.). Cf. Berthelot (1), p. 162; Bidez & Cumont (1), vol. 2, p. 317; Festugière (1), pp. 221, 332ff.

[b] Here there is a wealth of material; we refer only to Berthelot (1), pp. 15, 16, 35.

[1] 口訣 [2] 符

ainigmata, 'enigmas' (*αἰνίγματα*), or, as we might say, axioms or aphorisms. Let us then take a look at the most important of these, adding a running commentary in which the similarities and differences with Chinese thought can be described. To begin, then,

[1] The All is One, by It arises every thing, [all things tend to the One],[a] and if the All were not One, it would be nothing at all.[b]

The All is One, by It every thing is engendered; the One is the All, and if it did not contain all things, it could not engender them [or, it could never have come into existence].[c]

[1*a*] The Serpent is One, it possesses the Power according to the Two Symbols.[d]

Here the main affirmation would have commanded the assent of every ancient Chinese philosopher. 'The sage embraces the Oneness of the universe, making it his testing-instrument for everything under Heaven'.[e] The unity and uniformity of Nature is of course the basic assumption of natural science. 'Only the enlightened man holding on to the idea of the One can bring about changes in things and affairs'.[f] Side by side with this first Alexandrian aphorism we could reasonably set that beautiful passage from the *Lieh Tzu* book,[g] purporting to be the words of Lieh Yü-Khou's master Huchhiu Tzu-Lin, talking to his fellow-disciple Pohun Wu-Jen.

There is an Engenderer which was not itself generated.
There is a Changer which is itself unchanging.
The Ungenerated can generate generation,
The Unchanging can transform the things that change.
What is engendered cannot but generate in turn,
What changes cannot but undergo further change.
Therefore there is perpetual generation and perpetual transformation,
And there is never any time when generated things are not generating, and changing things not undergoing change.

He was speaking of the Tao, as it shows itself in the Yin and Yang, the four seasons, and all the cycles of growth and dissolution. So also in their way were the Greeks and Egyptians.[h] Presumably anyone anywhere in the world meditating on Nature could have said the same kind of thing, but in considering the cosmic arrangements we must remember that there were also more detailed parallelisms. Certain symbolic correlations

[a] Only in Ps.-Cleopatra's Chrysopoia figure, opp. p. 64 in Berthelot (1), cf. p. 61. Also (2), pp. 133, 135.

[b] *Corp.* II, iv, 27 (Olympiodorus, quoting Chēmes); III, xx, 1 (Zosimus). Cf. Berthelot (1), pp. 61, 178, 284. Cf. 'Gospel of Thomas', log. 81, in Doresse (1).

[c] *Corp.* III, xviii, 1 (Zosimus, quoting Chymes).

[d] Again Ps.-Cleopatra only. This has to do with the Ouroboros symbol, on which see pp. 374ff.

[e] *Tao Tê Ching*, ch. 22, cf. Vol. 2, p. 46. [f] *Kuan Tzu*, ch. 49, cf. Vol. 2, *loc. cit.*

[g] Ch. 1, p. 1*b*, tr. auct. This book consists of material of all periods between the −5th century and +380.

[h] The Greek background of Aphorism [1] has been studied by Sheppard (4). The idea of the world as a single whole or organism (*unum esse omnia*) seems to have started with Xenophanes (*c.* −530; cf. Diels (5), vol. 1, no. 21 (11), p. 121, no. 31 (2), from Simplicius, *Phys.* 22, 22ff.; Diels–Freeman, p. 93), unless an Orphic fragment preserved by Clement of Alexandria is earlier. Certainly Plato (*Soph.*, 242D, Fowler ed., p. 359) attributed it to the Eleatics before Xenophanes. Contemporaries of the Alexandrian proto-chemists often voiced the affirmation of cosmic unity, e.g. *Poimandres*, XII, 8 (Hermes to Thoth, in *Corp. Hermet.*, ed. Nock & Festugière, vol. 1, p. 177) and another Gnostic work mentioned by Clement—as also Hippolytus and Galen (for references see Sheppard).

in the world of the Hellenistic proto-chemists were similar to those of the Chinese, though not identical, e.g. the association of spatial directions with colours,[a] and of elements with metals, planets, and even lunar mansions.[b]

Next comes a very famous aphorism.

[2] One nature takes pleasure in another nature, one nature triumphs over another nature, one nature dominates another nature.[c]

[2*a*] You, O King, must know this, and all leaders, priests and prophets must know this; that he who has not learnt to recognise the substances, and has not combined them, and has not understood their forms and joined like with like, will labour in vain and his efforts will be fruitless—for the natures of things take pleasure in each other, are charmed by one another, destroy one another, transform one another, and generate again each the other.[d]

On this splendid proto-chemical saying much has been written, but perhaps it has not so far been pointed out that we almost seem to be listening to a version of the 'mutual production order' (*hsiang shêng*[1]) and the 'mutual conquest order' (*hsiang shêng*[2]) of the Chinese Five Elements as that doctrine developed after the time of Tsou Yen in the −4th century.[e] According to this there was a defined sequence in which the elements came into being, one from the other, and a second sequence in which they overcame and destroyed each other. When these doctrines were first explained we noted that there were certain hints of similar ideas among the pre-Socratics, notably Pherecydes of Syros (*c.* −550)[f] and Heraclitus of Ephesus (*c.* −500), but they are not much more.[g] To this should be added also that Plato, in the *Timaeus* (*c.* −360), envisaged an interchangeability between water, air and fire, in an ascending series, only earth, a *caput mortuum*, remaining always unchanged.[h] Nevertheless it seems doubtful whether this aphorism can be fully accounted for by Greek theories of preceding centuries, so here is a case where it might be well to leave open the possibility that some other influence, perhaps adjuvant rather than capital, came Westwards along the Old Silk Road.

As regards the second quotation, a point of interest lies in the words 'will join like with like' (*ta genē synapsei tois genesin*, τὰ γένη συνάψει τοῖς γένεσιν), for it echoes again the concern which the Chinese had with the idea of *thung lei*.[3] We have taken occasion to compare the Greek with the Chinese thought on this subject in another place (pp. 318ff.), and found the latter more developed, since the *lei* were divisions cutting

[a] Cf. Berthelot (1), pp. 35, 182. Jung (8), pp. 195, 292, was much impressed by this, though not too sure on his facts. [b] Cf. Berthelot (1), p. 49, (2), pp. 73ff.

[c] *Corp.* I, iii, 12 (Philos. Egg), I, v, 3 (Ouroboros), I, xiii, 7 (Isis to Horus), II, i, 3 (the temple vision in Ps.-Democritus), II, iii, 1 (Synesius, attributing to Ostanes), III, i, 7 and III, xix, 2 (Zosimus). Parts of the aphorism recur as a refrain in the *Physica kai Mystica*, II, i, 4–12, 14, 16–18, 20–28. Cf. Bidez & Cumont (1), vol. I, pp. 244ff.; Festugière (1), pp. 229, 231, 259; Berthelot (1), p. 151.

[d] *Corp.* VI, xiv, 3 (Philos. Anonym. quoting Ps.-Democr.). Cf. 'Gospel of Philip', 109, 113, 126 and Gaertner (1).

[e] See Vol. 2, pp. 253, 255–6. The similarity was noted briefly by Tsêng Chao-Lun (2). Cf. p. 312.

[f] Cf. p. 346 above.

[g] See also Vol. 2, p. 245. In later times echoes are more frequent and more explicit. The astrological work of Nechepso-Petosiris, supposed to be of the mid−2nd century, says: 'una natura ab alia vincitur, unusque deus ab altero...' (Riess fragm. no. 28, from Firmicus Maternus, *Math.* IV, 16). Or again Ptolemy: 'the lesser cause yields always to the greater and stronger', *Tetrabiblos* I, 3 (cf. Boll, 6).

[h] 56C to 57C; cf. Cornford (7), pp. 224ff.

[1] 相生 [2] 相勝 [3] 同類

across the basic distinction between Yin and Yang things. For this last we can find a parallel in Zosimus, where he speaks of some substances originating from water, others from fire.[a] Such are the roots of the idea of chemical affinity in both civilisations.

The next aphorism does not perhaps have such close similarities with Chinese thought.

[3] If you do not take away from bodies their corporeal estate, and if you do not transform incorporeal things into bodies, [and if you do not make two bodies into a single one],[b] you will never obtain what you are seeking [or, none of the results you hope for will be produced].[c]

On the surface there is of course community, for the interconversion of vapour (*chhi*,[1] *aithalē*, αἰθάλη) and solid substances, whether in sublimation, volatilisation, distillation, condensation, or chemical combination, was an exceedingly familiar phenomenon both in East and West; but the aphorism probably means a good deal more than that, having reference to the basic Greek proto-chemical doctrine of the deprivation and addition of forms (cf. pt. 2, pp. 22 ff.). It is a striking thing that in Chinese theory there does not seem to be any appearance of the death-and-resurrection motif, though in the Corpus this can be found explicitly referred to.[d] Nor can one find in China any parallel to the concept of *prima materia*, stripped of all forms, both those which it had before and those with which the aurifactor would endow it. The distinction between matter and spirit was always in China much less sharp (cf. pt. 2, pp. 86, 92), and at this early time, corresponding to the Han period, the later Neo-Confucian conception of *chhi*[2] and *li*,[3] matter and organisation,[e] had not developed—even when it did, it was not at all the same as Peripatetic matter and form. What substituted for these theories was the interaction of the forces represented by the trigrams and hexagrams (*kua*[4]) of the *I Ching*,[f] and of that there seems to have been no trace in Europe.

Though 'favourable times' (*kairoi*, καιροί) are mentioned in the Corpus now and then,[g] and time itself (*chronos*, χρόνος) measured and waited upon, there was nothing like so great an emphasis on time in Hellenistic proto-chemistry as in Chinese alchemy.[h] Our theoretical sub-section (pp. 242 ff.) has demonstrated how vital it there

[a] *Corp.* III, x, 2. In III, xxviii, 9, 10 we have 'similars' (*ta homoia*, τὰ ὅμοια) and even 'relationship' or affinity (*syngeneia*, συγγένεια). Cf. Berthelot (1), p. 160.

[b] Only in the quotations attributed to Mary the Jewess. Cf. 'Gospel of Thomas', log. 110 tr. Ménard; Doresse.

[c] *Corp.* III, iv, a fragment specifically attributed to Hermes. Mary is quoted in Olympiodorus (II, iv, 40) and in Zosimus or Ps.-Zosimus (III, xxix, 1). The aphorism also occurs in I, iii, 12 (Egg) and IV, i, 9 (Pelagius quoting Zosimus, but the first part only). Cf. Festugière (1), pp. 242, 253; Berthelot (1), pp. 134, 171–2.

[d] *Corp.* III, viii, 2 (Zos.). It is curious that fertility rituals figure very little in the Chinese material which Frazer collected for his 'Golden Bough'. Prof. Dubs (priv. comm. *c.* 1950) doubted whether the theme had ever played any prominent part in Chinese culture. This may be understandable if the idea of the resurrection of the body was primarily ancient Egyptian and Mesopotamian (cf. pt. 2, p. 79).

[e] See Vol. 2, pp. 472 ff.

[f] A point well made by Huang Tzu-Chhing (1), p. 723.

[g] E.g. III, xiv, xv (both Zosimus, but referring to Hermes). See especially Festugière (1), pp. 243, 264, 277, 278–9.

[h] As Sivin (2) was perhaps the first to emphasise.

[1] 氣 [2] 氣 [3] 理 [4] 卦

was, not only in connection with the experimental heating times (*huo hou*[1])[a] but also for the slow development of minerals and metals in the earth, this being artificially accelerated by the alchemist in the laboratory. Only perhaps in the Ouroboros symbol (cf. p. 375) did the Greeks and Egyptians implicitly accept the importance of cyclical processes in chemical change and the time inevitably taken by them.

On the other hand, and linking up with what has just been said on the interconversion of vapours and solid substances, there was much community of thought in China and the West about the formation of mineral and chemical substances in the earth. The two 'exhalations', dry and wet (*anathumiaseis*, ἀναθυμιάσεις), of Aristotle[b] were mirrored in the role of *chhi*[2] as the Chinese understood it. A classical statement of theirs runs as follows:[c]

> Rock and stone are the kernel of the *chhi*, and the bones of the earth. Large masses form cliffs and boulders, the smallest particles form sands and dusts. The seminal essence of the *chhi* gives gold and jade, its poisonous part produces white arsenical ore and arsenious oxide. When the *chhi* congeals it gives rise to the red and caerulean pigments; when it becomes transformed it trickles out in the form of alum (waters) and mercury. Such are its transmutations. Now it changes from something soft into something hard, as when concentrated brine crystallises into dense masses; now it changes from something moving into something still, as when petrifactions are formed from plants and trees. Even flying things and running things can be changed into stone, and the once animate pass into the inanimate. Even thunder and shooting stars can appear as stones,[d] the formless passing into that which has form. Thus do the treasures of the great earth come into existence. Though metals and minerals, formed on the great potter's wheel of Nature, and in its furnaces and bellows, may seem but dull and stupid things, the Shaping Forces have produced them in inexhaustible abundance; and human beings may rely on them as full of value in the preservation of life and health. Though they may seem but dead gewgaws their use and profit to mankind is inexhaustible.

With this de Mély compared the statements one can find in Seneca's *Quaestiones Naturales* (*c.* +60) on the breath of the earth producing metalliferous veins and all its other minerals.[e] And there are also closer parallels, such as the idea that lead is the ancestor of all the other metals.[f] And what the *Huai Nan Tzu* book says about the generation of metals in the earth (p. 225) can be paralleled closely enough by medieval European statements such as one we have given already from Vincent of Beauvais (*c.* +1246),[g] or others in Arabic sources such as Ibn Sīnā's *Kitāb al-Shifā'* (+1022).[h]

[a] Or, more precisely perhaps, the phasing of the alchemist's application of fire or other heat prescribed, on theoretical grounds.

[b] Discussed in Vol. 3 above, pp. 469, 636ff. One of the best accounts is that of Eichholz (1).

[c] *PTKM*, ch. 8, (p. 1), tr. auct. The now inadequate translation of de Mély (6), p. 317, was taken from *Wakan Sanzai Zue* (de Mély (1), text, p. 1, tr. p. 3).

[d] 'Thunder-axes' and meteorites.

[e] E.g. II, x, III, xv, VI, xiii, xvi (Clarke tr., pp. 60, 126, 240, 245).

[f] This is in *Corp.* III, xvii, 1 (Zosimus), cf. Berthelot (1), p. 229. Correspondingly, *PTKM*, ch. 8, (p. 12), taken from the *Thu Hsiu Chen Chün Pên Tshao*, *c.* +1040; thence de Mély (1), text, p. 22, tr. p. 27. Berthelot (3) noticed this. Of course Chinese texts cannot always be taken *au pied de la lettre*; apart from the symbolism of 'lead' in physiological alchemy, lead also stands for the Yin or feminine Metal element in the *Tshan Thung Chhi* type-process. Cf. p. 253.

[g] Vol. 3, p. 639.

[h] Tr. Holmyard & Mandeville (1), pp. 38ff.

[1] 火候 [2] 氣

One can only say that these ideas were common property throughout the length and breadth of the Old World from the beginning of our era onwards.

Moreover there was in antiquity what Halleux (1) has called a 'biological conception of the mineral world'. Already in the *Iliad* the formation of silver is described as *genethlē* (γενέθλη), a birth word normally only used of men.[a] *Nascitur*, or *gignesthai* (γίγνεσθαι), was the standard term later on for metals and minerals, opposed in Dioscorides, for example, to *skeuazomai* (σκευάζομαι) for artificial products. Thus the mineral world was assimilated to the vegetable and animal worlds,[b] hence indeed the idea that mines should be allowed to have a fallow period.[c] In Chinese we do not see this 'biological analogy' so clearly since the verb *shêng*[1] was always indifferently used for birth and for all natural production. This brings us, however, to the role of sex in proto-chemistry.

The next aphorisms take us right into the realm of the Yin and the Yang.

[4] Above, the celestial things, below, the terrestrial; by the male and the female the work is accomplished.[d]

[5] Join the male and the female, and you will find what you are seeking.[e]

[6] If the two do not become one, and the three one, and the whole of the composition one, the result attained will be nothing.[f]

Certainly nothing could be more like the *thien ti yang yin*[2] complementarity than the first of these,[g] but we have to reckon with a widespread tendency to sexualisation in the ancient West also, doubtless because sexual union was one of the most primitive analogies for all chemical reaction.[h] According to Seneca, the Egyptians recognised a male and a female manifestation of each element, earth, fire, air and water—male crags and boulders being opposed to female cultivatable land, male burning to female glow, windy maleness to misty femaleness, and the sea being manly while fresh water was feminine.[i] The ancients also believed that certain stones were of two sexes, male (*arrēn*, ἄρρην) and female (*thēlys*, θῆλυς). Three such are in Theophrastus, the *lyngurion*, (λυγγούριον), i.e. tourmaline or fossil amber, rated according to the degree of transparency, and the sex of the lynx the urine of which was supposed to have formed it; the *cyanos* (κύανος), i.e. azurite, basic copper carbonate, rated according to the depth of

[a] *Il.* 2.857.

[b] There is much further material on this in different times and places in Daubrée (1); Sébillot (1); Cline (1) and Eliade (5).

[c] On Virgil's remarks about the iron ore of Elba Servius commented that the iron grows again there. As Bailey says (1), vol. 2, pp. 175–6, weathering would transform exposed sulphide to the sulphate, but the idea in the minds of the ancients was certainly that of vegetative growth.

[d] *Corp.* III, x, 4 (Zosimus), but also as a kind of caption to one of the MS. drawings of apparatus, Berthelot (2), fig. 37, from 2327, fol. 81 v, cf. pp. 161, 163.

[e] *Corp.* III, xxix, 13 (Zosimus, reporting a saying of Mary). Cf. 'Gospel of Thomas', log. 1, 22, in Puech (4); log. 27, in Doresse (1); cf. Pagels (1).

[f] *Corp.* I, iii, 13 (Philos. Egg, an ancient fragment).

[g] As Holgen (1) already realised in 1917 (p. 404). Yoshida Mitsukuni, too, (7), p. 210, was much impressed by the parallelism.

[h] Olympiodorus records a symbolic correlation of Chinese type, making the east male (Yang) and the west female (Yin); *Corp.* II, iv, 32, commented on by Berthelot (1), p. 64. The immense importance for later Western alchemy of sexual ideas and imagery, as in the 'marriage of contraries', etc., often elsewhere referred to in these volumes (pt. 3, pp. 69, 214, and here, pp. 121, 253, 259) was well emphasised in a rather quaint paper by Redgrove (1).

[i] *Quaest. Nat.* III, xiv (Clarke tr., p. 125).

[1] 生 [2] 天地陽陰

the blue colour, and *sardion* (σάρδιον), i.e. cornaline or sardonyx, also by the depth of its red.[a] This was handing down older traditions.[b] Moreover it was only natural that magnetite should exercise a feminine attraction on martial iron,[c] and fire be struck from male flint.[d] And 'pregnant stones', aetites, geodes, nodular concretions, etc. we have already mentioned.[e] In the Corpus the actual words for marriage and sexual union are used in connection with chemical reactions again and again, e.g. *syngamēsōsin* (συγγαμήσωσιν) in Ps.-Democritus, corresponding precisely to the Chinese terms such as *chiao kou*[1] which we constantly encounter in the other parts of this Section.

Nor can one overlook the important presence of women adepts in proto-chemistry and alchemy from the very beginning—Pseudo-Cleopatra, Mary the Jewess and Theosebeia[f] correspond most strikingly with the wife of Chhêng Wei, the wife of Ko Hung, Wei Hua-Tshun or Kʻêng the Teacher in China.[g] Gnostic prophetesses or women Taoists, they were always in the picture.[h] If there were ancient connections between the culinary and the chemical arts, this is not so surprising, but surely there were much deeper reasons—there were certain things which could only be accomplished by collaboration between the sexes, and for the birth of new compounds as well as for the birth of children, goddesses and women could do what gods and men alone could not. Now no ancient civilisation had this dual function so deeply embedded in the nature of all being as did the Chinese, for the Yin and Yang were the most fundamental manifestations of the Tao; *i Yin i Yang chih wei Tao*[2].[i] The extent therefore to which this profound ontological sexualisation, so characteristic of Chinese thought, had influence beyond its borders Westwards during the Hellenistic period is a question which ought to be raised, and indeed kept open, while research continues.

Further aspects of generation, including fermentation, arise in the last of the Hellenistic aphorisms which we must consider.

[7] Gold engenders gold, as wheat produces wheat, and women give birth to men.[j]

[Or:] He who sows wheat harvests wheat, he who sows gold and silver will obtain more gold and silver.[k]

[a] *De Lapidibus*, see Caley & Richards (1), pp. 109, 122; Eichholz (2), p. 107. Pliny follows suit with the carbuncle and the sandastros, *Hist. Nat.*, XXXVII, 92, 101.

[b] Cf. Boson (3) on the Assyrian and Babylonian texts.

[c] Pliny, however, divided the magnet-stones themselves into male or female according to their attractive power (*Hist. Nat.* XXXVI, 128, 129).

[d] Cf. Nonnus, *Dionysiaca*, II, 493ff.

[e] P. 205 above, and Vol. 3, p. 652. See also especially Bromehead (2); Bailey (1), vol. 2, p. 253.

[f] The eminent role of women in Hellenistic proto-chemistry was underlined by Berthelot (1), p. 64.

[g] To say nothing of all the semi-legendary or mythical instructresses like Su Nü,[3] or rather the real women of charismatic skill who stood behind them. Cf. Vol. 2, pp. 147–8 and pt. 5 below.

[h] There were many ways in which they could have been important in chemical technology at an earlier time still. Already we have met with an Akkadian perfume-craft mistress of the −13th century—Tapputi-Bēlatēkallim; p. 83 above.

[i] *I Ching*, Hsi Tzhu App. I, ch. 5, (ch. 2, p. 35*a*, Wilhelm–Baynes tr., vol. 1, p. 319).

[j] *Corp.* I, xiii, 8 (Isis to Horus), II, iv, 32 (Olympiodorus). In both cases a husbandman is appealed to as witness (Acharantus and Achaab respectively), and in the second the saying is attributed to Hermes.

[k] *Corp.* IV, i, 8 (Pelagius). Cf. Berthelot (1), pp. 51–2, 186.

[1] 交媾 [2] 一陰一陽之謂道 [3] 素女

We are standing here at the beginning of human knowledge about the phenomena of catalytic action, but while part of it was based on a true appreciation of the working of ferments, another part originated from a metallurgical misunderstanding. Noble metals have the property of retaining many of their characteristics even with considerable 'dilution', hence the possibility of 'debasement'. As we know (pt. 2, pp. 18ff.), the papyri and the Corpus constantly speak of the imitation, or 'multiplication', of the precious metals by alloying them with others such as copper, tin and lead, but at least some of the gold and silver mixture (*asem*, *electrum*) had to be there, though quite a small amount might do. Hence the proto-chemical artisans and philosophers talked of the *diplōsis* or *triplōsis* (doubling or tripling) of *asem*, the necessary amount of which was often thought of as a 'seed', possibly something like what we might call a nucleus of crystallisation. Moreover, it is clear enough (p. 357 above) that the theme of 'projection', the conversion of much by the addition of little, was already in the Corpus, just as it had been in China a century or so earlier;[a] and it was most natural that the action of a small amount of substance (corresponding to the later philosophers' stone) should have been likened to the action of yeast. After all, this had been made use of, if not understood, for three or four millennia already. The idea of a pinch of leaven leavening a great mass was taken over simply from the empirical human technology of beer and bread—the 'domestication of yeasts', which must go back at least to Babylonian times.[b]

The word loosely used for ferment in the Corpus is *maza* (μάζα), meaning leavened barley-bread,[c] thought of, presumably, in the unrisen state. The ordinary word for yeast itself, *zymē* (ζύμη), was not used. Zosimus, writing to Theodore, speaks of that 'inexhaustible *maza*' that Moses obtained according to the precept of the Lord,[d] and explains that the *maza* is the copper, to be converted as the bread is. From this it is sure that Zosimus (*c.* +300) visualised projection as a kind of fermentation.[e] The 'inexhaustible stock' is referred to also in both the artisanal papyri.[f] What is more, it seems that the word *maza* came quite early to be identical with the name of the art, *chēmeia*, itself, for Zosimus describes a procedure contained in 'the *Maza* of Moses'.[g] This writing cannot be the 'Domestic Chemistry of Moses' (cf. p. 327) as we have it now, because that text[h] is assessed at a +7th-century date, but it could have been some earlier writing attributed to Moses; in any case Zosimus goes on to quote a sentence occurring 'towards the end of the *Maza* of Moses'. This by itself might not

[a] One recalls the theological-liturgical parallel; pt. 3, p. 38, to which add Staniloae (1).

[b] On beer and brewing in ancient Mesopotamia see Huber (3), almost but not quite replaced by Röllig (1). Modern biochemistry has enabled us to make a clear distinction between the process of fermentation as such and the growth by cell-division of the population of organisms concerned, but such knowledge was not available to the ancients.

[c] Inferior to leavened wheaten bread, *artos* (ἄρτος). Strange that a word so similar in sound, *matza*, referred in Hebrew to *un*leavened bread.

[d] *Corp.* III, xliii, 6. This is a *catalogue raisonné* of chapter headings and contents in a book now lost. Some of the subjects in the relevant chapter are of much interest, e.g. decomposition (*sēpseōs*, σήψεως), fermentation (*zymiōseōs*, ζυμιώσεως), transformation (*metabolēs*, μεταβολῆς), and regeneration (*palingenesias*, παλιγγενεσίας).

[e] Indeed he says as much explicitly, quoting Ps.-Democritus, in *Corp.* III, lii, 4.

[f] Leiden pap. no. 7, Stockholm pap. no. 8; cf. Caley (1, 2).

[g] *Corp.* III, xxiv, 4, 5. A similar reference to Chimes immediately follows. [h] *Corp.* IV, xxii.

be very convincing were it not for the undoubted fact that later on *massa*, the Latin equivalent, came to be a synonym of chemia and alchemia. *Massa* normally means, of course, a lump, as of dough, or an inchoate mass of anything.[a]

From all this ancient literature the idea of the metallurgical 'ferment' passed into the alchemy of the Arabs, where nearly all the writers have it—the Jābirian Corpus and Ibn Umail, also the *Turba Philosophorum* and the +11th-century 'Book of Alums and Salts'. Thence to Geber about +1300, and to the Villanovan Corpus of the early +14th century, where *massa* and *azymum* have become the regular words for the philosophers' stone as ferment,[b] actual gold and silver still being thought of as necessary elements in its composition. Indeed a garbled etymology at times derived alchemia itself from *archymum* (i.e. *azymon*, ἄζυμον, unfermented dough), so that all chemistry (*archēmia*, ἀρχημία) was synonymous with the 'yeasty craft' (*maza pragma*, μάζα πρᾶγμα), as in the early +14th-century Byzantine Greek translation of Pseudo-Albertus *Semita Recta* or *De Alchemia*.[c] And so *massa* came to rest in Ruhland's lexicon (+1661): 'Kymus, id est massa.[d] Kuria vel kymia, id est, massa, heist dieselb Kunst/alchimia, al-kymia'.[e] This replication process, whereby a certain thing could make more of itself, like the widow's cruse of oil, *ad infinitum*, was surely a strange and not often recognised ancestral foreshadowing of the knowledge we now have about the self-replicating ribonucleoproteins in all cell-division. And by the same token it well exemplifies the truth that 'the alchemists took a path just the opposite of later chemistry, for while we seek to explain biological processes in terms of chemical ones, they conversely explained inorganic phenomena in terms of biological events.'[f]

In Chinese alchemical literature we have not found so much use of the terminology of fermentation, whether for the yeast or the mass of material which it transforms into something else,[g] but by contrast a rich related vocabulary, that of embryology and foetal development, is very much to the fore. To *maza* and *massa* corresponds the 'chaos' of the yolk and white, the *hung-jung*,[1] as it is called already in the *Lun Hêng*,[h]

[a] One cannot help wondering (in spite of Murray's Etymological Dictionary) whether this word, associated as it was with bread, could have generated the term 'mass' used in the Western Church for the eucharist or holy liturgy. The usual derivation is of course from the words of 'sending away' or dismissal, either of the catechumens before the anaphora or of the whole people at the end of the rite—unless 'commission' was a direct parallel of 'leitourgia'. But if *maza* accomplished (fermentative) change, so did the words of institution when pronounced by an ordained presbyter. Could *matza* also be relevant (though only the Western church preferred unleavened bread)? Strange that in Aramaic *patir*, unleavened bread, also meant 'to dismiss', 'to send home'.

[b] See Ganzenmüller (2), pp. 148, 177; Darmstädter (1), pp. 122, 181. One Geber reference is *Liber Fornacum*, chs. 25–27, Russell tr., p. 255.

[c] See Berthelot (2), pp. 208–9.

[d] P. 272. Also p. 149, 'Chymus, id est, massa'. Cf. p. 403 below.

[e] P. 271. Cit. Berthelot (2), p. 257. There is even a suggestion that *massa* may have been the origin of the German word for brass, *messing* (von Lippmann (1), p. 573). In view of what we have seen (pt. 2, pp. 195ff. above) about the imitation of gold by means of the low-zinc brases, this may have distinct plausibility.

[f] Ganzenmüller (2), p. 150, Cf. p. 363 above.

[g] It does nevertheless from time to time occur, as in the passage from the *Tshan Thung Chhi* reproduced on p. 317 from ch. 32 (ch. 3, p. 5*a*) or *TT*990, ch. 3, p. 6*b*. Here it is closely in the context of *similia similibus*..., i.e. the *thung lei*[2] concept, categorical identity or similarity, a thought-complex probably derived in part from the biological phenomena of fermentation and generation in all the ancient civilisations.

[h] Vol. 2, p. 370.

[1] 鴻濛 [2] 同類

and to the 'hermetic' vessel which came to be called in the West the 'egg of the philosophers'[a] correspond *tan*,[1,2] the hen's egg, and even more frequently *thai*,[3] the womb or matrix. Certain paragraphs in our sub-section on theory in China have had to be devoted especially to these parallelisms,[b] which even went so far as to involve the actual use of avian egg-shells in the experimental or technical set-ups. The image of the chicken egg and embryo (*chi tzu*[4]) constantly recurs, and one often finds the expression *tan phi*,[5] the 'foetus of the elixir', i.e. intermediate stages in its formation. So also in the Hellenistic Corpus there are two tractates concerning the 'egg', the first entitled 'What the ancients said about the Egg',[c] the second 'Nomenclature of the Egg, the Mystery of the Art'.[d] Both these explain figurative cover-names for many reagents drawn from the components of the hen's egg, and there is a third of the same kind (not in the Corpus): 'Elucidation of the Parts of the Egg according to Justinian'.[e] The first two could be of the +2nd or +3rd century, the third probably of the late +7th. On the other hand, a further short piece is called 'Techniques of the Emperor Justinian'[f] and this deals with the dry distillation of real eggs, a procedure which occurs commonly elsewhere in the Corpus and led, as we know (pt. 2, pp. 252–3) to the 'divine' or 'sulphurous' water (calcium polysulphides).

The two ideas, of leaven and life-germing, were closely connected. Very early the development of embryos was thought of as a kind of fermenting, morphological differentiation, with the appearance of complex organs, muscles, nerves and vessels, being analogised in a simple-minded way with the varied textures, shapes and colours which appear in maturing cheese. In the early Jewish Wisdom Literature, Job is made to say: 'Hast thou not poured me out as milk, and curdled me like cheese? Thou hast clothed me with skin and flesh, and knit me together with bones and sinews.'[g] Aristotle was saying the same thing—for him the menstrual blood was the material basis of the foetus and the semen provided the form, acting upon it just as rennet acts upon milk.[h] This idea, though little further developed, remained a commonplace throughout the Western Middle Ages, prominent for example in the visions of Hildegard of Bingen (+1098 to +1180),[i] and related to what Albertus Magnus had in mind when he said that 'eggs grow into embryos because their wetness is like the wetness of yeast'.[j]

These lines of thought were to lead in the end to our present understanding of proteins and enzyme proteins. The fascination which Alexandrian proto-chemists and Chinese alchemists alike had felt about the extraordinary potentialities of the avian egg and its contents was felt again by Sir Thomas Browne (+1605 to +1682) in his

[a] Illustration in Berthelot (2), p. 170; the *kērotakis* or aludel.
[b] Cf. pp. 292ff. above.
[c] *Corp.* I, iii, re-titled by Berthelot & Ruelle.
[d] *Corp.* I, iv, a shorter fragment.
[e] In Berthelot (2), pp. 214–15. He suggests (pp. 176, 297) a Pseudo-Justinian II.
[f] *Corp.* V, xxiv. On the general significance of eggs cf. Berthelot (1), p. 51.
[g] Job 10, 10. The book is now dated soon after −400, written somewhere in Palestine or Arabia in the post-exilic period.
[h] For fuller discussion see Needham (2).
[i] See Singer (3, 4).
[j] *De Animalibus*, XVII, ed. Stadler (1).

[1] 蛋 [2] 蜑 [3] 胎 [4] 雞子 [5] 丹胚

chymical elaboratory at Norwich in the middle of the century, where he carried out many experiments with the apparatus then available to try and find out more about these proteinaceous substances.[a] Work paralleling this on the mammalian amniotic and allantoic fluids was done by his contemporary Walter Needham, and further efforts to unveil the secrets of the proteins of eggs were discussed at length by Hermann Boerhaave in his *Elementa Chemiae* of +1732. But no real break-through in the understanding of protein structure was possible of course until the development of organic chemistry in the nineteenth century, and the classical work of Emil Fischer stood nearer the end of that than the beginning.

This concludes what had to be said about the Hellenistic aphorisms and the light which they throw on the earliest Western proto-chemistry, sometimes very close to Chinese alchemy in its ideas and theories, sometimes further away. But the love of aphorisms and oracular sayings did not cease with the Greeks, it was handed down through all later European chemical technology and alchemy, stemming in large measure from the wisdom of its Arabic counterpart. Let us look at the most outstanding gnomic utterance of these subsequent times, the *Tabula Smaragdina* or 'Emerald Table'.[b] This was a short statement in about a dozen verses, purporting to reveal the whole secret of alchemy—to anyone who could understand it. Immensely influential, or at least highly regarded, throughout the later Middle Ages and post-Renaissance periods, it was first printed in +1541[c] and often afterwards, as in the *Musaeum Hermeticum* of +1678.[d] But it was already well known in the +13th century because it is mentioned in the *De Rebus Metallicis et Mineralibus*[e] (*c.* +1280) authentically of Albertus Magnus, and reproduced (in one of its many versions)[f] by Roger Bacon in his edition of Pseudo-Aristotle, *Secretum Secretorum* (+1255, with an introduction of *c.* +1275).[g] This was then, however, far from new, because in fact it was an Arabic work, the *Kitāb Sirr al-Asrār*, a book of advice to kings, first translated into Latin by Johannes Hispalensis *c.*+1140 and again by Philip of Tripoli, *c.*+1243. The book itself may have been compiled at some time around +800, and it may have had a Syriac original, though this is not certain.[h] The text of the *Tabula*[i] underwent several other translations into Latin, including one probably by Plato of Tivoli *c.* +1140 and another by Hugh of Santalla in the middle of the same century.[j] The former, studied and collated by Steele & Singer (1), was the source of the well known version of Holmyard;[k] that of Read, however,[l] derived from the early printed versions through

[a] On this and the rest of the paragraph further information is in Needham (2).

[b] Emerald was a name for any green stone, including green glass. For example, the 'sacro catino', a great dish taken by the Crusaders at the sack of Caesarea in +1101, said to have been brought to Solomon by the Queen of Sheba, and to have been used at the Last Supper, turned out, when taken from Genoa to Paris in 1809, to be of green glass.

[c] Anon. (101), the *De Alchemia* of Nuremberg.

[d] Anon. (87), tr. Waite (8), vol. 2, p. 243. [e] I, i, 3.

[f] Several of these were collected in Tenney Davis (9).

[g] Steele (1), fasc. 5, pp. xlviii ff., 115 ff. For English incunabula and later versions see Manzalaoui (1).

[h] Cf. Mieli (1), 2nd ed., pp. 69–70.

[i] Its Arabic title was *Kitāb al-Lauh al-Zumurrudi*.

[j] This last was published by Nau (2), and is reproduced in Ruska (8), p. 178. Cf. Haskins (1), p. 67.

[k] (1), p. 95. [l] (1), p. 51.

chemical historians such as Thomson[a] and Rodwell.[b] For the corpus of legend which was handed down about the *Tabula*, its discovery by Alexander the Great in the tomb of Hermes,[c] etc. etc. we may refer simply to Read, and expatiate no further here.

As was pointed out by von Lippmann,[d] no Greek original was known, and none has come to light since his time. Apart from the Pseudo-Aristotle,[e] Holmyard (13) was the first to find another Arabic version, in the *Kitāb Usṭuqus al-Uss al-Thānī* (Second Book of the Elements of the Foundation), one of the treatises in the Jābirian Corpus.[f] Actually the *Tabula* text appears in at least one of the other books in this, the *Kitāb al-Ḥayy* (Book of the Living).[g] But though that would imply the middle or latter half of the +9th century, the date was pushed still further back when Ruska (8) discovered the *Tabula* at the end of the *Kitāb Sirr al-Khalīqa wa Ṣan'at al-Ṭabī'a* (Book of the Secret of Creation and the Art (of Reproducing) Nature),[h] otherwise entitled *Kitāb Balaniyūs al-Ḥakīm fī 'l-'Ilal* (Book of Apollonius the Wise on the Causes).[i] This is not in the Corpus but it was extremely influential upon it,[j] and it has no connection with the +1st-century Apollonius of Tyana (Balīnās or Balīnūs) except in so far as he retained a great name among the Arabs for natural philosophy and magic.[k] Internal evidence shows that this book was written possibly as early as +650, more probably

[a] (1), vol. 1, p. 10.

[b] (1), p. 62.

[c] The Arabs later on were particularly partial to stories of occult inscriptions discovered in underground tombs or temples. Perhaps one may be allowed the surmise that the idea of a cavern containing treasures of (chemical) wisdom may go back to the cycle of legends associated with Adam's cave. Jewish apocryphal writings which first appeared about the −3rd century related that after their expulsion from paradise Adam and Eve found a cave in which they hid the treasures of the earth and in which they were themselves finally buried. This story germinated in the Adam-Book of the Sethian Gnostics (cf. Doresse (1), vol. 1, pp. 281ff.), but it also assumed a Christian form which said that what Adam hid in the Cavern were the treasures which the Magi afterwards took with them to Bethlehem. Eventually it gained wide diffusion in many languages—Hebrew, Aramaic, Syriac, Armenian, Arabic, etc. As finally edited by a Nestorian early in the +4th century, the Syriac 'Book of the Cavern of Treasures' (tr. Budge, 7) goes on to say that when they found the cave at the top of a mountain Adam and Eve were still virgin, but that he was now consumed with passion for her. So they took from the borders of the Garden gold, frankincense and myrrh (symbols of kings, priests and physicians to come) and blessing them laid them up in the Cavern to be a house of prayer for ever; which things being done they went down to the foot of the holy mountain and there they lay together. Thus Eve became pregnant with Cain and his twin sister Lebhūdhā, and again with Abel and his twin sister Kelīmath. Later the parents of mankind were buried in the Cavern. For further information on this legend cycle see Bezold (3), pp. 7–8; Preuschen (1); Götze (1); Monneret de Villard (2); Foerster (1) and Doresse (1), vol. 1, p. 202.

Of course one need not insist on a Hebrew origin for the cave-complex in view of the prevalence of cave-tombs on each side of the Nile valley, to say nothing of the adyta of the pyramids, but it might be another case of that confluence of Hebrew and Egyptian ideas which is so evident in the Greek proto-chemical Corpus.

[d] (1), p. 58. Cf. Ullmann (1), pp. 170ff.

[e] A +12th-century Arabic MS., ostensibly dictated by the priest Sergius of Nablus, was discovered by Ruska (25). The translation of this *Tabula* version is in Ruska (8), pp. 113ff.

[f] Kraus (2), p. 12, no. 6. Holmyard gave an English translation; also in Ruska (8), pp. 120 ff.

[g] Kraus (2), p. 47, no. 133; cf. (3), p. 280.

[h] The last half of the title refers to the *Tabula Smaragdina*, which was supposed to describe in veiled terms an esoteric doctrine of the making of the elixir (Kraus (3), pp. 302–3). On Ruska's discovery see Winderlich (1), pp. 15–16; Plessner (3).

[i] This was first studied by de Sacy (1) in +1799. Cf. Kraus (3), pp. 272ff.

[j] Kraus (3), p. 282.

[k] As has been well emphasised by Multhauf (5), pp. 125ff., 131ff

about +820 under al-Ma'mun.[a] Its content has made it seem close to that of the Syriac 'Book of the Treasures' written by Job of Edessa early in the +9th century,[b] and also to what we have of Nemesius of Emesa (Homs)[c] who wrote in Greek about +400, contemporary with Synesius, but there is no direct parallel or overlap with the texts of either of these.[d] Thus there is still no ancient version of the *Tabula* either in Syriac or Greek, and the possibility presents itself that a source farther in the east should be looked for.

It was the considered opinion of Ruska that the origin of the text lay in a north-eastern direction, from Further Asia.[e] It was, he said, neither Islamic, nor Persian, nor Christian; could it be 'Chaldean' or Harranian (cf. p. 426)? Ought we not to think, he went on, of 'the great culture-oases in the region of the Oxus and Jaxartes rivers, of Merv and Balkh, or Khiva, Bokhara and Samarqand, those great cities which since ancient times had seen the exchange of material and intellectual goods between West and East, and where Greek traditions endured for such a surprisingly long time?' These two rivers flowing into the Aral Sea enclose Sogdia and Bactria, with Khwarizm to the west and Ferghana to the east—but to mention such names is to evoke the spirit of Chang Chhien and to mention China also. And Ruska did not shrink from this, for he visualised the cities on the Central Asian trade-routes north and east of the Sassanian empire as filled with a mixed population of Persians, Turanians, Syrians, Indians and Chinese,[f] places, as we know, where Buddhism, Manichaeism and the Chinese cults met together with Nestorian Christianity. Here the Graeco-Egyptian culture-world had passed into a cloudy distance, but alchemy, astrological and macrobiotic, was very much alive.[g]

Resting one day in 1968 at a wayside auberge in the South of France, I read again the text of the *Tabula Smaragdina* and felt so much the Chinese flavour of it that I started translating it to see how it would look in that language. Later on, returning home, I found that Chang Tzu-Kung (1) had suggested a possible Chinese original as long ago as 1945.[h] Perhaps we may dare here to reproduce the text inserting the Chinese words which one might imagine could have been in the primary form of it.[i] It runs as follows:

[a] Ruska (8), pp. 125ff., 127, 166; Kraus (2), p. lviii, (3), pp. 272ff. Ruska considered that it could hardly be earlier than the +7th century.

[b] Tr. Mingana (1). [c] Lat. tr. Matthaei (1).

[d] Kraus (3), pp. 276, 278.

[e] (8), p. 167. This is in agreement with the general view of other scholars, e.g. Ganzenmüller (2), p. 32. [f] (8), pp. 174–5.

[g] As a living witness to this conception we may cite that leaf of paper discovered in Eastern Sinkiang which has on one side a Chinese Buddhist *sūtra* text and on the other a mystical-magical mineralogy or lapidary of Hellenistic type written in Turkish but evidently translated from Sogdian. This has been described by Thomsen (1), with comments by Andreas. On the geography of the Central Asian routes of communication the studies of Herrmann (2, 3, 5, 6) have not really been superseded. The importance of the Old Silk Road for Chinese–Hellenistic intellectual contacts was already realised by Holgen (1) in 1917 (p. 471) and later emphasised again by Huang Tzu-Chhing (2) and others. Cf. Fig. 1531*a*.

[h] He knew only the version of Read (1). Some thirty years later Yoshida Mitsukuni (7), p. 209, translated it into Japanese, using many expressions similar to or the same as those which occurred to us. The whole atmosphere of the alchemical creed seemed to him very reminiscent of the *Tshan Thung Chhi* (cf. Vol. 5, pt. 3, pp. 50ff.).

[i] Using the German translation of the oldest known Arabic text, in Ruska, (8) pp. 159ff.

1. True, true,[a] with no room for doubt, certain, worthy of all trust (is this).
2. See, the highest (*shang*[1]) comes from the lowest (*hsia*[2]), and the lowest from the highest; indeed a marvellous work of the One (*Tao*[3]).[b]

[3*a*. See how all things (*wan wu*[4]) originated (*shêng*[5]) from It, by a single process.][c]

[3*d*. How wonderful is Its work (*tsao hua*[6])! It is the principle (*li*[7]) of the world and its sustainer (*chu*[8]).][d]

4. The father of it (the elixir, *tan*[9])[e] is the sun (*Yang*[10]), its mother the moon (*Yin*[11]); the wind (*chhi*[12] or *fêng*[13]) bore it in its belly (*thai*[14]), and the earth (*thu*[15]) nourished it (*yang chih*[16]).
5. This is the father (*tsu*[17]) of wondrous works (*shen ming pien hua*[18]),[f] the guardian (*pao*[19]) of mysteries (*shêng jen miao yung*[20]), perfect in its powers (*tê*[21]), the animator of lights (*kuang*[22])
6. This fire (*huo*[23]) will be poured upon the earth (*thu*[15])....
7. So do thou separate the earth (*thu*[15]) from the fire (*huo*[23]), the subtle (*chhing*[24]) from the gross (*cho*[25]), acting prudently and with art (*shen shu*[26]).[g]
8. It (the Tao[3]?) ascends from the earth (*ti*[27]) to the heavens (*thien*[28]), [and orders the lights (*yao*[29]) above],[c] then descends again to the earth; and in it is the power of the highest and the lowest.[h] Thus when thou hast the light of lights, darkness will flee away from thee.
9. With this power of powers (the elixir, *tan*[9]) shalt thou be able to get the mastery of every subtle thing (*wei*[30]),[i] and be able to penetrate (*thung*[31]) everything that is gross (*cho*[25]).
10. In this way was the great world itself formed (*tsao wu*[32]).

[11. Hence thus and thus marvellous operations (*miao fa*[33]) will be achieved.][j]

12. Hence I am called Hermes, thrice great in wisdom.

[13. ....][k]

[a] This emphasis on truth reminds one that Jung (8), p. 348, was much impressed with the parallelism between the 'inner spiritual man', actually, the 'true man' (*alēthinos anthrōpos*, ἀληθινὸς ἄνθρωπος) of the Gnostics, and the *chen jen*[34] or 'perfected' or 'realised immortal', later 'adept', of China. It is hard to know what to make of a coincidence like this; standing by itself it may not mean very much, but who knows what words of wisdom and what same-seeming ideals were exchanged in the Central Asian cities? Cf. Leisegang (1), pp. 78ff., who points out that Philo Judaeus was one of the chief users of the expression.

[b] It would also come naturally in Chinese thought to write *Chhien*[35] and *Khun*[36] here (cf. Vol. 2, p. 315, Table 14), and the whole affirmation looks remarkably like the doctrine that the extreme of Yang (*Yang chi*[37]) generates Yin[38] and vice versa (see Vol. 4, pt. 1, p. 9, Fig. 277, as also Fig. 1515 above; and all the discussion of physiological alchemy in Vol. 5, pt. 5).

[c] Considered to be a later addition. [d] A much later addition, thought Ruska.

[e] Or, 'the primary vitality (*yuan chhi*[39])'.

[f] We conjecture that the original of 'works' here could have been the typical 'changes and transformations'. [g] Or possibly *chhiao kung*.[40]

[h] Is this not a palpable reference to the powers of pure Yang (*shun Yang*[41]) and pure Yin (*shun Yin*[42]) at their transient maxima?

[i] Or perhaps *chi*.[43] [j] Only in one Arabic version.

[k] Not in the Arabic, nor are any of the other Latin codicils either.

[1] 上 [2] 下 [3] 道 [4] 萬物 [5] 生 [6] 造化
[7] 理 [8] 柱 [9] 丹 [10] 陽 [11] 陰 [12] 氣
[13] 風 [14] 胎 [15] 土 [16] 養之 [17] 祖 [18] 神明變化
[19] 保 [20] 聖人妙用 [21] 德 [22] 光 [23] 火
[24] 清 [25] 濁 [26] 神術 [27] 地
[28] 天 [29] 耀 [30] 微 [31] 通 [32] 造物 [33] 妙法
[34] 眞人 [35] 乾 [36] 坤 [37] 陽極 [38] 陰 [39] 元氣
[40] 巧工 [41] 純陽 [42] 純陰 [43] 幾

Whatever may be thought of this rather unusual exercise,[a] it is at least reasonable to suggest that a sharp look-out should be kept for possible primary sources in the Chinese alchemical and philosophical literature. Chang Tzu-Kung, who noted many parallels in Chinese tradition for the inscribing of gnomic utterances on slabs and steles in caves and temples,[b] was inclined to see the origin of the *Tabula* in the Nei yeh[1] chapter (49) of the *Kuan Tzu*[2] book, a text datable in the late −4th century or the early −3rd. We are not sure how convincing this is, for no exact parallelisms of wording occur; and the long chapter, in rhymed prose, is mainly concerned with Taoist ataraxy, harmony of the self with the universe, and the beginnings of physiological alchemy in diet and breath control.[c] Still, there are beautiful passages about the world of Nature, two of which may be quoted.

Always the essence (*ching*[3]) of things is what gives them birth (*shêng*[4]);
Below, it gives life to the five grains; above, it orders the stars in their ranks.
Coursing through all things between heaven and earth, it may be called daemonic and spiritual,
Stored within the breast of a man, it may be called the sagely.
Therefore this breath (*chhi*[5]) of life—
How bright it is! As if mounting the heavens,
How dark! As if entering an abyss of gloom,
How vast! As if filling the whole ocean,
How compact! As if held within the self....[d]

Or again:[e]

What enables transformation (*hua*[6]) in unity with things (*i wu*[7]) is called spirit (*shen*[8]),
What enables change (*pien*[9]) in unity with (human) affairs (*i shih*[10]) is called wisdom (*chih*[11]).
To transform without altering one's breath of life,
To change without altering one's wisdom,
Only the enlightened man who grasps the unity of Nature (*chih i chih chün tzu*[12]) is able to do this!
And since he grasps this unity, and does not lose it,
He is able to reign as prince over the myriad things.
The enlightened man commands things, and is not commanded by things,
Because he has gained the principle of the One (*tê i chih li*[13])...

But it is not quite what we are looking for, and something much nearer would be needed to confirm our suspicion.

[a] I had, at least (without knowing it), the inspiring example of Genzmer (1), who succeeded in reconstructing the original German of a verse or two of epic theodicy (of −500 or so) from Tacitus' Latin (*Germ.* 11). This was most kindly brought to my knowledge by Dr Peter Dronke. For its further background see Ineichen, Scindler & Bodmer (1), pp. 708ff.

[b] A typical example has been given in translation in pt. 3, p. 195 above.

[c] We drew upon it now and then in Vol. 2, e.g., pp. 46, 60–1, but it is fully translated by Rickett (1), pp. 158ff.

[d] Pp. 1*a*, *b*, tr. Rickett, *op. cit.*, mod. auct.

[e] Pp. 3*b*, tr. Rickett, *op. cit.*, mod. auct.; cf. Haloun (2) in Vol. 2, *loc. cit.*

[1] 內業 [2] 管子 [3] 精 [4] 生 [5] 氣 [6] 化
[7] 一物 [8] 神 [9] 變 [10] 一事 [11] 智 [12] 執一之君子
[13] 得一之理

What does so rather more is the little that we know of the content of the 'Book of the Secret of Creation' of Balīnās himself, the first in which the *Tabula* occurs, and perhaps to be put in the +7th or +8th century. It has never been printed, so it is accessible only in the Arabic and Latin MSS, but something has been told of it by Multhauf.[a] It seems to contain several of the most characteristic motifs of later Arabic alchemy—knowledge of sal ammoniac and borax, the idea that all metals are mixtures of sulphur and mercury, and even (in one version)[b] the numerological or 'quantitative' analysis of elements and qualities in chemical substances. But in the account of 'creation', or cosmic evolution, the thought grows closer to Chinese origins. Heat acted as male, cold as female, their union producing humidity and dryness, just as Yang and Yin would be expected to do. The minerals and metals are each connected with the planets, as they would be in the Five-Element symbolic correlation system, but further the metals themselves are male or female (gold, iron and lead Yang, copper, tin and silver Yin, and mercury hermaphroditic or equally balanced).[c] Just as in the *Huai Nan Tzu* passage,[d] ores are concocted in the bosom of the earth century after century, mercury 'fermenting' with sulphur there, as so often it was made to do in the 'regenerated elixir' experiments of China.[e] Although it is generally agreed that 'Balīnās' refers to Apollonius of Tyana in Syria, one is almost driven to wonder whether this consensus should be questioned (for it rests on very little), and whether we might not have to have recourse to an Apollonius of Bactria? After all, the Euthydemid and Eucratid kings left behind them there a population Greek in names, and partly in speech, for centuries afterwards; and from a country where under many rulers the coins bore images of Hindu gods with Greek inscriptions almost anything might be expected. But even if we stick to Apollonius of Tyana (+1st century) as the eponymous hero we must remember that his biography registers much Asian contact, especially with the 'magi' in Mesopotamia and the brahmins and ascetics of India.[f] There is probably much more to be discovered yet about what Ruska called the 'Apollonische Schriftenkreise' than anything we can at present say.[g]

[a] (5), pp. 125ff., 132–3, following de Sacy (1). Cf. Plessner (9).

[b] According, at least, to one of the Jābirian writers; Kraus (3), pp. 188, 196.

[c] Of course this assignment of sexes is quite different from the Chinese. Cf. Fig. 1533.

[d] See p. 224.

[e] Cf. pt. 3, pp. 20, 73–4, etc.

[f] Cf. Meile (1); Goosens (1); Filliozat (6). The 'Life of Apollonius of Tyana' was written by Philostratus of Lemnos about +218; tr. Conybeare (1); Jones (1). He was one of the learned circle of the Syrian empress Julia Domna in Athens, and died *c.* +240. Most of the travels of Apollonius about which he wrote are considered quite apocryphal, but they include a visit to Taxila in India, and to Ethiopia. It remains, however, a most insipid book, and I find it very difficult to understand how Apollonius can ever have got such a reputation among the Arabs for alchemical natural philosophy.

[g] The other great *Tabula* of the Western Middle Ages was the *Tabula Chemica* attributed to Senior Zadith Filius Hamuel. There is no doubt about the identification of this writer with Muḥammad ibn Umail al-Ṣādiq al-Tamīmī, who died *c.* +960. The piece is a very allegorical poem in some 90 strophes, and derives directly from two works in Arabic, the *Kitāb al-Mā' al-Waraqī wa'l-Arḍ al-Najmīyah* (Book of the Silvery Water and the Starry Earth), and the *Risālat al-Shams ilā 'l-Hilāl* (Epistle of the Sun to the Cresent Moon). The Arabic texts were discovered by Rosen in 1877 and de Slane in 1883, and the identification was made by Ali, Stapleton & Husain (1), who published the Arabic and the Latin together in 1933. See also the discussions of Ruska (9, 10). The Latin versions are extremely corrupt, and the Arabic very Hellenistic in origin, quoting Hermes, Ps.-Democritus, Mary, Zosimus, etc. Although it uses their aphorisms freely, it is too long-winded to be regarded as aphorismic itself, so we do not consider it further here. Cf. also Holmyard (1), pp. 99–100.

In closing this balance-sheet, and in this connection, we should like to allude to a point which was acutely made by Berthelot[a] and which has already been referred to (pt. 2, p. 25). The word atom never once passes the lips of the Hellenistic proto-chemists. Thus the writers of the Corpus (like the artisans of the papyri) seem to stand aloof from the traditions of Greek atomism and Indian atomism alike, and though they were certainly close to some versions of Peripatetic philosophy (cf. pt. 2, p. 26), their lack of interest in atoms seems to link them, as it were, along the Old Silk Road, with those other, more northerly, regions of Iranian and Chinese culture where atoms were not in favour either.

(v) *Parallelisms of symbol*

Lastly comes the question of symbolism. As is well known, the MSS of the Hellenistic proto-chemical Corpus are illustrated by four depictions of a serpent with its tail in its mouth.[b] This (Fig. 1525) is the emblem (or representation of a mythological being) traditionally known by its Greek name as Ouroboros,[c] the 'dragon tail-eater' (*δράκων Οὐροβόρος*). Three of the pictures are captioned by variant forms of Aphorism [1] above; and it is not difficult to think of reasons why the Graeco-Egyptian proto-chemists should have chosen Ouroboros as their chief symbol.[d] The infinite rotation of transformations giving new things within the unity of matter and of Nature,[e] the reproduction of the original substances started with, as in the oxidation and reduction of metal and calx, the repeatability of combining and decomposition, the cycle of aurifactive or aurifictive changes produced by adding arsenic to copper and blowing it off again, even the *kērotakis* technique of reflux distillation,[f] all would justify the symbol of eternal recurrence.

In the Corpus itself there are three chief mentions, two short descriptions among the oldest fragments,[g] and one curious paragraph apparently written by Olympiodorus late in the + 5th century.[h] The first begins (obviously referring to chemical change):

> Here is the mystery: the serpent Ouroboros (devouring its tail) is the composition which as a whole is devoured and melted away, dissolved and transformed by fermentation (or putrefaction, *sēpsis*, *σῆψις*)...[i]

[a] (1), pp. 263–4.

[b] Two of these are pictorial and two diagrammatic. All are reproduced in Sheppard (4), perhaps the best paper on the subject, and of course in Berthelot (1), p. 59, opp. p. 64, 284; (2), figs. 11, 13, 34, pp. 193, 196. Sherwood Taylor (2) reproduces three, and all treatments of Greek proto-chemistry say something on them.

[c] A better English spelling would be Uroboros, analogous to words like 'urodele'. The etymology is from *oura* (*οὐρά*), tail, and the root of *bora* (*βορά*), food, *boros* (*βορός*), voracious.

[d] Serpents as such were also numinous because the sloughing of the skin typified regeneration and rebirth; cf. Macrobius, *Saturnalia*, I, xx. This could have been connected with the death-and-resurrection motif of *prima materia*; cf. Sheppard (5).

For a later Chinese Buddhist parallel cf. Vol. 2, p. 422 and Fig. 47.

[e] Berthelot (1), p. 284.

[f] Sherwood Taylor (2).

[g] *Corp.* I, v and vi, both titled by Berthelot & Ruelle.

[h] *Corp.* II, iv, 18.

[i] This may well have been a reference to the attacking of the base metal by the corrosive vapours in the *kērotakis*.

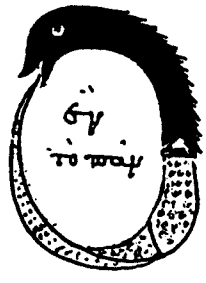


Fig. 1525

Fig. 1526

Fig. 1527

Fig. 1525. Hellenistic Ouroboros. A representation from MS. Marcianus 299, fol. 188v. The inscription says: 'The One is the All' (in *Chrysopoia*, ps-Cleopatra).

Fig. 1526. Hellenistic Ouroboros. Another representation, from Paris MS. 2327, fol. 196 (in Olympiodorus, late +5th century). The tail-eating serpent's three concentric rings are coloured green, yellow and red, from inside outwards respectively. The four feet are said to represent the basic elements (*tetrasōmia*), and the three ears the sublimed vapours (*aithalai*), probably sulphur, mercury and arsenic. Both these redrawings are from Sheppard (4).

Fig. 1527. Hellenistic Ouroboros on a Gnostic gem, one of the many Abraxas talismans. From King (3), redrawn by Sheppard (4). Date ± 1st century, contemporary with ps-Cleopatra.

And it goes on to explain another of the pictures (Fig. 1526) by saying that 'the four feet constitute the *tetrasōmia* (τετρασωμία)'[a] and 'the three ears are the three sublimed vapours (*aithalai*, αἰθάλαι)'.[b] For his part, Olympiodorus wrote:

Agathodaemon, having placed the original principle in the end, and the end in the original principle, affirmed it to be that serpent Ouroboros; and if he spoke thus it was not in jealousy (to hide the truth) as the uninitiated think. That is made obvious by the use of the plural—eggs.[c] But you who know everything—who was Agathodaemon? Some say he was the ancientest among the philosophers of Egypt, others that he was a mysterious messenger, the good angel of that land. Others have called him the heavens, perhaps because a serpent is the image of the world. And indeed certain Egyptian hierographists, wishing to represent the world on obelisks, or express it in sacred characters, have engraved the serpent Ouroboros, with its body studded with stars.

This was what I wanted to explain about the original principle, said Agathodaemon.[d] It was he who published the book on chēmeutics.[e]

His reference to the star-studded serpent reminds us that in fact Ouroboros was a symbol far older in time and more widespread in space than the proto-chemistry of Hellenistic Alexandria. The image of the serpent or dragon eating its own tail was very ancient both in Egypt and the Mesopotamian region. A primeval serpent was part of the cosmogonic mythology of the Pyramid Texts (*c.* −2300)[f] and occurs

[a] The Pb, Cu, Sn, Fe alloy supposed to be the starting-point of aurifaction.

[b] Certainly Hg, As and S. The second fragment is essentially a shorter version of the first. Both of them end with a passage about the ritual slaying and sacrifice of a temple-guarding serpent, which closely parallels one of the visions of Zosimus (*Corp.* III, i, 5); cf. Berthelot (1), pp. 60, 180–1. We have already encountered dragon-killing metaphors connected with alchemy in ancient China (pt. 3, pp. 7–8).

[c] Which generate fowls, and they eggs once again.

[d] Now a real person must be intended.

[e] Cf. p. 344 above.

[f] Rundle Clark (1), pp. 50ff. In the 'Book of the Dead', even older, the serpent Āpepi personifies the darkness which the rising sun (Horus), symbolised by a cat, must daily conquer (Budge (4), pp. 248, 280).

figured in Ouroboros form both in Coffin Text pictures (*c.* −1300)[a] and in the mythological papyri (*c.* −1050).[b] But two intertwined Ouroboroi are seen also in a relief of black asphalt excavated from a level of the Elamite necropolis at Susa antedating Hammurabi's time (*c.* −2000).[c] These ideas of cosmic serpents surrounding the universe were quite appropriate as symbols of the recurrences of the planetary revolutions, accurate in their several periods but incommensurable.[d] They would also have come to be connected quite naturally with celestial serpents and dragons, either in the form of constellations or of the monster which controlled solar and lunar eclipses.[e]

Ouroboros reached his apogee, so to say, in the Gnostic period (−2nd to +3rd centuries)[f] when the Greek and West Asian cultures had come together.[g] Many theologies resulted from that union.[h] The tail-eater appears on innumerable inscribed gems, seals and amulets which have come down to us (cf. Fig. 1527);[i] since the seventeenth century these have been known as Abraxas gems, because that word often occurs on them, as here, where it is accompanied by Iaō as well. The former was a Gnostic incantation or word of power,[j] the latter the name of one of the archons or evil demiurges and rulers who had created and now governed the material world,

[a] Rundle Clark (1), pp. 53, 81, 240ff., figs. 8, 11. Hermopolis, standing for the whole world, is surrounded by Ouroboros.

[b] Piankoff & Rambova (1), p. 73 and facsim. pl. 1 (the Papyrus of Her-uben A). Cf. Mahdihassan (26), fig. 3.

[c] *Mémoires de la Délégation en Perse*, vol. 13, pl. XXXVII, 8, in connection with the paper of Pottier (1). Cf. Deonna (3).

[d] 'The nous-demiurge, encompassing the circles and whirling them round with thunderous speed, set his creations in eternal revolution, so that every ending is a new beginning', *Poimandres*, 11 (*c.* +1st cent., *Corp. Hermet.*, Nock & Festugière (1), vol. 1; cf. Jonas (1), p. 150). Cf. Sir Thomas Browne: 'All things began in Order, so shall they end, and so shall they begin again; according to the Ordainer of Order, and the mysticall Mathematicks of the City of Heaven', 'Garden of Cyrus' (+1658), ch. 5.

[e] Cf. Vol. 3, pp. 228, 252. See also the fragment *De Dracone Coelesti* preserved in Cumont (5), vol. 8, pt. 1, pp. 194ff.; and further in Bouché-Leclercq (1), pp. 122ff.

[f] Perhaps before the life of Christ we should speak of proto-Gnostic ideas, cf. Grant (1), p. 14.

[g] The symbol had not been known in classical Greece or in the Etruscan and early Roman cultures.

[h] On the general relations of Gnosticism and proto-chemistry see Sheppard's interesting study (1). As Doresse (1), vol. 1, pp. 105ff. and Puech (3) have pointed out, there are very Gnostic passages in Zosimus (*Corp. Alchem. Gr.*, III, xlix, 'On the Letter Ω'), and in Olympiodorus (*Corp.* II, lv, 32) where the cosmic mythology of Adam and Eve is already sketched in purely chemical terms, foreshadowing the medieval equations: Adam = philosophical sulphur, and Eve = philosophical mercury (cf. Doresse, *op. cit.*, p. 130).

Again, there are echoes outside the Corpus. According to St Ephraim of Syria (d. +373), the Gnostics and Manichees say that the mingled constituents of good and evil 'conquer one another and are conquered by one another' (Mitchell (1), vol. 1, p. xvii). This is reminiscent of Aphorism [2].

The historian of chemistry should also be aware that Gnosticism in due time found a place within the bosom of Islam as part of the theology of the Ismailite (*Ismā'īlīya*) movement (+8th to +10th centuries). This was closely connected both with the scientific writings of the Brethren of Sincerity (cf. Vol. 2, pp. 95–6, Vol. 3, p. 602) and with the Jābirian Corpus in Arabic alchemy (cf. pp. 396ff. below). On this connection, the full implications of which are as yet far from being fully understood, see Corbin (1); Strothmann (1).

[i] See King (4), pl. XII, 1*a*, descr. pp. 206–7; and (3), pls. C 5 and M 2, also pp. 103, 213ff. Sometimes Ouroboros appears as one constituent part of the design, but often, as here, it forms the frame. These religious and magical representations, sometimes very complex and even now not entirely explained, were first studied and published by de Montfaucon (1) at the beginning of the +18th century. See the English edition, vol. 2, pt. 2, bk. 3, pls. 48–53. Cf. Berthelot (1), p. 62; Preisendanz (2); Bonner (1), pp. 19, 158, 250, pls. II, 39, VII, 141, 153, VIII, 172, IX, 191.

[j] Derived from the figure 365 in Greek mathematical-alphabetic notation.

planetary gods with names derived from those of the Old Testament God of Israel.[a] Ouroboros has been supposed to symbolise eternity here, but as like as not it stands for all the aeons, terrifying vastnesses of time and space in which man's spirit was imprisoned if no saviour came, each cyclical and perpetual like planetary revolutions.[b] By the +1st century the symbol was penetrating Roman,[c] Gallo-Roman[d] and Scythian[e] culture.

The Gnostic literature also has many references to Ouroboros. The tail-eater, 'king of the worms of the earth', occurs, identified with the serpent of Genesis, in the +2nd-century Jewish-Syriac 'Acts of Kyriakos and Julitta';[f] while in the apocryphal 'Acts of the Holy Apostle Thomas' (+3rd cent.) he too meets the tempter serpent, son of the world-encircling tail-eater.[g] This book is particularly interesting because it incorporates the older 'Song of the Apostle Judas Thomas in the Land of the Indians',[h] a beautiful allegory in which the son of an Asian king[i] is sent to Egypt to steal a pearl of great price guarded by a coiled dragon there. The details we omit, only drawing attention to the remarkable appearance in +2nd-century Syriac of an astronomical motif characteristically Chinese.[j] This is only one more indication of that Westward current which gave Buddhism such an influence not only on

[a] The real God of Light and Life, alien to this world but man's only true home, was sharply distinguished by the Gnostics from either Yahwé or Zeus, since (like Mani after them) they regarded all material things, including food and sex, as irredeemably evil. Their creator therefore was also evil, and the good God was not a creator. For one of the best accounts of Gnosticism see Jonas (1). But there is a rich expository literature, for example Leisegang (3); Wilson (1, 2) and the older book of Burkitt (2). Burkitt was one of my greatest teachers, but his conviction that all the Gnostic systems ought to be regarded as Christian heresies is hardly, I think, acceptable in the light of modern knowledge. Even though some of their books made much use of personages and *logia* taken from the Christian Gospels, as well as parallel soteriological doctrines, they were really forms of another religion.

We have no certainty that any form of Gnosticism as such ever spread as far as China, but it has long been suspected that the Taoist Trinity (San Chhing[l]) may have derived, at least in part, from the doctrines of Basilides; cf. Quispel (1).

[b] Jonas (1), pp. 51ff.; cf. Leisegang (3), p. 35.

[c] E.g. the bronze mask of Jupiter on an eagle within an Ouroboros, ascribed to the +1st century; Cumont (7). And the Mithraic monuments discussed in Cumont (6), vol. 1, p. 80, vol. 2, pp. 208 (no. 25, fig. 36), 453 (no. 15, fig. 407).

[d] E.g. the patera found near Geneva and described by Deonna (2).

[e] Here the serpent-dragon has become a lion or a horse; see Rice (1), several examples, and Rice (2), fig. 64. Cf. Mahdihassan (26), figs. 19–21.

[f] In Reitzenstein (2), p. 78.

[g] 3, 32, ed. Lipsius & Bonnet (1), vol. 2, pt. 2, p. 149; James ed. (1), p. 379; Bornkamm (1). Cf. Doresse (1), vol. 2, pp. 44ff. Cf. Fig. 1529.

[h] Called by modern editors 'Hymn of the Pearl' or 'of the Soul'; 9, 108–113, ed. Lipsius & Bonnet (1), vol. 2, pt. 2, pp. 219ff.; James ed. (1), pp. 411ff. A translation in verses by A. A. Bevan, revised by W. R. Schoedel, is given in Grant (1), pp. 116ff. For an exegesis see Jonas (1), pp. 112ff. Cf. too Doresse (1), vol. 1, p. 102; Reitzenstein (4).

[i] Seemingly Parthian. The 'Acts' and the 'Song' are considered closely related to the culture of the city of Edessa. One of the most recent discussions of the Thomas legends will be found in Dihle (2).

[j] See Vol. 3, p. 252, and *in extenso* de Visser (2). Another example of this kind can be found in a Gnostic prayer which has been deeply studied by Peterson (1). It occurs in one of a collection of magical papyri and addresses to the creator god Aeon (= Sabaōth), an appeal to save Adam and his descendants from that destiny (*heimarmenē*, εἱμαρμένη) meted out by the powers of the air (*daimōn aerios*, δαίμων ἀέριος) ruling like a high official between the Light and the Darkness. But Aeon is termed 'ruler of the Pole' (*akinokratōr*, ἀκινοκράτωρ) and is said to be 'throned on the Great Bear' (*heptameriou statheis*, ἑπταμερίου σταθείς). This is an eyebrow-raising parallelism, to say the least, for nothing more Chinese could be imagined than deities or sub-deities in that constellation (cf. Vol. 3, p. 240 and Fig. 90). See also Doresse (1), vol. 1, pp. 112ff., 186, 302.

Interesting examples of Indian–Gnostic connections were discussed by Kennedy (2) in his study of the Gospels of the Infancy, the *Lalita Vistara* and the *Vishnu Purāṇa*.

[l] 三清

Manichaeism[a] but on Gnosticism itself.[b] Naturally Ouroboros was especially important among the Ophite Gnostics, whose cosmology was discussed by Celsus (*c.* +178) and his opponent Origen in +248. For the Ophites Ouroboros–Leviathan[c] surrounded the seven planetary spheres; indeed it was the firmament itself, beyond which lay paradise.[d] Also in the +3rd century come mentions and depictions of Ouroboros in the magical papyri cognate to and even overlapping with the chemical-technological ones.[e] Finally, in the Egyptian Gnostic-Christian work *Pistis Sophia* (+4th cent.) purporting to record the teachings of Jesus during eleven years after his resurrection, the tail-eater appears twice, once as the outer darkness encircling the universe,[f] and again, paradoxically, as the sun's disc in glorious light.[g] These examples may suffice.[h]

We need not pursue the Ouroboros into its late medieval and post-Renaissance manifestations.[i] But it is interesting that a number of these are double, i.e. formed by two tail-biting animals, not one only. This device occurs in Arabic alchemical texts (if indeed it did not start with them), as in Ibn Umail in the first half of the +10th century.[j] It also appeared in China, as Rousselle found when in the early thirties he came to kneel in the centre of the carpet in the initiation hall of the Taoist community to which he was admitted in Peking.[k] The design figured prominently the double

[a] In this religion, which spread from Susiana to the shores of the Atlantic as well as those of the Pacific, and lasted a full twelve centuries (if it is not still latent though unacknowledged in some pseudo-Christian attitudes), the Gnosis came to full ecclesiastical form. This was already realised by J. C. Wolf in +1707. The founder Mani (+216 to +277) claimed to be the completer of the gospels of Zoroaster, Gautama Buddha and Jesus; among the best accounts of him and his religion are the books of Burkitt (1) and more recently Puech (1). Its absolute dualism was expressed with crystalline brevity by the Dominican Anselm of Alexandria (or whoever wrote the *Tractatus de Hereticis*) *c.* +1265: 'Notandum quod in Persia fuit quidam qui vocabitur Manes, qui ait primo intra se: Si deus est, unde sunt mala? Si deus non est, unde bona? Ex hoc posuit duo principia.' See Dondaine (1), p. 308; Puech (2), p. 65. The medieval tendency to treat Manichaeism as a Christian heresy was surely misguided; it was an essentially different religion. Perhaps it may be well to recall that its identification of evil with matter and darkness had nothing whatever in common with the Yin–Yang dualism, equally strong, of Chinese natural philosophy; that we explained in Vol. 2, p. 277. Cf. Bianchi (1).

[b] On this the very suggestive paper of Conze (8) should be read. Cf. also Kennedy (1) on the likenesses of the system of Basilides with Buddhism, and Przyłuski (2) on Persian in relation to Buddhist dualism and element-theories. Chavannes & Pelliot (1), 2nd pt., pp. 312–13, recall that in the early days of orientalism the Augustinian friar P. Georgi published a large work (+1762) attempting to prove that Buddhism in general and Lamaism in particular were nothing but the Manichaean 'heresy', in disguise, so to say. The boot is actually on the other foot – how much Gnosticism and Manichaeism drew from Buddhism, already by their time half a millennium old.

[c] Cf. Isaiah 27, 1; Psalms 74, 14 and 104, 26; Job 41, 1–10.

[d] *Contra Celsum*, VI, 24–26, 31, 35, with diagram and passwords for the archons of the spheres, tr. Chadwick (1), pp. 337ff. On the Ophites see esp. Leisegang (3), pp. 111ff., 160, Hilgenfeld (1), pp. 277ff.; Grant (1), pp. 52ff.; 89ff.

[e] Reuvens (1) and Berthelot (1), pp. 9, 18 on Leiden V and W; Leisegang (3), opp. p. 112 reproduces a drawing from the great British Museum magical papyrus.

[f] Tr. C. Schmidt (1), p. 207, § 319, 2nd ed. § 317; Mead (2), p. 265, § 319; McDermot (1).

[g] Tr. C. Schmidt (1), p. 233, § 359, 2nd ed. § 354; Mead (2), p. 296, § 359; McDermot (1).

[h] On the whole subject see further in Deonna (3); Preisendanz (3); Eliade (1).

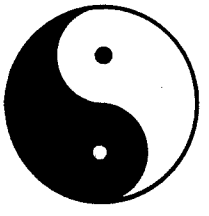
[i] Reference need be made only to Jung (1), figs. 6, 13, 20, 46, 47, 92, 117, 253, 256; Burckhardt (1), p. 137.

[j] Ali, Stapleton & Husain (1), pls. 1, A, 2, B, C. Hence perhaps its appearance (though in single form) on reliefs, relatively recent, in Dahomey, where it is said, according to Bebey (1), to represent the god of the rainbow.

[k] Rousselle (4*a*), Eng. vers. p. 68, (4*b*), p. 37. At the present time a double Ouroboros design of fishes is portrayed on Thaiwanese postage-stamps.

dragon, which there was taken to symbolise the 'backward-flowing circulation of the creative force'.[a] Naturally all the double tail-eaters were recognised by Mahdi-hassan[b] as dualistic symbols, putting him in mind of the world-famous Chinese geometrical Yin–Yang pattern.[c] There is no reason for doubting this likeness, and every probability that it did spring from later Chinese influence on the single Hellenistic Ouroboros.[d]

Such was the Western symbol of the cyclical processes of Nature. But there was no place where these were more appreciated and emphasised than in China, that civilisation which yet basically always rejected the other-worldliness and anti-worldliness of Indian, Iranian and Hellenistic religion. As we noted long ago,[e] the Taoists were obsessed by the problem of change, and particularly by cyclical change, adaptation to which makes a man a sage. The Tao is the tranquillity at the centre of all the disturbances of birth and death, rising and setting. Already the *I Ching* says:[f] '(If we examine) the original beginnings of things and their return to their endings,[g] we shall understand their coming-into-being and their passing-away (*yuan shih fan chung ku chih ssu shêng chih shuo*[1])'. And among its aphorisms we find: 'Wherever there is an ending, there is a new beginning (*chung tsê yu shih*[2])';[h] and also 'There is no going that is not followed by a returning (*wu wang pu fu*[3])'.[i] 'Return brings good fortune (*chhi lai fu chi*[4])';[j] 'Missing the time for reversion—misfortune! (*mi fu hsiung*[5])'.[k] In fact 'the Tao is made up of returning and reverting (*fan fu chhi Tao*[6])',[l] which echoes that great sentence in the *Tao Tê Ching*:



[a] See pt. 5 below on physiological alchemy. [b] (16, 26, 30, 34, 43).

[c] It is surprising that no monograph seems to have been written on the development of this, the *liang i*[7] sign of the 'two forces' or 'instruments'. Most art historians think that its origins must have been with Neo-Confucianism, but with the root rather than the flower; this points to Chhen Thuan (+10th cent.) or even Li Ao (+9th cent.); cf. Vol. 2, pp. 452, 467; and Needham (76). If so, the influence of the design would have reached Ibn Umail quite quickly.

[d] Mahdihassan's attempt (28) to interpret forms like Fig. 1525 as dualistic may be, however, less convincing; as also his efforts (29) to bring the uniped or ophidian shapes of the Chinese organiser god and goddess Fu-Hsi and Nü-Kua into the picture; cf. Vol. 1, p. 163 and Fig. 28, Vol. 2, p. 210, Vol. 3, pp. 23, 95; Przyłuski (1); Chêng Tê-Khun (7). It is interesting, however, that triple forms can occur in Tibetan and other Mahāyana iconography. Leisegang (3) has reproduced, opp. p. 32, and discussed, pp. 18ff., a mandala the centre of which is formed by a pigeon, a snake and a pig, biting each other's tails in Ouroboros form. This he considered to represent the three cardinal vices of hate, greed and unfeeling stupidity. Leisegang again pondered on the possible historical relations between Buddhism and the Gnosis. Mani at least acknowledged Gautama as one of his great forerunners.

[e] Vol. 2, pp. 74ff.

[f] Hsi Tzhu App. I, ch. 4, (ch. 2, p. 34*b*, Wilhelm–Baynes tr., vol. 1, p. 316). This, the Great Appendix, is probably of the −2nd century. The first four words became proverbial and were often used by Chinese naturalists of later times, e.g. Wang Khuei in the *Li Hai Chi* (cf. Vol. 6).

[g] Or: '(if we realise that) the original beginnings of things by reversion become their endings....'

[h] Kua no. 32, Hêng,[8] 'constancy' (ch. 2, p. 3*a*, Wilhelm–Baynes tr., vol. 2, p. 190).

[i] Kua no. 11, Thai,[9] 'prosperity' (ch. 1, p. 29*a*, Wilhelm–Baynes tr., vol. 1, p. 52).

[j] Kua no. 40, Chieh,[10] 'unravelling' (ch. 2, p. 15*a*, Wilhelm–Baynes tr., vol. 1, p. 165).

[k] Kua no. 24, Fu,[11] 'return' (ch. 1, p. 49*b*, Wilhelm–Baynes tr., vol. 1, p. 106).

[l] The same (ch. 1, p. 48*b*, Wilhelm–Baynes tr., vol. 1, p. 103). All these are in the canonical text, which may be as old as the −7th century.

[1] 原始反終故知死生之說 [2] 終則有始 [3] 無往不復 [4] 其來復吉
[5] 迷復凶 [6] 反復其道 [7] 兩儀 [8] 恆 [9] 泰
[10] 解 [11] 復

'Returning is the characteristic motion of the Tao (*fan chê Tao chih tung*[1])'[a]. It also says:[b]

> The myriad things all do their works and acts
> But I have seen how each has its returning (*fu*[2]);
> All beings howsoever they flourish
> Return and go home to the roots that bore them
> (*ko fu kuei chhi kên*[3]).

All this was naturally applied to history too, as in the opening sentence of the *San Kuo Chih Yen I*[c] which became proverbial—'Whenever there has long been division reunion must come, but union cannot last for ever and division will assuredly occur again (*thien hsia fên chiu pi ho, ho chiu pi fên*[4])'.

That it was also applied in chemistry we have already seen most abundantly both in the practical and theoretical sub-sections, *huan tan*,[5] the 'cyclically-transformed elixir' and the 'regenerated (or regenerative) enchymoma', as the case may be.[d] No phrase or technical term is more all-pervading in the alchemical literature. One of its oldest occurrences may be in connection with Chüeh Tung Tzu[6] in the −2nd century;[e] and we can never forget that Tsou Yen[7] in the −4th began with a 'method of repeated transmutation' (*chhung tao*[8]).[f] The cyclically-transformed elixir, with its nine repetitions (*chiu chuan*[9]), is prominent in the writings of Ko Hung[10] and his contemporaries (*c.* +300);[g] and it echoes on for centuries in the operations of such men as Chang Yuan-Yu[11] (+555),[h] Liu Tao-Ho[12] (+760),[i] and Chhen Thuan[13] (+970).[j] We have generally had most in mind the successive formations and decompositions of mercuric sulphide, but this was probably not the only process involved, for the repeated purification of gold by cupellation,[k] and its isolation by amalgamation with mercury,[l] have also to be considered. Again, just as the Hellenistic protochemists had the image of Ouroboros for their reflux distillations, so also the Chinese could have thought of it for their cycles of fire-phasing[m] and their arrangements for microcosmic circulation.[n]

This being so it would be natural to ask whether the Ouroboros motif occurs in Chinese art, and the answer is yes, though with less explicit relation to cosmological

[a] Ch. 40 (Waley (4), p. 192. Cf. ch. 25 (Waley (4), p. 174, and Vol. 2, p. 50 above).
[b] Ch. 16, tr. auct., adjuv. Duyvendak (18), p. 49, Chhu Ta-Kao (2), p. 26, Lin Yü-Thang (1), p. 109, Blakney (1), p. 68. Cf. Waley (4), p. 162.
[c] The famous Yuan historical novel by Lo Kuan-Chung (cf. Vol. 1, p. 112).
[d] See particularly pp. 218–19, 249, 261–2, and pt. 3, pp. 86, 109, 140, 195.
[e] Vol. 5, pt. 3, p. 20. The authority for this alchemist, Li Hsiu,[14] is rather late.
[f] *Ibid.*, p. 14.
[g] Vol. 5, pt. 2, p. 128; pt. 3, pp. 82–3, 86, 90, 109. Cf. also Ware (5), pp. 64, 82.
[h] Vol. 5, pt. 3, p. 131. [i] *Ibid.*, p. 140 [j] *Ibid.*, p. 194.
[k] Vol. 5, pt. 2, p. 277. [l] *Ibid.*, p. 278.
[m] Based doubtless on their recognition of cosmic cycles in time (cf. above, p. 242). Descriptions in Vol. 5, pt. 3, pp. 60, 73–4, and also above, pp. 266ff.
[n] Described above, pp. 281ff.

[1] 反者道之動 [2] 復 [3] 各復歸其根 [4] 天下分久必合，合久必分
[5] 還丹 [6] 絕洞子 [7] 鄒衍 [8] 重道 [9] 九轉
[10] 葛洪 [11] 張遠遊 [12] 劉道合 [13] 陳摶 [14] 李脩

or chemical theory than in the West. Dragons of course appear in all Chinese ornamentation everywhere, but those pursuing the moon-pearl and those coiled with their heads in the centre[a] are not what we are looking for. Some, however, do have their tails in or near their mouths[b]—we illustrate one in jade[c] and one in bronze[d] from the Middle Chou period, another from the Thang, and a compact jade ring form which may be as old as the Shang[e] (Fig. 1528*a–e*). At least seven other Ouroboros forms in stone, jade and bronze, have been recovered from Shang-ling-tshun, and three or four more from Chün-hsien (Hsin-tshun) and Chia-ko-chuang (−9th to −7th centuries), including some double ones.[f] The motif is also found more to the West in the Tagar I culture (−8th to −6th centuries) of the Minusinsk basin in Southern Siberia near Krasnoyarsk north of the Altai mountains.[g] Coiled dragon-like monsters occur, too, in Scythian tombs in the Crimea;[h] and the dating now available indicates that this influence was travelling from east to west rather than in the opposite direction. Perhaps the primeval sky-serpent of ancient Egypt met the tail-eating dragon of ancient China in the lands of the Scyths.

Tail-eaters widely various in date and context keep on turning up in Chinese culture. Hopkins showed long ago (17, 18) that the word *chhen*,[1] meaning an asterism used as a sidereal reference mark, was originally a pictograph of a dragon or serpent coiled round almost in a circle (see cut).[i] One of the 'great markers' (*ta chhen*[2]) is defined in the *Erh Ya*[j] as 'the house, the heart and the tail', which being interpreted means the lunar mansion constellations Fang,[3] Hsin[4] and Wei,[5] covering together[k] a region from 238° to 265° R.A. and from 20° to 45° Decl. S. approximately, i.e. just about the area taken up by our constellation Scorpio. Old copies of the *Erh Ya* and the *Hsing Ching* often represent this as an almost circular ring of stars, but in fact the whole body is of course quite long drawn out. Nevertheless the tail in the Chinese sky

[a] The *phan lung*[6] pattern. E.g. Watson (4), pl. 26*a*, *b* and p. 37 (−11th cent.); Anon. (*27*), pls. XVIII, XIX (−9th cent.); Kuo Pao-Chün (*2*), pl. LXXXII, no. 1, p. 51, no. 87 (−9th cent.). A pair of bronze *piao*[7] horse-bit ornaments with this design (−10th cent.) in the collection of Dr Chêng Tê-Khun was exhibited in the Oriental Studies Institute at Cambridge, May 1971.

[b] E.g. Salmony (5), pls. XXII, 1, 2 (−12th cent.), XXXVIII, 3, 4 (−10th cent.), LXIII, 1 (−8th cent.); Anon. (*27*), pls. XXIX, 7, LII, 4 (−8th cent.); Salmony (4), pl. XIX, 3 (−5th cent.); Salmony (5), pls. LXXXIV, 7, LXXXV, 1, 3, 4, 6 (−5th cent.); Salmony (1), pl. LXII, 3 (−4th cent.); Pope-Hennessy (1), pl. LV and p. 123 (+8th cent.); Gray (1) and Gure (1), pl. 99, no. 260, p. 49 (+11th cent.). All these datings, especially the pre-era ones, are of course very approximate, fixable only plus or minus a century or two. The animals, moreover, are not all dragons, but may be tigers, serpents, etc.

[c] Jenyns (3), pl. XXXVI B (−9th to −6th cents).

[d] Palmgren (1), pl. XXIV, 5 and p. 112 (−9th to −7th cents), described and figured also in Heine-Geldern (4), p. 385.

[e] Buhot (1), fig. 72 and p. 95. We add an incomplete specimen from the Seligman Collection (communicated by Mrs Brenda Seligman, 1954), cf. Hansford (2). These are theriomorphic variants of a very old and simple ornament, the split-ring disc; cf. Salmony (5), pls. XXX, 8, 9 (−10th cent.), LXXXIX, 1–9 (−5th cent.). Other examples are figured in Salmony (1), pl. XXII, 2, 4 (−9th cent.), and Dr Chêng Tê-Khun has in his collection a beautiful theriomorph split-ring disc from the Shang period (−12th or −11th cent.).

[f] Cf. Watson (6), pp. 107, 168, fig. 48, pls. 70, 72.

[g] *Ibid.*, pp. 107ff., pl. 71.

[h] *Ibid.*, pls. 73, 74. Cf. also Gryaznov (1); Artemenko *et al.* (1).

[i] Cf. K455 *f*, *g*. Both bone and bronze forms occur.

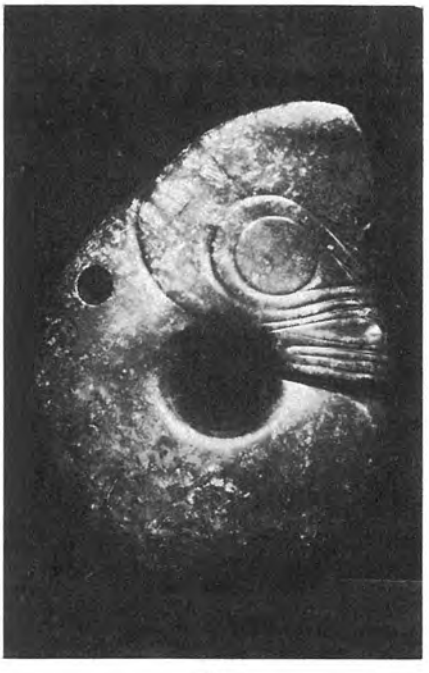
[j] Ch. 8, p. 12*b* (Shih Thien or Fêng Yü).

[k] Hsiu nos. 4, 5 and 6; see Table 24 in Vol. 3.

[1] 辰 [2] 大辰 [3] 房 [4] 心 [5] 尾 [6] 蟠龍 [7] 鏢

(*a*)

(*b*)



(*c*)

(*d*)

Fig. 1528

(*e*)

Fig. 1528. Examples of the Chinese Ouroboros.

(*a*) Jade ring of the Chou period (−9th to −6th century) from the Eumorphopoulos Collection in the British Museum (Soame Jenyns (3), pl. 36B). Diam. 2·3 cms.

(*b*) Bronze ornament of the Chou period (−9th to −7th century) in the Museum of Far Eastern Antiquities, Stockholm (Palmgren (1), pl. 24).

(*c*) Compact jade split ring from Shang or Chou, or possibly a Sung imitation, in the Musée Guimet, Paris (Buhot (1), fig. 72).

(*d*) Incomplete specimen of a similar kind, from the collection of Mrs Brenda Seligman. Cf. the catalogue of Hansford (2).

(*e*) Jade ornament of Thang date, +8th century, from the Eumorphopoulos Collection in the British Museum. Cf. Pope-Hennessy (1), pl. 55.

Fig. 1529. A painting by Tung Chhi-Chhang (+1555 to +1636), one of the first Chinese painters to try the European style. Laufer (28), p. 103, supposed the subject to be John the Baptist, but it must surely be St Thomas of the Indies, who in the apocryphal *Acts of Thomas* had indeed an encounter with an Ouroboros. A similar figure can be seen in the cartouche of the oriental map of Elwe (1).

does in fact coil round upon itself, so that one can see how the idea arose.[a] But this astronomical nomenclature had no close connection with cosmological or chemical symbolism, signifying rather certain patterns in the sky, and moreover there were several other ring-like constellations in Chinese astrography.

On the other hand, at the further end of history, there is a close and very strange connection. Early in this century Laufer (28) acquired an album of paintings by Tung Chhi-Chhang[1] (+1555 to +1636) who was one of the first Chinese artists to try painting in European style. The fourth of this series (Fig. 1529) represents some Christian saint holding an Ouroboros; this was identified by Laufer for no particular reason as John the Baptist, Hagios Prodromos—but surely in the light of what we read above in one of the Apocryphal Acts he must be St Thomas the Apostle of the Indies, with the very sign of the noxious serpent which in the Gnostic story he first compelled to restore to life a young man whom it had killed, and then destroyed utterly.[b] One can only conclude that some Jesuit or layman in China at the time knew this apocryphal text and suggested the theme to Tung Chhi-Chhang.

However that may be, there was something singularly prophetic, or perhaps one should say, not devoid of insight, in the cyclical aspect of chemical things which the Chinese and the Greeks both recognised. For in fact the development of modern chemical and biochemical science has revealed a wealth of cyclical processes in the organic as well as the inorganic world.[c] In the +17th century Stahl evolved the idea of a cycle of phlogiston as the vehicle of nutrition of plants and animals, and though that hypothetical entity died long ago the carbon–nitrogen cycle which he visualised is clearly acceptable today.[d] So also in the inorganic world there is the very different carbon–nitrogen cycle in stars, a series of nuclear reactions which convert hydrogen into positrons and helium with great release of energy;[e] and all the many examples of catalysis (such as the role of bromine in the oxidation of sulphur by nitric acid) have been shown to involve chain reactions with restoration of the catalyst. Then there came the recognition of the phosphate cycle in yeast fermentation by Harden & Young;[f] and in modern biochemistry the tricarboxylic acid cycle which oxidises pyruvic acid in muscle,[g] the phosphorylation cycles transferring energy in that tissue,[h] and the ornithine cycle which synthesises urea in many phyla of animals.[i] Thus in chemistry as well as in physiology[j] the intuitions of ancient men have proved justified by the growth of knowledge.

With this we can bring to an end our digression on serpentine symbolism, leaving

[a] See Fig. 94 in Vol. 3. Antares (Ta huo[2]), the central star of Hsin hsiu, is specifically called a Ta Chhen[3] in the *Kungyang Chuan*, ch. 23, p. 5*a* (Duke Chao, 17th year).

[b] 'Acts of Thomas', 3, 30–38; M. R. James tr. (1), pp. 378ff.; Bornkamm tr. (1), pp. 459ff.

[c] See the classical biological cosmography of Lotka (1).

[d] His ideas have been expounded by Strube (1).

[e] Cf. Bethe (1).

[f] This great advance was made in 1908.

[g] See Krebs (1), a paper which discusses other examples of the chains of enzyme cycles which build up metabolic cycles.

[h] Cf. D. M. Needham (2).

[i] Cf. Krebs (2).

[j] On ancient Chinese conceptions of the circulation of the blood, long antedating Europe, see Sects. 43 and 44 in Vol. 6; and meanwhile Lu Gwei-Djen & Needham (5). Understanding of the meteorological water-cycle was probably one of the most ancient appreciations of natural circulation in all cultures; cf. Vol. 3, pp. 467ff.

[1] 董其昌 [2] 大火 [3] 大辰

(very appropriately) two stings in the tail. First, that Ouroboros actually lives—in the shape of the South African armadillo lizard, which when disturbed holds the tip of its tail in its mouth in order to protect its belly by its spring scales.[a] Not impossible therefore is it that the ancients had a living pattern before them, rather than having to form one entirely out of their imaginations. Secondly, there is considerable evidence that the tail-eating serpent provided a stimulus for Kekule's first cyclic formula in organic chemistry, that of the benzene ring (1865).[b] His own autobiographical account mentions that a year or two before this the idea came to him as he visualised in a reverie a snake seize hold of its own tail.[c] Such points as these alone, apart from the perennial interest of archetypes, might justify our disquisition, but the main lesson still remains, namely that however the streams of influence flowed back and forth, the whole of the Old World was 'in the circuit'; and in no context more so than that of the cycles of Nature and the symbols than men made for them.

From all the foregoing discussion there remains, as they say, one loose end—why was there that curious connection of Gnosticism and Proto-Manichaeism with the earliest Alexandrian proto-chemistry? How exactly it came about is not at all obvious, for if the material world was essentially evil there should surely not have been much inducement to study it—and that an inhibition such as this might be effective, to some extent at least, we have already seen reason to suspect in the case of Chinese Buddhism.[d] But Gnosticism, like its successor Manichaeism, did believe in the possibility of the ultimate salvation of the souls or sparks of light imprisoned in the darkness, so perhaps the 'ascent' of matter implicit in aurifaction was one of the ideas that inspired the Alexandrian proto-chemists.[e] Other parallels can easily be imagined—for example many a Graeco-Egyptian philosophical artisan must have pondered the model of an oil separating from an aqueous solution after shaking, first the confused mass, then the dispersed globules gathering with their likes, finally the two phases homogeneously asunder. Just so did the Gnostic and the Manichee visualise the kingdoms of God and Demiurge, Light and Darkness; 'the spirits of just men made perfect' ascending from the latter to the former.

One wonders whether the technique of distillation itself (first developed, in its Western form,[f] so far as we can see, by the Alexandrian proto-chemists of the + 1st and + 2nd centuries) did not have something to do with this mentality of modelling a

[a] Carr (1), pp. 166–7.

[b] Madhihassan (27, 28, 40); Read (3), p. 180. See also Schneider (2); Benfey & Fikes (1); Partington (7), vol. 4, pp. 533ff, 553ff.

[c] Berthelot's publications on the Corpus did not begin till 1885, but Kekule had studied under the historian of chemistry, Kopp, who would certainly have known about Ouroboros, and in any case Kekule could have been familiar with many of its representations in late alchemical books. He had also been involved in early life, it seems, in a legal case in which some jewellery with an interlinked design of the Susa type (p. 376) had prominently figured, and this made a deep impression upon him.

As a parallel for the Ouroboros stimulus to Kekule, Rather (1) has devoted an intriguing paper to the possibility that a kabbalistic structural-combinatorial principle (the 'creative word') was a powerful influence on the development of the idea of genetic coding in modern molecular biology, starting with Nägeli and Hertwig.

[d] Vol. 2, pp. 417ff.

[e] Sometimes the theological thought is expressed very chemically, as in Basilides (see Hippolytus, *Ref. Omn. Haeresium*, VII, 22, 26; McMahon & Salmond tr., vol. 1, pp. 277–8, 283, 285; Legge tr., vol. 2, pp. 69–70, 74, 77). For a case of similar Buddhist thinking on 'upward' and 'downward' transformations, cf. Vol. 2, pp. 421–2.

[f] Cf. pp. 84–5 above.

particular world-conception. Burkitt used the word several times to translate the Manichaean idea of the ascension of souls into the realm of light, e.g. in a hymn quoted by St Ephraim the Syrian, who died in +373:

> Day by day [they say] diminishes
> The number of souls (on the earth)
> As they are distilled and mount up.[a]

So also, translating a sentence of Cumont on the Manichees:[b] 'Man knows henceforth the way of enfranchisement; he must consecrate his life to keeping the soul from all corporal defilement by practising continence and renunciation, so as to set free little by little from the bonds of matter the divine substance both within him and disseminated throughout Nature, thereby joining in the great work of distillation which God is carrying out in the universe.'[c] One can thus begin to see something of the mystical significance which would have attached to vapours and volatile substances, whether aqueous or oily, arsenical or sulphurous, in the minds of the Graeco-Egyptian and Persian proto-chemists, 'spirit' rising from the 'hell' of the distilling flask to be caught in the heaven of the receiver. An analogous idea was that of the cosmic noria or water-raising wheel[d] with twelve buckets which lifted up the souls of the Manichaean elect at death into the heavens, running out there like glittering water into the waxing moon. As it waned it trans-shipped them to that other celestial vessel, the sun, eventually to rise aloft beyond the spheres in a 'column of glory'.[e]

[a] 'Discourse to Hypatius', v; in C. W. Mitchell (1), vol. 1, pp. cix, 162, vol. 2, p. clxxxiii.

[b] (8), p. 49.

[c] It was Burkitt (1), pp. 32, 35, who inserted the idea of 'distillation'; Mitchell had 'refined and mount up' (*badmiṣṭal-lān wsālḳān*), Cumont wrote 'épuration'. But Burkitt may have shown a deep insight in his rendering.

[d] An extended discussion of this will be found in Vol. 4, pt. 2, pp. 356ff. We concluded that the noria was an Indian invention which reached the Hellenistic world about the −1st century, and the illustration of the +2nd-century Apamea mosaic (our Fig. 596) is directly relevant here. But equally the *sāqīya* could have suggested the idea; this we recognised as typically Hellenistic (from −200 or so), and now a beautiful −2nd-century fresco painting of one of these machines in a tomb at Wardian near Alexandria has been published by Riad (1).

[e] See Puech (3) and the special study of Cumont (9). Chavannes & Pelliot (1), p. 517, were the first to realise, from a Chinese Manichaean text, one of the Tunhuang MSS, that Mani's model must have been the noria (by which they may well have meant the *sāqīya*), both of these machines having certainly been common in Mani's +3rd-century Mesopotamia. In this text the wheel is called *yeh lun*,[1] and seems to be of threefold nature, or perhaps supplied by three auxiliary wheels, those of water, wind and fire. Here one cannot help being reminded of the *ching*,[2] *chhi*[3] and *shen*[4] so prominent in physiological alchemy (see Vol. 5, pt. 5). The other source of the noria idea must assuredly have been the zodiac, with its twelve divisions. Greek Pseudo-Zoroaster apocrypha of the −1st and −2nd centuries have a theory of souls traversing the zodiacal round. A similar notion has lived on among the Parsis (de Menasce, 2). One classical exposition of the noria doctrine occurs in Hegemonius' *Acta Archelai*, VIII, 6–7, an important +4th-century account (more than somewhat romancé, however) of a disputation between Bp. Archelaus of Khalkar in Mesopotamia and Mani himself about +262; see Migne, *Patrol. Graeca*, vol. 10, col. 1439; cf. Puech (1), pp. 22ff. Another is in the *Panarios* of Epiphanius, Bp. of Constantia in Cyprus from +367 onwards (d. +403), heresy no. 66, § xxvi; in Migne, *Patrol. Graeca*, vol. 42, col. 74. Further on the whole subject see Burkitt (1), p. 43; Puech (1), pp. 83, 176.

The cosmic noria may even have got into book-titles. A lost *Ying Lun Ching*[5] is mentioned in one text, and the *Thung Chih Lüeh* lists a *Ying Lun Hsin Chao*[6] by one Chiang Chhüan-Chhing,[7] seemingly astrological. See Chavannes & Pelliot (1), 1st pt., pp. 555–6, 2nd pt., pp. 104–5.

One wonders whether the name noria (*al-nā'ūra*) could have had anything to do with the puzzling

[1] 業輪 [2] 精 [3] 氣 [4] 神 [5] 應輪經 [6] 應輪心照 [7] 蔣權卿

We do not wish to be understood as saying that Gnostic philosophy or theology was responsible in the first place for a technique like distillation, which arose much more probably from prior artisanal practice pondered by philosophical minds, but it may have given some inspiration to people like Pseudo-Democritus, Comarius, Pseudo-Cleopatra and Mary the Jewess in the conduct of their experiments. It seems clear, at all events, that the doctrine of the fundamentally evil nature of the material world, held by both Gnostics and Manichaeans, did not prevent all proto-scientific exploration of it; perhaps they felt that they ought to know more about the nature of their prison-house. It is rather striking that when the +4th-century *Pistis Sophia* (cf. p. 378 above) enumerates in its tedious way the 89 distinctions which the mystery of Jesus will explain, it includes most of the questions which science asks—the differences of animals and minerals, what really are gold, silver, copper, iron and lead,[a] 'why the matter of glass has arisen and why the matter of wax has arisen', finally why plants are what they are.[b] Obviously it would be an elementary mistake to think of the Alexandrian proto-chemists—or their contemporaries the Taoist elixir-seekers either —as scientific workers of modern type, interested in the analysis of natural phenomena for its own sake, and the real powers which they are aware that this will bring; no, the former probably looked upon chemical operations primarily as numinous symbolic rituals, the latter more as numinous natural magic. But both were extremely interested in cosmic models,[c] these being valued partly no doubt for their demonstrative analogical significance, partly for their believed powers of sympathetic magic, and partly for the real chemical effects (as we should think of them today) which happened in them. But the cosmologies, the macrocosms of these experimental microcosms, were widely different in East and West; and so were the main objectives, aurifaction in the West, material immortality in the East. The common factor was simply the belief that chemical cosmic working models could be made, and that it was worth while to make them.

To sum it all up, there existed from ancient times a trans-Asian continuity, greatly enhanced after Alexander's conquests (−320) and further facilitated after Chang Chhien's diplomatic and commercial expeditions (−110). Ostanes the Mede personifies it. We may never be able to trace the exact capillary channels which connected Tsou Yen's tradition with that of Bolus and Pseudo-Democritus; all we can do is to go on deepening our understanding of both of them and contrasting them each with the other. Most likely the two foci of aurifiction and aurifaction, centered primarily on Chhang-an and Alexandria, had essentially independent origins—the question is how far there were mutual influences once they had begun to develop. Westward may have

personage Norea discussed by Pearson (1). A wicked temptress spirit in Jewish apocryphal literature, she was for the Gnostics a Hagia Sophia figure, a moving symbol of cosmic redemption. In the legendary corpus, including the Nag Hammadi texts, she gets confused, among others, with Na'amah the sister of Tubal Cain, as well as Noah's dubious wife, and appears as a beautiful seducer of the angels in the Enoch legend (cf. p. 341).

[a] A sixth metal seems to be mentioned in the text, but the word has not been identified.

[b] See § 206–16, esp. C. Schmidt tr. (1), 2nd ed., p. 136, § 212; Schmidt & Till (1); Mead (2), p. 176, § 210. Burkitt (2), p. 75, was particularly struck by this.

[c] Seen abundantly for China in the sub-section on theories, pp. 279ff. above.

come the root of the name *chēmeia* (that 'goldery' that would have so much interested the merchants on the Old Silk Road); the idea of the loves and wars of the elemental natures; a strengthening of the sexual Yin–Yang concept of chemical reaction at the birth of all novelty; and perhaps the belief in the possibility of 'projection'. What certainly did not come at this time was the basic idea of material immortality and the belief in an elixir of life; for that a different eschatology would have been needed; nor did the emphasis on time in Chinese alchemical theory have much echo in the West. The conviction of the value of mineral and metallic medicines did not get through; nor yet the scheme of natural forces symbolised by the trigrams and hexagrams of the 'Book of Changes', unexportable, this last, for two and a half millennia until the age of modern scholarship transcending ethnic barriers had dawned, with men like Wilhelm and Jung. Similarly the death-and-resurrection motif of Greek *prima materia* never found its way to China; but it is possible that the idea of distillation did, though it could only have been a stimulus diffusion since the design of Chinese stills was so radically different. As for biological analogies, the West emphasised fermentation, while China emphasised rather generation. Common factors, however, were the majority of the chemical reagents, and the role of breaths, *chhi*, *anathumiaseis*, and the like in Nature's operations. And finally neither the Graeco-Egyptians nor the Chinese cared much about atoms, leaving them to the Graeco-Roman philosophers, the Indians and the Buddhists. It was all a pattern of very imperfect communication,[a] but that there was no communication, and no will for it, could hardly be sustained in the light of modern knowledge.

(2) China and the Arabic World

When between +635 and +660 the tribesfolk of the Arabian deserts, inspired by the new religion of the prophet Muḥammad and determined to replace their poverty by a fuller life, poured forth into the surrounding areas of age-long culture, a fresh civilisation with its own language and its own characteristic features was born. It was destined, as everyone knows, to inherit the major part of Hellenistic science and technology, and to pass it on in due course to the Latin West; a process of absorption, enrichment and transference facilitated geographically by the fact that Islam conquered not only the Near and Middle East but also North Africa and Spain. But its cultural boundaries stretched much farther eastwards, reaching to the borders of India and the bounds of Sinkiang, covering everywhere in fact as far east as the longitude of Lop Nor and all the space between the Chad and the Caspian. Hence it is

[a] We are not by any means the first to have raised the question of possible Chinese influences on Hellenistic proto-chemistry, or at least of mutual contacts at that early time. A case for it was eloquently put forward by Barnes (3) in 1935, and it has been supported by Huang Tzu-Chhing (1) and Ganzenmüller (2), p. 32.

In an interesting paper Sheppard (6) speaks of a 'multi-focal' origin of alchemy, but the definition of it then used by him was not the same as ours (cf. pt. 2, pp. 9ff. above). Provided his 'alchemy' be understood in the sense of aurifiction and aurifaction only, we would be inclined to agree with him and to see these practices arising independently in Hellenistic, Persian, Indian and Chinese cultures—but macrobiotics is quite another thing. We see the *hsien* Taoism of China as its only original home, whatever the external stimuli may have been which helped it to crystallise in that milieu.

easy to understand that Hellenistic knowledge was not at all the only river which flowed into the lake of Islam—Persia and Iranian tradition was swallowed up in it, and strong currents of influence came westwards now from India and now from China.[a] Obviously when Arabic culture began to concern itself with chemical matters much would be added to the proto-chemistry of the Hellenistic world, and in what follows we must try to trace particularly the passage westwards of Chinese alchemical theory and practice.

(i) *Arabic alchemy in rise and decline*

Although at the present time relatively few scholars are devoting themselves to the study of alchemy in Arabic culture, there were giants who worked on this subject in the fairly recent past (Kraus, Ruska, Stapleton and Wiedemann, for example), and we can learn from the results of their labours.[b] The first question to be decided is whether there was any significant chemical movement under the second Caliphate, the Umayyad (+661 to +750), or whether it began rather under the third, the 'Abbāsid (+750 to +1258), a period corresponding with the golden age of alchemy in China, the Middle and Late Thang and the Northern Sung. While there are hints that something was brewing in the late +7th and early +8th centuries,[c] the main figures of this period to whom alchemical activities were traditionally attributed have been shown with fair certainty to have had no such interests. Indeed Arabic alchemy begins with a striking paradox, in that Khālid and Ja'far were quite real historical personages but not alchemists, while Jābir was among the greatest of alchemists but not real, that is to say not a single person, rather a syndicate of heterodox natural philosophers.

Khālid ibn Yazīd ibn Mu'āwiya (*c.* +665 to +704) was a kind of crown prince who did not obtain the Caliphate; he supposedly occupied himself with alchemy, was taught by a Byzantine named Stephanus, and wrote alchemical poems. But the tradition has been demolished by the critical analysis of Ruska (4).[d] Debate on the matter has been going on ever since the +14th century, for while Ibn abī Ya'qūb al-Nadīm al-Warrāq al-Baghdādī reported three alchemical books by Khālid in his *Fihrist al-'Ulūm* (Bibliography of the Sciences) finished in +987,[e] Ibn Khaldūn in his *Muqaddima* denied all possibility of this attribution.[f] Khālid's name appears in a kind of colophon to one of the early Arabic alchemical writings, the *Kitāb Qarāṭīs al-Ḥakīm* (Book of Crates the Wise, or the Physician)[g] but there cannot be any real

[a] On the focal character of Islamic science, uniting West and East as never before, much has already been said in Vol. 1, pp. 214ff., 220ff.

[b] Their greatest successor today is Ullmann (1). Convenient digests of what is known about alchemy in Arabic culture will also be found in Leicester (1), pp. 62ff.; Multhauf (5), pp. 117ff. Older, but very useful, general papers are those of Wiedemann (15, 21, 24, 25, 29, 32). See also Haschmi (6).

[c] For example the story of Bishr ibn Marwān (p. 475 below) and the embassy of 'Umāra ibn Ḥamza (p. 391 below).

[d] Its authenticity is still defended by Dunlop (6), pp. 205ff., (7), p. 3, but Ruska's rejection has been followed by Mieli (1), 2nd ed., p. 55 and by Hitti (1), 2nd ed., pp. 255, 380.

[e] Fück tr., p. 93; cf. Dodge (1), vol. 2, p. 851. [f] Rosenthal tr. (1), vol. 3, pp. 229–30.

[g] Tr. Berthelot & Houdas (1), pp. 9ff., 44ff. The personage of the title is not otherwise known. We shall refer again to the book on p. 427.

connection, for this text can be dated to the end of the +8th or the beginning of the +9th centuries, when it was put together from visionary Graeco-Egyptian and Ḥarrānian[a] materials of perhaps the +6th.[b] As for the poems, they must be later forgeries since sal ammoniac is prominent in them, and this salt was almost certainly not known to the Greek proto-chemists in +700 (see pp. 432 ff. below). Finally, Ibn Khallikān about +1280 recorded a correspondence between Khālid and a Byzantine hermit named Morienus, probably modelled on a Greek dialogue between Heraclius and Stephanus of Alexandria;[c] this had a great vogue after its translation into Latin though resting on a purely fictional base.[d]

Here already at the outset something about Khālid detains us, however, because of its significance for the East Asian influence on Arabic alchemy which we shall develop in what follows. In the +11th century Qāḍī al-Rashīd ibn al-Zubair wrote a lapidary entitled *Kitāb al-Dhakhā'ir wa'l-Tuḥaf* which dealt with gems, precious metals, and minerals with strange properties. In this he averred that Khālid gained his alchemical knowledge from a book on the subject sent by the emperor of China to his Mu'āwiya grandfather, the first Umayyad Caliph.[e] This would imply a transmission between +661 and +680, the time of Thang Kao Tsung; and it is imaginable that some work of Thao Hung-Ching, Su Yuan-Ming or Sun Ssu-Mo could have been sent,[f] but what is really hard to imagine is its translation into Arabic at that early time.[g] Perhaps the story need not be taken too seriously as history, but the existence of the story some centuries later is the historical and significant thing.

The traditions about Ja'far al-Ṣādiq, the sixth Imām,[h] were similarly demolished by Ruska (5). The main claim of this religious teacher (+699 to +765) is that he is mentioned as the instructor of Jābir in the *Fihrist*,[i] as also in many of the books of the Jābirian Corpus itself,[j] but this is evidence only for the second half of the +9th century or the first half of the +10th, not for the +8th. Ja'far may well have been interested in the 'occult arts', since his name was persistently associated from the beginning of the +9th century onwards with geomancy (sand divination), prognostics from twitches and cramps, weather forecasting, physiognomy, oneiromancy, etc. but there is no real basis for his alchemy.[k] Certain alchemical texts of later times do indeed

[a] See pp. 426 ff. below. [b] Cf. Kraus (3), p. 35; Ruska (36).

[c] See the *Kitāb Wafayāt al-A'yān*, a collection of biographies, tr. McGuckin de Slane (2), vol. 1, pp. 481 ff.; and, for the whole question, Ruska (4), pp. 31 ff.

[d] There is a modern English translation by Stavenhagen (2). Cf. p. 403 below.

[e] Ullmann (1), pp. 120, 192.

[f] See Vol. 5, pt. 3, pp. 120 ff., 130, 132 ff., 140.

[g] It would have been early even if the language had been Syriac or Greek. There is more than one candidate for the honour of being the first translation of a secular text into Arabic—the usual view is that it was a medical text from Syriac in +684 (cf. Dunlop (7), p. 2). Ullmann (1), p. 152, seems to favour an alchemical one, a treatise of Zosimus done from the Greek and dated +659; but this depends on a very late manuscript described by Stapleton & Azo (2), a +15th-century copy of a +13th-century collection (cf. p. 415).

[h] The imāms, seven or twelve in number, according to the reckoning of diverse Shī'ah sects, were the direct descendants of 'Alī, alone invested (for Shī'ah Muslims) with the spiritual authority of the Prophet, hence infallible and impeccable. See Hitti (1), 2nd ed., pp. 255, 380, 441–2.

[i] Fück tr., p. 96; cf. Dodge (1), vol. 2, p. 853.

[j] See Kraus (2), pp. xxviff., (3), pp. 35, 77, 114, 141, 183, etc.

[k] Ruska (5), pp. 26 ff.

bear the name, but it has been shown that in such connections we must speak of Pseudo-Ja'far.[a]

Arabic alchemy does not really begin until the +9th century,[b] but it may be significant that we have a circumstantial account of aurifaction seen by an Arab envoy at Byzantium towards the end of the previous one. His name was 'Umāra ibn Ḥamza, and being despatched on a mission by the Caliph al-Manṣūr in +772 he was present at a demonstration in a secret elaboratory in the imperial palace when lead was turned to silver by the projection of a white preparation, and copper to gold by the projection of a red one.[c] The story is told in a geographical work, the *Kitāb al-A'lāq al-Nafīsa*, written by Ibn al-Faqīh of Hamadan about +902.[d] At the end of his narrative 'Umāra concludes that it was this incident which awakened the interest of the Caliphs in alchemy. There is no particular reason for disbelieving the story, but whether aurifaction was really the first chemical exercise to intrigue the Arabs is doubtful, for the pursuit of macrobiotics may have been known at least as early, as we shall duly see; and that must have come from a diametrically opposite quarter.

The great days of Arabic alchemy are reached with that flood of books and tractates which go under the name of 'Jābir ibn Ḥayyān' and can be dated with certainty to the last half of the +9th century and the first half of the +10th. Understanding of this was the solution of one of the most intractable puzzles in the history of chemistry, namely the relation of the 'Geber' who wrote in Latin towards the end of the +13th century and the 'Jābir' who lived in the golden age of the 'Abbāsids. The breakthrough came in two classical papers by Ruska (2) and Kraus (1) published side by side in 1930.[e] Historians of the last century (Schmieder, Hoefer) generally confused Geber and Jābir, though Kopp first realised that the Geberian titles were not to be found in the Arabic bibliographies, while Berthelot & Houdas[f] not only recognised the great difference between the two types of texts but also knew that already in +987 the author of the *Fihrist* recorded grave doubts concerning Jābir's authorship and historicity.[g] Jābir does not know many things which are in Geber, and Geber shows no trace of having been translated from the Arabic, though Latin translations of a few of the Jābirian works have been found.[h] The fact is that the Jābirian writings form a

[a] So, for example, Ruska (5) was able to identify a *Kitāb Risālat Ja'far al-Ṣādiq fī 'Ilm al-Ṣanā'a wa'l-Ḥajar al-Mukarram* (Book of the Letters of Ja'far al-Ṣadiq on the Science of the Art and the Noble Stone) with a *Ta'wīdh al-Ḥākim bi-'amri'llāh fī 'Ilm al-Ṣan'a al-āliya* (Talisman of al-Ḥākim (the Ruler, by the Grace of God, Fatimid Caliph, r. +996 to +1020) on the Science of the Exalted Work), which was found in an Indian library and published by Stapleton & Azo (2), pp. 77ff. From these translations it is clear that the text must have been written between about +1050 and +1280 and has nothing whatever to do with Ja'far.

[b] The book of Balīnās, of which we have already spoken (p. 369), and to which we shall refer again (p. 457), may indeed be as old as about +750, the very beginning of the 'Abbāsid Caliphate, but though it was influential on the later Arabic writers it contains, strictly speaking, no alchemy. One may of course be inclined to speculate that there were alchemists among Balīnās' Central Asian circles, and that they wrote texts which have been lost, but here we have no solid evidence. And in any case the neighbourhood of +820 is a better date for his book. It got into Latin early, with Hugh of Santalla, about +1130.

[c] On white and red elixirs cf. p. 392. Haschmi (5) discusses them in terms of ion exchange coatings on metals.

[d] It may be read in full in the translation of Dunlop (6), pp. 217ff.

[e] See also Ruska (31, 35). [f] (1), p. 17. [g] Fück tr., p. 96; cf. Dodge (1), vol. 2, p. 855.

[h] Berthelot (10), pp. 320ff. (12); Ruska (3). Others are surmised; Plessner (8).

Corpus, the work of many different writers with a common philosophical outlook; none can be earlier than about +850 and the whole collection must have been completed not only before +987 but before about +930 because there are quotations in Ibn al-Waḥshīya al-Nabaṭī.[a] As for the real existence of Jābir ibn Ḥayyān himself, it has been and still is a matter of debate,[b] but if he is accepted as historical his dates cannot have been far from *c.* +720 to +815,[c] perhaps some decades later.[d] Whether he wrote any of the Corpus texts, even the earliest, remains undecided.[e]

Partial lists of the titles in the Jābirian Corpus have been given from time to time with appropriate commentaries,[f] but the main authority is still that of the two magnificent monographs of Kraus (2, 3) published in Egypt by 1943. The census of titles and MSS which he conducted gave no less than 1143 books and tractates on alchemy, 847 on magic and theurgy, sympathies and antipathies, 500 on medicine and pharmacy, 300 on philosophy, 100 on mathematics and astronomy, and another hundred on theology.[g] This invites comparison with the *Tao Tsang* itself, though there of course the range of datings is much wider.[h] All the Jābirian texts are roughly similar in style, but Kraus and Ruska were able to establish that they were produced in an order which we can still trace.[i]

The oldest book in the Corpus is probably the *Kitāb al-Raḥma al-Kabīr* (Greater Book of Pity),[j] so entitled because of the compassion which the writer felt for the common aurifictors who got into such trouble straying from the true path. This text is very Hellenistic in a way, containing developed forms of the famous aphorisms (cf. pp. 358 ff. above); but it strikes also many new and previously unheard notes, speaking of elixirs in a markedly chemo-therapeutic manner (cf. p. 479 below), and hinting already at the theory of mercury and sulphur as constituents of all the metals.[k] A decade or so before +850 would be a good guess for its date, and then during the

[a] See Kraus (2), p. lix. There is doubt about the historicity of this personage, but his books were real enough, if not entirely what they purported to be.

[b] Holmyard, the leading Arabist in the field outside Germany, was slow to be convinced of the great distinction between Geber and Jābir (cf. 3, 8, 16) but he agreed in the end, retaining as long as he lived, however, a belief in the historicity of the latter (cf. (1), pp. 66 ff. (17), etc.).

[c] Dunlop (6), p. 209, following Holmyard (in Richard Russell (1), mod. ed.).

[d] As Ruska (5) persuasively suggests.

[e] Recent attempts by Sezgin (1, 2) and Haschmi (4) to defend their 'authenticity' in this sense, as a whole, have been refuted by Plessner (4), cf. Ullmann (1), p. 199; Rex (1).

[f] For example Holmyard (2); Ruska (3), in (37).

[g] It must be understood that these figures are somewhat inflated because Kraus left many blank numbers out of respect for the Arabic bibliographers' rough estimates of the wealth of the literature, and in the expectation that many further MSS would come to light. If we deduct these vacancies there remain 568 alchemical books and tractates—still a goodly collection—few of which have had the study they deserve, and almost none translated. The figures for the other subjects need reduction in like manner. But the enumeration is very difficult because on some counts the individual chapters of the larger works are reckoned as independent tractates.

[h] The time of the Jābirian Corpus corresponded to the last half-century of the Thang and the whole of the Wu Tai period. Cf. Vol. 5, p. 3, pp. 141 ff., 167 ff.

[i] Using the classical philological method of notes on who is cited by whom, besides much other evidence; cf. Kraus (2), pp. xxxiv ff., lvii ff.

[j] Kr5, i.e. No. 5 in the census of Kraus (2). This abbreviation will be taken as standard hereafter. Tr. Berthelot & Houdas (1), pp. 163 ff.

[k] Berthelot & Houdas tr., pp. 166–7, 170, 172–3, 181. The red and white elixirs also come in, pp. 180–1, 189.

next forty years came the two groups called respectively the One Hundred and Twelve Books[a] and the Seventy Books.[b] These contain the marrow of Jābirian alchemy, purely technical, concerned with substances, apparatus and processes; though the latter group is more systematic than the former. At and around the turn of the century we have to place the Books of the Balances (*Kutub al-Mawāzīn*),[c] those strange treatises in which it was sought to determine the proportions of elementary constituents in the composition of substances (cf. pp. 394, 459 below). Afterwards come the Five Hundred Books, or Epistles,[d] writings in which the alchemical-practical is subordinated to gnostic allegories and theological speculations of a Shī'ah character.[e] In these many things of interest can however be found, as for example the *Kitāb al-Ḥajar* (Book of the Stone),[f] which treats of the relations between alchemy and medicine. Towards +930 or rather later come the last books of the Corpus. The *Kitāb al-Khawāṣṣ al-Kabīr* (Greater Book of Properties)[g] and the *Kitāb al-Baḥth* (Book of the Search)[h] revive or continue the ancient lore of sympathies and antipathies in fuller medieval form;[i] but of much more chemical interest are the Books of the Seven Metals (*Kutub al-Ajsād al-Sab'a*).[j] Finally the *Kitāb al-Raḥma al-Ṣaghīr* (Lesser Book of Pity),[k] which presupposes the existence of all the others, purports to expound the essence of alchemy but does so more vaguely than ever, yet echoes the concern of the earlier work of the same name for the unfortunate aurifictors.[l]

As for the identity of the writers of the many Jābirian books, very little positive is known.[m] Some of those named in later sources as 'Jābir's' disciples may be suspected,[n] and 'commentators' may well have been actual authors.[o] One name we have of a man who was asserted by a contemporary to have written some of the books,[p] but that is all.

When we survey the actual content of Jābirian and all Arabic alchemy we find ourselves in a world quite different from that of Hellenistic proto-chemistry, even though Greek influences were manifold and went very deep.[q] Putting it epigrammatically one could say that aurifiction and aurifaction no longer dominate, for macrobiotics and 'chemo-therapy' have come prominently into the picture, together with biological products and substances, more pharmacological interest,[r] and a certain

[a] Kr 6 to 122. [b] Kr 123 to 191.
[c] Kr 303 to 446. [d] Kr 447 to 826. [e] Cf. p. 396 below. [f] Kr 553.
[g] Kr 1900. [h] Kr 1800. [i] Cf. pp. 311 ff. above.
[j] Kr 947 to 956. [k] Kr 969, tr. Berthelot & Houdas (1), pp. 133 ff.

[l] It is worth recalling that the Jābirian period corresponds with the time of Tuku Thao and Hokan Chi, publisher of the first printed book on alchemy in any civilisation, the *Hsüan Chieh Lu*, as also with the time of appearance of that important book of metallurgical chemistry, the *Pao Tsang Lun*. See Vol. 5, pt. 3, pp. 158, 167, 180, 211.

[m] See especially Kraus (2), pp. lxii ff.

[n] For example 'Uthmān ibn Suwayd al-Ikhmīmī (*fl.* +890), whom we shall shortly meet again (p. 399) in another connection.

[o] E.g. Abū Qirān al-Nisibī (perhaps a significant patronymic, cf. p. 410), or Abū Bakr 'Alī ibn Muḥammad al-Khurāsānī (perhaps also significant, p. 425), or Abū Ja'far Muḥammad ibn abi al-'Azāqir al-Shalmaghānī (d. +933).

[p] This is al-Ḥasan ibn al-Nakad al-Mawṣilī (*fl.* +932). He made money on it too.

[q] Brief introductions to the subject will be found in Leicester (1), pp. 64 ff.; Multhauf (5), pp. 128 ff.; but the only extended and penetrating treatment is that of Kraus (3).

[r] Cf. the *Kitāb al-Sumūm wa-daf' Maḍārrihā* (Book of Poisons and Antidotes), a 'veritable Summa of toxicology', Kr 2145 in the Corpus; as also another *Kitāb al-Sumūm*, written by Ibn al-Waḥshīya about +930 and showing stronger East Asian influences, on which see Levey (8). Cf. p. 449.

thread of preoccupation with all life phenomena. Theory also plays a considerably greater role, and Arabic alchemy is hence much more precise and logical than Hellenistic proto-chemistry, even though the structure is often based upon the most arbitrary and (to us) implausible assumptions.

For its theory of matter Jābirian alchemy adopted the four Aristotelian principles of heat, cold, moisture and dryness,[a] looking upon these, however, not so much as qualities or accidents but as real material constituents of things.[b] Substances, such as metals, had both external (*barrānī*) and internal (*jawwānī*) characteristics, so that gold, for example, was hot and moist externally but cold and dry inside. To convert one thing into another, as in this case silver to gold, it was only necessary to bring out the internal characteristics of the less noble metal; as for chemical change in general, everything depended on the admixture or *krasis* (κρᾶσις), *mizāj* in Arabic, of the primary constituents, external and internal. The agents for changing these balances, and so converting one substance into something else by a transmutation (*qalb* or *iqlāb*), were none other than the elixirs (*al-iksīr*), among which there was a supreme elixir (*al-iksir al-aʿẓam*); these and this were capable both of neutralising constituents present in excess and also of supplying the deficiencies of others. On account of the vital importance of the elixir concept for the general history of chemistry in the whole of the Old World we shall have to examine minutely a little later on (pp. 472 ff.) both the name and the thought. Here, continuing our sketch, it may be added that the Jābirian and Arabic alchemists believed that the actual qualities or constituents themselves could be obtained pure if one went on operating long enough.[c]

All this was associated with a highly elaborate body of theory known as the Science of the Balance ('Ilm al-Mīzān).[d] This was nothing less than an attempt to determine the proportional constitution of every natural object, but although the idea was exact and quantitative the execution was based not on experimental weighings but on numerological computations. We have already come across indications of this kind of thing in Chinese contexts (p. 304), but the Arabic theory remains perhaps the greatest example of such a procedure in all the history of science. Among its various sources the rough Galenic attempt to classify all drugs in four degrees (*taxeis*, τάξεις) of pharmacodynamic intensity was certainly one,[e] but there were also origins of a more theurgic or magical character, and the system lost all contact with reality when it divined the composition of substances from the letters and syllables of their Arabic names.[f] Thus the heat, cold, dryness and moisture in metals or salts were solemnly 'measured' in

[a] The Arabic terms are, respectively, *ḥarāra*, *burūda*, *ruṭūba* and *yubūsa*.

[b] There is one very 'Jābirian' text in the Hellenistic Corpus, namely v, ii, 'On the Work of the Four Elements', tr. Berthelot & Ruelle (1), vol. 3, pp. 322ff. They were sure it was later than the +7th century, and indeed it could well be of the +9th or +10th and derivative from the Arabic.

[c] For a quotation exemplifying this see Leicester (1), p. 66, taken from Kraus (3), p. 10, translating from the *Kitāb al-Talkhīṣ* (Book of the Reduction), Kr 164. The mania of the Arabs for almost endlessly repeated distillations, etc. up to 700 or 800 times, is often shown, as in the only English translation of a Jābirian book, that of Steele (3), the *Kitāb Hatk al-Astār* (Book of the Rending of Veils), Kr 972. This was no great contribution.

[d] Cf. Kraus (3), pp. 23ff. but especially pp. 187ff.

[e] Cf. Kraus (3), pp. 189ff.; Harig (1).

[f] Kraus, *op. cit.*, pp. 223ff.

units of much precision (*qīrāṭ*, *dirham*, *dānaq*, etc.).[a] In all these computations, the numbers 1, 3, 5, 8 and 17 keep on coming in, and these have more importance than one might think, because of the light they throw on origins and transmissions (cf. p. 459 below).[b]

At the same time, Jābirian and Arabic alchemy was more advanced than Hellenistic proto-chemistry because of its clearer and more rational classifications. These have come down to us in much detail, on which the specialist works are to be consulted;[c] here perhaps we need only say that in the Corpus, there are in general five spirits or volatile substances (*arwāḥ* or *nufūs*), seven metals, malleable and sonorous (*ajsām*), and an indefinite number of pulverisable minerals (*ajsād*) which later are divided into vitriols (*zājāt*), boraxes (*būraq*), salts (*milḥ*), stones (*ḥajar*) and the like. And here the Arabs have gone beyond the Greeks because a new volatile spirit is added to the classical sulphur, mercury and arsenic, namely ammonia in the form of sal ammoniac; for all the Arabic writings are characterised from the beginning by knowledge and use of ammonium chloride ('mineral ammoniac', *nūshādir*) from natural sources in Central Asia, and ammonium carbonate ('derived ammoniac', *nūshādir mustanbaṭ*) obtained by the dry distillation of hair and other animal substances.[d] This points up what has already been said, namely that Arabic alchemy is full of animal and plant substances of every kind,[e] very often submitted to destructive distillation, and so producing gases, inflammable materials, liquids, oils and ash (a palpable demonstration, for those times, of the air, fire, earth and water elements). Or they could be treated with weak acids, alkalies and alcohol solutions, sublimed for camphor or distilled wet for essential oils. A certain development of laboratory apparatus also occurred during these Arabic centuries. Moreover, a new salt was added to those previously known, saltpetre (potassium nitrate).[f] As for the volatile substances it must also be said that in the Jābirian Corpus we find the Western beginnings of the idea that all the metals (and perhaps other substances too) are combinations of sulphur (*al-kibrīt*) and mercury (*al-zībaq*) in different proportions,[g] all having naturally developed with great slowness in the bosom of the earth (cf. pp. 224, 454, 458).[h]

One should add that Jābirian alchemy was surrounded by an aura of speculative philosophy bordering on the magical. Reference has already been made to the Science of Properties ('Ilm al-Khawāṣṣ), by which the Arabic writers meant the tradition of causes and effects, sympathies and antipathies, going back to Bolus of Mendes[i] and

[a] Kraus, *op. cit.*, pp. 230ff.

[b] Kraus, *op. cit.*, pp. 194ff., 219.

[c] Cf. Kraus (3), pp. 18ff.

[d] Kraus, *op. cit.*, p. 41. A typical work on this technique is the *Kitāb al-Ḥukūma* (Book of Government), Kr 134, cf. Ruska (3).

[e] An extensive treatment of the use of these in chemistry is found in the *Kitāb al-Ḥayy* (Book of the Living), Kr 133, cf. Ruska (3).

[f] See pp. 195ff. above, where the exceptional importance of this salt is made clear.

[g] The oldest Arabic statement of this doctrine is found in the 'Book of the Secret of Creation' of Balīnās (see p. 369 above), early in the +9th century; later (pp. 455, 459) we shall consider its possible Chinese origin and the developments to which it led. See Ruska (8), p. 151. It also comes in the 'Epistles of the Brethren of Sincerity', in Ibn Sīnā, and in most of the Arabic alchemists.

[h] Cf. statements deriving from al-Rāzī in Ruska (21), pp. 62, 64, 96, 98.

[i] And, for all we know, to Huai Nan Tzu also (cf. p. 311 above).

generally covered by the Greek term *physica* (φυσικά).[a] But besides this there was also the Science of Theurgy and Apotropaics ('Ilm al-Ṭilasmāt)[b] and the Science of Generation ('Ilm al-Takwīn).[c] This last had to do not only with the formation of all kinds of ores and minerals but with the spontaneous and artificial generation of plants, animals and men; hence the idea of the homunculus, which later was absorbed into Latin alchemy, and some very strange directions for creating life, including the incubation of an artificial foetus within a model of the celestial spheres maintained in perpetual motion. This pseudo-science is of so much interest for the origins of the elixir idea that we must presently return to it.[d] Last of all, the Jābirian Corpus includes a number of books on cosmology and cosmogony, in which the chemical properties of substances are brought into relation with the construction of the universe itself.[e]

Here we come close to theology. It is thus of great interest that Kraus and Ruska were able to establish that all the works of the Jābirian Corpus were produced by a school or group essentially Ismā'īli in character,[f] and so foreshadowing the notable scientific collection called *Rasā'il Ikhwān al-Ṣafā'* (Epistles of the Brethren of Sincerity). These were produced rather later, in the second half of the +10th century, and covered a wider spectrum of heavenly and earthly sciences than the alchemy of the Corpus; we have already had a good deal to say about them.[g]

What was the Ismā'īlīya movement? It arose as part of the schism caused by the insistent belief of the Shī'ah Muslims in the transmission of the Prophet's spiritual authority through his son-in-law 'Alī, the first Imām.[h] Partly political from the beginning, this movement became even more so as it gained the support of the Iranian people, maintaining their own traditions over against purely Arab ideas. The theory of the Imāmate involved belief in a succession of either seven or twelve inspired leaders, and the Ismā'īlis took their name from the seventh, either Ismā'īl ibn Ja'far or Muḥammad ibn Ismā'īl. Both before and after their time the imāms had been, and became again, invisible, but one of the incarnate succession would one day appear in a kind of *parousia* as al-Mahdī to rule the earth in justice, peace and righteousness.[i] This ecclesiology and eschatology has evident similarities with ideas such as the apostolic succession, the Second Coming, and the rebirths of Buddhas and Bodhisattvas, but most of all with millenniarism and chiliasm, whatever religion they might be attached to. Hence the interest of the Qarmatian movement,[j] an Ismā'īli organisation deeply

[a] See Kraus (3), pp. 61ff.

[b] E.g. talismans.

[c] See Kraus, *op. cit.*, pp. 97ff., 109, 119. The principal treatise on these subjects is that entitled *Kitāb al-Tajmī'* (Book of the Concentration), Kr 398. Partial translation in Berthelot & Houdas (1), pp. 191ff. ending with a late interpolation (p. 225).

[d] See pp. 485ff. below.

[e] Kraus (3), pp. 135ff. The most important treatise on these subjects is the *Kitāb al-Taṣrīf* (Book of the Transmutation, or, the Morphology), Kr 404.

[f] See especially Kraus (2), pp. xlviiiff.

[g] Vol. 2, pp. 95ff. and *passim* in other volumes. See the fuller accounts also in Mieli (1), 2nd ed., pp. 128ff.; Hitti (1), 2nd ed., pp. 372–3.

[h] Cf. Hitti (1), 2nd ed., pp. 441ff.; Mieli (1), 2nd ed., pp. 59ff.

[i] One cannot help being reminded of Maitreya, the Buddha to come.

[j] Encountered already in Vol. 2, p. 96. Chinese parallels are discussed in Needham (56).

socialist or communist in practice, which began about +885, succeeded in establishing an independent State near Bahrein on the Persian Gulf,[a] kept up continual war with the Caliphate throughout the +10th century, and even after being overthrown in Iraq bequeathed much of its equalitarian doctrine to the Fatimid dynasty of Egypt and to the Neo-Ismā'īlites of Alamūt and Syria, groups destined to last on until the Mongol floods of +1260.[b] So what the Brethren of Sincerity in their time (*c.* +960 to +980), and the writers of the Jābirian Corpus in theirs (*c.* +890 to +920),[c] had in common with the early medieval Taoists was the simultaneous possession of mystical, scientific and political tendencies. They all acknowledged the existence of mysteries in Nature transcending *a priori* ratiocination, they all believed in the efficacy of manual operations for the development of sciences based on observation and experiment (though of course they found it very hard to distinguish between real effects and magical claims), and they all looked for the coming of an equalitarian and classless society. It is very remarkable that we can still find such clear traces of the movements of this kind which manifested themselves both in Western and Eastern Asia several centuries before the scientific revolution in Europe.[d]

Copious though it is, the Jābirian Corpus was far from exhausting the alchemical effort of the +9th and +10th centuries, and mention has to be made of other writers seemingly independent of it; three remarkable men and one strange book the authorship of which we are still not quite sure about. The three men are Dhū al-Nūn al-Miṣrī (d. +859), Ibn Isḥāq al-Kindī (+800 to +867) and the great al-Rāzī (+865 to +925). The book was the *Turba Philosophorum* (to give it its best-known name) or 'Congress of the Philosophers', datable somewhere very close to +900. It must be symptomatic of the amplitude already attained by Arabic civilisation that the Corpus never refers to any of these, nor do they refer to texts that are in it.

With the Egyptian Dhū al-Nūn ('Him of the Fish') we are in presence of the allegorical and ecstatic-visionary trend already noticed in the Corpus, which goes back to Zosimus and Olympiodorus among the Greeks. Hence it is of much interest that Dhū al-Nūn, whose full name was Abū al-Fayḍ Thawbān ibn Ibrāhīm al-Ikhmīmī al-Miṣrī, came from the same city as Zosimus—for Ikhmīm was the Arab name for Panopolis.[e] He is often regarded as one of the first of the sufis or mystical Neo-Platonic philosophers of Islam, and seems to have been close to the Ismā'īlis, but there is nothing practical attributable to him.[f] The case of al-Kindī is altogether different. Abū Yūsuf Ya'qūb ibn Isḥāq ibn al-Ṣabbāḥ al-Kindī was one of

[a] Quite reminiscent of the semi-independent theocratic Taoist State in Northern Szechuan founded by Chang Tao-Ling[i] in the +2nd century. On this one may read Maspero (13, 32).

[b] The Ismā'īlis are by no means extinct even today, and form a number of more or less independent sects, some ten million people in all, in the Middle East and India.

[c] The Qarmatians are occasionally mentioned by name in the Corpus (Kraus (2), p. xlix), e.g. in the *Kitāb Ikhrāj mā fī'l-Quwwa ilā'l-Fi'l* (Book of the Passage from Potentiality to Actuality), Kr 331; along with Indians, Mazdaeans and Greeks. Tr. Rex (2).

[d] On the wider significance of this association of mystical naturalism with early science and revolutionary social movements see Sect. 10(*f*) in Vol. 2, pp. 86ff., or Needham (77).

[e] In the Nile delta.

[f] Cf. Mieli (1), 2nd ed., p. 64; Hitti (1), 2nd ed., p. 435; Dunlop (6), p. 297.

[i] 張道陵

the greatest and most prolific philosophers of Islam, but also a great naturalist, meteorologist, mathematician and physicist.[a] We have already met with his important work on the chemistry of perfumes and distillations, *Kitāb Kīmiyā' al-'Iṭr wa'l-Taṣ'īdāt* (pp. 127 ff. above).[b] At the same time he was against aurifaction, and wrote an 'Epistle in Refutation of those who Claim the Artificial Fabrication of Gold and Silver'.

Just before al-Kindī died there was born at Rayy in Persia one of the greatest of all Arabic scientific men, Abū Bakr Muḥammad ibn Zakarīyā al-Rāzī.[c] In him chemistry and alchemy were combined not with philosophy but with medicine, for he was the leading physician of his time, and headed the great hospital in Baghdad. On his bibliography much work has been done,[d] though few of his texts have been adequately studied, apart from the *Kitāb Sirr al-Asrār* (Book of the Secret of Secrets), an integral translation of which we owe to Ruska (14).[e] The characteristic of his chemical writing is a complete matter-of-factness and freedom from all mysticism; there is none of that aura of 'nonsense' which pervades the Corpus. His classification of naturally occurring substances (*'aqāqīr*) is similar to that in the Corpus, if more elaborate and clearer;[f] in other ways also there is much similarity,[g] as in the concept of elixirs, the knowledge of sal ammoniac, the mention of East Asian things, the great use of plant and animal materials, and the preparation of caustic alkalies.[h] One of the works most influential in the Latin alchemy of the Middle Ages, the *De Aluminibus et Salibus*, has been shown to derive from parts of the 'Book of the Secret of Secrets'; it must have been translated and enlarged by some very practical Spanish alchemist of the +11th century, and the further work of translation is often attributed to Gerard of Cremona (+1114 to +1187).[i] But practical though al-Rāzī was, he never doubted the possibility of aurifaction, and one of his tractates was entitled: 'Refutation of al-Kindī with regard to his including Alchemy in the Category of the Impossible'.[j] It is to be feared that both these refutations are lost.

Next a word about the *Turba Philosophorum*.[k] One cannot refer to its proper title in Arabic because the original version has not yet been found,[l] and we depend on

[a] Cf. Mieli (1), 2nd ed., p. 80; Dunlop (6), pp. 178, 223, 229, 231.

[b] Tr. Garbers (1).

[c] Cf. Mieli (1), 2nd ed., pp. 89ff., 132ff.; Hitti (1), 2nd ed., pp. 365ff.; Leicester (1), pp. 68–9; Kraus & Pines (1).

[d] See Ranking (1); Ruska (15). Ruska (16) and Kraus (5) have discussed the account of al-Rāzī's life and writings given by al-Bīrūnī about +1036. A translation is given by Dunlop (6), pp. 237ff.

[e] It seems that al-Rāzī wrote two books, one 'of Secrets', the other 'of the Secret of Secrets'. Both are combined in a MS. collection in the Tashkent Library, and Karimov (1) has published a Russian translation of the latter, apparently the larger work of the two. He believes that Ruska's translation was of the former. These texts have nothing to do with the *Secretum Secretorum* that Roger Bacon was interested in (pp. 297, 368 above, pp. 494, 497 below).

[f] There is a study of this in Stapleton, Azo & Husain (1).

[g] General accounts of al-Rāzī's chemistry have been given by Partington (17) and Heym (2).

[h] Translations and textual comparisons (but no interpretations) in Ruska & Garbers (1).

[i] There is an excellent monograph on this book and its history by Ruska (21). See also Multhauf (5), pp. 160ff., especially on the part played by Gerard.

[j] Ranking (1), no. 40.

[k] The most important papers on this are those of Ruska (6) and Plessner (5, 6, 7). There is an English translation, not perhaps meeting present-day scholarly standards, by Waite (13).

[l] It was probably *Muṣḥaf al-Jamā'a* (Book of the Assembly); Ullmann (1), pp. 213ff.

several Latin translations none older than the +12th century, though more or less parallel texts in Arabic are not unknown.[a] The structure of the work is intriguing; in a series of speeches reminiscent of those at a symposium or congress nine pre-Socratic Greek philosophers give each their divergent opinions, from Anaximander to Xenophanes, after which follow sixty-three other speeches all dealing directly with alchemy—these more international since they include Astanius (Ostanes), Bonellus (Balīnās) and others. The dating of this work has been difficult, but that it must have been put together in the neighbourhood of +900 appears from the following considerations. The first person to quote from it is Ibn Umail, who died about +960.[b] The *Fihrist* says that 'Uthmān ibn Suwayd al-Ikhmīmī, who was certainly living about the turn of the century, wrote a work entitled 'Book of the Controversies and Conferences of the Philosophers', and this was most probably the *Turba*.[c] It must have been put together after the appearance in Arabic of the Indian book of poisons, *Kitāb Shānāq*, *c.* +830, because the theme of the poison-maiden, which is used in the *Turba* as an alchemical allegory, came into Arabic literature by this means.[d] If Ruska and Berthelot were right in dating the *Kitāb al-Ḥabīb* to the middle or early +9th century, then it may well have been a precursor of the *Turba* for it certainly contains many speeches and dialogues.[e] Ruska (36) identified it with a work listed in the *Fihrist*, 'Book (of Dialogues) of Mary the Copt with the Philosophers who assembled at her House'.[f] The idea was surely very much in the air in the +9th century because similar ideas about symposia can be found in the Jābirian Corpus.[g] As for the earlier roots of the *Turba*, it has been possible to show borrowing from the *Refutatio Omnium Haeresium* written by Hippolytus[h] in +222, and a close connection with the opinions of philosophers as reported by Olympiodorus (+6th century) in the Hellenistic proto-

[a] A *Jamā'a Fīthāghūras* (Compendium of Pythagoras) is listed in the *Fihrist* bibliography (see Fück (1), p. 94) There was an Arabic text of it in Cairo in the +16th century, so it may still be recovered. Kraus also found a MS. entitled *Min Maṣḥaf al-Jamā'a* (From the Book of the Assembly), see Ruska (6), p. 297.

[b] We shall speak further of him immediately below.

[c] Fück (1), p. 107; Dodge (1), vol. 2, p. 865. The suggestion is due to Plessner (5), and has been generally accepted, as by Nasr (1), p. 283.

[d] This is an interesting story in itself. The *Kitāb Shānāq fī 'l-Sumūm wa'l-Tariyāq* (Book of Canakya on Poisons and Theriaca) was based, as textual parallelisms show, on the *Arthaśāstra* (+3rd cent.), and Canakya was Kautilya. The *Suśruta* and *Caraka samhitas* also afforded material. About +790 it was translated from Sanskrit into Persian by one of the Indian physicians at Jundi-shāpūr, Mankah or Kankah (Kanaka), to whom there is a reference in the Jābirian Corpus (Kraus (3), p. 59). Then by +830 it was done into Arabic from Persian by one Abū Ḥātim, and revised by al-'Abbās ibn Sa'īd al-Jauharī, who added Greek materials. It is not very closely related to the *Kitāb al-Sumūm* of the Corpus (Kr 2145), on which see Ruska (38). We owe an exhaustive study of the Shānāq book to Bettina Strauss (1), afterwards the wife of Paul Kraus. Its translation under the 'Abbāsids has to be set beside the similar incorporation of Indian medical and astronomical sources into the Arabic literature described in Vol. 1, p. 216 (cf. Dunlop (7), pp. 6ff.). On Kautilya see also Vol. 5, pt. 3, pp. 164–5. On the history of the poison-maiden theme see at length Penzer (2) and Hertz (1).

[e] Al-Ḥabīb ('friend') appears to be a personal name. Translation in Berthelot & Houdas (1), pp. 76ff. Though all the personages have Greek names, many Chinese and Indian notes are struck in what they say; cf. pp. 469, 470, 471, below.

[f] See Fück (1), p. 94.

[g] The details are given by Kraus (3), p. 59, citing especially the *Kitāb al-Mujarradāt* (Book of Abstractions), Kr 63, 64.

[h] Who has come into our argument before, p. 124 above. All the nine pre-Socratics appear in his book, and there are textual resemblances with the *Turba*, as Plessner (5) was the first to notice.

chemical Corpus,[a] though these are descriptive or doxographic rather than in dialogue form.

The general view now is that the 'Mob, or Congress...' was an attempt to put Hellenistic proto-chemistry and natural philosophy into Arabic form and adapt it to Islamic science.[b] There can be no doubt that the writer had a remarkable knowledge of Greek thought, but the essential points which he wanted to make (and made through the mouth of Xenophanes) were first the importance of Islamic monotheism,

Fig. 1530. A Chinese *Turba Philosophorum*, from *Shen Hsien Thung Chien*, Hua tsang thu, p. 45 a. The conclave consists of Yin Chhang-Shêng (cf. Vol. 5, pt. 3, pp. 75–6), Chang Kung-Chao, Ma Ming-Shêng (ibid. p. 77), Khung Yuan-Fang, Lu Tung-Hsüan and Liu Tzu-Nan. Its date would be about the middle of the + 2nd century, in the Later Han period.

secondly the uniformity of Nature, and thirdly the universality of the four elements as components of all created things. Obviously Greek and Byzantine influence was paramount in the work, yet even here traits distinctively Further Asian keep on coming in—for example, a great emphasis on sexuality in chemical substances and

[a] *Corp.* II, iv, 19–28; also Plessner's find.

[b] There is nothing quite similar in Chinese literature, though dialogues occasionally occur; we shall meet with one on physiological alchemy in Vol. 5, p. 5. But paintings and drawings of natural philosophers in conclave are quite frequently found, and we reproduce here a picture of six ancient alchemists in plenary session (Fig. 1530). Ma Ming-Shêng and Yin Chhang-Shêng we know from Vol. 5, pt. 3, pp. 43, 49, 51, 75–7, and the other four are also of the later Han period, + 2nd century (*Shen Hsien Thung Chien*, Hua tsang thu, p. 45 *a*).

reactions, quite reminiscent of the theory of Yin and Yang,[a] a marked imagery of the processes of animal generation,[b] and explicit references to India.[c]

Ibn Umail has just been mentioned, and he is the next of our landmarks.[d] Muḥammad ibn Umail al-Ṣādiq al-Tamīmī (*c.* +900 to +960) wrote much on alchemy, but his most renowned work was the *Kitāb al-Mā' al-Waraqī wa'l-Arḍ al-Najmīya* (Book of the Silvery Water and the Starry Earth); this found its way into Latin as the *Tabula Chemica* (cf. p. 373 above) with his name still attached to it in the somewhat disguised form of Senior Zadith Filius Hamuel.[e] Similarly, his alchemical poem, the *Risālat al-Shams ilā'l-Hilāl*, on which the former work was really a commentary, was translated into Latin, in this case keeping its exact title *Epistola Solis ad Lunam Crescentem*. There is something ominous about alchemical poems. They presage and preside over the decaying end of a tradition, when the hard factual side has been pushed as far as it will go within the prevailing intellectual cadre, and there is no real way further forward; this one can see very clearly both in the Hellenistic proto-chemical and the Chinese alchemical traditions as well as in the Arabic.[f] Ibn Umail's writing is by no means devoid of a practical and experimental basis, but it has much in common with that of Dhū al-Nūn, being very allegorical and mystical, with visions in the crypts of the pyramids and so forth; it also accepts the possibility of aurifaction and belongs to the mineral-metallurgical school, warning against the use of animal substances in alchemy. Then with Maslama ibn Aḥmad al-Majrīṭī a little later (he died *c.* +1007) comes the development of Arabic alchemy in Spain, for his *Rutbat al-Ḥakīm* (The Sage's Step) reveals much practical knowledge.[g] He discusses

[a] This runs all through the text. In the speech of 'Socrates' chemical reaction is compared with generation, lead is male and orpiment female; according to 'Diamedes' both male and female substances are needed, mercury being the former and sulphur the latter; 'Ostanes' makes copper female and mercury male; 'Theophilus' has allegories of nights of love between man and wife, etc. etc. See the translation of Ruska (6), pp. 200, 215–16, 229, and 247; also his summaries, sects. 54, 55, 57, 59. Many traces of the *Turba* are found in later Latin texts, such as the +14th-century *Consilium Conjugii, seu de Massa Solis et Lunae*, a very Yin–Yang production; on this see Ruska (6), pp. 333ff., 342; Ferguson (1), vol. 1, p. 176; Berthelot (10), p. 249. On the meaning of *massa* here see p. 366 above. Ruska himself well appreciated how much non-Greek ideology the *Turba* contains, (6), p. 295.

[b] Notable e.g. in the speech of 'Bonellus' (Balīnās) analogising the alchemical work with the development of the embryo in egg or womb (Ruska (6), p. 247, summary 59; cf. p. 292 above). We have already mentioned the strange ideas of the Jābirian Corpus on artificial generation within cosmic models (p. 396 above), and we shall return to this presently because of its close connection with the idea of the life-giving elixir (pp. 485ff. below).

[c] In his speech, 'Leucippus' says: 'What Democritus had on the science of the natures [i.e. the four elements] he got from me, and hence (in the last resort) from the philosophers of India and Babylonia: I think, however, that he excelled all others of his time in science.' Perhaps Babylonia here meant Persia and the Ostanes tradition, as opposed to the Graeco-Egyptian Hermes-Agathodaemon tradition. It will be remembered that the Hellenistic Corpus contains a 'Letter of Pseudo-Democritus to Leucippus' (*Corp.* II, ii). The only mentions of India in this Corpus both concern wootz steel (cf. Needham, 32); one fragment may be quite early (*Corp.* I, xvii, 3), but the other must be late, perhaps +10th century (*Corp.* V, v).

[d] The fullest study of him is that of Ali, Stapleton & Husain (1), but Holmyard (1), p. 99 and Leicester (1), pp. 63, 80 have something to say on him too. He quotes al-Rāzī (cf. Stapleton & Azo, 2) as well as the *Turba*. See also Ruska (9).

[e] Cf. pp. 366 above.

[f] Cf. pt. 2, p. 17, pt. 3, pp. 148, 195, and p. 327 above.

[g] See especially Holmyard (11) and Ruska (28). Mentions also in Mieli (1), 2nd ed., pp. 180–1: Holmyard (1), p. 98; Leicester (1), p. 71. But there is some discrepancy about the dating of the 'Sage's Step'; the +950 of some MSS seems too early, and the +1050 of others is certainly too late, hence, though the question is still unsettled, the book may be by Maslama al-Majrīṭī's immediate pupils.

cupellation and cementation,[a] and describes the oxidation of mercury, but he believed in transmutation by elixirs, and indeed that every alloy was a new species. Al-Majrīṭī and his school also propagated in the West the writings of the Brethren of Sincerity, and doubtless of the Jābirians too.

The +11th century yields two names of importance, one much better known than the other. In +1034 Ibn 'Abd al-Malik al-Ṣāliḥī al-Khwārizmī al-Kaṭī produced his *'Ain al-Ṣan'a wa-'Aun al-Ṣana'a* (Essence of the Art and Aid to the Workers).[b] This was basically a book of metallurgical chemistry in the Hellenistic tradition, allowing of aurifiction as well as aurifaction; 'tingeing' is prominent, calcium polysulphide used, arsenical copper known, as well as the dilution of silver with copper, and one finds also the surface-enrichment of gold–copper alloys by a sulphide method.[c] East Asian influence might also be detected, however, in the attention given to the combination and liberation of mercury and sulphur, while sal ammoniac is used to obtain the chlorides of tin from a tin–mercury amalgam. Similarly the description of corrosive sublimate if not calomel suggests knowledge of antecedents in Chinese chemistry.[d] Far more celebrated was the great physician and naturalist Ibn Sīnā—Abū 'Alīal-Ḥusain Ibn Sīnā (+980 to +1037), who certainly occupied himself at one time or another with chemical operations, even though the totality of the books and tractates on alchemy, mostly in Latin, afterwards attributed to him, is an apocryphal literature.[e] As we know, he resolutely denied the possibility of transmutation or aurifaction in a genuine book, the *Kitāb al-Shifā'* (Book of the Remedy),[f] and the same opinion is advanced in another genuine text, the tractate *Ishāra ilā Fasād 'Ilm Aḥkām al-Nujūm* (Demonstration of the Futility of Astrology).[g]

By the middle of the +11th century the great days of Arabic alchemy were over, and little remained save poets and commentators.[h] Within less than a century, however, the process of translation out of Arabic into the Latin was to commence. During this period there are only two Arabic names to mention, first al-Ṭughrā'ī and then Ibn Arfa' Ra's; both wrote poetical works. Abū Ismā'īl al-Ḥusain al-Ṭughrā'ī, who was executed in a religious persecution in +1121, wrote a *Kitāb al-Ǧauhar al-Naḍīr fī Ṣinā'at al-Iksīr* (Book of the Brilliant Stone and the Preparation of the Elixir), which has been studied and expounded by Razuq (1). It is much more allegorical than practical, but he may have been the Artephius of the Latins.[i] Later in the century there was Ibn Arfa 'Ra's al-Andalusī (d. +1197), chiefly known for his *Dīwān Shudhūr al-Dhahab* (Poem on the Particles of Gold). This contains some references and information not found anywhere else.[j]

[a] Cf. Vol. 5, pt. 2, pp. 36ff., 51ff.

[b] See Stapleton & Azo (1) and Ahmad & Datta (1). Mieli (1), 2nd ed., p. 133 has a word on him.

[c] Cf. Vol. 5, pt. 2, pp. 39, 251.

[d] Cf. Vol. 5, pt. 3, pp. 123, 127ff.

[e] Ruska (26, 27). Nevertheless, see also Stapleton, Azo, Husain & Lewis (1).

[f] Holmyard & Mandeville (1). Their translation of the passage has been quoted already in Vol. 5, pt. 2, p. 30.

[g] Cf. Ruska (26); Ullmann (1), p. 252.

[h] To keep step with events in China, we may recall that this was the time of the Imperial Alchemical Elaboratory at the capital, the activities of that outstanding metallurgical adept Wang Chieh, and the publication of the military encyclopaedia *Wu Ching Tsung Yao*, with all its information on gunpowder weapons (see Vol. 5, pt. 3, pp. 182, 184, 187).

[i] See Mieli (1), 2nd ed., p. 156; and p. 495 below.

[j] Cf. Holmyard (1), p. 100; Mieli (1), 2nd ed., p. 289; Hopkins (1), p. 152.

These men were contemporaries of the translators, busy as bees between +1120 and +1180 mostly in Spain but also in the Near East.[a] The majority of the alchemical translations have remained anonymous, but of the many names known some must have occupied themselves in such work.[b] One thinks of Hugh of Santalla (*fl.* +1125), Adelard of Bath (*fl.* +1130) who worked in the East, Dominic Gundisalvi the archdeacon (*fl.* +1135), Hermann the Carinthian or Dalmatian (*fl.* +1141) companion of Robert of Chester, finally Gerard of Cremona (*fl.* +1167). Perhaps it was Robert who produced the first exactly dated alchemical translation, the *De Compositione Alchemiae* of +1144, a rough précis of the Khālid–Morienus dialogue preceded and followed by other materials,[c] but this has been the subject of some controversy.[d] A translation of rather similar date, though cast in a different form, is the *De Anima in Arte Alchimiae*, compiled from various Arabic sources about +1140 but nothing whatever to do, in spite of what it says, with Ibn Sīnā himself.[e] Some of al-Rāzī's work was also translated at this time, as in the *Liber Secretorum Bubacaris*, i.e. of Abū Bakr.[f] And in this first wave there seems to have been also a translation, very garbled, of the Seventy Books (i.e. tractates) in the Jābirian Corpus, entitled *Liber de Septuaginta Johannis* and done by another scholar from Cremona, Renaldus.[g] At all events by +1250 a whole flood of Latin translations, however crude, from Arabic alchemical texts had become available in the Western world.

Meanwhile Arabic alchemy continued, though the steam had mostly gone out of it. Early in the +13th century there was 'Abd al-Raḥīm al-Dimashqī al-Jaubarī with his *Kitāb al-Mukhtār fī Kashf al-Asrār wa-Hatk al-Astār* (Choice Book of the Revelation of Secrets and the Tearing of Veils), chiefly notable for its strong stand against aurifaction.[h] The allegorical trend was continued in the second half of the

[a] During this time in China Wu Wu and others were writing much on alchemical apparatus, and the development of the Northern and Southern Schools of Taoism was occurring, accompanied by a strong wave of interest in physiological alchemy. See Vol. 5, pt. 3, pp. 198, 200; and pt. 5 below.

[b] On the Latin translations see Thorndike (1), vol. 2, pp. 217ff.; Berthelot (10), pp. 229ff.; Dunlop (7); and on the translators Thorndike (1), vol. 2, pp. 19, 78, 83, 86–7; Steinschneider (1, 4); Burnett (2).

[c] Robert's prologue is the *locus classicus* where 'alchemia' is treated as a concrete noun, a substance, in fact the elixir. The words are: 'Alchymia est substantia corporea ex uno et per unum composita, preciosiora ad invicem per cognationem et effectum conjungens, et eadem naturali commixtione ingeniis melioribus naturaliter convertens'. Cf. p. 366 above.

[d] First Reitzenstein (5) recognised the very Hellenistic nature of Morienus' explanations, and showed a close connection with the Heraclius–Stephanus dialogue of *c.* +630 (cf. p. 327 above). Then Holmyard (19) demonstrated marked textual parallelisms with the *Kitāb al-'Ilm al-Muktasab* of al-'Irāqī (cf. p. 404 below) who would have used the Morienus document about +1270. Nevertheless Ruska (4), esp. pp. 31ff., 35ff. (41, 42) came to believe, for various reasons, that the whole thing, both prologue and text, was a pastiche, plausibly Italian, of the late +13th or +14th century. His scepticism was not, however, supported by Thorndike (1), vol. 1, pp. 773–4, vol. 2, pp. 214ff. Steele & Singer (1) also defended the authenticity of the work, and they have now been vindicated by Stavenhagen (1) after a thorough study of the widely scattered manuscripts. This does not of course reinstate the historicity of Morienus or the alchemical interest of Khālid. There is a modern English translation by Stavenhagen (2). Although the main emphasis of the work is on projective aurifaction, there is an interesting, perhaps significant, allusion to the longevity of Morienus (pp. 7, 66). But the original Arabic text itself can hardly be older than about +820 because it contains passages (pp. 20, 25, 27) implying knowledge of ammonium chloride (sal ammoniac, cf. p. 437 below). There is also of course 'the marriage of fire and water' (p. 33); and the elixir is frequently mentioned, 'alchemy' being used as a noun synonymous with it (pp. 35, 41, 43, 47). See also Burnett (1).

[e] Ruska (26); Berthelot (10), p. 293.

[f] Cf. Berthelot (10), p. 306.

[g] Kraus (2), p. 42; Berthelot (10), pp. 69, 77, 320ff.

[h] Cf. Mieli (1), 2nd ed., p. 156.

century by Abū al-Qāsim al-Sīmāwī al-'Irāqī with his *Kitāb al-'Ilm al-Muktasab fī Zirā'at al-Dhahab* (Book of Knowledge acquired concerning the Cultivation of Gold), studied and translated by Holmyard (5).[a] This is not entirely divorced from practice,[b] but it tends to philosophy and the discreet revealing of the cover-names in the trade.[c] Al-'Irāqī drew heavily from Ibn Umail, and was in turn commented upon by 'Alī ibn al-Amīr Aidamur al-Jildakī (*fl.* +1342).[d] If there was more of quotation than of practice in his *Al-Burhān fī 'Ilm Asrār 'Ilm al-Mīzān* (Proofs of the Secret Science of the Balance), his other main work, the *Nihāyat al-Ṭalab* (End of the Search), on which Taslimi (1) and Holmyard (15) have written at length, contains many concrete instructions and shows a genuine love of experiment. Holmyard called him 'the last of the outstanding Muslim alchemists'.[e]

At the end of the day it is possible to take a retrospective survey of Arabic alchemy by means of those remarkable chapters on the subject which Ibn Khaldūn incorporated in his 'Prolegomena' or 'Introduction to History', the *Muqaddima*, written in +1377. 'Abd al-Raḥmān ibn Muḥammad ibn Khaldūn, the first historical sociologist, perhaps, in any civilisation, discussed in his book many sciences human and divine, and one of them was alchemy. Here aurifaction was dominant, but not exclusively so, for Ibn Khaldūn entertained the speculation that if only the *mizāj* (*krasis*) of the elements of man's being were made perfect by an elixir, he would live eternally; just as gold, with its *krasis* more perfect than in any other metal, persists for ever without spontaneous decay.[f] Still, he defines alchemy as

> a science which studies the substance through which the generation of gold and silver may be artificially accomplished, and comments on the operations leading to it. The (alchemists) acquire knowledge of the tempers and powers of all created things, and investigate them critically. They hope that they may thus come upon the substance that is prepared to (produce gold and silver). They even study the waste matter of animals, such as bones, feathers, hair, eggs and excrement;[g] to say nothing of minerals.... The (alchemists) assume that all these techniques lead to the production of a natural substance which they call 'elixir'.[h]

The alchemists, he goes on to say,[i] in a reference to the *materia prima* of Hellenistic proto-chemistry, have been inspired by the thought that mineral substances may be changed and transformed artificially one into another because of the plain matter devoid of all qualities which is common to them all. But he also mentions fermentation.

[a] See also Holmyard (1), p. 100; Nasr (1), p. 278; Mieli (1), 2nd ed., p. 156.

[b] Cf. Fig. 1533.

[c] About the same time, in +1283, the collection of Persian and Arabic alchemical texts known as the Rampur Corpus was made; on this see Stapleton & Azo (2).

[d] Cf. Mieli (1), 2nd ed., p. 289; Wiedemann (32), pp. 21ff.

[e] It will be remembered that Arabic alchemy was now facing, as it were, powerful competition from Latin alchemy, for the time of Geber had come, with all its basic discoveries, especially that of the strong mineral acids. Saltpetre and gunpowder, with all that that implied, were also now reaching Western Europe. As for China, as we have seen, the late Sung and Yuan periods were a time of decline in proto-chemical alchemy, with physiological alchemy finding increasing favour.

[f] See Rosenthal (1), vol. 3, p. 232; we shall quote the passage in full presently (p. 480).

[g] A reference to the making of ammonium carbonate by dry distillation. Cf. pp. 432ff.

[h] Rosenthal tr., vol. 3, pp. 227ff.

[i] Rosenthal tr., vol. 3, p. 267.

Competent (alchemists) think that the elixir is a substance composed of the four elements. The special (alchemical) processing and treatment give the substance a certain temper and certain natural powers. These powers are such as to assimilate to themselves everything with which they come into contact, and transform it into their own form and temper. They transmit their own qualities and powers to it just as yeast in bread assimilates the dough to its own essence and produces in the bread its own looseness and fluffiness, so that the bread will be easily digestible in the stomach and quickly transformed into nourishment.[a] In the same way the elixir of gold and silver assimilates the minerals with which it comes into contact to (gold and silver) and changes them into the forms of (gold and silver). This is in general the sum total of the theory (of the alchemists).[b]

Ibn Khaldūn was well read in the alchemical literature of his culture, from 'Jābir' through Maslama al-Majrīṭī to al-Ṭughrā'ī, and (as we saw) he vehemently denied that Khālid ibn Yazīd had started it.[c] But while he was not against the real knowledge of chemical substances which the alchemists had acquired, he believed that most of the practitioners had been rank charlatans—he did not know of one successful honest alchemist. It was an infatuation. The deceivers, especially Berber 'students' in the Maghrib, would cover silver with a gold veneer or copper with silver, diluting the noble metals with the base, or 'blanching' copper with mercury.[d] As for the theory of aurifaction itself, he could trace a debate which had been going on for centuries. Abū Naṣr al-Fārābī (d. +950)[e] and the Spanish philosophers who followed him maintained that the metals were not 'distinct species' but variations, as it were, on a single theme (the *prima materia*), therefore aurifaction was possible—and al-Fārābī wrote a special monograph to prove it, *Kitāb fī Wujūb Ṣinā'at al-Kīmiyā'* (Book on the Necessity of Alchemy).[f] Ibn Sīnā (d. +1037)[g] and the Eastern philosophers who followed him, however, maintained the opposite, therefore aurifaction was impossible. Al-Ṭughrā'ī (d. +1121) countered this by drawing attention to the phenomena of biological metamorphoses (some quite real, more based only on legend).[h] Ibn Sīnā's scepticism, Ibn Khaldūn felt, would not resist al-Ṭughrā'ī's argument, but he had thought of something better—the alchemists, it was admitted on all hands, sought to accelerate that production of gold which happens very slowly in any case within the bosom of the earth, but this 'embryology' of gold could obviously be known only to God—moreover, if instant aurifaction were possible, why should Nature take such a long time about it underground? Ibn Khaldūn went on to say that 'those who claim to have made gold with the help of alchemy are like those who might claim success in the artificial creation of man from semen'.[i] Curiously enough, that was exactly what

[a] The *massa* theory, on which see p. 366 above.

[b] Rosenthal tr., vol. 3, p. 268.

[c] Rosenthal tr., vol. 3, pp. 228–9.

[d] Rosenthal tr., vol. 3, pp. 269, 271. Impatience with charlatanism seems a typical sign of the impending death of an alchemical tradition; cf. our comparison in Vol. 5, pt. 3, pp. 212ff. For a glimpse of the medieval Islamic underworld see the interesting study of Bosworth (1).

[e] Eminent philosopher, born at a place on the Jaxartes R., i.e. in Sogdia or Ferghana (Fig. 1531*a*).

[f] Dunlop (6), p. 241.

[g] Equally great philosopher and physician, born at Bokhara on the Oxus, i.e. a Khwarizmian. It might not be a coincidence that both these men were from almost the borders of China, differing in their attitude to alchemy but deeply interested in it. More will be said on this point later, p. 424.

[h] Like Petrus Bonus later on, cf. Vol. 5, pt. 2, p. 64.

[i] Rosenthal tr., vol. 3, p. 276.

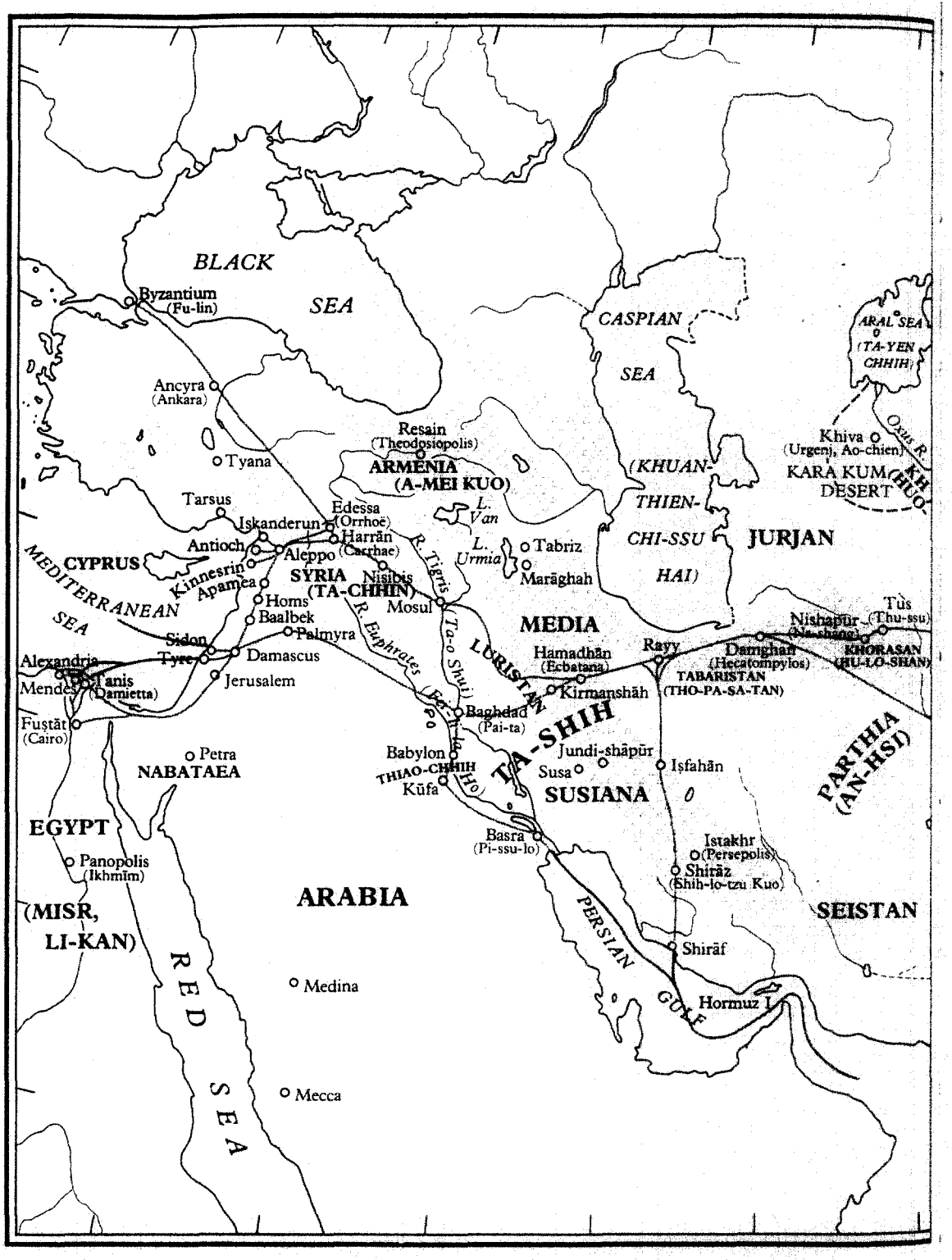
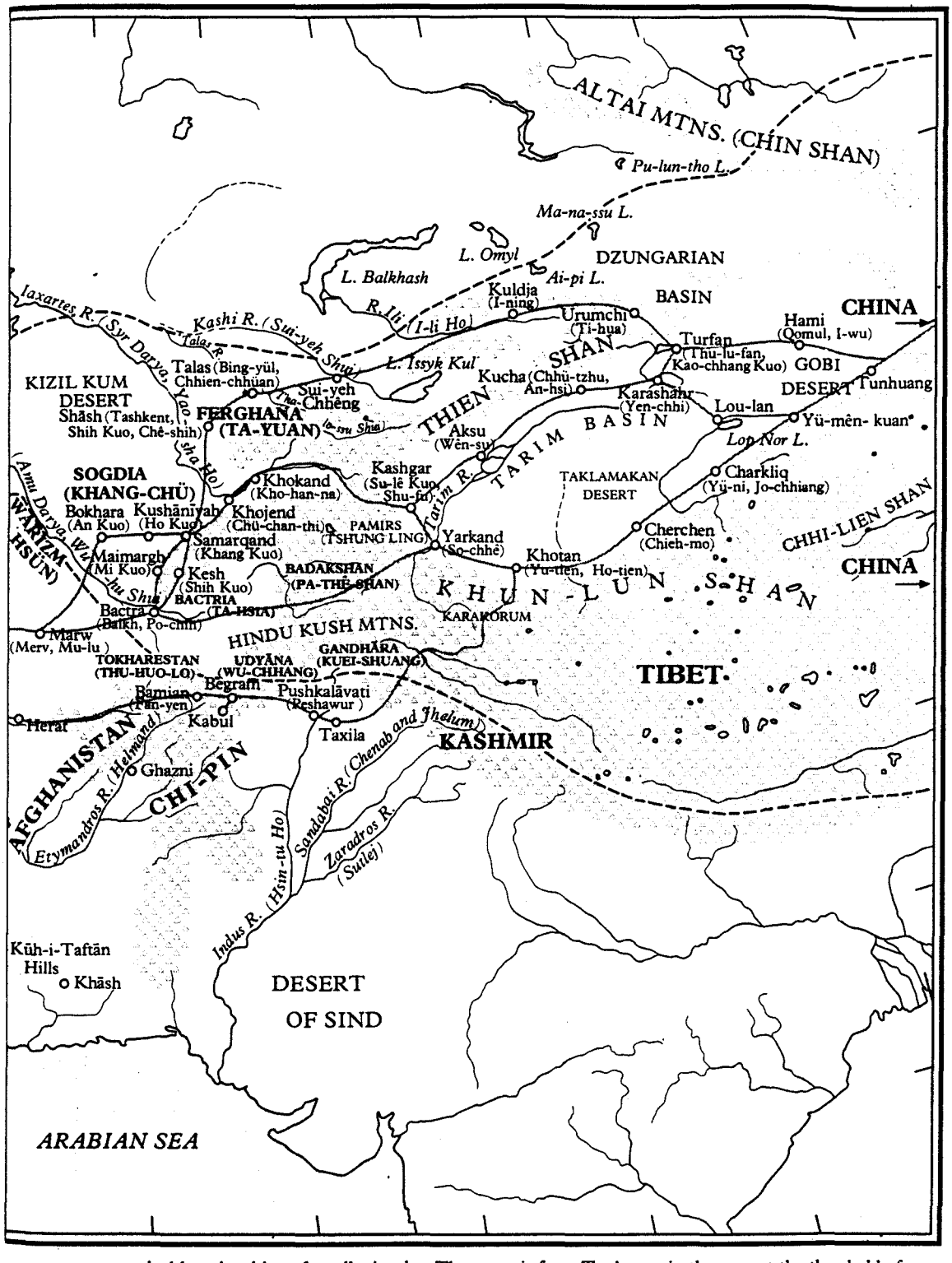


Fig. 1531*a*. Map to show the communication routes, mainly overland, between the Chinese and Arabic culture-areas, as also the relations between Chinese, Iranian and Eastern Mediterranean lands and cities. Focussed on Central Asia, the map was drawn on a Harvard–Yenching Institute physical blank, extended westwards to the same scale, 1:6,250,000, with the assistance of the Cambridge Department of Geography and Cartography. The area covered is from approximately longitude 25° East to longitude 95° East, and from approximately latitude 45° North to 20° North. The reproduction here is reduced by just over three times in longitude and twice in latitude. Mountainous regions are



marked by a hatching of small triangles. The range is from Tunhuang in the east, at the threshold of China, to Alexandria and Byzantium (Istanbul) in the west; it goes as far north as the northern ends of the Caspian and Aral Seas, and as far south as the mouth of the Persian Gulf. Most of the Chinese names for places outside China are those current in the Thang period (+ 7th to − 10th centuries). All the area enclosed by the - - - line was in Chinese occupation or subject to Chinese suzerainty in the Thang, according to the historical atlas of Thung Shih-Hêng (*1*).

the Jābirians had claimed (cf. pp. 326 above and 485 below), but either Ibn Khaldūn had not read those particular books or dismissed them as the wildest nonsense. Finally he brought up a few supplementary arguments. God, he said, had provided gold and silver as the means of exchange in the daily life of the peoples, how then could he allow the making of alchemical gold to upset this pre-established harmony? Moreover, with this fermentation theory, the transformation of dough by yeast is, after all, a corruption or destruction, while the production of gold from other minerals by fermentation would be creative and constructive—therefore the whole analogy is wrong.[a] There is no such thing as aurifaction—but if alchemy cannot be a natural craft, its effects might always be produced by sorcery or miracle-working—and there Ibn Khaldūn was prepared to leave the matter.

The curtain falls with 'Abd al-Wahhāb al-Sha'rānī (d.· +1565) and his *Laṭā'if al-Minan wa'l-Akhlāq* (Pleasant Gifts and Traits of Character).[b] Here deceptive aurifaction by impostors and charlatans is most prominent, but the belief still persists, for among a thousand unsuccessful practitioners, there was one who achieved his aim—yet for religious reasons declined to use any of the gold he made, Shaikh Aḥmad ibn Sulaimān al-Zāhid (d. *c.* +1420). May Allāh have mercy on his soul, for he loved not the goods of this present world.

(ii) *The meeting of the streams*

Throughout the foregoing account there have been inescapable indications that the early chemistry of the Arabs was not at all exclusively Graeco-Egyptian in origin, that this inheritance in fact was paralleled by a contribution both theoretical and practical coming westwards from China, India, Central Asia and Persia. Presently we shall briefly but carefully study what the main features of this contribution were; first let us enquire into the historical geography that provided the scene for so great a cultural movement of synthesis.

Long ago, Ruska (32), studying the sources of the material in the Jābirian Corpus, came to the conclusion that the lands along the route of the Old Silk Road[c] had been particularly important. From North and East Persia many influences now radiated, from Tabaristan along the south shore of the Caspian, from Khorasan with cities like

[a] This sounds many echoes of thought about upward and downward transformations in Nature; we have seen them in China in Buddhist contexts, cf. Vol. 2, pp. 420 ff. What is particularly interesting to recall here is that in +1678 there was published in London an anonymous pamphlet entitled 'Of a Degradation of Gold made by an Anti-Elixir; a strange Chymical Narative'. As we learn from Ihde (1), who has gone into the question, Robert Boyle's pen was accepted by contemporaries as the source, and indeed his name was printed on the title-page of the second edition of +1739. The anti-elixir, the nature of which was never disclosed, was a dark red powder which would convert pure gold into a brittle silvery mass and baser materials such as a yellowish-brown powder partly vitrified. The de-aurifaction purported to have been proved by the touchstone, cupellation and the hydrostatic balance. Ihde considers various possibilities—a joke, but it was not in character for Robert Boyle to jest—a fraud, but that would have been beneath him—a parable enshrining a set of beliefs, and Boyle was indeed prepared to take aurifaction seriously— or possibly an experiment 'cooked' by one of his laboratory assistants. Ihde decides for the last suggestion, but it is not a very convincing one, and the incident remains passing strange. See Anon. (104).

[b] See Dunlop (6), pp. 248–9; Hitti (1), 2nd ed., p. 742.

[c] Cf. Vol. 1, pp. 181 ff., and here Fig. 1531*a*.

Tus, Nishapur and Herat in its mountain ranges, from Khwarizm in the Oxus valley, with Khiva as its capital, from old Sogdia and Bactria between the Oxus and the Jaxartes, the land of Balkh, Bokhara and Samarqand, finally from Ferghana beyond the Jaxartes on the very borders of Sinkiang. 'Historical research', wrote Ruska, 'is realising more and more the role of transmission played by Central Asia after Alexander the Great between the human cultures of West, East and South. And it is also seeing more and more how Islam became the great basin into which all these streams of ideology flowed, uniting themselves in Central Asia from East and West and also from India to form remarkable (new) religious and philosophical patterns'.[a] In Arabic alchemy, he went on to say, a Western 'Egyptian-Spanish' set of ideas and techniques, infused with Hellenistic metallurgical mysticism, joined with an 'Eastern-Persian' set, characteristically chemo-therapeutic in nature. 'Both flow side by side and interpenetrate at times, finally delivering all into the alchemy of the Latin Middle Ages.'

The horizons of Kraus were rather more limited to the Hellenistic world, and more Greek than Egyptian at that, but even he could write as follows:[b] 'Jābirian alchemical theory...has few traits in common with what remains to us of ancient (Graeco-Egyptian proto-chemistry). The Graeco-Oriental tradition from which it derives was much more experimental in tendency and more systematical, it was more averse from symbolism and allegory, and it made use of animal substances and products, emphasising (a new volatile agent), "sal ammoniac" (ammonium chloride and carbonate) unknown to the Hellenistic world. Also one finds in the Jābirians a theory of (composition and) transmutation based on numerological principles hardly any trace of which is found in the Greek Corpus. The (Western) traditions on which the Jābirian system depended come more into focus in the science of "properties" (sympathies and antipathies), the Greek, not to say Neo-Pythagorean, inspiration of which can be established with greater certainty. One can thus try to define what parts of the whole complex derived from materials originating further East, in India and even perhaps in China.' Kraus also recalled the claim of 'Jābir' to have visited India;[c] and in another place pin-pointed the Ṣābians of Ḥarrān as a group which seems to have transmitted both Pythagorean, Hermetic and Gnostic ideas from the Mediterranean area as well as indigenous Chaldaean 'Nabataean' notions and certain characteristically Chinese terms, things and concepts.[d] We shall go into all this in a moment, but first we must trace the exact way in which Hellenistic proto-chemistry and the other sciences got into Arab dress.[e]

The key area was Syria and the northern half of Mesopotamia, the latter having long been bisected by a north–south line forming the frontier between the Roman (Byzantine) Empire and the Persian Empire (Sassanid from +224). But Susiana was

[a] (32), p. 270. [b] (3), p. viii.
[c] E.g. in *Kitāb al-A'rāḍ* (Book of Accidents), Kr 182. Cf. Kraus (3), p. 91.
[d] (3), pp. 305–16.
[e] There are many fuller accounts of this process to which reference can be made. One may mention certain admirable summaries like Meyerhof (3) or books such as O'Leary (1); Dunlop (7); Berthelot & Duval (1); see also for authoritative surveys Hitti (1), 2nd ed., pp. 309ff.; Mieli (1), 2nd ed., pp. 65ff.

also important, east of the lower waters of the Tigris. By the +5th century the city of Edessa (al-Ruhā', mod. Urfa) east of the upper Euphrates and within its great bend, had become a notable academic centre of Syrian Christians where much translation from Greek into Syriac was carried out.[a] But then came the theological controversy occasioned by the views of Nestorius (*fl.* +431) and the ensuing closure of the academy at Edessa by the emperor Zeno in +489. The Nestorian scholars fled across the border, first to Nisibis[b] (near the upper Tigris, north-west of Mosul), some later to join the new academy founded about +555 by the Persian king Khosrau Anūshirwān at Jundi-shāpūr.[c] This became a very great university where Greek science and medicine were taught in Syriac and probably Persian, having also a celebrated hospital as well as facilities for translators. Throughout the +8th century it flourished much, not declining till the end of the +9th, by which time it had played a great part in transmitting Hellenistic science through Syriac into the world of Islam.[d]

Edessa, Nisibis and Jundi-shāpūr were by no means the only important centres of Syriac learning. There was also Resain (Ra's al-'Ayn, Theodosiopolis) in Mesopotamia between Edessa and Nisibis, home of a great scholar Bp. Sergius (d. +536), certainly also a physician, for he translated Galen,[e] and perhaps also interested in Hellenistic proto-chemistry.[f] Running south from Aleppo (across the Euphrates from Edessa) there was a chain of centres, Kinnesrin (Qinnasrīn),[g] Homs and Baalbek (Heliopolis),[h] all places where Greek science and philosophy were transferred into the Syriac tongue. And Ḥarrān (class. Carrhae), only a short distance south of Edessa, west of Mosul, was also in the circuit, yet standing very much by itself because from the +5th to the +11th centuries it was primarily non-Christian and non-Islamic, perpetuating older indigenous religion, and influences from far in the East. After the

[a] For example, Thaufīl al-Rūmī (Theophilus of Edessa, d. +785) was an important astrologer and translator in the time of the Caliph al-Mahdī. O'Leary emphasises the role of Christianity as a Hellenising force in the Near East during the first four or five centuries.

[b] This was the home town of the famous bishop and translator Severus Sebokht (*fl.* +660), already spoken of in Vol. 1, p. 220, Vol. 3, *passim*. Another bishop, the Monophysite Georgius (d. +724) working in Mesopotamia about the same time, also translated works of Aristotle into Syriac.

[c] In Susiana not far south-west of Susa. In the meantime, in +529, the academy of Athens had also been closed, by the emperor Justinian, as a measure directed against the teaching of the non-Christian philosophers there, after which they all migrated to Persia; and though some of them later found a home within the Byzantine domains at Alexandria (+533), others may have stayed, most probably at Jundi-shāpūr (cf. Sandys (1), vol. 1, p. 375; Dunlop (6), p. 172; Nasr (1), p. 189). The city itself had been founded about +270 by Shāpūr I, and it has been conjectured that the metallurgical aurifictors expelled by the Diocletian edict of +296 (cf. p. 332) also took refuge at Jundi-shāpūr if not at Edessa (Hopkins (1), pp. 8, 125). The city was damaged during the Arab occupation of Susiana (Khūzistān) in +639, but not irreparably.

[d] The date of the Hejira, +622, from which all Arabic chronology starts, may here be recalled. During the Umayyad Caliphate (+661 to +750) arms still prevailed over letters, but from the beginning of the 'Abbāsid Caliphate onwards (+750 to +1258) the Arabs were ready to conquer all the worlds of the intellect.

[e] Cf. Brunet & Mieli (1), p. 880. This was about the time of the great anonymous compendium of Galen in Syriac put into English by Wallis Budge (6).

[f] On the extant Syriac proto-chemical and alchemical MSS something is said elsewhere (p. 88 above and pp. 411, 430, 473 below). The only collection is that of Berthelot & Duval (1).

[g] Severus Sebokht's see.

[h] One of its sons was none other than Callinicus, the inventor of 'Greek Fire' at Byzantium in or about +673.

+9th century the mainstream of science was flowing in channels other than Syriac, but as late as the +13th the language could still count men of considerable importance, such as Bar Hebraeus, alias Patriarch Gregorius of the Jacobites, alias Abū al-Faraj al-Malaṭī (d. +1386), a Christian of Jewish stock who worked with the Muslim and Chinese astronomers at the Marāghah observatory,[a] and wrote not only on cosmology but also on history, theology and philosophy.

Meanwhile in +762 Baghdad had been founded as the new Arabic capital, and three years later al-Manṣūr summoned for consultation a Christian Syrian physician from Jundi-shāpūr, Jūrjīs (George) al-Bakhtīshū' (d. *c.* +771), a man destined to found a famous medical family at the seat of the Caliphate. This was a symbol of the 'brain-drain' that the Arabs were creating, for other physicians and naturalists made the same move. By the time when al-Ma'mūn founded the academy there called Bait al-Ḥikma (+830, the House of Wisdom) the second great epoch of translation, from Syriac into Arabic, had already got under way. It seems to have started as early as +684 when a Jewish physician of Basra, Māsarjawayh,[b] translated, almost certainly from Syriac, a book of notes on medicine by the priest Aaron of Alexandria (*Kunnāsh Ahrūn al-Qass*). But the +9th century it was which saw the peak of activity, with the work of Ḥunain ibn Isḥāq al-'Ibādī (d. +877), 'the Shaikh of the Translators', and several members of his family.[c] Another Christian, Qusṭā ibn Lūqā al-Ba'labakkī (of Baalbek, d. *c.* +912) was outstanding in translation as well as an original writer. But perhaps significantly Ṣābians were also prominent, such as al-Ḥajjāj ibn Yūsuf ibn Maṭar (*fl.* +786 to +833), first successful translator of Euclid[d] and Ptolemy. Corresponding to Ḥunain as head of the Nestorian scholars, the head of the Ṣābian ones was assuredly Thābit ibn Qurra (+836 to +901) who organised the translation of the bulk of the Greek mathematical and astronomical works.[e] The names of the translators of the proto-chemical literature have unfortunately not been preserved. So much for the passage from Greek through Syriac to Arabic.

By contrast with all this, what can be said about the transmission of ideas into Arabic from Sanskrit, and even more interesting to us, from Chinese? Immediately we find ourselves arrested by certain remarkable texts. One of the *ḥadīths*, or 'undoubted' sayings of the Prophet himself, handed down in tradition, runs: 'Go in quest of knowledge even unto China.'[f] Then al-Nadīm, concluding the section on alchemy in his *Fihrist* of +987, wrote as follows:[g]

I, Muḥammad ibn Isḥāq, have lastly only to add that the books on this subject are too numerous and extensive to be recorded in full, and besides the authors keep on repeating the statements of their predecessors. The Egyptians especially have many alchemical writers

[a] Cf. Vol. 1, p. 218. [b] Dunlop (6), pp. 38–9, 213. We shall meet him again, p. 476 below.

[c] He was a Nestorian Christian physician of Jundi-shāpūr, and known to the later Latins as Johannitius.

[d] Cf. Steinschneider (3).

[e] Biographies of some thirty eminent Ṣābian scholars will be found in Chwolson (1), vol. 1, pp. 542ff. Cf. p. 426 below.

[f] Or, 'Seek for knowledge even though it be as far away as China'. Suhrawardy (1), no. 273. Cf. Wensinck (2); Mahdihassan (15), p. 82.

[g] Flügel ed., vol. 1, p. 360; tr. Berthelot & Houdas (1), p. 40; Fück (1), p. 109; Dodge (1), vol. 2, p. 868, mod. auct.

and scholars, and (some say) that that was the country where the science was born; the temples (*al-barābī*, with their elaboratories) were there,[a] and Mary (the Jewess, or, the Copt) worked there.[b] But others say that the discussions on the Art originated among the first Persians,[c] (while) according to others the Greeks were the first who dealt with it. And others yet again say that alchemy originated either in India or in China. But Allāh knoweth best (what is the truth)!

Thus by this time, in spite of the powerful influence of Hellenistic proto-chemistry and its traditions, it could be thought possible that not only Iran but the cultures of East Asia could have produced the spagyrical art.[d] After this it comes as less of a surprise to find that Hermes himself could be regarded as an inhabitant of China.[e] The Spanish Muslim alchemist of the +12th century, Ibn Arfa' Ra's, has already been mentioned, and in an anonymous Letter derivative from him we can read a curious passage.[f]

The real name of Hermes was Aḫnuḫ (Enoch)[g] and also Idrīs (Adam's son).... He was a dweller in the upper land of China, as the author of the 'Particles of Gold' pointed out, where he says: 'Mining was looked after by Hermes in China, and Āris [Horus?] found out how to protect the workings from flooding by water.' Now Āris lived in lower China, and belonged to the first of the Indians. Further he says that Aḫnuḫ (on whom be peace) came down from the upper to the lower land of China, into India, and went up a river valley in Sarandīb (Ceylon) till he came to the mountain (of that island) whence Adam (peace be upon him) descended.[h] That was how he found the cavern which he called the Cave of Treasures....

This was filled with gold and gems and engraved tablets expounding the treasures of the sciences, from among which Hermes chose out the most beautiful and best—a typical example of the cave-legends already referred to in connection with the *Tabula Smaragdina*.[i] The anonymous letter, which has to be dated early in the +13th century, then goes on to some rather vague descriptions of aurifactive methods, very syncretistic in character because sal ammoniac is prominent in it, together with *diplōsis*, *leucōsis* and *xanthōsis*,[j] effected by elixirs.[k] Elsewhere, in a pre-Jābirian apocryphon entitled *Muṣḥaf al-Ḥayāt* (Book of Life) there is a discussion between a Byzantine

[a] For an explanation of this see Fück, *loc. cit.*, p. 90.

[b] Cf. pp. 32, 327 above.

[c] Cf. Vol. 5, pt. 2, pp. 201 ff., pp. 253 ff. above.

[d] Other suspicious 'oriental' references in the *Fihrist*'s tenth discourse, that on alchemy, can be noted in Fück (1), p. 89, 91, 95, etc. Al-Nadīm knew of a book entitled: 'Conversations of Uṣtānis al-Rūmī (Ostanes) with Tauhīr, King of India', and another 'Epistle of the Indians to Iskandar (Alexander)'.

[e] On the legend of the Three Hermes (like a line of reincarnated Buddhas), first formulated in Arabic literature by Abū Ma'shar Ja'far (d. *c.* +886) in his *Kitāb al-Ulūf* (Book of the Thousands), see Burnett (1). For Albumasar (as the Latins called him) and his translator Hermann of Carinthia (+1140) the second Hermes, founder of astrology and alchemy, gained his knowledge in the Indies. Perhaps the fact that Abū Ma'shar was also named al-Balkhī may not be without significance (cf. p. 424).

[f] This is the *Qabas al-Qābis fī Tadbīr Hirmis al-Harāmisa*, tr. Siggel (4), pp. 299 ff. Cf. Ullmann (1), p. 168; Plessner (2); Pingree (1), p. 10.

[g] Cf. pp. 341 ff. above.

[h] A reference to the well-known footprint on Adam's Peak.

[i] Cf. pp. 335, 369 above.

[j] Cf. Vol. 5, pt. 2, pp. 18, 23; and pp. 358, 365 above.

[k] Siggel's account of this work was quoted by von Lippmann (11), and this must have been the source of Chang Tzu-Kung's suggestion (1) that Hermes was Chinese.

emperor, Theodorus, and an adept named Āras (Horus?) who came from 'Lower China'.[a]

Another interesting exchange demands mention here because a medieval Persian writer of a history of China attributed the invention of chemistry to a Chinese named Hua Jen,[1] or 'Changer'; while (at first sight) the Persian's Chinese source regarded him as a man from the Far West. Rashīd al-Dīn al-Hamdānī, in his history of China finished in +1304,[b] speaking of the time of the High King Mu of the Chou,[2] mentions the exploits of the legendary charioteer Tsao Fu,[3] and then goes on to say:

at that time there lived a man called Ḥwār.n (Hua Jen). He invented the science of chemistry and also understood the knowledge of poisons, so well that he could change his appearance in an instant of time...[c]

Here there is no suggestion that Hua Jen was anything but a Chinese.

In order to clarify Rashīd al-Dīn's source one has to know two things expounded by Jahn & Franke: first that he and his assistants were helped by two Chinese Buddhist physicians, Li Ta-Chih and K.msūn;[d] and secondly that he depended on a little-known genre of Chinese historical writing, general surveys done from a Buddhist angle and incorporating the lives of Buddhas, arhats and bodhisattvas within the framework of Confucian secular history. The oldest of these, says Franke (18), was the *Li Tai San Pao Chi*,[4] written by Fei Chhang-Fang[5] in +597; but the closest to Rashīd al-Dīn's history was the work of a monk named Nien-Chhang,[6] entitled *Fo Tsu Li Tai Thung Tsai*[7] (General Record of Buddhist and Secular History through the Ages)[e] and printed in +1341. Since this was twenty-three years after the death of the great Persian scholar it cannot have been his direct source as such, but he could have used an earlier manuscript form of it, and this was probably what happened.

The statements of Nien-Chhang[f] about 'Changer' are as follows:[g]

In King Mu's time a Changer appeared from the Furthest West. He could overturn mountains and reverse the flow of rivers, he could remove towns and cities, pass through fire and water, and pierce metal and stone—there was no end to the myriad changes and transformations (which he could effect, and undergo). The King revered him as a sage, and built for him a Tower of Middle Heaven to dwell in; indeed his appearance was like that of Maṇjuśrī or Maudgalyāyana or some such bodhisattva. But what the King did not know was that he had in fact been a disciple of the Buddha.

The story echoes familiarly, for it was nothing but a condensation and Buddhist adaptation of the opening part of the third chapter of the *Lieh Tzu* book, datable

[a] Ullmann (1), p. 190.

[b] Part of his famous *Jāmi' al-Tawārīkh*, all completed by +1316. Cf. Vol. 1, p. 218.

[c] Tr. Jahn & Franke (1), p. 43, eng. auct.

[d] The characters for their names are not known. They recommended a Buddhist compilation on Chinese history by three monks, Fo-Hsien, Fei and Shan-Huan. We do not know the characters for their names either, nor can this work be identified.

[e] Still extant, and preserved in *Ta Tsang* (Taishō Tripiṭaka), vol. 49, pp. 477ff.

[f] Born in +1282, his secular name had been Huang.[8]

[g] Comm. in ch. 3 (p. 495.3), tr. auct. The translation given on p. 43 of Jahn & Franke (1) seems not to be from the *Fo Tsu Li Tai Thung Tsai* as stated (except for the last sentence), but from the *Lieh Tzu* text itself.

[1] 化人 [2] 周穆王 [3] 造父 [4] 歷代三寶紀 [5] 費長房
[6] 念常 [7] 佛祖歷代通載 [8] 黃

therefore to any time between the −3rd and the +4th centuries.[a] Now, in its Buddhist incarnation, it evoked the magic powers (*siddhi*) of the Tantric saints.[b] Its original intention had probably been to suggest that the visible world was like a dream or a magician's illusion, and Changer was certainly not a historical person, but the chemical artisans of the middle ages did not appreciate such fine distinctions, so it was wholly natural that Changer should have become in due course the technic deity[c] and patron saint of the art, craft and science of chemical change.

As for the 'Furthest West' in *Lieh Tzu* and the *Fo Tsu Li Tai Thung Tsai*, it never meant Europe or the Roman Empire, but rather that legendary land of the immortals, thought of as somewhere near Tibet or Sinkiang, where reigned the Great Queen Mother of the West, Hsi Wang Mu,[1] nothing short of a goddess. King Mu of Chou paid her a celebrated visit, the main theme of the ancient book *Mu Thien Tzu Chuan*,[d] and also referred to in *Lieh Tzu*.[e] When centuries later the story came to the knowledge of real Westerners like the group around Rashīd al-Dīn all this was omitted, and they took Changer (Hua Jen) to have been a Chinese with marvellous chemical knowledge.[f] The significant fact that early in the +14th century they were quite ready to do this is the only justification of these paragraphs.[g]

The reality that lay behind these fabulous ideas can be approached from several different angles. First one can take a look at the known intensity of Arab–Chinese intercourse over the centuries in question. Secondly one can notice the fact that so many of the greatest scholars of the Islamic world came from countries on the borders of the Chinese culture-area, and though they made their fortunes in metropolitan Iraq or Egypt they may well have been recipients and transmitters of ideas current in their home-lands. Thirdly one may see whether we can identify any particular place at the western end of the Old Silk Road which could have been a focal entrepôt in the transfer of Chinese notions—something analogous in the realm of the intellect to Begram in that of the products of the arts.[h]

[a] Ch. 3, pp. 1*a*ff., tr. Graham (6), pp. 61ff. Most of the phrases used by Nien-Chhang are verbal quotations from the *Lieh Tzu*, though not in full nor in the same order.

[b] Cf. Vol. 5, pt. 5.

[c] See Vol. 1, pp. 51ff.

[d] On this see Vol. 3, p. 507.

[e] Graham tr., p. 64. Her fabled visit to the Emperor Wu of the Former Han is the nub of the *Han Wu Ti Nei Chuan*, tr. Schipper (1).

[f] Of course the activities of magical men, 'tricksters' or 'transformers', are found in mythologies world-wide; cf. Radin (1); F. Boas (1), pp. 407, 474. They are often beings of selfish motivation, but also often endowed with the beneficent attributes of culture-heroes and deified inventors. Boas remarked (p. 414) that the more sophisticated an Amerindian tribe was, the more sharply would the line be likely to be drawn between the trickster and the culture-hero. I am indebted to Prof. Gene Weltfish for discussions and references on this.

More recently, the trickster-figure has been recognised as an archetype in psycho-analysis; cf. Jung (15). A traditional Thai trickster-tale has been edited and translated by Brun (1).

[g] A somewhat parallel case concerns the transmission of the stories concerning the ancient sacrifices of girls to the god of the Yellow River (cf. Vol. 2, p. 137). Mahdihassan (57) found this in Islamic tradition, but attributed to the Nile instead, with the Caliph 'Umar replacing the humanitarian Confucian governor.

[h] In 1937–9 a French expedition to Begram, near Kabul on the southern slopes of the Hindu Kush and in the lands of ancient Bactria, unearthed two walled-up stores of transit trade-goods, appropriated as customs-duty, no doubt, by the Kushān kings in the years before +250. There were lovely carved

[1] 西王母

As for texts and books it may be said at once that in contrast to the flood of Greek scientific books which poured into Arabic we do not so far know of one Chinese work which was translated into that language until a very late date. Of Persian writings there were many and of Sanskrit more than a few,[a] but because Chinese books remained behind the ideographic-alphabetic barrier that is no reason whatever for thinking that Chinese ideas also did.[b] Indeed seminal concepts divested of verbiage might be all the more compelling. Unfortunately very few Persian texts on alchemy or metallurgy have so far been discovered. Almost the only one as yet reported on, and that but briefly, has been a 'Treatise of Jāmās (Jāmāsp) for Ardashīr the King on the Hidden Secret', of which an Arabic translation was found by Stapleton & Azo[c] in the Rampur MS. A colophon says that the text was copied by al-Ṭughrā'ī himself in the early +12th century, the collection was made in +1283, and the MS. is no earlier than the +15th century. The content of the 'Treatise' is very similar to that of the books of the Hellenistic Corpus, with mentions of Pseudo-Democritus and Ostanes;[d] Stapleton & Azo were inclined to consider it a genuine production of the +3rd century, in which case its date would be about +235, but this seems extremely doubtful, and pending further study it may more conservatively be regarded as an Arabic translation of some Hellenistic writing of the +4th to the +7th centuries—especially as it seems to have nothing characteristically Persian about it.[e] A parallel text exists in the Cairo Library.[f] Stapleton (4) regarded the *Risālat al-Ḥadhar* (Book of Warning), supposedly addressed to his disciples by Agathodaemon when dying,[g] as a typical Ḥarrānian text; if so, they had not got much beyond the Hellenistic Corpus.[h] Finally for Syriac alchemical and metallurgical texts not simply translations from the Greek we are better off, as may be seen from those printed and rendered into French (very indifferently, it seems)[i] by Berthelot & Duval (1); these we shall discuss below as occasion arises.[j]

plaques of bone and ivory from India, lacquer-ware, especially boxes, from China, and bronzes and glass vessels from Syria and Alexandria going eastwards in exchange for the Asian products (cf. Fig. 293 in Vol. 4, pt. 1). See the reports of Hackin & Hackin (1); Hackin, Hackin, Carl & Hamelin (1).

[a] Here the classical guide is Steinschneider (2). And we have discussed the book of Shānāq on p. 399 above. See also Ullmann (1), pp. 165, 186–7.

[b] Here we recall the tradition mentioned on p. 390 above about the gift of alchemical texts by the Chinese emperor to the first Umayyad Caliph.

[c] (2), p. 59.

[d] Cf. pp. 333ff. above. A reference to the 'water of life' (Stapleton (4), p. 28) gives one pause, but it seems that this is nothing more than Hellenistic metaphor concerning reflux distillation (cf. pt. 2, p. 72 above). Parallels in Ibn Umail; Stapleton, Lewis & Taylor (1), pp. 72, 76.

[e] For the entry in Ḥajī Khalīfa's bibliography see Flügel (2), vol. 3, p. 384, no. 6068.

[f] This is entitled 'Book of Asfīdūs on the Wisdom of Aflārūs'. It awaits further study.

[g] There is a précis translation by Stapleton & Husain (1).

[h] Stapleton himself regarded this text as pre-Hellenistic, but here we cannot follow him, nor in his attempted chronology of the ancient Mediterranean proto-chemists either, (4), p. 36.

[i] Cf. Ruska (13).

[j] They consist mainly of two MSS in the British Museum, Egerton 709 and Or. 1593. Each is in two parts, a Syriac half and an Arabic half written in Syriac script. The former is considered to be contemporary with the early parts of the Jābirian Corpus (mid +9th cent.) but based on Syriac antecedents of the +5th and +6th centuries. Giving a 'Doctrine of (Pseudo-) Democritus', it is very Hellenistic in tone, but uses the term elixir, and ends with diagrams of apparatus. The latter is of the +9th to the +11th centuries, much of it contemporary with the later parts of the Jābirian Corpus and

The Prophet died in +632, and within forty years Khorasan fell, with all the rest of Persia, to the Arab empire. Early in the +8th century all the great cities of Western Central Asia were taken—Balkh in Bactria (Tokharistan), Bokhara and Samarqand in Sogdia, Khiva in Khwarizm. By +715 Ferghana was added nominally to Islam, though Tashkent not occupied till +751. With these conquests of Transoxiana (*mā warā' al-nahr*, that which lies beyond the River), and their consequent suppression of Zoroastrianism and Buddhism, Islam stood militarily face to face with the outer defences of the Chinese culture-area.[a] But strangely the confrontation came to no climax and brought no long conflict. For in the same year that Tashkent was taken the Arabs secured a Pyrrhic victory against a Chinese army led by a Korean general, Kao Hsien-Chih,[1] at the Battle of the Talas River;[b] the Chinese were defeated but the Arabs so mauled that they could press no further. Soon afterwards, because of the rebellion of An Lu-Shan,[2] the Chinese withdrew from the whole of Turkestan (Sinkiang) leaving a vacuum as it were between the two civilisations; and very soon afterwards al-Manṣūr was to be seen despatching (in +756) a contingent of Muslim troops to help the young emperor Su Tsung regain control after An Lu-Shan's revolt.[c] Thus it came about that no Arab army ever crossed the Chinese border in hostility. And already a closeness of cultural contact had appeared, for many Chinese artisans taken prisoner at the Talas River settled with their arts and crafts in Baghdad and other Arabic cities, some returning home in +762 but others (like the paper-makers and weavers) staying to exert permanent effects—very likely some workers with chemical knowledge were among them, especially as painters and gilders are mentioned.[d] We even know their names.

During the last half of the +7th century and the first quarter of the +8th, Chinese contacts were mostly with the ousted Iranian ruling families, who were granted asylum at the Chinese imperial court,[e] and with the not yet Islamised peoples of Central Asia. Around +660 there were Turki dancing-girls as far south as Kweilin,[f] and burials in Sinkiang and Shensi have disclosed Arab and Thang coins side by side.[g] That there was an Arabic embassy to China in +651 is very unlikely, and probably rests on the tradition that one of the Companions of the Prophet, Sa'd ibn abī Waqqāṣ, the conqueror of Persia, was sent as an envoy to Canton, where indeed his supposed tomb is still venerated. Chinese historical records mention however a real ambassador

al-Rāzī. Here sal ammoniac is prominent. Late +13th-century interpolations include mentions of gunpowder and mineral acids. The third MS. (Cambr. Mm 6. 29) is very miscellaneous in content, with some Hellenistic material as early as the +2nd to the +6th centuries.

[a] For the whole story of the Arab conquest of Central Asia see H. A. R. Gibb (4, 5).

[b] Cf. Vol. 1, pp. 125, 179, 187, 215. Detailed descriptions of the battle, which was technically a great Arab victory, will be found in Chavannes (14), pp. 142–3, 297.

[c] Besides the 3000 Arab troops there were many contingents from the Central Asian States, such as Tokharestan and Ferghana. See Chavannes (14), pp. 158, 299 and Mahler (1), pp. 76, 100–1. The reason for this will be more understandable from p. 423 below. The rebellion was over by +759. Mahler contests the tradition that Islam in West China dates from this time, on rather insufficient grounds.

[d] Cf Vol. 1, p. 236. [e] Vol. 1, p. 214. [f] Schafer (16), p. 76; Chavannes (14), pp. 301–3.

[g] See Yang Lien-Shêng (8), and Yen Chi (1) retailing Hsia Nai (3). Sassanian coins have been found in Chinese tombs several times also; cf. Hsia Nai (2).

[1] 高仙芝 [2] 安祿山

from the Umayyads, one Sulaimān, in +726, probably sent to explore the situation after the Central Asian acquisitions.[a] But from the start of the 'Abbāsid Caliphate in +750 onwards merchants were much more important than diplomats, and since the overland routes were temporarily rather obstructed they reached Canton (Khanfu) by sea in ships.[b] There, and at Hangchow (Khinzai, Quinsay), and other ports, they set up 'factories' and everywhere an Arab quarter (*fan fang*[1]) with a headman (*qāḍī*, or *fang chang*[2]) responsible to the Chinese magistrate for law and order.[c] Sometimes this arrangement broke down, as in +758, when Arabs (possibly from a settlement in Hainan) burned and looted Canton, or in +878, when thousands of them were killed in a Chinese peasant rebellion, equalitarian turned xenophobic, led by the salt-merchant Huang Chhao.[3] But the trade and intercourse went steadily on. Described by many Arabic geographers, it was the actual experience of some writers and informants, such as Sulaimān al-Tājir (the Merchant) who told of the period centering on +851 in the book entitled *Akhbār al-Ṣīn wa'l-Hind*.[d] One such trader, Ibn Wahb al-Baṣrī, was received, it seems, by the Thang emperor Hsi Tsung in +876. And for the whole Arab–Chinese mercantile field between the +8th and the +13th centuries we have the incomparable *Chu Fan Chih*[4] (Records of Foreign Peoples)[e] written by Chao Ju-Kua[5] in +1225. The extinction of the 'Abbāsid Caliphate by the Mongols under Hūlāgū Khan thirty-three years later made hardly any difference for Arabic–Chinese intercourse except to intensify the traffic on the overland route as compared with the sea one. And so it continued until the arrival of the Portuguese in the Indian Ocean at the end of the +15th century ushered in a modern world. But this later period (+13th to +15th centuries, Southern Sung, Yuan and Ming)[f] is much less important for our present purpose than the earlier one (+7th to +11th centuries, Thang, Wu Tai and Northern Sung) because that was when Arabic alchemy received its fertilising Chinese influences.[g]

[a] Vol. 1, p. 215, with sources. Other authorities give +716 and +729 (*Tshê Fu Yuan Kuei*, ch. 971, p. 1a, ch. 974, p. 17a, ch. 975, p. 9*b*; Chavannes (17), pp. 32, 50). The man in +716 declined to kowtow, but was let off; Sulaimān apparently had no such objection. Bretschneider (2), vol. 2, p. 46, put the first embassy in +713, but probably only because that was the first year of the reign-period; on the other hand he adduced Arabic sources for fixing it during the caliphate of Sulaimān, +715 to +717. There was another embassy in +798, from Harūn al-Rashīd, cf. H. A. R. Gibb (1). During the Jurchen-Chin and Sung dynasties in the +10th and +11th centuries more than twenty diplomatic or semi-diplomatic missions were exchanged with the Buwayhid Caliphate.

[b] Vol. 1, pp. 179ff., Vol. 4, pt. 3, *passim*. On this Arab–Chinese trade and the shipping used in it see Ferrand (1); Hourani (1); Huzzayin (1); Hadi Hasan (1); Richards (1).

[c] He also led the prayers in the mosque, gave the Friday sermon, and administered Islamic law and charities. It was a curious anticipation of the extraterritoriality of the later foreign concessions, though doubtless with much less pretension of immunity from Chinese law.

[d] Ed. and tr. Sauvaget (2); earlier Ferrand (2) and others.

[e] Tr. Hirth & Rockhill (1); and for Islamic lands only, Hirth (11).

[f] See Vol. 1, pp. 218ff.

[g] On the whole story of Arab–Chinese contacts there is a classical survey by Schefer (2); to say nothing of the older literature. Schefer gives an interesting account of Abū'l 'Abbās Aḥmad Shihāb al-Dīn al-'Umarī (d. +1338), who in his *Masālik al-Absār fī Mamālik al-Amsār* (Ways of the Eyes to Survey the Provinces of the Great States) speaks of the great skill of Chinese craftsmen—their saddles (cf. p. 452 below), their clothes made of plant fibre, their sugar and their paper money—and even a story about a dental prosthesis told by one Sa'īd Tāj al-Dīn Ḥasan ibn al-Khallāl al-Samarqandī.

[1] 蕃坊 [2] 坊長 [3] 黃巢 [4] 諸蕃志 [5] 趙汝适

Of course the Arabic and Persian merchants, whether themselves from Egypt, Iraq, Iran or Central Asia, were not confined to the foreign quarters in the great coastal ports, for many came in overland along the Old Silk Road; and since in Thang times foreign people and things were all the rage, there was hardly a city in China unfamiliar with the *hu*[1] merchants (Fig. 1531, *b*), as they were universally called.[a] *Hu* girls were also widely in service as maids and entertainers.[b]

Fig. 1531 *b*.

They excelled in beautiful dances with whirling gyrations to left and right 'as swift as the wind', with long hair, fluttering sleeves and gauzy scarves. A special troupe of them was attached to the imperial court, occupying a College in Thai-chhang Ssu, and their skill was celebrated by poets such as Pai Chü-I and Yuan Chen. Judging by the frequency of the figurines representing them, another numerous group of Central Asians in Thang China were the Turkic grooms and camel-drivers, some of whom must have brought, and doubtless exchanged, knowledge of veterinary medicine. Armenian-looking wine-sellers often appear, too, a fact which might well have some significance in connection with the history of freezing-out and distillation (cf. pp. 141 ff., 151 ff. above). And for philosophical discourse, besides the Buddhists, there were Zoroastrian Persians, Manichaean Tocharis, Nestorian Christian Uighurs, Muslim Arabs, perhaps even Ṣābian Ḥārranis. At the Chinese capital there were whole streets of the shops and warehouses of foreign merchants, restaurants where they ate their strange food and spoke their strange tongues, caravanserais where they and their convoys put up, lastly the temples and churches of many religions. It could easily have been said of Chhang-an that if you stayed there long enough you could meet representatives of every country in the known world. Not only 'Parthians, Medes and Elamites, and the dwellers in Mesopotamia...'[c] all were there, but rubbing shoulders too with Koreans, Japanese, Vietnamese, Tibetans, Indians, Burmese and Sinhalese; and no one who did not have something to contribute on the

Fig. 1531 *b*. Statuette of a Persian or Arabic merchant, Thang in date. Buff clay, all-over crazed yellow glaze with flecks of green (photo. Royal Ontario Museum, Toronto). Many similar representations of Central and Western Asian travellers, pedlars, camel-drivers, grooms, envoys and servants, are given in the illustrations of Mahler (1).

[a] Cf. Vol. 1, p. 125 and Fig. 22, opp. p. 128. Strictly speaking, the term *hu* meant Sogdian, but by extension was commonly used for all Persians (Po-ssu[2]) and Arabs (Ta-shih[3]) as well. The Manichaean astronomer who came to China in +719 (Vol. 1, p. 205, Vol. 3, p. 204) was a *hu*; and so was the Zoroastrian princess Māsiš who died in Sian at the age of 26 in +874, and whose bilingual tomb inscription in Pehlevi and Chinese has been translated by Itō Gikyo (1).

[b] Ichida Mikinosuke (1).

[c] Acts 2, 8.

[1] 胡 [2] 波斯 [3] 大食

nature of the world, and the wonders thereof. One may well ask oneself how they looked to the eyes of their hosts.[a]

Fortunately there is a colourful source from which we can gain a good idea of what the Arabs and Persians at least meant to the ordinary Chinese, and by good luck it brings us back precisely to our main theme of alchemy and early chemistry. In +977, as part of a general programme of producing new encyclopaedias and collections,[b] the second Sung emperor, Thai Tsung, commissioned a treasury of 'rustic histories', 'biographical traditions' and 'short tales'. This was the *Thai-Phing Kuang Chi*[1] (Miscellaneous Records collected in the Thai-Phing reign-period), edited by Li Fang[2] and twelve colleagues, and finished in the following year. Exactly how much of this material might be considered based on solid historical facts it is not now possible to say, certainly a great deal of it was fictional, but in the present context that does not matter, for the texts give a clear indication of how the *hu* merchants seemed to the general run of literate Chinese in the Thang and Wu Tai periods.[c] Hence the extraordinary interest of the fact that they were often mixed up with alchemy and Taoism, skilled in recognising the gold of aurifiction or aurifaction, or engaged in studying the art itself, and not only that but concerned with life-elixirs and physiological alchemy as well. This is an element not to be overlooked in the case for transmission of Chinese alchemical ideas to Arabic culture. So, to summarise, as Schafer put it, the *hu* merchant in China was wealthy and generous, a befriender of young and indigent scholars, extremely learned in the knowledge of gems, minerals and precious metals, a dealer in wonders and not devoid of magical and mysterious powers. Let us look at a few of the stories to gain the advantage of some concrete detail.

In one report, dated between +806 and +816, a young man, Wang Ssu-Lang,[3] masters the technique of making artificial gold (*hua chin*[4]), and saves his uncle from financial difficulties by giving him an ingot of it. Of this gold it is said that 'the Arabic and Persian merchants from the Western countries particularly wanted to buy it. It had no fixed price, and he (Wang) used to ask what he liked for it'.[d] Another account, referring specifically to +746, tells of a man named Tuan Lüeh[5] who met a merchant in a shop in Wei-chün who had more than ten catties of drugs most valuable for the preservation of longevity (*yang shêng*[6]) and for helping one to avoid cereal food (*pi ku*[7]). Some of these were very difficult to get, however, and each day he used to go to the market to enquire of the Arabic and Persian merchants if they had any for sale.[a] Here then the *hu* apothecaries are directly involved in a trade related to

[a] Cf. Hsiang Ta (3). A mine of information is also contained in the book of Schafer (13) on Thang 'exotica'. Many contemporary statuettes of *hu* merchants exist, on which see the monograph of Mahler (1).

[b] One result of this was the indispensable *Thai-Phing Yü Lan* (+983), so often quoted in these volumes.

[c] Much credit is due to Schafer (2) for having seen this and discussed it in a pioneer paper. The *Thai-Phing Kuang Chi* is of peculiar value because more than half the books which it excerpted have long been lost.

[d] *TPKC*, ch. 35, pp. 3*a*–4*a* (vol. 1, pp. 189–90). Attention was drawn to this by Fêng Chia-Shêng (5), p. 135. The editors drew the story from the *Chi I Chi*[8] of Hsüeh Yung-Jo.[9]

[1] 太平廣記 [2] 李昉 [3] 王四郎 [4] 化金 [5] 段碧
[6] 養生 [7] 辟穀 [8] 集異記 [9] 薛用弱

the characteristically Chinese physiological alchemy. Relevant to this, and to the idea of bodily incorruptibility,[b] is a third tale, that of Li Kuan,[1] who having received a beautiful pearl from a dying Persian merchant in recompense for his kindness, decided to place it in the mouth of the dead man. Many years later when the tomb was opened, the body was found quite undecayed, with the pearl still in position.[c] Another alchemical story is that of Mr Lu and Mr Li,[2] both Taoist adepts doing gymnastics and breathing exercises on Thai-pai Shan. One having acquired great wealth by means of aurifaction bestowed an alchemical staff upon the other, which he said could be sold for a great sum at the 'Persian shop' at Yangchow, and so indeed it turned out.[d] Evidently the *hu* merchants knew something valuable when they saw it. Our last example is perhaps the longest and most impressive, the story of Tu Tzu-Chhun[3].[e]

Tu, we are told, was an idle young scholar who met a strange old man in the Persian Bazaar in the Western Market at Chhang-an, and having caught his fancy was transferred from hunger and cold to a rich life of the utmost comfort. But before long it appeared that the stranger required his services for the accomplishment of an alchemical procedure designed to make an immortality elixir. There is a graphic description of Tu Tzu-Chhun arriving at a remote palace near Hua Shan forty *li* or so out of the capital, and there in the great hall was the old man attired in Taoist vestments, with an alchemical furnace nine feet high pouring out purple vapours, through which could dimly be seen nine Jade Maidens bearing the insignia of the Caerulean Dragon and the White Tiger.[f] But then the story takes a curious twist, for after ingesting certain drugs and sitting down to gaze in meditation at a blank wall, Tu found himself undergoing the torments of a variety of Buddhist hells, and was eventually reincarnated in another body before breaking the spell by a burst of uncontrollable emotion. Thus having failed to master these terrifying apparitions, Tu awoke, and the experiment, which would have gained *hsien* immortality for both the old Persian and himself, also ended in failure.

Putting all this together, it seems evident that in the eyes of ordinary people at least during the Thang period, the merchants from Persia and the Arab countries were very

[a] This was also noted from *TPKC* by Fêng Chia-Shêng, *loc. cit.* but his reference (ch. 6) seems to be wrong, and we have not been able to find the right one. Central Asian drugs were of course coming as tribute, and being imported commercially all through this period, cf. e.g. Mahler (1), pp. 75, 79, 89. In +729 the monk Nan-Tho[4] was sent from Balkh in Tokharestan with tribute of valuable drugs (*TFYK*, ch. 971, p. 8*a*), and in +746 the king or emir of Tabaristan offered 'thousand-year longevity jujube-dates' (*TFYK*, ch. 971, p. 15*b*). In all, between +713 and +755 some two hundred different drugs, together with perfumes, precious red stones and glass, came from the Turkic countries (*CTS*, ch. 221B, p. 5*a*, tr. Chavannes (14), pp. 157–8; cf. (17), pp. 50, 57, 76 from *TFYK*). On this period see also Chhen Pang-Hsien (1), pp. 154ff., and our Vol. 1, pp. 204–6.

[b] This has been discussed already in Vol. 5, pt. 2, pp. 294ff.

[c] *TPKC*, ch. 402, p. 6*b* (vol. 3, p. 1543). The story was taken from the *Tu I Chih*[5] of Li Jung,[6] a book we have had occasion to quote from before.

[d] *TPKC*, ch. 17, pp. 3*b*–4*b* (vol. 1, pp. 136–7). The story was taken from the *I Shih*[7] of a writer named Lu[8] whose given name has been lost.

[e] *TPKC*, ch. 16, pp. 1*b*–4*a* (vol. 1, pp. 132–3). The story was taken from the *Hsüan Kuai Hsü Lu*[9] written by Li Fu-Yen.[10]

[f] Cf. Vol. 5, pt. 5.

[1] 李灌 [2] 盧李二生 [3] 杜子春 [4] 難陁 [5] 獨異志
[6] 李冗 [7] 逸史 [8] 盧氏 [9] 玄怪續錄 [10] 李復言

interested indeed both in the metallurgical and the macrobiotic aspects of Chinese alchemy.[a] Looked at from this angle it seems almost to stand to reason that Chinese ideas would have found their way westwards to join with the Hellenistic ones that had been taken up into Arabic thought. This conclusion is not affected at all by the seeming fact that no one attempted the translation of an entire book of the *Tao Tsang*,[b] for instance, into Arabic—and how difficult that would have been—because all we are looking for is a new substance here and there, a few theories which might or might not have been misunderstood, and one basic grand conception not misunderstood, namely that chemical operations could perform miracles of life-giving and life-prolonging.

If one would like to make the personal acquaintance of a group of *hu* merchant-naturalists in the China of this period, one could hardly do better than consider the Li family of Szechuan.[c] Li Hsün[1] (*fl.* +900 to +930) was of a Persian family which had settled in China during the Sui (*c.* +600) and moved to Szechuan about +880; they were wholesalers, shipowners and caravan patrons in the spice trade. Li Hsün, apart from renown as a poet, became expert in materia medica, perfumes and natural history, the author of a *Hai Yao Pên Tshao*[2] on the plant and animal drugs of the southern countries beyond the seas. This was in the same genre as the +8th-century *Hu Pên Tshao*[3] of Chêng Chhien[4],[d] but unfortunately neither work has survived entire.[e] Li Hsün's younger brother, Li Hsien,[5] was more of an alchemist, occupying himself with arsenical and other mineral drugs as well as essential oils and their distillation; he was also noted as a chess-player. This was the time of the Chhien Shu kingdom in Szechuan, and the younger sister, Li Shun-Hsien,[6] herself a poet of great elegance, became one of the ladies of that court.[f] Probably unrelated to this family, though of the same name, was the *hu* physician Li Mi-I,[7] who had sailed east to Japan in +735, and participated in the cultural renaissance of the Nara period.[g]

Let us turn now to the lands just west of the westernmost borders of Chinese Turkestan. There is no need to labour the point that they did indeed produce many of the most famous scholars of the Islamic centuries, but it is worth giving a few examples.[h] Taking a bird's-eye view of Western Central Asia let us proceed westwards

[a] Here we should not forget the possible role of Jewish merchants. From Vol. 3, p. 681, we know that in the +9th century a group of these called al-Rādhānīyah (perhaps from their centre at the town of al-Rayy, near mod. Teheran) travelled regularly both by land and sea between China and Provence. They spoke all the languages current along the routes, and since both Damascus and Oman were among their entrepôts, they could well have been a link between the Chinese alchemists and the Jābirians.

[b] One should perhaps remember here that in the Thang the Chinese alchemical literature was not nearly so rich as it became afterwards during the late Sung, for example.

[c] There is a special paper by Read (10) on the transmissions in natural history arising from Arabic-Chinese contacts.

[d] *Fl.* +742. *SIC*, p. 1366.

[e] It would be well worth while collecting all the quotations to assemble as much as is left.

[f] To illustrate this paragraph, we give a picture of a silver ewer of strikingly Arabic or Persian design and Sung date, now preserved in the Provincial Historical Museum at Chhêngtu, the home city of the Li family (Fig. 1532).

[g] Cf. Vol. 1, pp. 187–8.

[h] Arabic personal names, though excessively complicated, have the advantage that a man's birthplace is immediately evident in them.

[1] 李珣 [2] 海藥本草 [3] 胡本草 [4] 鄭虔 [5] 李玹
[6] 李舜絃 [7] 李密醫

Fig. 1532. Evidence of the close relations between China and the Islamic countries in the Sung; a silver ewer of West Asian character (orig. photo. 1972, at the Exhibition of History and Archaeology, Chhêngtu).

from the north–south mountain-range which joins the Thien Shan with the Pamirs and the Hindu Kush, that range through which run the most important of the passes on the Old Silk Road.[a] Thus we should speak first of Ferghana, with Tashkent (al-Shāsh) as its capital;[b] then of old Sogdia and Bactria between the two north-westward-flowing rivers (the Jaxartes and the Oxus) with great cities at Bokhara, Samarqand and Balkh respectively;[c] then again of Khwarizm along the Oxus, centred on Khiva;[d] and finally of Khorasan, with the towns of Merv, Tus, Nishapur and modern Meshed strung along the NW–SE rampart of the Kuh-i-Alādāgh mountains. The city of Kashgar, on the eastern side of the Thien Shan–Hindu Kush connecting range, was the most easterly place ever under Islamic sovereignty, as at times it was, so perhaps the Taklamakan Desert and the inhospitable Tarim Basin were even greater barriers than the range itself. But broadly speaking the Arabic flood washed up to that range and stopped, leaving there a permanent cultural tide-mark. It is not part of our present purpose to demonstrate traces of Chinese influence in the writings of the scholars who came from these parts; all that needs pointing out is how near they were

[a] Cf. the map (Fig. 32) in Vol. 1; and here, Fig. 1531*a* on pp. 406–7 above.

[b] It may be of interest from the chemical point of view to note that when the Arabs obtained Ferghana they got at the same time important mines of mercury, as well as one of the few centres of asbestos production in medieval times (cf. Vol. 3, pp. 655ff.).

[c] Balkh is just south of the latter river.

[d] Cf. Tolstov (1, 2, 4).

to it—and if it be urged that the shrouds of linguistic understanding were too great, all that need be said is that young and intelligent merchants, both Chinese and Arabic-Persian, did sometimes themselves personally travel in the caravans, and must have talked. We cannot impose on them a silence *ex hypothesi*.

Moreover, what is not generally understood—histories of the Arab world tend to overlook it—is that for a century or so before the Arab conquests the Turkic States of Western Central Asia had mostly been Chinese protectorates more or less self-governing.[a] After the first flooding of the whole region by the Turkic tribes (Thu-chüeh[1]) a series of campaigns by Chinese armies had led to the acceptance of the sovereignty of the Son of Heaven from +659 onwards; this applied to Ferghana, Sogdia and Bactria, Khwarizm in part but not Khorasan, though including a number of States in the mountains to the south in what is now Afghanistan, reaching down through old Gandhāra to the plains of India. Thus in their turn, for a time, the Chinese had been able to impose their rule on many lands west of the mountain ranges that plug like a cork the western end of Sinkiang. Ferghana they knew as Pa-han-na;[2] and Tashkent (al-Shāsh), Shih,[3] appropriated sometimes the ancient term for the whole country, Ta-yuan.[4] Sogdia retained its classical name, Khang-chü,[5] Samarqand being Khang[6] and Bokhara An.[7] Bactria or Tokharestan was transliterated as Tu-huo-lo,[8] with Balkh itself as Po-chih.[9] Khwarizm, though tributary only, not protected, was Huo-li-hsi-mi[10] or Huo-hsün,[11] but Khiva seems not to appear in Chinese, unless it was Chi-to-chü-chê[12] which sounds more like Korkandj. Thus everyone who was born in any of these parts after the middle of the +7th century must have had a mental background in which many typical Chinese ideas circulated—and that without any direct access, or very little, to the Chinese literature itself.

From Ferghana, then, one can name one of the most celebrated Muslim astronomers of the +9th century,[b] and somewhat surprisingly, an authority on the poetry in the Arabic language.[c] A little further West, the neighbourhood of Bokhara produced perhaps the greatest of all Islamic scientists, the 'Third Master (al-mu'allim al-thālith)',[d] Ibn Sīnā himself.[e] Samarqand was significant rather later, in the +13th

[a] The best account of all this is to be found in Chavannes (14), pp. 268ff., 299ff., together with his additional notes in (17). Cf. Gibb (4, 5). A summary set in the context of a general survey of Chinese history is given by Gernet (3), pp. 209, 221ff., 250ff.

[b] Abū al-'Abbās ibn Kaṯīr al-Farghānī, the Alfraganus of the later Latins, *fl.* +861. See Mieli (1), 2nd ed., pp. 82–3; Hitti (1), 2nd ed., p. 376.

[c] Abū Muḥriz Khalaf al-Aḥmar (d. *c.* +800). See Dunlop (6), p. 28.

[d] The first was Aristotle. But the second was also a scholar from Turkestan, namely Abū Naṣr Muḥammad ibn Muḥammad ibn Ṭarkhān ibn Uzlagh al-Fārābī (d. +950), commentator of Aristotle, Porphyry, Plotinus, etc. and interested in such matters as the classification of the sciences. See Mieli (1), 2nd ed., p. 94.

[e] Abū 'Alī al-Ḥusain Ibn Sīnā, the Avicenna of the Latins (+980 to +1037). See Mieli (1), 2nd ed., p. 102. His *Qānūn fī' l-Ṭibb* is still one of the greatest of all medical works in any civilisation. And, as we shall see in Sect. 44, his extreme emphasis on sphygmology, the role of the pulse in diagnosis, demonstrates even in detail a close connection with the medical practice and writings of earlier Chinese physicians.

[1] 突厥 [2] 拔汗那 [3] 石 [4] 大宛 [5] 康居 [6] 康
[7] 安 [8] 覩貨羅 [9] 蒲知 [10] 貨利習彌 [11] 火尋 [12] 急多觀遮

and +14th centuries, with an important astronomer[a] and a famous physician.[b] Balkh, however, kept on producing men of great authority, in the +8th century the first of all the Islamic mystics (sufis),[c] in the +9th the first of a series of great geographers[d] and a widely known astrologer-astronomer,[e] in the +10th an Ismā'īli polymath whose writings are still read with interest today.[f] And on the political side, where much influence must have been exerted, there was the famous Barmecide family of viziers, who practically ruled the Caliphate till +803. The founder of this line, Khālid ibn Barmak (*fl.* +765), came from Balkh, where his father was said to have been a Buddhist lay devotee (*upasaka*).[g]

When we reach Khwarizm we find no less than four prominent al-Khwārizmī's, the proper differentiation of whom has doubtless been a pitfall to scholars inexpert in Arabic fields before now. One was perhaps the most celebrated mathematician in all Islamic history, he who gave us the very name of algebra;[h] and a second, of more immediate interest, was an alchemist whose work has already been mentioned (pp. 83, 402).[i] The other two were both encyclopaedists, one in the +10th,[j] the other in the +12th century,[k] and both chose for their books very similar titles meaning 'Key to the Sciences'. Though the second was almost wholly philological the former has much present relevance, for it contained a large section on alchemy which has been carefully studied and translated in modern times. And the neighbourhood of Khwarizm was also the birthplace of one who did not take his name from that locality—the great

[a] This was 'Aṭā ibn Aḥmad al-Samarqandī (*fl.* +1362), whose contact with Chinese astronomy was particularly close. See Vol. 1, p. 218.

[b] Muḥammad ibn 'Alī Najīb al-Dīn al-Samarqandī (d. +1223). See Mieli (1), 2nd ed., p. 163.

[c] I.e. Ibrāhīm ibn Adham (d. *c.* +777). See Hitti (1), 2nd ed., p. 434.

[d] Namely Abū Zayd Aḥmad ibn Sahl al-Balkhī (+849 to +934), whose *Kitāb al-Ashkāl* (Book of the Seven Climes), written *c.* +920, was the foundation of the famous *Kitāb al-Masālik wa'l-Mamālik* (Book of Roads and Provinces) after its enlargements and re-writings by al-Iṣṭakhrī about +950 and Ibn Ḥauqal. See Dunlop (6), pp. 164–5; Mieli (1), 2nd ed., p. 117.

[e] Abū Ma'shar Ja'far al-Balkhī, the Albumasar of the Latins (d. +886). His best known book was the *Kitāb al-Mudhākarāt*. Details in Mieli (1), 2nd ed., p. 89; Dunlop (6), pp. 174, 176, (9).

[f] Nāṣir-i-Khusraw al-Qubādiyānī (d. +1060). Mieli (1), 2nd ed., p. 116.

[g] Ruska (32); Hitti (1), 2nd ed., p. 294. But I remember that the late Professor F. C. Burkitt used to say that judging from the 'Barmecide feast' and other evidence the Barmak family was much more likely to have been Manichaean than Buddhist. Another tradition makes them hereditary managers of a Zoroastrian fire-temple.

[h] Abū 'Abd Allāh Muḥammad ibn Mūsā al-Khwārizmī, of course, *c.* +750 to *c.* +850. He was the Librarian of the Khizāna of the Bait al-Ḥikma (House of Wisdom) at Baghdad. For his mathematical geography, *Kitāb Ṣūrat al-Arḍ*, he drew upon sources much wider than Ptolemy; while his *Kitāb al-Sindhind* was based on the Indian astronomical work *Brāhmasphuṭa Siddhānta* which had been translated in +771 by al-Fazārī. The book that laid the foundations of post-Diophantine algebra was the *Kitāb al-Mukhtaṣar fī Ḥisab al-Jabr wa'l-Muqābala*; see Dunlop (6), pp. 150, 152, 154, 217; Mieli (1), 2nd ed., p. 82.

[i] Ibn 'Abd al-Malik al-Ṣāliḥī al-Kātī al-Khwārizmī, *c.* +1034. Mieli (1), 2nd ed., p. 133; Stapleton & Azo (1); Ahmad & Datta (1).

[j] Abū 'Abd Allāh Muḥammad ibn Aḥmad ibn Yūsuf al-Khwārizmī, the secretary (al-Kātib), whose *Mafātīḥ al-'Ulūm* was finished in +976. The important part on alchemy has been translated by Wiedemann (15), and many other parts examined and translated in Wiedemann (23). Another study of the alchemy is that of Stapleton, Azo & Husain (1). See also Dunlop (6), pp. 246–7; Mieli (1), 2nd ed., pp. 94, 136.

[k] Abū Ya'qūb ibn abī Bakr al-Khwārizmī, the die-engraver (al-Sakkākī), +1160 to +1229, whose book was entitled *Miftāḥ al-'Ulūm*. Dunlop (6), pp. 246–7.

Abū al-Raiḥan Muḥammad ibn Aḥmad al-Bīrūnī (+973 to +1048).[a] Often mentioned in our previous volumes,[b] he was one of the greatest of Arabic scientists, making important contributions in mathematics, astronomy and geography, but also in the biological and medical sciences. Besides this he was a famous traveller who stayed long in India, and expounded the arts, sciences and customs of that culture in great detail to the rest of the world; an association with Further Asia which makes him particularly relevant in the present context.

It remains to speak of Khorasan, further west in Persia proper, and as far as it would be reasonable to go geographically here. It was a region of high culture, producing eminent Koranic commentators,[c] historians,[d] literary men,[e] and the greatest theologian of Islam,[f] to say nothing of the statesman who under the first Ilkhān was to be the founder of the Marāghah observatory.[g] But what gives particular pause in the line of thought we are following is the persistent tradition that Jābir ibn Ḥayyān was a man of Tus, al-Ṭūsī, either born there or brought up there.[h] The biographical memorials concerning this great but shadowy alchemical figure which Holmyard (17) studied suggest that this was so, but even if the historicity of Jābir himself is quite dismissed, the tradition may conceivably enshrine a certain truth about the origin of Jābirian alchemy. In this connection one should recall the conclusions reached above (p. 370) concerning the probable area of origin of the Balīnās or 'Apollonius' literature, especially the *Kitāb Sirr al-Khalīqa* of *c.* +750, or more likely *c.* +820, which may be looked upon as the start of the whole Arabic alchemical literature.[i] Balkh in Bactria, or indeed any of the Transoxianic centres beyond, can be found in the forefront of the picture.

Finally, apart from the merchants already envisaged, great scholars travelled, we should remember, to Khorasan and points east. One need instance only the geographer al-Mas'ūdī (+895 to *c.* +957), who wrote about those parts in his *Murūj al-Dhahab*...[j] But there were also official expeditions like that of Sallām al-Tarjamān

[a] Cf. Mieli (1), pp. 98ff.; Hitti (1), pp. 376–7.

[b] For example, Vol. 1, pp. 216–17; Vol. 3, pp. 252, 612; Vol. 4, pt. 2, p. 534; Vol. 4, pt. 3, pp. 502, 579.

[c] E.g. Abū Isḥāq Aḥmad ibn Muḥammad al-Tha'ālibī from Nishapur (*c.* +950 to *c.* +1020), cf. Dunlop (6), p. 55.

[d] Like Ibn abī Ṭāhir Ṭayfūr (al-Khurāsānī), *fl.* +819 to +833, who wrote a good 'History of Baghdad'. See Dunlop (6), pp. 80–1. On China in Islamic historiography, see Jahn (1).

[e] Like Abū Manṣūr 'Abd al-Malik al-Tha'ālibī, also from Nishapur (+961 to +1038) whose *Laṭā'if al-Ma'ārif* (Pleasant Sorts of Knowledge) gave him an extraordinarily high reputation. Among other things it contains a list of 'firsts', technical inventors, etc.; cf. Vol. 1, pp. 51ff. for Chinese parallels. On this al-Tha'ālibī see Dunlop (6), pp. 54ff. Unlike the historian just mentioned, he was highly regarded for the perfection of his Arabic style.

[f] Abū Ḥamīd al-Ghazālī al-Ṭūsī (Algazel to the Latins, the Aquinas of Islam), +1059 to +1111, sufi and philosopher of religion. See Mieli (1), 2nd ed., p. 94; Hitti (1), 2nd ed., p. 431.

[g] Naṣīr al-Dīn al-Ṭūsī (+1201 to +1274). See Vol. 1, pp. 217–18. We know the name, though not the characters, of one Chinese astronomer at Marāghah, Fu Mêng-Chi, and one of his colleagues was an al-Andalusī who wrote on the calendrical science of the Chinese and the Uighurs. Scientific contacts between China and Persia during the Mongol period have been summarised by Jahn (2).

[h] He was also commonly termed al-ṣūfī, which again might be significant.

[i] See Ruska (8); Multhauf (5), p. 128.

[j] *Murūj al-Dhahab wa-Ma'ādin al-Jawāhir* (Meadows of Gold and Fields of Gems); cf. Mieli (1), 2nd ed., p. 114; Dunlop (6), pp. 99ff. We often quote the translation of de Meynard & de Courteille (1).

(the interpreter) and his party to the 'Dyke' (*sadd*) of Dhū'l-Qarnain ('Him of the Horns', Alexander the Great) i.e. the Great Wall, also known to the Arabs as the Wall of Gog and Magog.[a] This took place in the reign of the Caliph al-Wāthiq (+842 to +847), but whether they reached the Wall itself or only passes with suggestive names in the Thien Shan remains uncertain.[b] Nevertheless, ideas could well have travelled with such men.

The last subject needing discussion here is the possible identification of a place or places on or near the Old Silk Road which could have acted as a focal point for the spread of East Asian ideas among the Syrians and Arabs. There is one city which has attracted suspicion of this kind, namely Ḥarrān, the classical Carrhae, a short distance south-east of Edessa (Orrhoë) and within the great bend of the Euphrates, in the province known about +400 as Osrhoene Euphratensis. This city is near the top of the arch of the Fertile Crescent rather than at its eastern end, where one might expect such a transmission-point to have been, but here perhaps religion was more important than geography, and Ḥarrān was unique in that it was neither Christian nor Muslim.[c] The Ṣābians of Ḥarrān were doggedly 'pagan', not because they perpetuated the conventional worship of the Graeco-Roman pantheon, nor yet because they were given to one or other of the Hellenistic mystery-religions, but because they had a cult of their own, based apparently on ancient Babylonian or 'Chaldean' practices[d] more than anything else. There seems to be nothing wrong with the tradition that the Ṣābians were adherents of a special religion who adopted the name comparatively late in order to enjoy the privileges of being considered 'People of the Book' (*ahl al-kitāb*) like Jews and Christians.[e] Ṣābians had indeed been mentioned in the Holy *Qur'ān*,[f] though who these were remains still problematical; in any case it is suggested that the book which the men of Ḥarrān adopted as their sacred scripture consisted of the writings attributed to Hermes-Agathodaemon, which in those days people on all hands were prepared to venerate no less than the Torah or the Gospels.[g] Now Ḥarrān in the first three Arab centuries was not only a great trade centre[h] but also famous for its astrolabists, alembic makers, and producers of astrological talismans;[i]

[a] Holy *Qur'ān*, Sur. XVIII, 82 ff.

[b] See the discussion in Vol. 4, pt. 3, pp. 56–7, and Dunlop (6), pp. 167–8.

[c] Neither Zoroastrian ('Magian'), Mazdaean, nor Mandaean either, one might add.

[d] For example, the historian Ḥamza al-Iṣfahānī (+897 to +967) says in his *Ta'rīkh Sinī Mulūk al-Arḍ wa'l-Anbiyā'* (Chronology of the Kings and Prophets of the Earth) that originally all easterners were *samīniyyūn* (from *sramana*), i.e. Buddhists, while all westerners were *kaldāniyyūn*, i.e. Chaldaeans in religion, as the Ṣābians still are. Dunlop (6), p. 114.

[e] As late as *c.*+830, according to Chwolson (1), vol. 1, p. 470. This notable work, now some two decades more than a century old, remains to the present day the indispensable source of information about the Ṣābians. See also the *Fihrist*, tr. Dodge (1), vol. 2, pp. 745 ff.

[f] Sur. V, 72–3.

[g] As Massignon remarked, they hoped that the Hermetic connection would get them accepted as monotheists. Cf. Stapleton (4), pp. 22, 25 and Stapleton & Husain (1), discussed critically on p. 415 above. See also Stapleton, Azo & Husain (1), p. 398. The role of the Ṣābians in transmitting texts attributed to Hermes (in Persian, Hōsheng; cf. Seybold, 1) has naturally made them of particular interest to those who study that literature; see e.g. Sarton (13); Massignon (4); Plessner (2); Stapleton, Lewis & Taylor (1); Yates (1), pp. 49 ff.

[h] It was a cross-roads of the E–W Susa–Baghdad–Aleppo–Antioch route and the N–S route from the Hittite Pontus region down to Babylon and Basra. Cf. Meyerhof (4).

[i] Chwolson (1), vol. 1, p. 344.

that alchemy or proto-chemistry was much cultivated there is quite clear if only from internal evidence in the writings of al-Rāzī.[a]

The Ṣābian religion, though very syncretistic, was really an old Syrian–Mesopotamian system Hellenised—though not to the point of giving up human sacrifices. Worship was paid to the sun and moon,[b] and to the five planets, considered as demiurges, assistants of the creator-god or gods.[c] Each one of the planets was associated with a particular colour, a particular geometrical shape (embodied in the construction of its temple),[d] a particular sacrifice and liturgy, and a particular metal (used for the image), as in the table overleaf.[e]

Of course, there is something rather Chinese about a symbolic correlation system such as this in itself.[f] But our attention is then caught by the fact that mercury was excluded

[a] See especially Stapleton, Azo & Husain (1), pp. 340–2 (cf. also 317, 335, 345, 361, 398, 401); also Stapleton & Azo (2), pp. 68, 72. The authority most quoted by al-Rāzī in his historical work *Kitāb al-Shawāhid* (Book of Evidences) is one Sālim al-Ḥarrānī.

[b] The great temple of the Assyrian moon-god, Sin, at or near Ḥarrān, had already been important in −2000 and was sacked by the Persians in −610. An interesting article by Seton Lloyd describes an archaeological prospection of it (*Times*, 21 March 1951). Later archaeological discoveries on and near the site have been reported by Seton Lloyd (2); Lloyd & Gökce (1) and Gadd (1). On what remains of Ḥarrān itself see Lloyd & Brice (1). Surrounding medieval Ṣābian monuments have been investigated by Rice (1) and Segal (1).

[c] Chwolson (1), vol. 1, pp. 158ff., pp. 725ff.; Segal (2). Much information on these liturgies and their sacrifices has come down to us in the Arabic literature. Some of the fullest detail occurs in that strange book of planetary, astral and talismanic magic known as *Picatrix* in its Latin form; a translation of the *Ghāyat al-Ḥakīm* (Aim of the Wise), compiled in Spain in the mid +11th century (by +1056), and attributed to Maslama al-Majrīṭī the alchemist, but certainly not by him (cf. Plessner, 1). The peculiar Latin name was a corruption of Buqrāṭīs, which in turn may have corrupted Hippocrates. There are full instructions for the adoration of the planetary gods (trs. Dozy & de Goeje (2); Ritter & Plessner (1), vol. 2, pp. 167 ff., 206ff., 213ff.) and curious accounts of other Ṣābian rites such as bull sacrifice (to Saturn), child sacrifice (to Jupiter), initiation ceremonies of young men (Ritter & Plessner, *op. cit.*, pp. 237ff.), and the strange dissolution in oil of the human sacrifice to Mars, with the story of the prophesying or divining by its separated head (Ritter & Plessner, *op. cit.*, pp. 146ff., 240–1). One is tempted to regard the legend of the brazen head of Roger Bacon as derivative from this Ṣābian fable, the factual basis of which remains highly problematical. Another echo is Scandinavian. Davidson (1) tells that in Viking mythology the ancient giant Mimir, guardian of the sacred well under the World-tree Yggdrasil, was beheaded by the gods, 'but afterwards Odin embalmed his head and kept it so that he might consult with it when he was in urgent need of counsel'. The motif has lived on into our own time, as witness the novel of C. S. Lewis, 'That Hideous Strength'.

[d] The *Kitāb al-Qarāṭis al-Ḥakīm* (Book of Crates the Wise), one of the oldest Arabic alchemical books (cf. p. 389 above) has a distinctly Ṣābian flavour, for the principal vision takes place in a temple of Venus which has an 'Indian' high priest; cf. the translated text in Berthelot & Houdas (1), pp. 61ff. Furthermore, the 'Indian' temple attendants aim their arrows at Crates, and we know that shooting the sacrifice to death was precisely one of the ceremonies at the Ṣābian planetary temples (in the liturgy for the moon, cf. Stapleton, Azo & Husain (1), pp. 400, 402).

Two relevant extant books are attributed to Balīnās (Ullmann (1), pp. 173–4). One is entitled *Kitāb al-Aṣnām al-Sab'a* (Book of the Seven Idols); the other, the *Kitāb al-Qamar al-Akbar* (Greatest Book of the Moon). Cf. p. 369.

Finally, strengthening the alchemical connection, we are told by al-Mas'ūdī that al-Rāzī himself wrote a book on the Ḥarrānian religion (de Meynard & de Courteille (1), ch. 64; comm. Stapleton, Azo & Husain (1), p. 341).

[e] Modified from Stapleton, Azo & Husain (1), pp. 398ff., 403, after Chwolson (1), vol. 2, pp.380ff. The chief authority was al-Dimashqī, writing about +1300.

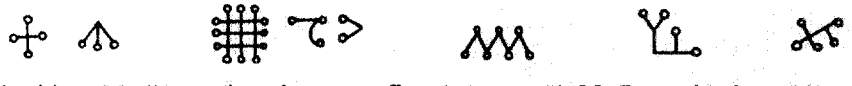
[f] Cf. Vol. 2, pp. 261ff. We might also remember here the considerable influence exerted in China by the Chhi Yao[1] books on astronomy and calendrical science between the +5th and the +8th centuries; see Vol. 3, pp. 204ff. These 'Seven Luminaries' texts were recognised as West Asian in origin, so perhaps they were of Ṣābian inspiration acting eastwards.

[1] 七曜

Planet	Colour	Shape	No. of steps in the temple	Metal
Saturn (Zuḥal)	black	hexagon	9	lead
Jupiter (Mushtarī)	green	triangle	8	tin
Mars (Mirrīkh)	red	oblong rectangle	7	iron
Sun (Shams)	yellow	square	6	gold
Venus (Zuharah)	blue and white	triangle	5	copper
Mercury ('Uṭārid)	brown	hexagon and square	4	*khārṣīnī*
Moon (Qamar)	white	pentagon	3	silver

from the metals, and 'Chinese arrow-head metal', *khārṣīnī*,[a] put in its place. Since all the Arabic writers agree about this, and since religious custom is notoriously so conservative, there can hardly be any other conclusion than that Chinese connections here must have gone back a long way. Exactly what *khārṣīnī* was we shall shortly discuss (p. 431)—some have suggested metallic zinc, but cupro-nickel seems really more probable—at any rate it was something which came from China in relatively small amounts and which neither Ṣābians nor Arabs knew how to make themselves. Perhaps because of its scarcity, the image of 'Uṭārid was cast, it was claimed, of an alloy of all the metals as well as *khārṣīnī*. For the rest, the Ṣābian religion had cosmic male and female forces prominently in its system,[b] much light-mysticism,[c] and a special interest in cosmic cycles similar to the Great Year;[d] other hints of East and

Chinese influence in *Picatrix* has not so far been looked for, but it seems to be very much there, and some of the numerous 'Indian' ascriptions may really refer to 'Further India'. The question is important because it bears on the East Asian contacts of the Ṣābians. Listening to Professor Plessner at the Barcelona Congress of 1959 I was much impressed not only by the prominence of the 28 *manāzil* or lunar mansions (= *hsiu*,[1] *nakshatra*) in the book (see Ritter & Plessner (1), vol. 2, pp. 14ff.)—so characteristic a feature of Chinese and Indian astronomy—but by the fact that they and other asterisms are depicted in the typically Chinese 'ball-and-link' convention of drawing constellations, i.e. as hollow circles connected by straight lines (cf. Vol. 3, pp. 276ff.). Examples from Ritter & Plessner (1), vol. 2, pp. 85, 111, 112, 114, 310, 320ff.) are shown in the inset drawings. Others can be seen in the monograph



of Winkler (1) on Muslim magic seals, pp. 150ff. and esp. p. 166. Mr Destombes has told us that a similar style of drawing occurs on Arabic astrolabes and spread to Latin astronomical MSS of the + 12th and + 13th centuries. Further on the lunar mansion lists in Arabic see Plessner (2). Other suspicious features in the *Picatrix* book include (*a*) Chinese tutty, onyx and the 'laughing-stone' (cf. p. 449 below), (*b*) the use of magic squares as childbirth charms (p. 463 below), (*c*) microcosmic–macrocosmic correlations between human anatomy and celestial patterns and numbers (as Hartner (13) has already noted), and (*d*) an apotropaic authority called Kināṣ the Pneumatologist, who lived till the age of 540 years and could control the *pneumata*—just like a *hsien*[2] with powers over the *chhi*.[3] See Ritter & Plessner (1), vol. 2, pp. 40ff., 172–3, 189, 259ff., 405, 407. All this is relevant to the question of Chinese relations with Ḥarrān.

[a] Also known as *ḥadīd ṣīnī*, 'Chinese iron'.
[b] Recalling Yin and Yang.
[c] Doubtless with Gnostic connections.
[d] Perhaps the Indian influence of *kalpas* and *mahākalpas* might be descried here.

[1] 宿 [2] 仙 [3] 氣

South Asian connections are also to be found.[a] At all events, Ḥarrān seems to have been a place through which ideas emanating from those parts of the world may have been channelled into the Arabic mind.

By the + 10th century the very orthodox Ash'arīs got the upper hand in Islam, and Ḥarrān became very uncomfortable. In +933 the *muḥtasib* or police chief of Baghdad, a man named al-Iṣṭakhrī, demanded the extermination of the Ṣābians; and it seems that most of them now gradually accepted Islam, their last official head, Ḥukaim ibn 'Īsā ibn Marwān, dying in +944.[b] But during the previous three or four centuries the role of Ḥarrān may have been truly important in transmitting both ideas and things. Let us now see what some of these were—and first, the things.

(iii) *Material influences*

As we have just been talking about a certain Chinese metal or alloy, *khārṣīnī* (barb or arrow-head metal of China), or *ḥadīd al-Ṣīn* (iron of China), which made such a great impression in Arabic culture, let us first see what more there is to be said about it, even though it was certainly not the most important of the substances which the Arabs got to know about from their friends further East. Still, it figured regularly (presumably under Ṣābian influence) in Arabic lists[c] of the seven metals (*ajsād*),[d] displacing mercury or glass (*zujāj*).[e] Other mentions of it in the Arabic alchemical texts are quite numerous.[f] Indeed, there was a special book devoted to it in the Jābirian Corpus, the *Kitāb al-Khārṣīnī*.[g] So we shall want to know when it first appeared in the West Asian lands, and what in all probability it really was.

[a] For example, Indian imagery in the temple of Saturn. Such connections were taken very seriously by Chwolson (1), vol. 1, p. 798. Though A. J. Hopkins was one of the first to appreciate the possible importance of Ḥarrān, he went much too far in saying, (1), p. 156, that the Ṣābian religion 'was derived from Iran and further back from China'.

[b] The case is slightly reminiscent of the liquidation of Aztec culture by the Spaniards centuries later, and one has similar mixed feelings about it, for very much the same reasons. Sarton (13) seems to suggest that some Ṣābians found refuge in Christendom, but that sounds rather unlikely. More probably the Hermetic strain continued within the bosom of Islam itself (cf. Massignon, 4), and found its way to Latin Europe and the Renaissance by way of Spain.

[c] On these lists in the Jābirian Corpus see Kraus (3), pp. 19, 22–3. One is in the *Kitāb al Khawāṣṣ* (Book of Properties), Kr 78, another in the *Kitāb al-Khamsīn* (Book of the Fifty), Kr 1825–1874. For al-Rāzī (*c.* +900) see Stapleton, Azo & Husain (1), pp. 321, 340–1, 345, 363, 370, 405. For al-Kātib al-Khwārizmī (+976) see Stapleton, Azo & Husain (1), p. 363; Wiedemann (15), p. 80. For al-Qazwīnī (*c.* +1275) see Stapleton, Azo & Husain (1), p. 406.

[d] The Hellenistic proto-chemists had recognised only six; cf. *Corp.* III, xvii, 1, classed by Berthelot & Ruelle as a Zosimus text. So also the *Caraka* and *Suśruta samhitas* in India, with all later tradition; Ray (1), vol. 1, pp. 25, 44, 48, 72, 127, 157.

[e] As in the Jābirian Seventy Books, towards the end, pointed out by Stapleton, Azo & Husain (1), p. 405; Kraus (3), p. 21. They were referring to the *Kitāb al-Ghasl* (Book of Washing, i.e. Purification), Kr 183.

[f] Cf. Siggel (2), p. 79, (3), p. 12. For the Jābirian Corpus see Kraus (2), p. xxxv, (3), pp. 19, 22ff. *Ḥadīd ṣīnī* comes in the *Kitāb al-Sirr al-Maknūn* (Book of the Hidden Secret), Kr 389. For al-Rāzī see Ruska (14), pp. 42, 84, 85, 134, 138, 156; Stapleton, Azo & Husain (1), pp. 405–11. For al-Bīrūnī (*c.* +1020), see Kraus (3), pp. 22–3. For al-Ṣafadī (d. +1363) see Wiedemann (32), p. 9. For Ibn Khaldūn (+1377) see Rosenthal (1), vol. 3, p. 271. *Khārṣīnī* seems not to occur in *Picatrix*, but instructions are given for a charm to be inscribed on a ring made of 'Chinese iron' (Ritter & Plessner (1), p. 411).

[g] Kr 953; see Kraus (2), p. 116.

If the Arabo-Syriac MS. published by Berthelot & Duval were a text of the early +9th century it might be the first mention of 'Chinese arrow-head metal' in the West, for the name occurs in connection with the 'filtration' of metals, or descensory distillation, through a crucible with a perforated floor, in the *bot-bar-bot* apparatus (cf. p. 33 above);[a] but this work is considered to include material as late as the late+10th century.[b] Moreover, *khārṣīnī* is not mentioned in its list of metals.[c] The Jābirian Corpus therefore seems to be the beginning.[d]

Various ideas were current about *khārṣīnī*. It was exceedingly scarce,[e] it caused mortal wounds when actually made into arrow-heads,[f] and it resembled the metal of which mirrors were made (though somewhat softer),[g] while pots and cauldrons were also manufactured from it.[h] In his encyclopaedia *Kitāb 'Ajā'ib al-Makhlūqāt*... (Marvels of Creation)[i] Abū Yaḥyā al-Qazwīnī (*c.* +1275) considered that when the

[a] Berthelot & Duval (1), pp. 149, 150. Actually 'Chinese iron' is the reading here rather than 'Chinese arrow-head metal'. The device was the ancestor of the Gooch crucible.

[b] Later mentions in Syriac are plentiful. For example, the 'Book of Dialogues' of Severus bar Shakko (d. +1241), has *parzla* (iron) of China; cf. Ruska (40), p. 159. For this reference and for help in the study of the Syriac texts in general we are much indebted to Dr Sebastian Brock.

[c] *Op. cit.*, p. 156.

[d] But we may find a reference from an unexpected source which would take back 'Chinese iron' to a point some four centuries earlier. It occurs in Sir Harold Bailey's fascinating account of the past half-century of Iranian studies. What he says is of such philological erudition that we cannot but quote it verbatim.

'The Kharoṣṭhī Kroraina texts [he says, (1), p. 103] are important because of the Iranian words which they contain; they assure a date around +300, before the bulk of the extant Khotan Śaka texts were written. One problem they have raised is the source of the north-western Dardic Pašai word *čimár*, "iron", and the related words of Dardistan and Nuristan. In a Buddhist Sanskrit manuscript of the *Saṃghāṭa-sūtra* from the Gilgit monument called a *stūpa*, probably therefore about +400, there occurs the word *cīmara-kāra*, "a worker in cīmara metal". The Chinese translation proposed the meaning "iron", the Tibetan translation gave "copper". Modern dialects have the meaning of "iron". Now this word probably occurs in Kroraina in the phrase *cina-cīmara*... If we render by "Chinese *cīmara*", that is, "Chinese iron", one is at once reminded of the Arabic *ḥadīd-ṣīnī*, "Chinese iron", possibly meaning nickel [or cupro-nickel]. This Buddhist Sanskrit word *cīmara-* has such a similar appearance to Turkish *timür*, "iron", that the older form of that word is likely to be **čimr-* with *-ür* replacing *-r-* after consonant, as the Turks turned Persian *babr*, "tiger" into the name Babur.'

For us all this is rather strong support for the view expressed a few pages below that 'Chinese iron' or 'Chinese arrow-head metal' was cupro-nickel and not zinc, because it takes back the export to Chin times; cf. Vol. 5, pt. 2, pp. 225ff. It also means that the expression 'Chinese iron' was in some Iranian languages long before it ever got into Arabic.

[e] Cf. al-Rāzī, in Stapleton, Azo & Husain (1), p. 345; Kraus (3), p. 23.

[f] Cf. Laufer (1), p. 555, quoting Steingass' Persian dictionary, p. 438. There may have been some substance in this notion, because from the earliest days of proto-gunpowder in China, incendiary weapons involved toxic compositions and smokes; cf. Davis & Ware (1). The time with which we are here concerned would have been rather early for proto-gunpowder, but not for incendiaries, and there could have been confusion with a strange metal.

[g] See al-Rāzī (tr. Stapleton, Azo & Husain (1), p. 371), and al-Dimashqī, *c.* +1325, who speaks of distorting mirrors (Wiedemann (33), p. 403). This suggests whiteness (as of a high tin bronze like gun-metal), and reflectivity. Whiteness is also indicated by the alternative name of 'Chinese iron'. The Persian terms *isfīd-rūy* and *sepīd-rūy* meant 'white copper', but they raise the same nomenclature problems that we have faced in Chinese (pt. 2, p. 232 above), and in fact they were almost certainly used to mean high tin bronzes rather than *pai thung*, cupro-nickel. Cf. von Lippmann (1), p. 417. For another reference to Chinese mirror metal in al-Rāzī see Stapleton, Azo & Husain (1), p. 387. That mirrors from China said to be made of steel were sold in Baghdad around +990 for double or several times their weight in silver we learn from al-Tha'ālibī's *Laṭā'if al-Ma'ārif* (Dunlop (6), p. 58).

[h] Al-Ṣafadī, in Wiedemann (32); at Badakshan, says al-Qazwīnī, in Kraus (3), p. 23.

[i] Mieli (1), 2nd ed., p. 150.

proportions of mercury and sulphur were just right for silver but injured by cold before coction, *khārṣīnī* was formed.

The formation of *khārṣīnī* [he wrote] is like that of the other metals already mentioned. Its mine is in the land of China. Its colour is white, with a reddish tinge. All spear or arrow heads made from it are very injurious. It is also worked into fish-hooks by means of which large fishes are caught, for when once they have swallowed one of these they cannot escape except with the greatest difficulty. From this metal also is made a kind of mirror which is the best treatment for palsy, since a paralysed man will derive benefit if he sits and gazes at it in a darkened room. Pincers are furthermore made from it good for the pulling out of hairs, and if the place where they were is then oiled several times, the hair will not grow again.[a]

Al-Qazwīnī adds that no other metal yields a ring (of resonance) equalling that of this one, and that none is so suitable for the making of bells large and small.[b] Yet it was not regarded as very potent, for to 1 part of the elixir there corresponded the following quantities:[c]

'mineral ammoniac' (ammonium chloride)	$2\frac{1}{2}$ parts
gold	5
'derived ammoniac' (ammonium carbonate)	$6\frac{1}{4}$
silver	10
copper	$14\frac{2}{7}$
tin	20
lead	25
iron	50
khārṣīnī	100

This was a strange 'Pythagorean' numerological anticipation of modern experimental orders such as the atomic weight or the electrochemical series. In the *Kitāb al-Ḥadīd* (Tractate on Iron)[d] the Jābirian writer expressly says that the planet Mercury is to be correlated not with mercury but with *khārṣīnī*; and Kraus remarked that the Arabic alchemists who preferred to regard mercury as one of the volatile spirits needed something else to complete the set of metals.

What then was *khārṣīnī*? There have been two main opinions—de Sacy, Laufer and Ruska said cupro-nickel,[e] Humbert and Stapleton said zinc.[f] Others could not decide between them.[g] Stapleton was rather optimistic, we suspect, in believing that al-Rāzī was too good a practical chemist to have classed it among the basic metals unless he had satisfied himself that it was not an alloy.[h] Would he really have been able to distinguish about +900? Another approach is now possible on the basis of what we have learnt about the dates of first preparation of metallic zinc and cupro-

[a] Tr. Stapleton, Azo & Husain (1), p. 407.

[b] Wiedemann (33), pp. 403–4; Kraus (3), p. 23. Kashgar, it seems, was famous for them.

[c] Kraus (3), p. 23ff. [d] Kr 950.

[e] Laufer (1), p. 555; Ruska (14), pp. 42–3; de Sacy (2), vol. 3, pp. 452 ff. Or, as some of them put it, tutenag. [f] Stapleton, Azo & Husain (1), p. 407; Humbert (1), p. 171.

[g] E.g. Bocthor (1); Dozy & Engelmann (1), pp. 252, 294.

[h] Stapleton *et al. loc. cit.* Other alloys discussed by al-Rāzī (Stapleton *et al. op. cit.*, pp. 324, 408ff.) were *isfīd-rūy*, bronzes; *shābah* or *rūḥ-i-tūtiyā*, brasses; and *ṭālīqūn*, an alloy of copper and lead, also called *nuḥās* (or *mis*) *ṣīnī*, i.e. 'Chinese copper'. Some Chinese coin compositions were indeed rather high in lead, up to nearly 30% (cf. Table 98 and p. 215 in Vol. 5, pt. 2).

The *Kitāb al-Aḥjār* or Lapidary of Pseudo-Aristotle, a Syrian–Persian–Indian compilation of the early +9th century, attributes to *ṭālīqūn* several of the same properties as those ascribed by al-Qazwīnī to

nickel elsewhere (pt. 2, pp. 212ff., 225ff.). From that it is clear that the Chinese could not have exported metallic zinc before this very time, about +900, while cupro-nickel could have been sent to the western countries at any period from the late Han or San Kuo onwards, say the +2nd or +3rd century.[a] Consequently if some at least of the Jābirian references are to be placed in the early or middle +9th century the time would have been rather too early for zinc, and cupro-nickel would be more probable. True, one gets the impression that *khārṣīnī* occurs in the later Arabic alchemical books rather than in the earliest ones, so the point is rather difficult to prove by datings. However, the references to the bell-like resonance of *khārṣīnī* speak almost decisively in favour of cupro-nickel and against zinc, for this was one of the characteristics of paktong most admired in +18th-century Europe. In any case, we are clearly in presence of one material substance which greatly interested the Arabs, and which they knew came to them from China.

Khārṣīnī was far from being the only substance to which the Arabs applied the epithet 'Chinese'. When they learnt of saltpetre in the +13th century they called it 'Chinese snow' (*thalj al-Ṣīn* or *thalj ṣīnī*),[b] just as rockets were known among them as 'Chinese arrows' (*sahm al-Khiṭāi*).[c] We shall come across several other examples of this nomenclature presently. But the transmission of saltpetre and gunpowder belongs to a period rather later than that on which we are now concentrating in connection with the transmission of the elixir idea. There was one new substance however which characterised Arabic alchemy almost from its beginnings, a substance of striking properties and reactivity, and one which unquestionably came (to begin with) from regions further East—this was sal ammoniac, *nūshādir* or *nūshādur*. Properly speaking, the term means ammonium chloride (NH_4Cl), but the Arabs, and indeed the later Latins, did not clearly distinguish it from ammonium carbonate ($(NH_4)_2CO_3$), except that the former was considered mineral or natural (*al-ḥajar*) and the latter derived or artificial (*mustanbaṭ*). In explanation one can broadly say that the former was exported from the mountainous regions of Central Asia such as the Thien Shan, while the latter, seemingly a characteristic product of Arabic alchemy, was obtained by the dry distillation of hair. A little later it was found, also in the Near East, that the chloride itself could be obtained by sublimation from heated soot. But in China the natural product always occupied the chief place.

khārṣīnī; cf. Ruska (19); Stapleton, Azo & Husain (1), p. 409. But it would have been neither silvery nor resonant.

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[a] The episode of the cupro-nickel coinage in ancient Bactria will also not be forgotten (cf. pt. 2, pp. 237ff. above). Could this perhaps have decanted a continuous Central Asian tradition into the Arabic world?

[b] Cf. Partington (5), pp. 202ff., 310, 313. This comes first in Ibn al-Baiṭār, *c.* +1240 (cf. p. 194 above). Ḥasan al-Rammāḥ the military pyrotechnician, writing about +1280, adds many similar expressions such as 'Chinese flowers', 'Chinese wheel', 'Chinese arsenic' and 'Chinese iron', which was probably not the same as *khārṣīnī*.

[c] Cf. Laufer (1), pp. 555–6. It may have already been suggested that the two names betray a passage westwards by the sea and land routes respectively; see Vol. 1, p. 169. The Liao dynasty of the Chhitan Tartars lasted from +907 to +1125, when the Mongols eliminated it, but the appellation 'Cathay' remained in use in various forms in Central Asia for long afterwards, and it was natural that things travelling over the Old Silk Road should receive the adjective 'Cathayan'.

That the sal ammoniac of modern times, the *nūshādir* of the Arabs and the *nao-sha* of China,[a] was quite different from the 'ammoniac salt' (*halas ammōniakon*, ἅλας ἀμμωνιακόν) of the Western ancients, Beckmann at the end of the + 18th century was probably the first to realise.[b] The mentions of this natural product in Herodotus,[c] Columella,[d] Dioscorides[e] and other writers[f] clearly show that it came from the neighbourhood of the desert oasis of Siwa (near the present-day border between Egypt and Libya), with its famous temple of Amūn-Ra; later Pliny confused the etymology by bringing in the Greek word for sand (*ammos*, ἄμμος).[g] But from all descriptions the properties of this salt were quite unlike those of ammonium chloride, and by general agreement it must have been either rock-salt (sodium chloride) or natron (sodium carbonate).[h] This has to be remembered when considering, as presently we must, the names which ammonium chloride has borne in the history of the nations.

If we open one of those vintage Victorian chemical textbooks which are often so much more useful to the historian of science than contemporary expositions, which have become more than half physics; a volume, for example, in one of the many editions of Roscoe & Schorlemmer,[i] we can find a history of sal ammoniac briefly set forth. It is of great importance for it is the pre-history of the most useful volatile alkali, gaseous ammonia. This was Priestley's 'alkaline air' (+ 1774), the composition of which (NH_3) was determined by Berthollet (+ 1785) and more accurately by Austin three years later. Down to Priestley's time ammonia was known only in aqueous solution, by two names, *spiritus volatilis salis ammoniaci* and 'spirits of hartshorn'. Glauber in the + 17th century already knew that a volatile alkali could be produced by the action of a fixed alkali on sal ammoniac,[j] hence the first name. The second recalled the original method, essentially Arabic, of destructive distillation of animal refuse such as hoofs, horns, bones, hair, etc.,[k] the ammonium carbonate produced ('salt of hartshorn' or *sal volatile*) now being neutralised by hydrochloric acid.[l] Most of the sal ammoniac used in Renaissance and seventeenth-century Europe was imported from Egypt, where it was obtained by sublimation from soot, especially that of camel dung fires such as those of the baths (*ḥammām*)[m] and the

[a] See pp. 443ff. below. [b] (1), vol. 2, pp. 396ff.

[c] IV, 181. [d] *De Re Rust.*, VI, xvii, 7, 8. [e] V, 126.

[f] 'Ammoniac salt' is twice mentioned in the Leiden Papyrus (cf. pt. 2, p. 16), but Berthelot (2), pp. 30, 45, well realised that it was not sal ammoniac. Similarly, there is no trace of sal ammoniac under any name in the earlier parts of the Hellenistic Corpus (Ruska (13), p. 5).

[g] *Hist. Nat.*, XXXI, xxxix. He and other Latin writers used an initial aspirate form making 'hammoniacum'.

[h] On 'natron' and 'nitre' cf. pp. 179ff. above. The properties of ammonium chloride, volatilising so completely without decrepitation and liberating so easily 'insupportable vapours' could not have been overlooked. Cf. Bailey (1), vol. 1, pp. 41, 163.

[i] (1), 3rd or 4th edition, vol. 1, pp. 452ff., vol. 2, pp. 287ff., 297ff.

[j] And therefore that it consisted of an alkaline and an acid part, cf. Partington (7), vol. 2, p. 353. This was in + 1647; Tachenius in his *Hippocrates Chemicus* of + 1666 (II, viii) expressed the matter even more clearly. Cf. Partington, *op. cit.* pp. 293–4.

[k] Cf. Stapleton (1), p. 28, quoting al-Khwārizmī al-Kātib's *Mafātīḥ* (+ 976).

[l] Since Sala (+ 1620); Partington (10), p. 318, (7), vol. 2, p. 279. Or taken through the sulphate to react with common salt, cf. Aikin & Aikin (1), vol. 2, pp. 281ff.

[m] Accounts of this go back a long way indeed, to Abū Isḥāq al-Iṣṭakhrī, for instance, *c.* + 970 (Mieli (1), 2nd ed., p. 115), to Abū Ja'far al-Ghāfiqī, d. + 1165 (Mieli, *op. cit.*, p. 205), and to Abū

ovens used for artificial incubation of hen's eggs (*ma'mal al-katākīt*).[a] Latin Geber, *c.* +1300, has an account of the preparation of sal ammoniac by the distillation of urine, sweat and wood soot with salt,[b] hence the origin, it has been supposed, of the term *spiritus salis urinae*.[c] But whether this method could ever have produced any sublimed crystals of the chloride has been gravely doubted since the beginning of the +18th century, as Multhauf (8) has shown, so it may well be that the Geberian formula was a cover-up for something else, and that the Venetians who in the previous century were supposed to be using it were really importing the chloride from Egypt.[d]

The historical importance of sal ammoniac lay in its great reactivity, providing the Arabic alchemists with a new 'volatile spirit' to set beside mercury, sulphur and arsenic; for both the chloride and the carbonate sublimed readily, and unchanged. The former will attack, or colour,[e] many metals, even silver, producing the chlorides; it reduces metal oxides as a flux giving a clean metallic surface suitable for tinning, silvering or gilding;[f] it also found employment in the dyeing craft where ammonia alum was wanted as a mordant;[g] and it has useful pharmacological properties.[h] A strongly refrigerant effect on solution attracted notice early,[i] and the 'English drops' or 'smelling-salts' familiar since the +17th century were only confections of ammonium carbonate.[j] Stapleton sought evidence of some of these uses in the +12th-

'Abd Allāh al-Anṣārī al-Dimashqī, *c.* +1320 (Mieli, *op. cit.*, p. 275). Such references have been collected in von Lippmann (1), pp. 403, 418. For similar accounts of fairly recent date see Aikin & Aikin (1), vol. 2, pp. 280ff.; Parkes (1), vol. 4, pp. 339ff.; Ure (1), vol. 1, pp. 140ff.; Clow & Clow (1), p. 420.

[a] See Needham (2), pp. 6–7. It was the report of the French Consul at Cairo, Lemere, in +1719, that drew attention to this (in Parkes, *loc. cit.*).

[b] *De Invent. Veritatis*, ch. 4, tr. Darmstädter (1), pp. 105, 174. Stapleton (1), p. 28, had this reference wrong, for *De Investigat. Perfectionis*, ch. 4 (Darmstädter tr., p. 97) has only a re-sublimation process for the purification of the salt; but he deserved great credit for his pioneer monograph on the whole subject. The only other studies comparable in importance are those of Ruska (13, 39), and we draw on all of these here.

[c] Cf. Libavius, *Syntagma*, VI, viii, 39; Partington (7), vol. 2, p. 264.

[d] In modern times all other sources have been ousted by the ammonium sulphate of 'gas liquor', a by-product in the distillation of coal and coal-tar. But ammonium carbonate distilled from bones and offal was still a mainstay of the industry at least as late as 1830; cf. Multhauf (8); Ure (1), vol. 1, pp. 135ff.

[e] Cf. Partington (7), vol. 2, p. 19.

[f] Cf. Agricola, *De Nat. Foss.* (+1546), IV, ix; Partington (7), vol. 2, p. 53.

[g] Cf. Ure (1), vol. 1, p. 147.

[h] An expectorative stimulant, mild cholagogue, and diaphoretic; cf. Sollmann (1), pp. 556ff. Acting as dispenser for my father, when a boy, I remember many prescriptions containing 'am. carb.' and 'am. chlor.' Sal ammoniac, we now learn, was commonly added to snuff (Parkes (1), vol. 4, pp. 339ff.).

[i] Cf. pt. 3, p. 225 above. There can be a temperature fall to −10°, or with snow or pounded ice, to −18° (Ure (1), vol. 2, pp. 296–7).

[j] Our remark at an earlier point (pt. 2, p. 90) will be remembered, namely that Ko Hung would have considered these a perfect instantaneous elixir capable of recalling the absent souls and restoring consciousness. Indeed, he may well have used *nao-sha* in some such way (cf. p. 440 below). This was probably the application which brought sal ammoniac into the poems of Robert Burns. In his 'Death and Doctor Hornbook' (a satire on John Wilson, schoolmaster of Tarbolton, who professed medical knowledge), speaking of quack drugs and Latin patter, he wrote:

> 'Forbye some new uncommon weapons—
> *Urinus spiritus* of capons,
> Or mite-horn shavings, filings, scrapings
> Distill'd *per se*,
> Sal alkali o' midge-tail clippings
> And mony mae.'

century *De Anima in Arte Alchemiae* of Pseudo-Avicenna.[a] The 'hardening of mercury' and the softening of other metals by the 'water of hair' must refer to the action upon them of ammonium chloride prepared from the carbonate got by dry distillation.[b] The mention of ceration (ready melting without fumes on a hot plate) may mean that the late Arabs and later Latins succeeded in preparing one or other of the complex salts of ammonia and mercury.[c] The addition of hair (and perhaps salt) to the zinc carbonate used in the making of brass, and the 'fumes of hair turning copper yellow', probably imply the use of the ammonia salts as fluxes. And since sal ammoniac when heated in a confined space often acts like gaseous hydrochloric acid, one can see that the early medieval Arabic alchemists had come into possession of a new reagent of real importance.

That sal ammoniac (*nūshādir*) is constantly mentioned in Arabic alchemical texts needs no proof. The writings of the Jābirian Corpus often speak of it in both its forms,[d] and though no individual title embodies its name, there is, significantly, a 'Book of Hair' (*Kitāb al-Sha'ar*),[e] as well as more general treatments in the 'Book of the Living' and the 'Book of Government'.[f] They constituted but one aspect of that emphasis on organic in addition to inorganic materials which the Arabs shared with the Chinese,[g] in contrast to the Greeks. All this suggests that we can confidently place Arabic knowledge of the natural ammonium chloride as far back as about +850 and of the carbonate (from hair and other animal material)[h] by about +875. Knowledge

[a] (1), pp. 37ff., elucidating v, xx, vii, iii, etc.

[b] Presumably then either via the sulphate using blue vitriol followed by common salt, or directly using the magnesium chloride of bittern, processes later industrially current; cf. Multhauf (8).

[c] I.e. 'fusible white precipitate' ($2NH_3.HgCl_2$, mercuri-diammonium chloride), cf. 'infusible white precipitate' ($NH_2.HgCl$, amino-mercuric chloride), and 'sal alembroth' ($(NH_4)_2.HgCl_4.H_2O$, ammonium chloro-mercurate); see Partington (10), pp. 399, 401–2; Durrant (1), pp. 375–6; Aikin & Aikin (1), vol. 2, pp. 82, 283. The second of these was of practical importance because it multiplied the solubility of corrosive sublimate some twenty times. The term alembroth, pointing so unmistakably to Arabic origins, has been considered a corruption of al-Rāzī's references to the axes required for breaking up certain hard minerals or preparations (von Lippmann (1), vol. 3, pp. 29–30). Sal alembroth was used in medicine, being regarded as less irritant than other mercurials (Sollmann (1), p. 638).

[d] E.g *Kitāb al-Raḥma al-Kabīr*, Kr 5, see Berthelot & Houdas (1), pp. 167, 187, corr. by Ruska (13), p. 10. The second reference speaks of *nūshādir* purified by resublimation. *Kitāb al-Tajmī'*, Kr 398, see Berthelot & Houdas (1), p. 205, corr. by Ruska (13), p. 11. *Kitāb al-Aḥjār*, Kr 40, see Kraus (3), pp. 226–7. *Kitāb al-Khawāṣṣ al-Kabīr*, Kr 1900, see Kraus (3), pp. 18–19, *nūshādir al-sha'ar*, 'hair ammoniac'. *Kitāb al-Sumūm*, Kr 2145, see Ruska (39). Consult also Kraus (3), pp. 25, 41–2, 109, 233.

[e] Kr 34. Other titles in the Hundred and Twelve Books which tell the same story are the *Kitāb al-Bayḍ* (Book of Eggs), Kr 32; the *Kitāb al-Dam* (Book of Blood), Kr 33; the *Kitāb al-Bawl* (Book of Urine), Kr 56; the *Kitāb al-Ḥayawān* (Book of Animals), Kr 55; and perhaps the *Kitāb al-Nabāt* (Book of Plants), Kr 35.

[f] I.e. the *Kitāb al-Ḥayy*, Kr 133, and the *Kitāb al-Ḥukūma*, Kr 134, respectively, both among the Seventy Books; cf. Ruska (3), p. 43. The first twenty tractates of this group are all on animal chemistry; Kraus (2), pp. 44, 47. Apparently the different parts and excreta of animal and human bodies each had their 'partisans' as sources of *nūshādir*. The *Kitāb al-Lāhūt* (Book of Divine Grace), Kr 123, and the *Kitāb al-Balāgha* (Book of Attainment), Kr 135, name marrow, blood, hair, bones, urine and sperm as the most important; among the best animals the 'hottest', i.e. lion, viper and fox; among human beings bilious men, thin men, Yemenis, sea islanders, Sindhis and Copts; failing any of these one has to be content with cattle, gazelles, and asses wild and tame. Cf. Ruska (3), p. 41; Kraus (3), p. 4.

[g] Cf. pp. 393, 398, 401 and 404 above, and p. 497 below.

[h] Stapleton (1), pp. 30ff., gives a long excursus on the magical properties attributed to hair, etc. in Asian cultures, and adds examples of biological metamorphoses, real and supposed, which made its transformation into an important elixir chemical seem more likely (cf. pt. 2, p. 64 above on Petrus

of the chloride obtained by sublimation from dung and its soot would have followed about +900. This last can be traced in many poetical verses praising that alchemical treasure which is to be got from the lowest and most repulsive origins.[a] Of these perhaps the most famous lines are those attributed, doubtless wrongly, to Khālid ibn Yazīd (p. 389 above):

> Take talc, with *ushshaq* gum,[b] and what thou findest in the streets,
> Add a substance resembling borax, and weigh them without error;
> Then, if thou lovest God, thou shalt be master of all his works.[c]

But there are numerous other statements of the idea.[d] Naturally from the beginning of the +10th century sal ammoniac is seen in constant use.[e]

To fix the first appearance of *nūshādir* in Western Asia more exactly is a difficult matter, for the helpfulness of our Syriac documents is vitiated by the many interpolations from Arabic which they afterwards received. The two main Syriac MSS studied by Berthelot & Duval speak of *melḥē armōnīqōn*[f] (which would be the ammoniac salt or soda of the ancients),[g] and *nshādr*, *nūshādr* (which must be the ammonium chloride of the Arabs),[h] but as they are no earlier than the early parts of the Jābirian

Bonus). Such passages can be found in the +10th-century text translated by Berthelot & Duval (1), p. 155, and in Ibn Khaldūn's *Muqaddima* quoting al-Ṭughrā'ī (d. +1121), tr. Rosenthal (1), vol. 3, p. 272.

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[a] A deeply important theme of introspective psychology, this—the 'lotus rising from the mud' in other civilisations. Or 'samsara *is* nirvana'.

[b] I.e. 'gum ammoniac' (the name a coincidence here), from the Persian umbellifer *Dorema Aucheri* or *ammoniacum*. It is a balsam or gum-resin still used in pharmaceutical flavouring; cf. Sollmann (1), p. 121.

[c] Tr. de Meynard & de Courteille (1); Wiedemann (27), p. 346, repr. (23), vol. 1, p. 52; Ruska (4), p. 28; Dunlop (6), p. 206; v. Lippmann (1), pp. 357–8, eng. et mod. auct.

[d] Both in prose and verse. For example the Jābirian *Kitāb al-Raḥma al-Ṣaghīr*, Kr 969, see Berthelot & Houdas (1), p. 136. Or the post-Jābirian *Kitāb al-Jāmi'*, see Berthelot & Houdas, *op. cit.*, p. 118, cf. p. 125; Kraus (2), p. 197.

[e] See, e.g. Partington (17) for al-Rāzī, as also Heym (2); and Stapleton, Azo & Husain (1) and Ruska (14) translating the *Kitāb Sirr al-Asrār*, *passim*. On the derivative *De Aluminibus et Salibus* see Ruska (21), pp. 82ff., 125. Cf. Stapleton (1), p. 28 on al-Khwārizmī al-Kātib (+976). Add Ruska (5), pp. 74–5, 79, 86, 106, 112, 124, translating the *Ta'wīdh al-Ḥākim*...of *c.* +1050, cf. p. 391 above. And Stapleton & Azo (2), p. 80. Further, Stapleton (1), p. 29, on Ibn al-Tilmīdh and Abū Ja'far al Ghāfiqī (both d. +1165); and al-Sharīf al-Idrīsī (d. +1166). For al-Khwārizmī al-Kāṭī see Stapleton & Azo (1); here sal ammoniac of Khurāsān is often mentioned (+1034). There are many references also in the tractates of the Rampur Codex, see Stapleton & Azo (2), pp. 60, 64, 79, 80, 83.

[f] Or *armenaitā* (Berthelot & Duval (1), p. 70, text, p. 39, corr. Ruska (13), p. 16).

[g] (1), pp. 8, 9, 86, text pp. 4, 48. The difficulty is that Duval may have punctuated his text wrongly in some places, so we cannot be sure that this adjectival combination is always present where he thought it was; see Ruska (13), pp. 14–17. *Armōnīqōn* may sometimes be a separate word meaning a mineral from Armenia. There could also be a confusion with the gum already referred to (Berthelot & Duval, *op. cit.*, p. 10; Ruska, *op. cit.*, p. 16). The translations of Duval were distinctly careless and did not take adequate account of the various technical terms used in the texts, hence the later corrections of Ruska are indispensable. Ruska dated the lists incorporated in these texts, and in which the words occur, about the time of Ḥunain ibn Isḥāq the great translator, i.e. *c.* +850 to +870. We cannot follow him in all his interpretations, however.

[h] (1), pp. 13, 64, 66, 70, etc. *Nūshādir* is prominent in the +11th-century Arabic MS. written in Syriac script, as would be expected, cf. (1), pp. 143, 155, 159, 160, 183, 197. Among late Syriac references one could quote Severus bar Shakko (d. +1241); see Ruska (40).

Corpus they do not take us much further.[a] The focal point remains at +850 or the decades just preceding that date.[b] Where, one may now ask, did the natural sal ammoniac then obtained by the Arabs come from?

There can be no doubt that Central Asia was the region and that the salt was collected at the mouths of clefts or vents in the earth which also gave forth variously gases, flames and smoke; often, according to the accounts, these vents were situated within natural caves. All the Arabic writers, from the +10th to the +14th century, agreed that mineral sal ammoniac came from these eastern lands, China, Ferghana and Persia—whether Ibn 'Alī al-Mas'ūdī *c.* +947 or al-Dimashqī the cosmographer *c.* +1320.[c] Parallel Chinese accounts, which we shall be considering in a moment, fully confirm the importance of Sinkiang as a source of sal ammoniac. The medieval and traditional descriptions were not of course precise about the geological nature of the phenomena, and it has long been assumed that the mountains of Central Asia, if not numbering any volcanoes still eruptive, were yet capable of sufficient activity of that kind to account for the sal ammoniac production. That ammonium chloride is deposited around the openings of volcanic vents (fumaroles, solfataras),[d] and crystallises on the surface of cooling lava in its cracks and fissures, is not to be doubted in view of the many eye-witness accounts available.[e] But all the geological evidence goes to show that the Thien Shan and Altai mountain ranges ceased to be the scene of volcanic activity many ages ago, and that the real source of sal ammoniac in these regions was the burning of underground seams of coal.[f]

[a] Nor does the *Lexicon* of Bar Bahlul (*c.* +980), Berthelot & Duval (1), pp. 135, 137; Ruska (13), pp. 17–18. See p. 447 below. Nor does the Cambridge MS., which is of very miscellaneous content, hard to date; Berthelot & Duval, *op. cit.*, pp. 248, 297.

[b] According to Multhauf (5), p. 126, sal ammoniac is mentioned in the *Kitāb Sirr al-Khalīqa* (Book of the Secret of Creation, see p. 370 above), which may be dated at about +820. Another early mention is that in the Arabic Lapidary of Pseudo-Aristotle which belongs to the same time; Ruska (19), p. 173. It recurs of course in the enlarged Lapidary of al-Qazwīnī (*c.* +1250); Ruska (24), p. 40.

[c] See the *Murūj al-Dhahab*, tr. de Meynard & de Courteille (1), and the *Nukhbat al-Dahr*, tr. Mehren (1), pp. 93, 169, 308, cit. von Lippmann (1), p. 418. A collection of the accounts of Arabic writers will be found in Ruska (39) and Laufer (1), p. 507.

[d] This is well known for the fumaroles of Hecla, Etna, Vesuvius, Pozzuoli and other European volcanic regions; Roscoe & Schlorlemmer (1), vol. 2, p. 287; Singer (8), pp. 172–4, 203; Bischof (1), Eng. ed., vol. 1, p. 345, 2nd Germ. ed., vol. 1, pp. 636ff. A Vesuvian sample analysed by M. H. Klaproth (1), vol. 2, pp. 67ff., in +1794 was found to be almost pure. The first account of natural volcanic sal ammoniac in Europe was given, it seems, by J. B. da Porta in +1589 (Partington (7), vol. 2, p. 21).

[e] See, for example, Abich (1) on Vesuvius, and Pough (1) on Parícutin in Mexico. Here 'the gas vents in the lava were lined with snowy crystals of ammonium chloride with an occasional seasoning of mustard-coloured iron ammonium chlorides'. A colour photograph is given in fig. 4.

[f] There is a special study of this problem by Ruska (39) well worth reading. As the Atlas of Chang Chhi-Yün (2), vol. 2, map 15, shows, the Thien Shan range is rich in coal deposits everywhere along its length, though especially to the north round the rim of the Dzungarian Basin. From Friederichsen's monograph on Thien Shan morphology (1) we know that there are igneous rocks in the mountains, and one dead volcano just north of Kashgar, but absolutely no volcanic activity. Since coal combustion loci would be likely to vary from time to time it is not surprising that modern travellers such as Regel (1) or v. Lecoq (1, 2) have failed to remark on them. Coal as the source was suggested long ago by Bischof (1), 2nd Germ. ed., vol. 1, pp. 636ff., and indeed by von Humboldt himself. As for ignition, lightning may have played a part as well as camp fires on outcrops, and geologists seem not to exclude the possibility of some kind of spontaneous combustion.

Still, the mountainous country north of Kucha (Khu-chhê[1]) in Chinese Turkestan, especially Pai-shan[2] or Huo-shan[3],[a] was famous century after century for its sal ammoniac caves.[b] So also was Pei-shan[4] mountain on the northern side of the Thien Shan south of Kuldja (I-ning[5]),[c] places on the southern side further east near Turfan,[d] and a field of 'solfataras' near Urumchi (Ti-hua[6]) five miles in circumference.[e] The Altai range to the north across Dzungaria is also said to have produced sal ammoniac,[f] and apparently Khotan (Ho-tien[7]) too, from the slopes of the Khun-lun Shan to the south.[g] It has been widely considered that all the regions of the earth were excelled by Central Asia for sal ammoniac deposits,[h] and this is not unlikely. But if Sinkiang was the main region there were lesser areas of importance both east and west of it.

In China proper, where almost no active volcanoes have existed in historical times,[i] vents in northern Shansi, according to von Humboldt, yielded much sal ammoniac;[j] while in the south of the province slowly-burning unworked coal-seams gave, he knew, another harvest of the salt.[k] Westward of Sinkiang, on the other hand, across

[a] We give the Chinese names with diffidence since we have no modern maps sufficiently detailed to mark the small places. But references to the neighbourhood of Kucha recur constantly in the Chinese sources, as we shall see; here we may mention only the geographical work *Ta Ming I Thung Chih*,[8] finished in +1461; cf. Bretschneider (2), vol. 2, p. 243. Other accounts are translated and considered in Liu Mao-Tsai (1), pp. 17–18, 160, 171, 238–9.

[b] See, e.g. von Humboldt (4), vol. 1, pp. 100ff.; Fuchs (1), pp. 271ff.; Ritter (1), vol. 2, pp. 333–7; J. Klaproth (6), vol. 2, pp. 357ff.; von Richthofen (2), vol. 1, p. 560; Timkovsky (1), vol. 1, pp. 389ff.; Keferstein (1), pp. 156–7, probably the authority for Porter Smith (1), p. 190.

[c] Cf. Ruska (39); Fuchs (1), pp. 271ff.

[d] Von Humboldt (4), vol. 1, pp. 118ff.; Fuchs, *op. et loc. cit.*; Ritter (1), vol. 2, p. 342. This was the subject of a correspondence between Rémusat (10) and L. Cordier (1) in 1824; the former translated a passage from the *Wakan Sanzai Zue* and believed that it proved the existence of active volcanoes in Sinkiang. Though this is unacceptable now, many Chinese sources justify the old Western statements about the production of the salt in this area, for example, *Hsin Wu Tai Shih*, ch. 74, p. 8*b*, *Sung Shih*, ch. 490, pp. 11*b*, 12*a*, *Ming Shih*, ch. 329, p. 19*b*, and *Ta Ming I Thung Chih*, cf. Bretschneider (2), vol. 2, p. 193. Individual localities with burning vents in the Turfan depression are Karakhojo (Huo-chou[9]) and Liu-chhêng[10] just east of Turfan city itself; *TMITC*, cf. Bretschneider, *loc. cit.*

[e] Fuchs (1), pp. 271ff.; Ritter (1), vol. 2 pp. 386–8. Validation comes from *Tu Shih Fang Yü Chi Yao*, ch. 65, p. 51*a*, *b* and *Ming Shih*, ch. 329, p. 19*b*, cf. Bretschneider (2), vol. 2, p. 190 (quoting Chang Khuang-Yeh's account, cf. p. 442 below).

[f] According to von Humboldt (4), vol. 1, pp. 120, 141. But there is little coal there.

[g] Von Humboldt (4), vol. 1, pp. 118ff. I could find no confirmation of this in Rémusat (7) however. Also there are no coal deposits near by. But the export is confirmed by *Sung Shih*, ch. 490, p. 7*a*, and *TMITC*, cf. Chang Hung-Chao (1), p. 221.

[h] Fuchs (1), pp. 271ff.; Bischof (1); both accepted the volcanic explanation, but the latter suspected coal-seams as well. The Uighur people were in general closely associated with the production, cf. *Hsin Wu Tai Shih*, ch. 74, p. 10*a*.

[i] See Anon. (145). The Khun-lun Shan in southern Sinkiang has long had a few active volcanoes.

[j] (4), vol. 1, p. 213, referring especially to Pao-tê[11] near Ho-chhü,[12] on the Yellow River just south of the Great Wall's crossing. There is much coal in this neighbourhood (Chang Chhi-Yün (2), vol. 5, map 17); and authentication of the report is forthcoming from *TSFY*, ch. 40, p. 19*b*.

[k] (4), vol. 1, p. 215. The same is true of Kansu, especially around Linthao, south of Lanchow, according to *TMITC* and *TSFY*, ch. 60, p. 4*a*. Working out along the Old Silk Road, at least three other places were associated with sal ammoniac, (*a*) Chhih-chin, between Chiayükuan and Yümen (cf. Vols. 1 and 4, pt. 3), *TMITC*, cf. Bretschneider (2), vol. 2, p. 214, (*b*) Anhsi city, junction for Tunhuang and Hami, cf. *Hsin Thang Shu*, ch. 40, p. 11*a*, (*c*) Tunhuang itself, the Shachow Exarchate), cf. *Sung Shih*, ch. 490, p. 23*b*. There is coal in these desert regions, but they could have been centres of transmission rather than of production.

[1] 庫車 [2] 白山 [3] 火山 [4] 北山 [5] 伊寧 [6] 烏化
[7] 和闐 [8] 大明一統志 [9] 火州 [10] 柳城 [11] 保德
[12] 河曲

the mountain barrier, the whole area between Samarqand in Sogdia and Tashkent in Ferghana has been said to possess sal ammoniac vents;[a] while the region of Bokhara was renowned for the product.[b] The most westerly region of all lies further to the south, in Persian Baluchistan, where the Damindān (now Tamindan) valley in the Kūh-i-Taftān range, a relatively inactive volcanic massif, produces sal ammoniac down to this day.[c] Perhaps this is the only place where the substance was almost certainly volcanic in origin rather than sedimentary. The general upshot is that Central Asia, broadly speaking, was the first source of ammonium chloride for the Arabic alchemists; but whether they obtained knowledge of it directly or from their Chinese contacts might depend in our estimation on how long the chemical had been known in China beforehand, and this must be our next enquiry.[d]

Broadly speaking, it had been familiar there for some three and a half centuries, if not indeed for as many as seven, before the Arabs came to know about its interesting properties. Under the name of *nao sha*[1] (with a very varying orthography)[e] it appears with certainty from about +500 onwards, and it will be worth while giving a brief account of this literature, but first let us look at what may be the oldest references.[f] In the *Tshan Thung Chhi*, datable at +142, we find the following admirable passage:[g]

If the chemical substances used are not of the right sorts, if their categories (*lei*[2]) are not compatible, and if the measuring out of the mixture (of reactants) is at fault, then the natural pattern (*kang chi*[3])[h] will be lost. In such a case, even if Huang Ti were to set up the furnace and Thai-I to work the fire, even if the Eight Adepts were to take charge of the process and the Prince of Huai-Nan to moderate and harmonise it;[i] however impassioned the prayers to the spirits, however splendid the alchemical temple—failure will be inevitable. It would be like mending a cauldron with glue, or bathing a boil with sal ammoniac, or driving away cold with ice, etc. etc.....

The difficulty here is that the word used is *lu*,[4] and while *lu sha*[5] has meant sal ammoniac in medieval and modern times,[j] it is hard to be sure that this held good in

[a] Ruska (39), but the evidence is not very sure. Still, tribute of the salt from Hei-lou,[6] a country believed to be Khorasan, is recorded in *Ming Shih*, ch. 332, p. 22*b*, for +1453; cf. Bretschneider (2), vol. 2, p. 272. The Buttam Mts. in eastern Ferghana are regarded as an important source (Barthold (2), p. 169).

[b] See Burnes (1), vol. 2, p. 166, 'found in its native state among the hills near Juzzak'. The sal ammoniac of Bokhara was first studied by Model in +1758, and M. H. Klaproth's analysis of it in +1794 showed it to be nearly pure.

[c] See the description of Skrine (1). The region is in Seistan just west of the modern Pakistan border and north of the city of Khāsh. Damindān as an earthly hell (like Gehenna, cf. pt. 2, p. 79 above) has had centuries of renown; for the Iranian *Bundahishn* (93.3) calls it a cavern perpetually smoking, a fountain of *dōzakh* (hell). The poem *Zarārusht-nāma* has: 'may he save me from *dōzakh* and the demons of Damindān' (Rosenberg ed., 1565). We are grateful to Sir Harold Bailey for these references.

[d] Something has already been said about sal ammoniac in Vol. 3, p. 654, but its importance for Arabic–Chinese relations compels us to look at it again here from a somewhat different angle.

[e] We write here one of the commonest, and perhaps the oldest, forms. See further on p. 445 below.

[f] If it was mentioned in the *Pên Ching* (i.e. the *Shen Nung Pên Tshao Ching*) we should have to place Chinese knowledge of it in the −2nd century. But none of the reconstructions of the text justify this. Only occasionally later pharmaceutical natural histories attribute *nao sha*[7] to the *Pên Ching* (e.g. the *Shao-Hsing Chiao-Ting Ching-Shih Chêng-Lei Pei-Chi Pên Tshao* of +1159, Okanishi Tameto ed. tshê 1, ch. 5A); this was presumably a mistake.

[g] Ch. 30, p. 26*b*, tr. auct., adjuv. Wu & Davis (1), p. 257.

[h] Cf. Vol. 2, pp. 554ff. and Needham (50).

[i] Cf. p. 168 above.

[j] Giles (2), dict.; RP126.

[1] 硇砂 [2] 類 [3] 綱紀 [4] 碌 [5] 碌砂 [6] 黑窶 [7] 硇砂

the +2nd century. But the ancient meaning of sand, shingle or pebbles would make no sense here, while sal ammoniac would, for its refrigerant effect[a] would soothe an inflammation without doing anything to cure it. Next, *nao sha*[1] is not in the *Pao Phu Tzu* book (*c.* +300) as we have it today, but Li Shih-Chen in the *Pên Tshao Kang Mu* gives a quotation which may indicate that the substance was known to Ko Hung, since he makes *Pao Phu Tzu* say that 'there are many ways of subduing sal ammoniac (*fu nao yao*[2])'.[b] Most of these involve calcium salts, so presumably the non-volatile calcium chloride was being made. Li Shih-Chen here also quotes Lei Hsiao[3] to the effect that 'when *nao*[1] meets with "red feathery crystalline mercury" (*chhih hsü hung*[4]) it stays in the metal reaction-vessel (*liu chin ting*[5])'. The reference is an unusual one, but probably to the sulphide or the oxide,[c] though the exact salt does not matter for the chlorides of mercury, copper and tin are evidently being formed. The most likely origin of this is the *Lei Kung Yao Tui*, which is datable perhaps about +450 but certainly not later than +560.

When we reach the lifetime of Thao Hung-Ching we find a man to whom sal ammoniac was almost certainly known. There is no reference to it in what is left of the *Pên Tshao Ching Chi Chu*, but a longish description in the *Ming I Pieh Lu* was carefully copied in most of the pharmaceutical natural histories from the *Hsin Hsiu Pên Tshao* (+659)[d] onwards, through the many different editions of the *Chêng Lei Pên Tshao*,[e] and into later compendia. This would point to +510 as a rather firm date. Soon the character and the definition of the substance makes appearance in the literary dictionaries, such as the *Yü Phien*[6] of +543[f] and the *Chhieh Yün*[7] of +601.[g] At the same time reports begin to accumulate of sal ammoniac brought in tribute and trade from Central Asia, the first perhaps that of the *Wei Shu*[8] in +554 telling of its coming from Sogdia,[h] though Thao Hung-Ching or his disciples had already said that it was produced by the western barbarians (Hsi Jung[9]). In +610 Phei Chü[10] told in his *Hsi Yü Thu Chi*[11] how White Mountain in Kucha (Chiu-tzhu,[12] Pai-shan[13]) was a great source of sal ammoniac,[i] and this was confirmed by the *Sui Shu* in +636,[j] adding, together with the *Pei Shih* (+670),[k] details about Sogdia. The eighth century brings many more references. Chhen Tshang-Chhi in his *Pên Tshao Shih I* (+725) tells us that the Hu[14] people call it *nêng sha*;[15] Wang Thao in the *Wai Thai Pi Yao* (+752) describes its pharmacological properties; Hsiao Ping[16] in *Ssu Shêng Pên Tshao*[17] (*c.* +775)

[a] Cf. p. 434.

[b] Ch. 11, (p. 59). It must always be remembered that Li Shih-Chen had many writings at his disposal not available to us now.

[c] There might be some connection here with the legendary Taoist Chhih Hsü Tzu (cf. *PPTJNP*, ch. 15, p. 11*b* and Kaltenmark (2), p. 135), but the simplest interpretation arises from the character of the salt.

[d] Ch. 5, p. 8*b*.

[e] E.g. *Ta-Kuan Pên Tshao*[18] (+1108), ch. 5, p. 7*a*, *b* (p. 111), and *Chêng Lei Pên Tshao* (+1249), ch. 5, (pp. 125.2, 126.1).

[f] Ch. 22, p. 15*a*.

[g] Judging from *Kuang Yün*[19] (Chiao Pên), ch. 2, p. 11*b*, and *Chi Yün*,[20] ch. 3, p. 16*a*.

[h] Ch. 102, p. 27*b*.

[i] See Chang Hung-Chao (*1*), p. 222.

[j] Ch. 83, pp. 8*b*, 11*a*.

[k] Ch. 97, p. 26*a*.

[1] [2] 伏硇藥 [3] 雷敩 [4] 赤鬚汞 [5] 留金鼎
[6] 玉篇 [7] 切韻 [8] 魏書 [9] 西戎 [10] 裴矩
[11] 西域圖記 [12] 龜茲 [13] 白山 [14] 胡 [15] 濃沙
[16] 蕭炳 [17] 四聲本草 [18] 大觀本草 [19] 廣韻 [20] 集韻

was perhaps the first to refer to the rich sal ammoniac production of Pei-thing (mod. Urumchi or Ti-hua[1]) in the Thien Shan, hence the name *pei-thing sha*;[2] and the *Tan Fang Ching Yuan* of about +780 seems to have been the earliest text to introduce the expressive name *chin tsei*,[3] the 'thief of the metals', alluding of course to the propensity of ammonium chloride for attacking them and forming their salts. All this was a long time before the discussions of *nūshādir* in the Jābirian corpus.

It may be good, however, to follow the Chinese evidence through the +9th and +10th centuries a short way. The former opens with the *Shih Yao Erh Ya* defining sal ammoniac with further names (+806);[a] and the latter with two texts of +918, in China the *Pao Tsang Lun* of Chhing Hsia Tzu (cf. pt. 3, p. 180), in Japan the *Honzō Wamyō*.[b] Tuku Thao discusses the salt in his *Tan Fang Chien Yuan* of *c.* +938, and in +972 the *Jih Hua Chu Chia Pên Tshao* brings a new name, *ti yen*,[4] 'barbarian salt';[c] the geographical work *Thai-Phing Huan Yü Chi* (+980 approximately) confirms the import from Sogdia and Kucha.[d] Lastly the *Hsin Wu Tai Shih* in +1070 emphasises the contribution of sal ammoniac from Turfan and the Uighurs,[e] while the *Pên Tshao Thu Ching* of +1061 adds another name, *chhi sha*[5] or 'pneumatic salt', clearly derived from the property of volatilising completely without decrepitation.[f] This is of course far from being the end of the Chinese literature on sal ammoniac, but we have said enough to prove the point that it flourished long before that of the Arabs, hence the strong probability that this was the line of transmission.

A rather impressive amount of knowledge about ammonium chloride accumulated in China during those early centuries. The endothermic effect occurring on solution seems to have been known very early,[g] and also the formation of ammonium carbonate by exchange with lime salts. The reduction of oxides on metal surfaces to the chlorides and the consequent cleaning effect was seized upon by the metal-workers, and as an outstanding flux ammonium chloride 'can be used', says the *Ming I Pieh Lu* text, 'in soldering (*kho wei han*[6])'. This function is particularly prominent in the many processes described in the *Thai-Chhing Tan Ching Yao Chüeh* of Sun Ssu-Mo,[h] datable about +640. But the fact that under suitable conditions ammonium chloride will attack all the base metals and silver much more strongly was also known to Thao Hung-Ching or his followers: 'it softens gold and silver (*jou chin yin*[7])' says the *Ming I Pieh Lu*;[i] 'it can dissolve the five metals and the eight minerals, and it rots the guts of man', says the *Yao Hsing Lun* some fifty years later. Hence the name 'thief of the five metals (*wu chin tsei*[8])' found in the *Pao Tsang Lun*. But both this book and another

[a] Ch. 1, p. 2*a*. E.g. *niu sha*,[9] perhaps by phonetic corruption. In some, the adjective 'yellow' occurs, probably because the salt was sometimes mixed with the mustard-yellow iron ammonium chlorides.

[b] Ch. 1, p. 11*a*. As usual, several different ways of writing *nao* are given.

[c] Cit. *CLPT*, *loc. cit.*

[d] Ch. 183, p. 3*b* and ch. 181, p. 5*b*.

[e] Ch. 74, pp. 8*b*, 10*a*.

[f] *CLPT*, *loc. cit.*, *PTKM*, ch. 11, (p. 58).

[g] Cf. pp. 434ff. above.

[h] Pp. 20*b*, 21*a*, *b*, 23*b*, 24*a*, *b*, 25*a*, 26*b*, Sivin (1) tr., pp. 194, 196–7, 201, 203–4, 207–8, 283. *Huang nao sha* (yellow sal ammoniac) comes on p. 22*b* (Sivin tr., pp. 198, cf. 279); if this was not a cover-name for sulphur (as in *SYEY*) it would be the mixed iron ammonium chlorides.

[i] In *HHPT* and *CLPT*, *locc. citt.* So also the *Yao Hsing Lun*, preserved by the *Chia-Yu Pên Tshao* of +1057.

[1] 廸化 [2] 北庭砂 [3] 金賊 [4] 狄鹽 [5] 氣砂 [6] 可爲銲
[7] 柔金銀 [8] 五金賊 [9] 狃砂

+10th-century work, Tuku Thao's *Tan Fang Ching Yuan*, warn how poisonous the metal chlorides are if taken internally; the resulting powders (*hui shuang*[1]) lead to grave illness, with boils and ulcers as in elixir poisoning.[a] By +1116 the *Pên Tshao Yen I* tells of a kind of cupellation process for distinguishing between true and false gold and silver: 'these can be detected using sal ammoniac, for if thrown in when melted, the false metal is all dissolved and dissipated (*wei wu chin hsiao san*[2])' as, of course, the chlorides.[b] Much is said in the literature about purification of the salt, generally solution and filtration or decantation (*shui fei*[3]) followed by three successive sublimations (*fei*[4]). As for its medical uses, the diaphoretic action and the stimulation of the central nervous system are referred to, but the most striking effect noted was expectorant, the relief of coughing in bronchial and other catarrhs by the secretion of thinner and less tenacious mucus. The *Wai Thai Pi Yao* even applies this to the removal of fish-bones lodged in the throat. Otherwise we hear of the healing of scorpion stings[c] and the curing of certain eye-diseases by ammoniacal vapours,[d] while one strange relation, that of Su Sung and his collaborators in the mid +11th century, avers that some of the men of Central Asia use sal ammoniac for the pickling or curing of meat.[e] Perhaps they did.

And so we come back to the Chinese accounts of the way in which these Turkic and Tartar peoples collected the salt. The oldest dates from between +981 and +984, during which years a Chinese envoy, Chang Khuang-Yeh,[5] was in those parts. After his return he wrote an account of his travels entitled *Hsing Chhêng Chi*,[6] in which the following words occur:[f]

In the Pei-thing Shan[7] (mountains) north of the prince's palace (i.e. near Urumchi) sal ammoniac (*nao sha*[8, 9]) is produced. There are places in these hills where smoke and vapours sometimes issue forth even on the clearest days. In the evening light, the flames look like torches burning, and shed a ruddy glow even on birds and rats. Those who collect (this salt round the openings) put on wooden shoes to gather it, for otherwise the soles of their feet would be scorched...

Another account of what must have been the burning coal-seams near Urumchi is found in the *Hsi Yü Chiu Wên*[10],[g] probably from the *Hsi Yü Wên Chien Lu*[11] of +1777.

Near Urumchi thirty li west of Pu-la-kho-thai, there's a place more than 100 li around with ashy dust that flies in the air. At the centre there are flames springing up. If you throw in a stone you get a sudden issue of black smoke which takes a long time to die down. In winter

[a] See on this subject Sect. 45 below, and meanwhile Ho Ping-Yü & Needham (4).
[b] On cupellation methods see pt. 2, pp. 36 ff. above.
[c] Cf. Wang Chia-Yin (1), p. 54. [d] This is the *Pên Tshao Yen I* of Khou Tsung-Shih again.
[e] Could there have been a confusion here with saltpetre or even with borax?
[f] This passage was very often reproduced, as for example in *Hsi Chhi Tshung Hua* (*c.* +1150), ch. 2, p. 34*b*, in *Sung Shih*, ch. 490, pp. 11*b*, 12*a*, and in *PTKM*, ch. 11, (p. 58). Tr. auct. It was known to Ritter (1), vol. 2, p. 342, and to Schott (2). It goes on to speak about a bluish-green mud which comes out with the salt, and itself turns to a granular salt, but this is probably only a reference to the colour of the surrounding earth. The local people use the sal ammoniac for working leather.
[g] P. 14*a* (p. 227), in *Chou Chhê So Chih* coll., tr. auct. This passage was known to von Humboldt (4), vol. 1, pp. 100ff.

[1] 灰霜 [2] 僞物盡消散 [3] 水飛 [4] 飛 [5] 張匡鄴
[6] 行程記 [7] 北庭山 [8] 碙砂 [9] 磏砂 [10] 西域書聞
[11] 西域聞見錄

when the snow can lie ten feet deep in the neighbourhood, only this place has no snow. They call it Huo-yen[1] (Blazefield).[a] Even the birds don't dare to fly over it.

In a separate place, the same geographer, the 71-year old Mr Chhun-Yuan,[2] spoke of the sal ammoniac industry in the hills north of Kucha:[b]

Nao sha[3] is produced in the mountains of that name which lie to the north of Kucha city. In spring, summer and autumn, the many caves there are full of fire. From a distance at night they look like thousands of lamps, so bright that it is hard to go near them. In winter here the cold is extreme, sometimes with heavy snow, and at this season the fires die down. Then the local people go there to collect the sal ammoniac, entering the caves naked (because of the heat). The *nao sha* accumulates inside the caves like stalactite drippings.

The fullest description occurs very late, from the last decade of the + 18th century. In the *Chu Yeh Thing Tsa Chi*[4] (Miscellaneous Records of the Bamboo-Leaf Pavilion), Yao Yuan-Chih[5] wrote as follows:[c]

According to Hsü Hsing-Po,[6] the mountains where sal ammoniac is produced near Kucha have no special name now but were called in Thang times the 'Great Magpie Mountains'. They have extremely hot places which look from afar at night like so many lanterns. No one dares go near them in spring or summer. Even in very cold weather, the people take off their ordinary clothes, and wear leather bags with holes through which they can see. They enter the caves to dig up (the sal ammoniac), but come out after one or two hours and could not possibly stay longer than three; even then the leather bag is scorching hot. The *nao sha* sparkles on the ground with a reddish glow; they collect it and bring it out mixed with lumps of rock (on which it was deposited), and for every dozen pounds of rock spoil they do not get more than one or two tenths of an ounce of the salt. The product has to be kept in earthenware jars holding more than a picul, with their mouths tightly sealed, yet not full, and kept cool, otherwise it will all disappear. It will also disappear if subjected to wind, wetness or damp, leaving only an unchanging white residue of granular appearance. Though this is the least valuable part, it is probably the only kind which finds its way to the central provinces of China.[d] I suspect that these fire-mountains of Kucha are only one area of a whole ancient region of like activity.

Similar descriptions are to be found in Arabic authors, also from the + 10th century onwards.[e]

Much—perhaps too much—has now been said of the diffusion of the wonderful new volatile salt in East and West, but the fascinating problem of the name is still unanswered: what has *nao sha* got to do with *nūshādir* and *nūshādur*? Stapleton, rushing in where angels feared to tread, affirmed that the oldest term was the Chinese

[a] Cf. *TSFYCY*, ch. 65, p. 51*a*, *b*.

[b] *Hsi Yü Wên Chien Lu*, in *Hsi Yü Chiu Wên*, p. 20*b* (p. 240), in *Chou Chhê So Chih* coll., tr. auct., corr. Vol. 3, p. 655. The passage was known to many earlier Western writers, notably von Richthofen, (2), vol. 1, p. 560; Ritter (1), vol. 2, pp. 333–7; von Humboldt (4), vol. 1, pp. 100ff.; Timkovsky (1), vol. 1, pp. 389ff.

[c] Cit. Chang Hung-Chao (1), p. 222, tr. auct., corr. Vol. 3, p. 655.

[d] This was much too pessimistic, for when Hanbury (6) analysed several samples sent from Peking in 1865 by William Lockhart, he found that two out of three were rather pure.

[e] See Ruska (39); Ouseley (1), p. 233; de Meynard & de Courteille (1), vol. 1, p. 347.

[1] 火鼓 [2] 椿園七十一老人 [3] 硇砂 [4] 竹葉亭雜記 [5] 姚元之
[6] 徐星伯

and that it had given rise to a Persian form with the ending *dārū*, drug or medicine.[a] Laufer, a dozen years later, dismissed this suggestion as that of a chemist, not a philologist, and felt compelled to seek the original name in Sogdia (one of the homes of the product), since he regarded the Chinese characters as phonetic transcriptions of some foreign word and not an indigenous coinage.[b] He therefore suggested Sogdian forms such as **navša* or **nafša*. Other scholars since then have proposed various alternatives, such as Schafer's Iranian **njau-ṣa*,[c] but all of them remain purely conjectural. However, there is a real word in Sogdian, *nwš' 'tr* (= **naušātur*), which occurs, in the only instance so far found, as the name of one of the constituents in a magical-pharmaceutical recipe dating from about +600. Since it is described as broken or pounded, it is presumably our salt.[d] In Iranian the word is interpreted as derived from *anōsh*, immortal, and *ātur*, fire; but this could be a 'popular' explanation of an essentially foreign term.[e]

Although Laufer did not say it in so many words, he for his part was clearly suspicious of the autochthonous origin of *nao sha* as a name because there were so many ways of writing it. And indeed it is true that the orthography of the phrase shows a singularly wide range of alternatives. One must admit however that there are other instances of a similar phenomenon, such as the famous hundred ways of writing the character *shou*,[1] longevity, for which it would be quixotic to claim an implication of foreignness.[f] Establishing the facts here is distinctly difficult because successive reprintings may have followed the fashion of their time rather than the script of the original text, and quotations in later books cannot be taken as firm evidence for the original way of writing; yet we can also rely to some extent on the deeply-rooted conservatism of the Chinese literati. Inscriptions would of course be the best evidence, but as they do not often talk about drugs and chemicals such research would be very difficult, perhaps impossible, and in any case has not yet been done. Therefore what we shall say here is subject to all necessary reserves. One further point at the outset—there is no semantic distinction between the two forms of *sha*,[2,3] 'sand' or granular crystalline chemical; they were used in *nao sha* indiscriminately.

With one important exception to which we shall return in a moment, there were in pre-Thang times four different ways of writing the character for sal ammoniac, *nao*.[g]

[a] (1), pp. 40–1. Arabic etymologists, said Stapleton, had suggested *nūsh dārū*, 'life-giving medicine' (not a bad name for smelling-salts), but he preferred to see *nao sha* as the origin of the *n-sh* part of the word. Earlier de Mély (6), p. 339, (1), p. li, had had the same thought, but could present no theory about the last syllable.

[b] (1), pp. 503 ff. [c] (13), p. 218.

[d] Paris Sogd. text 3.173, tr. Benveniste (2). We owe our knowledge of this to the kindness of Sir Harold Bailey, who advised us on the probable date. The recipe also includes camphor, sandal-wood, costus and musk, so it was probably fumigatory in nature.

[e] Bailey, priv. comm. Ruska (13), p. 7, thought of *nōsh aḍar*, 'drinking fire', as just a possibility, but the same impression would apply.

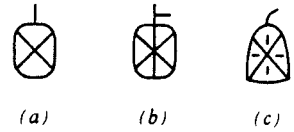
[f] Doubtless this abundance derived from the caprices of decorative artists, yet there are very many characters which can quite correctly be written in two or three or even up to a dozen different ways. One of the real difficulties for beginners in classical Chinese is to know when one or two strokes 'make all the difference', and when they do not.

[g] *Nao*[4,5,6,7]. The first of these is regarded as the primary form. The second is supposed to derive from Rad. no. 122, *wang*,[8] net. The phonetic in the third is *kang*,[9] a ridge, and would be expected to

[1] 壽 [2] 砂 [3] 沙 [4] 硇 [5] 硇 [6] 磞 [7] 硇 [8] 罔 [9] 岡

During the Thang period (+7th to +10th centuries) nine more were added, some purely phonetic with no visually relevant component in the character at all.[a] In Wu Tai and Sung times we find seven more;[b] and finally by the +15th century one last one, generally admitted to be 'incorrect', brought up the rear.[c] No wonder that Laufer, sensing this multitude of forms, believed that the original name must have been a foreign one, and that the Chinese could never make up their minds how to write it.

But all those who have worried over this problem hitherto have reckoned without the form *lu sha*[1] which we met with in the oldest reference of all, the *Tshan Thung Chhi*,[d] and this can no longer be overlooked. It may well be correct there, and no corruption. Yet the considered opinion of Chang Hung-Chao[e] was that all the forms of *nao* derived from *nao*.[2] Here the right-hand phonetic component was an old word pronounced *hsin*, and defined in the *Shuo Wên* (+121)[f] as the fontanelles of the skull where the cranial bones meet.[g] The ancient form of the character given by Hsü Shen here is shown in (*a*) in the inset cut. Chang suggested that this character was borrowed as a substitute for *nao*,[3,4] the brain, to give the sound in *nao*.[5] He did not say why this substitution took place, but one could imagine without difficulty that the more complex phonetic was already occupied, in use for agate, *ma nao*.[6,7] Nor did he say why some connection with the brain was wanted, but here Li Shih-Chen comes to the


(*a*) (*b*) (*c*)

lead to the pronunciation *kang* or *khang*, but in all these cases where guidance is given by commentaries they indicate the sound *nao*. So also for the last, though derived presumably from *ka*[8] or *ko*[8], to beg.

[a] Nao.[9, 10, 11, 12, 13, 14, 15, 16, 17] The first four of these were close to the primary form. The fifth, which was favoured in Japan, has special significance for the argument we are developing. The expected pronunciation of the sixth and seventh would be *nêng* or *nung*, but *nao* is always indicated; as we noted on p. 440 above, one of our medieval authorities, Chhen Tshang-Chhi in +725, regarded this as an attempt to transliterate some name of *hu*[18] (Persian, Turkic, Sogdian) linguistic origin. *Niu*, the eighth, anciently meant a small gong, and *niu*, the ninth, perverse or evil; though here pronounced *nao* they had no visible connection with minerals or even water.

[b] *Nao.*[19, 20, 21, 22, 23, 24, 25] The first three of these were fairly close to the primary form, and the fourth not very far away from it, though obviously borrowed from the old word for a vent, flue or impluvium, *chhuang*[26] (cf. Vol. 4, pt. 3, p. 121). The fifth and sixth come again from the *wang*[27] radical (122), while the seventh brought in yet another theme, that of *chiung*,[28] waste border land (Rad. no. 13), generating *kung*,[29] the bright light on it.

[c] *Nao.*[30] This was explicitly rejected in a note at the end of the entry for sal ammoniac in the later editions of *PTKM*, ch. 11, (p. 61).

[d] And as mentioned in Vol. 3, p. 654, we have checked this in the *Tao Tsang* text as well as several other editions.

[e] (*1*), pp. 221ff.; and the Morohashi dict. too, viii, 359.

[f] P. 216.2.

[g] This character has never died out, though its pronunciation has changed slightly, and one finds it in the current colloquial expressions for fontanelles, *hsing mên*,[31] and skull-cap, *hsing mao*.[32] In the course of time it came to be written in a more complicated way as *hsing*[33] or *hsing*,[34] and this assimilated naturally to the *tshung*[35] phonetic (meaning 'hurried') as *hsing*.[36] In this form we find it in the title of an interesting anatomical-medical tractate on the fontanelles dating from the end of the Thang or the beginning of the Sung, the *Lu Hsing Ching*.[37]

[1] 碻砂 [2] 硇 [3] 㽲 [4] 腦 [5] 硇 [6] 瑪瑙 [7] 瑪瑙
[8] 匈 [9] 砸 [10] 汹 [11] 硇 [12] 洶 [13] 碙 [14] 碾
[15] 濃 [16] 鐃 [17] 狃 [18] 胡 [19] 肉 [20] 硇 [21] 洶
[22] 碙 [23] 㽲 [24] 碙 [25] 碙 [26] 囪 [27] 网 [28] 冂
[29] 冏 [30] 硇 [31] 囟門 [32] 囟帽 [33] 顖 [34] 顖 [35] 囪
[36] 顱 [37] 顱顖經

rescue, saying that if much sal ammoniac is taken the brain is disturbed or irritated, hence the name.[a] This might be dismissed as a late 'fanciful etymology', but again it might not, for the effect of this and other simple salts upon the blood alkalinity and hence upon mental processes, is no fable.[b] Furthermore, what Chang Hung-Chao did not notice was that the *Shuo Wên* goes on to say that the old way of writing *hsin*[1] was *hsin*,[2] i.e. something extremely similar to *lu*.[3]

Chang was inclined to write off all instances of the use of this last word as corruptions of *nao*[4] but he had overlooked the appearance of it in the *Tshan Thung Chhi*. Although lexicographers in general tended to define it as just sand or gravel as such (without specifying what kind of sand),[c] it keeps on cropping up in situations where it can only mean sal ammoniac. These texts differ widely in date; one might mention as examples the *Thai-Phing Huan Yü Chi* of *c.* +980 (cf. p. 441 above) and the *Chu Yeh Thing Tsa Chi* at the end of the +18th century.[d] If we look into the origins of *lu*[5] itself, the *Shuo Wên* tells us that it meant 'salty soils in the West',[e] an interesting definition in the present context; adding the seal form shown in (*b*) in the inset cut. The form of the character in Chou inscriptions is simply as we see in (*c*) of the inset cut,[f] an interesting graph because it does not have the 'signal' at the top which characterises the *lu*[5] (salt) radical (no. 198) and connects it with the *pu*[6] (divination) radical (no. 25). Then in the +16th century Wei Hsiao gave, as another ancient alternative, the form *lu*,[7] with the dots but without the 'signal'.[g] And finally Tsêng Hsi-Shu also says[h] that in the Shih Chou[8] script[i] the character was simplified in yet

[a] *PTKM*, ch. 11, (p. 58): *Nao sha hsing tu, fu chih shih jen nao luan, ku yüeh nao sha.*[9] The second of these three *nao* is obviously intended to be read *nao*[10] (= *nao*[11]), disturbed, or more likely *nao*,[12] the brain, itself.

[b] The late J. B. S. Haldane, my predecessor as Sir Wm. Dunn Reader in Biochemistry at Cambridge, made many experiments of this kind on himself in his classical studies of induced acidosis between 1920 and 1930. I remember once meeting him in a befuddled state on the staircase of the Institute, and on offering to help was told: 'I shall be all right in an hour or two; at present I'm about 80% sodium haldanate.' Haldane began by breathing high CO_2 concentrations and ingesting sodium bicarbonate; see Davies, Haldane & Kennaway (1). Apart from many results of physiological interest, he devoted a special paper (3) to the mild but peculiar hallucinations resulting. He then went on to take as much as 55 gms. of ammonium chloride at one time, obtaining a marked and prolonged acidosis also associated with neuropsychological abnormalities; see Haldane (2); Baird, Douglas, Haldane & Priestley (1); Haldane, Wigglesworth & Woodrow (1, 2); Haldane, Linder, Hilton & Fraser (1). The condition was regularly termed an 'intoxication', accompanied by 'air hunger' and physical exhaustion. Ammonium chloride is still used, though not on Haldane's heroic scale, for the purpose of producing experimental acidosis, as for example when it is desired to establish a low urinary pH in studying the excretion of a basic drug; or clinically to sterilise the urinary tract after a urethral infection. We are grateful to another former collaborator of J. B. S. Haldane's, Dr Martin Case, for some of this information.

[c] E.g. the +11th-century *Chi Yün*, ch. 5, p. 18*b*. Cf. Morohashi dict., viii, 397.

[d] Both Giles (2) in his dictionary and Read & Pak (1) in their glossary admit it as in wide nineteenth-century use.

[e] P. 247.1, *hsi fang hsien ti yeh.*[13] The word ultimately came to mean rock-salt.

[f] Cf. K 71*b*, and Tsêng Hsi-Shu (1), Hai chi, hsia, p. 17*a*.

[g] In the *Liu Shu Ching Yün*[14] (Collected Essentials of the Six Scripts) by Wei Hsiao[15] (+1483 to +1543). See Tsêng Hsi-Shu, *loc. cit.*

[h] (1), *loc. cit.*

[i] Also of the Chou, supposedly early in the Chhun Chhiu period. On Shih Chou and his *Phien*, see Vol. 6, Sect. 38.

[1] 㘝 [2] 㘝 [3] 磏 [4] 硇 [5] 鹵 [6] 卜
[7] 㘝 [8] 史籀 [9] 硇砂性毒服之使人硇亂故曰硇砂 [10] 撓
[11] 撓 [12] 腦 [13] 西方鹹地也 [14] 六書精蘊 [15] 魏校

another way, with all the dots left out, i.e. *lu*,[1] approximating again to *hsin*.[2] Thus in the end there was very little differentiation between the *lu* derivatives and the *hsin* (and *nao*) derivatives. There is no reason to talk of corruption; people borrowed because they had a need to do so.

What does all this add up to? Simply the suggestion that ammonium chloride was after all first known and studied in China before the end of the Han. One remembers the evidence that the north-western provinces produced it; it did not have to be imported from abroad. If so, and if Ko Hung about +300 also spoke of *lu*[3] rather than *nao*,[4] perhaps that was the original technical term. It would not have been defined with modern precision. But this very special medicinal salty 'sand', which could affect men's minds like strong drink, needed to be distinguished from sand in general, so at least by the time of Thao Hung-Ching (*c.* +500) a graph very similar to it but without the dots was borrowed from a word meaning the brain-cover. This brought with it the sound of the character for brain as such (*nao*), which itself embodied graphically the essential square component with its diagonal cross.[a] One could say that this was punning, but that would be neither bar nor criticism, for puns have often played a part in Chinese ideographic development. Later on, as the knowledge of the salt spread westwards, it would have been very natural for the Sogdians to speak of *naušātur* by the +7th century, though whether their penultimate consonant could have derived from *tu*[5] or *thu*,[6,7] or some other Chinese word, we could not presume to say.[b] Thus an attentive study of the nomenclature and its history, so far as we can make it on the evidence we have, justifies Stapleton rather than Laufer and points to China as the true native land of sal ammoniac.

From Sogdian to Arabic and to *nūshādur* was no great step, and little need be said about it,[c] but we can hardly escape without a final word on the transference of the name and the knowledge to the European West. Into the languages of that region *nūshādur* entered but did not permanently stay, being soon replaced by sal ammoniac, a reincarnation of the ancient 'ammoniac salt' with a totally different meaning. Ruska saw this development as having taken place in two stages.[d] First, when Bar Bahlul was writing his Syriac encyclopaedia about +980, his Nestorian medical colleagues were so convinced of the greatness of Galen and Dioscorides that they imagined that all the drugs of Persia must have been known to the Greeks, so they looked for equivalents and equations and naturally found them. That was why Bar Bahlul wrote: '*Armōnīqōn*, i.e. the salt *anūshādōr* or *nūshādīr*', as well as two other similar entries. After that the way was open for the Latin translators of the +12th century to replace words like *almizadir*[e] or *alnuzadir*, which at first they tended to use, by sal ammoniacum.[f] Ruska thought that it was probably the Jewish physicians, as

[a] A certain abbreviation or simplification took place at the same time.
[b] Poison (active principle), earth, and 'to smear on' or 'bathe in' respectively.
[c] Late Skr. *navasara* or *navasadara* show the spread into Indian culture.
[d] (13), pp. 18ff.
[e] This occurs in the *De Compositione Alchemiae* (+12th century); cf. p. 403.
[f] See e.g. the *Liber Sacerdotum*, a translation from the Arabic done in the late +12th or early +13th century, Berthelot (10), pp. 81ff., 179ff., tr. 187ff., 209ff.; 'Almiçadir, id est sal ammoniacum', p. 217.

[1] 鹵 [2] 囟 [3] 碵 [4] 硇 [5] 毒 [6] 土 [7] 塗

much at home in Spain as in Syria, who affirmed and authorised this change of terminology. The Byzantine Greeks adapted another word, *tzaparicon* (τζαπαρικόν),[a] but it had no future because the further development of alchemy lay in Latin rather than Greek; and even in Russian, *nashatyr*, taken directly from Arabic sources, remained permanently in possession. Thus by the time of the Geberian Latin writings[b] the term sal ammoniac had become fully accepted in its modern meaning; and with a mention of the shortened form, *salmiak*, current in German from *c.* + 1600 onwards, we can conclude the whole story.[c] What it all seems to show is that the knowledge of this volatile salt with striking chemical properties, capable of liberating a rather alkaline gas (ammonia) and a strong acid (hydrochloric),[d] started in China about the beginning of the + 1st millennium, then spread across the length and breadth of the Old World, reaching Western Asia by the + 9th century and the Latin West by the + 12th. If we have expatiated upon it rather fully that is because its peregrinations constitute a model for those of the elixir idea itself.

If time, space and patience permitted, much more could be said about the material influences of China on the alchemy and natural history of the Arabs, but we must confine ourselves to a few particularly interesting examples. An early source of value is the *Kitāb al-Aḥjār* or Lapidary, falsely ascribed to Aristotle, and done into Arabic from the Syriac some time during the first few decades of the + 9th century by Luka

Cf. von Lippmann (1), p. 484. The same form occurs in the translation from the Jābirian Corpus, *Liber Septuaginta*, cf. Berthelot (10), p. 327. But a whole chapter is devoted to sal armoniacus in *De Anima in Arte Alchemiae* (cf. p. 403 above).

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[a] This was derived from one of the Arabic cover-names (Ruska (13), p. 6). For examples, see *Corp. Alchem. Gr.* VI, xvi, 11, a fragment of Cosmas, + 11th century; also V, i, 5, another late text; also the + 13th-century Mount Athos icon-painters' treatise; Partington (18). In other similar texts, however, *halas ammōniacon* (ἅλας ἀμμωνιακόν) seems to have its new meaning of sal ammoniac, not its old one (*Corp.* V, xxi, 1). Von Lippmann (1) was self-contradictory here; at one moment he said that 'the Byzantine Greeks were hardly acquainted with sal ammoniac before the + 13th century' (p. 107), but at another he opined that 'the Arabs got to know of sal ammoniac from the late Alexandrian chemists' (pp. 392, 398). The former dating was too late, the latter statement (perhaps due to a mistake of al-Jāḥiẓ) was the fallacy of Bar Bahlul, the idea that the Greeks knew everything.

[b] *De Invent. Veritatis* and *De Investigat. Perfectionis*, cf. p. 391 above.

[c] On the developments following, reference may again be made to Multhauf (5), pp. 333 ff., (8). In tribute to friends who have passed away I should like to mention here a long and instructive correspondence on the sal ammoniac problem which took place between Dr H. E. Stapleton, Dr Dorothea Singer, Prof. H. H. Dubs, Prof. Gustav Haloun and myself in 1950–1.

[d] Sal ammoniac deserves truly to be regarded as one of those 'seminal' substances or 'limiting factors' on which the most fundamental chemical advances depended, alongside saltpetre (potassium nitrate) and copperas (green vitriol, ferrous sulphate), which we discussed in this light at an earlier place (pp. 195 ff.). For the + 12th-century *De Aluminibus et Salibus* (chs. 11, 81), deriving from al-Rāzī (cf. Ruska, 21), used sal ammoniac to prepare corrosive sublimate from mercury (cf. pt. 3, pp. 123 ff. above). 'This preparation', wrote Multhauf (5), pp. 162–3, 'marks the beginning of the most significant period in the history of the science of matter between ancient times and the organisation of chemistry in the + 18th century.' For thus began 'the systematic pursuit of synthetic chemistry', the chloride of mercury being a reactive substance capable of chlorinating other substances, as the writer of the *De Aluminibus* knew. And in the following (+ 13th) century, when the Geberian practitioners added sal ammoniac to the mixture of saltpetre, alum and copperas which gave them on distillation nitric acid, they got the strongest acid of all, *aqua regia* (Sherwood Taylor (4), pp. 90–1). This making of nitric and hydrochloric acids could thus be seen as a development from the earlier chlorination of mercury—and all depended on Thao Hung-Ching's *nao sha* and *hsiao shih*.

bar Serapion.[a] This was afterwards the basis for an enlargement made by Zakarīyā' ibn Maḥmūd al-Qazwīnī and incorporated in his 'Cosmography' about +1275.[b] The original writer seems to have been some Syrian who knew both the Greek and the Eastern traditional lore about gems and minerals but depended much more on the latter than on Theophrastus; he used many Persian words, and the places of origin of his stones were very often Persia, Khorasan, India or China. For example, a kind of sand called *sunbādhaj*, which could be used for polishing, and if ground very fine as tooth-powder, came from the islands in the Chinese seas.[c] Similarly China was known as one of the principal sources of onyx (*jaz'*),[d] a precious stone equated by Laufer with caerulean jade (*pi yü*[1]).[e] But the most amusing item—almost too amusing —was the Chinese stone *al-bāhit*, which drove people mad when they saw it, and made them laugh themselves to death.[f] In some versions this was connected with the Alexander-Romance,[g] because it was said that the world-conqueror built a city wall of it without any city inside, so that all those who approached, being attracted as if by a magnet for men, climbed up, fell in laughing and were never seen again.[h] There must have been a lot of interest in the laughing-mad stone, for very soon after Pseudo-Aristotle a whole tractate in the Jābirian Corpus, the *Kitāb al-Bāhit* (Book of the Surprising) was consecrated to it.[i] A century later it was prominent again in the *Kitāb al-Sumūm* (Book of Poisons) attributed to Ibn al-Waḥshīya,[j] and we find it too in the Latin *Picatrix* (cf. pp. 313, 427–8 above),[k] the Arabic source of which would have been finished by +1056. It may well be that something very solid lay behind these mythological ghosts and shadows, for there was indeed in China a hallucinogenic mushroom which leads to uncontrollable laughter and may well kill in excessive doses.[l] But one could hardly say the same for another queer stone that came from China, *khuṣyat iblīs*, 'devil's testicles', good though they were said to be for defending travellers against all danger of brigands.[m]

The shape of these things might suggest that they were of fossil origin. Sometimes

[a] I.e. Lūqā ibn Sarāfyūn, cf. Mieli (1), 2nd ed., pp. 69, 71. The best study and translation of this work is by Ruska (19), who thought (p. 46) that it might have been drafted by Ḥunain ibn Isḥāq (d. +877) himself.

[b] This was studied and translated by Ruska (24).

[c] Ruska (19), p. 150, (24), p. 26.

[d] Ruska (19), p. 145, (24), p. 12.

[e] (1), p. 554, (13), p. 52.

[f] Ruska (19), pp. 8ff., (24); Kraus (3), p. 74.

[g] Cf. Vol. 4, pt. 3, pp. 56–7, 674, cf. pt. 2, p. 572.

[h] This is most fully developed by al-Qazwīnī, who has two entries for the stone. He also has a lot to say about magnets (*lāqiṭ*) for almost everything—gold, silver, lead, hair, wool, nails, bones, cotton, whetstone and brass; Ruska (19), pp. 16, 155ff. This may possibly have been a Chinese idea (see Vol. 4, pt. 1, p. 235), but so far we have not encountered any text which would support that.

[i] Kr 118, see Kraus (2), p. 39, (3), pp. 74–5. The *bāhit* stone is also discussed in the *Kitāb al-Khawāṣṣ al-Kabīr* (Greater Book of Properties), Kr 1900.

[j] Levey (6), pp. 11, 27, cf. (8). There is always uncertainty about the authenticity of this writer; according to Kraus (2), p. lix, the book should be placed about +980 rather than +930, and attributed to Ibn Aḥmad al-Zayyāt.

[k] Ritter & Plessner (1), vol. 2, p. 405.

[l] Cf. pt. 2, p. 121 above, and more fully in Sect. 45 below. *Chün Phu*, p. 3*a*.

[m] See Ruska (24), p. 21; Laufer (1), p. 554.

[1] 碧玉

other accounts in these books put us in mind of Chinese originals, though the country the stones come from is not necessarily named. For example:[a]

Mirād. A wonderful stone. Aristotle says: 'It is found in the lands of the south. If it is taken from the earth when the sun is in the south its nature is hot and dry, but if the sun is in the north then its nature is cold and wet. It is red in colour in the former case, but green in the latter.' In Greek it is called *sarūṭāṭīs*, which is to say 'flying stone'; and that is because this stone is formed in the air from fine dust or mist that rises from the earth, stirred up by the wind, so that it is driven here and there, going round in circles. In the air its colour is greenish-black, like the colour of indigo used by the dyers. If the wind blows harder, the movements of these stones become wilder, but when the sun goes down it stops so that many of them fall to the ground and can be picked up; thus they rise into the air and fall again. If anyone takes one of these stones about with him, the *shaiṭān* (satans, fallen angels) follow him and teach him everything that he wishes to know, if he allows himself to be taught by them.

This reminds one of nothing so much as the Chinese 'stone-swallows' story, i.e. the fossil brachiopods which we met with in an earlier volume,[b] their flight in the air disproved by the sceptical scholar Tu Wan in +1133. Elixir stones turning copper or mercury to silver, and silver to gold, are not unexpected in these books,[c] but it is curious to find that *shādanaj* (haematite) comes in two sorts, male and female (Yang and Yin), presumably the red and the brown.[d]

Chinese kaolin was also known to the Arabs, imported and used by them, not for the making of porcelain, which nobody outside China could accomplish until the +18th century, but for medicinal purposes, since it acts as a valuable antacid and adsorbent in the gastro-intestinal tract, besides coating the stomach wall and preventing ulceration.[e] Hence it is interesting that the *Fihrist* lists a book, presumably of the +9th or the early +10th century, entitled *Kitāb al-Suyūb wa'l-Ma'jūnāt wa'l-Ghaḍār al-Ṣīnī* (Book on Ores, Electuaries and Chinese Clay).[f] Its author was Ja'far ibn al-Ḥusain, a worthy nothing to do with the Sixth Imām.[g] Other cases there are where we listen to Arabic alchemists talking about Chinese substances no longer identifiable. For example, 'Chinese salt', which they say was extremely hard to get, remains for us incognito.[h] And Bar Bahlul was in a morass of confusion about 'Claudianos—the Chelidonium of China';[i] he was not sure whether it was the old multiple alloy of the Alexandrians[j] or a salt of arsenic or copper, or even a plant root or an animal product. All we can tell is that substances of Chinese origin were being used in alchemy in his time in Syria.

[a] Ruska (19), p. 88, (24), p. 36, eng. auct. This is in al-Qazwīnī but not in Pseudo-Aristotle, as we now have it.

[b] Vol. 3, pp. 614–15. The present entry concludes with an interesting echo of Enoch and the fallen angels, especially the Slavonic version, on which cf. p. 343 above.

[c] Ruska (19), p. 157, (24), pp. 17, 21, 30, 33–4, etc.

[d] Ruska (24), pp. 26–7. On sex in minerals see also p. 363 above.

[e] See e.g. Clark (1), pp. 340, 343, 573.

[f] The Persians called it *khāk-i-chīnī* (Laufer (1), p. 556). Cf. Dodge (1), vol. 2, pp. 743–4.

[g] See Ruska (5), pp. 8–9. Wiedemann (31), p. 6, gave a wrong translation of the title.

[h] Berthelot & Duval (1), p. 146; Stapleton, Azo & Husain (1), p. 375—references in al-Rāzī's writings or of his time.

[i] Berthelot & Duval (1), p. 138.

[j] Cf. pt. 2, pp. 20, 195 above.

Thus far we have been speaking of natural products but there is something to say about artificial ones also, many of which were very relevant to the activities of the Arabic alchemists. First of all, the Jābirian corpus has references to the casting of iron, a technique which, as is well known, no one in the world could carry out before the end of the +14th century—except the Chinese.[a] One of the Seventy Books, the *Kitāb al-Naqd* (Book of Testing, or of Coinage)[b] has a good deal on the casting of iron, information which must have reached this group of writers from further East.[c] The time would be the second half of the +9th century. But what it says is very strange and garbled, for it envisages the melting of the iron in a crucible suspended within a cosmic model like an armillary sphere, and kept in perpetual motion above the furnace by some kind of machinery.[d] This is closely connected with the Arabic ideas on artificial spontaneous generation, mentioned already (p. 396) and to be looked at again (p. 485). The *Kitāb al-Naqd* also speaks of the transmutation of iron into silver and gold, which recalls the Chinese episode of Wang Chieh and his predecessors (cf. pt. 3, pp. 186 ff.).

Then there was glass, and porcelain, both important for chemical apparatus. Wiedemann (26) showed that glass from China (*zujāj al-Ṣīn*) was appreciated in or soon after Jābirian times,[e] though the imitation of gems in Alexandrian fashion remained a living tradition among the Arabs.[f] As for porcelain, it was just called 'china' (*ṣīnī*) as it is with us.[g] One might well ask when such vessels first became known in Arabic lands, and the answer seems to be that it was just about the same time as paper, i.e. in the course of the Central Asian conquests of the mid +8th century. The question was asked almost a century ago by Hirth (25), and Laufer (10) touched upon it, but the best studies are those of Kahle (7, 8).[h] The oldest Arabic reference so far found comes from the same year as the Battle of Talas River, +751, for when at that time Abū Dā'ūd Khālid ibn Ibrāhīm took a city near Samarqand he got great store of Chinese porcelain, some painted and (more surprisingly) gilded.[i] Subsequent mentions are numerous, as by Ibn Khurdādhbih in +846, and he is well justified by the abundant finds of Chinese porcelain contemporary with him at Samarra and elsewhere.

But sometimes the china got broken, and cement was necessary for mending it. That however is not at all the only thing which gives great interest to a whole set of

[a] See Needham (31, 32).

[b] Kr 156. Cf. Kraus (2), p. 53, (3), pp. 57–8.

[c] Parallel passages are to be found in two other books of the Corpus, the *Kitāb al-Rāwūq* (Book of the Filter), also among the Seventy (Kr 140), and the *Kitāb al-Khawāṣṣ al-Kabīr*, ch. 9 (Kr 1900). Eng. tr. of the passage in the former by Nasr (1), p. 260.

[d] The great authority on all these methods is one Arius (Ariyūs), a name which neither Kraus (3), pp. 54–5, nor anyone else has ever succeeded in explaining.

[e] On the history of glass in Chinese culture see Vol. 4, pt. 1, pp. 99ff.

[f] He tells of a special work on this subject by Ibn Muḥammad al-Bisṭāmī, a man apparently of the +12th century, but not otherwise known.

[g] See the glossary of Siggel (2), p. 83. According to Laufer (1), p. 556, (10), p. 126, the Persian term for porcelain was *faghfūr-i-chīnī*, derived from Sogdian and a literal translation of 'Son of Heaven', the Chinese emperor's name. Thence it got into all Slavonic languages. Cf. Vol. 1, p. 169.

[h] See also Krenkow (2).

[i] The story is in Abū Ja'far al-Ṭabarī (de Goeje ed., ser. III, vol. 1, p. 79). The conqueror also got many valuable Chinese saddles, an interesting point in view of what immediately follows.

Chinese formulae or recipes for dyes, inks, varnishes and other chemical preparations occupying several chapters of the *Kitāb al-Khawāṣṣ al-Kabīr*.[a] Some of the more interesting of these may be listed as follows.

1. A waterproof and dust-repelling cream or varnish for clothes, weapons, etc.
2. A Chinese lacquer, varnish or cream (*duhn ṣīnī*) for protecting leather harness straps, belts, scabbards, bow-cases, etc.[b]
3. An absolutely fire-proof cement for glass and porcelain (*ghaḍār ṣīnī*).
4. How to make Chinese saddles (*surūj*).[c]
5. Recipes for Chinese and Indian ink.
6. A waterproof cream for impregnating silk, useful for the garments of divers.[d]
7. Other impregnating preparations for clothes, swords, wood, silk, etc.
8. Imitation of a Tibetan wood.
9. A Chinese cream for polishing mirrors.
10. Methods for making riding-whips (*miqra'a*).
11. Methods for transforming wrought iron (*narmāhan*) into steel (*fūlādh*).[e]

Thus by the latter half of the +9th century there were not only natural products from China in use by the Arabs, but also those of art, and even the transcription and adoption of some of the methods of these arts themselves. This is a significant item of evidence in one's estimate of the westward passage of chemical ideas.

In the preceding paragraphs we have occasionally mentioned plants and vegetable materials, and in concluding we ought to remind ourselves how much from the Chinese materia medica passed over to the Arabs.[f] Of the activities of the drug merchants of both cultures something was earlier said (p. 419), and the implication of the great trade in silks and tea was naturally part of the background. But there were many objects of much higher medical importance—cinnamon (*dār ṣīnī* the China tree, or *dār ṣīnī al-Ṣīn*, real China tree from China),[g] zedoary root (*jadwāre khitāi*),[h] ginger (*zanjabīl ṣīnī*),[i] bitter coptis root (*māmīrān ṣīnī*),[j] sweet-flag (*wajj* or *ighir*),[k] and

[a] Chs. 28 to 31 of Kr 1900. A detailed discussion of four of them was given by Ruska (7), with translation and chemical commentary. Cf. also Kraus (3), pp. 78–9.

[b] Recommended by the writer on the ground of personal experiments.

[c] It seems that a considerable export trade from China to the Arab countries developed in these articles; cf. B. Lewis (1), ch. 5.

[d] The writer claims to have got this from al-Faḍl ibn Yaḥyā al-Barmakī (+765 to +803), who said it was from an old unidentifiable MS. If the statement is acceptable it would place the coming of the recipe about the time of the Arab conquest of Central Asia.

[e] It would be interesting to know whether this was some form of the characteristic co-fusion process (see Needham, 31, 32).

[f] The point is made by Nasr (1), pp. 116ff., and was long ago expounded by Laufer (1), pp. 535ff. See also Levey & al-Khaledy (1).

[g] *Cinnamomum Cassia, chün kuei*[1] (R494). Cf. Meyerhof & Sobhy (1), pp. 468ff., translating the abridgment of al-Ghāfiqī's 'Book of Simple Drugs' (late +12th century) by Bar Hebraeus (late +13th). See also Levey (6), *passim*.

[h] From *Kaempferia pandurata* (formerly called *Curcuma zedoaria*), *phêng o shu*[2] (R648).

[i] *Zingiber officinale, shêng chiang*[3] (R650). Cf. Levey (6), p. 87.

[j] *Coptis Teeta, huang lien*[4] (R534).

[k] *Acorus Calamus, chhang phu*[5] (CC1918), listed in the +9th-century *Aqrābādhīn* discussed by Levey (10). Of the items in this pharmacopoeia 31% were of Persian or Indian origin.

[1] 菌桂 [2] 蓬我茂 [3] 生薑 [4] 黃連 [5] 菖蒲

officinal rhubarb (*rīwand ṣīnī*).[a] This is only to list a few, and to say nothing of fruits such as the peach[b] and the apricot,[c] which came westwards so early that they lost all national suffixes or epithets.[d]

There is one final point which ought to be made. Though no one has so far looked into the matter, it would be well worth examining how far the Arabic alchemists inherited some of the terms for chemical states and operations which their earlier Chinese confrères had used. Having noted one or two possible examples of this during our studies we mention them here with all due reservations. For instance, the conception of 'resistant to fire' (*qayyūm al-nār*), brought about when a fugacious or volatile substance is changed into another which no longer has this property, seems to mirror the Chinese idea of 'subduing' (*fu*[1]) or conquering (*shêng*[2]). Mentions of this sort of fixation are quite easy to find.[e] One wonders whether it derives entirely from the Alexandrians. Or again, the Arabic *mudbir*, 'regeneration', turning or returning, seems reminiscent of the Chinese *huan*,[3] so often used in the description of cyclical processes for the making of elixirs.[f] But this question must be left for further research. It is time that we turned to the ideological rather than the material influences of Chinese upon Arabic alchemy.

(iv) *Theoretical influences*

In Ben Jonson's 'The Alchemist' (+1610) we hear Subtle engage in an instructive harangue on what is meant by 'remote matter'. 'It is', he says,[g]

> of the one part
> A humid Exhalation, which we call
> *Materia liquida*, or the unctuous *Water*;

[a] *Rheum officinale, ta huang*[4] (R582). Cf. Vol. 1, p. 183; and Levey (6), p. 58.

[b] *Prunus persica, thao*[5] (R448). [c] *Prunus armeniaca, hsing*[6] (R444).

[d] Nor is it to say anything of the rich veins of Arabic toxicology,which drew upon all the lore of the known world from Spain to China. In the context of Chinese connections it is interesting to meet in the *Kitāb al-Sumūm* attributed to Ibn al-Waḥshīya (just mentioned, p. 449) with a reference to 'purging croton, that calamitous thing'. This is of course *Croton Tiglium* or *pa tou*[7] (R322), indeed a dangerously poisonous purgative. Even more characteristic of China, however, are other references to *ku*[8] poison (though not so named), made by letting several tarantula spiders sting themselves to death, and then working up the survivor. We have already had a good deal to say about this strange procedure (Vol. 2, p. 136) and shall return to it in Sect. 45; it deserves much more investigation than it has yet had, both scientific and philological. Meanwhile, something of the part which *ku* could play in national scandals and court intrigues in the Han period may be appreciated from the study of Loewe (5). Thirdly we hear much of lethal incenses, a subject very relevant to the Chinese fumigations which we have discussed above, pt. 2, pp. 148ff. In the translation of Levey (6), for croton see pp. 12, 94, for *ku* poison pp. 52, 67, and for poisonous smokes, pp. 39ff.; cf. also his summary (8). The *Kitāb al-Sumūm* of the Jābirian Corpus (Kr 2145), quite a different work and perhaps rather earlier, has been translated by Siggel (5); its overt literary sources appear to be entirely Greek, but many Persian drugs are mentioned, and there is talk of toxic smokes.

Perhaps one could also include under this rubric the Chinese doll (*timthāl* or *ṣanam*) mentioned in the Jābirian corpus used to bring about insomnia; Kraus (3), p. 85.

[e] For example in the +9th-century *Kitāb al-Ḥabīb*, tr. Berthelot & Houdas (1), pp. 79, 83, 112. Cf. Mahdihassan (12), p. 97.

[f] Attention was drawn to this first by Mahdihassan (17), p. 81. Cf. pp. 380ff. above.

[g] Pp. 382–3.

[1] 伏 [2] 勝 [3] 還 [4] 大黃 [5] 桃 [6] 杏 [7] 巴豆
[8] 蠱

On the other part, a certain crass and viscous
Portion of Earth, both which, concorporate,
Do make the Elementary Matter of Gold,
Which is not yet *propria materia*,
But commune to all Metals, and all Stones.
For where it is forsaken of that moisture,
And hath more driness, it becomes a Stone,
Where it retains more of the humid fatness,
It turns to Sulphur, or to Quicksilver,
Who are the Parents of all other Metals.
Nor can this remote Matter suddenly
Progress so from extreme unto extreme,
As to grow Gold, and leap o're all the Means.
Nature doth first beget th' imperfect, then
Proceeds she to the perfect. Of that aiery
And oily Water, *Mercury* is engendred;
Sulphur o' the fat and earthy part; the one
(Which is the last) supplying the place of Male,
The other of Female, in all Metals....

Of all the theories which the pioneers of chemistry entertained through the ages none was more important or more widespread than the belief that all metals, or all fusible bodies, were composed of mercury and sulphur in one form or another. It is generally acknowledged that this doctrine first appears in Arabic alchemy at the beginning of the +9th century, there being no antecedent for it in the writings of the Hellenistic proto-chemists.[a] But after that its ramifications continued down to the +18th century, even across the threshold, one might say, of modern chemistry. Having become a commonplace among the Arabic writers from the Jābirians to al-Jildakī it entered naturally into Latin alchemy,[b] and can be demonstrated in a thousand quotations from *c.* +1150 through the Geberian texts (*c.* +1290) onwards.[c] Petrus Bonus of Ferrara could write in +1330:[d]

Sulphur is a certain earthy fatness, thickened and hardened by well-tempered decoction, and it is related to quicksilver as the male to the female, and as the proper agent to the proper matter. Some sulphur is fusible and some is not, according as the metals to which it belongs are fusible or not. Quicksilver is coagulated in the bowels of the earth by its own proper sulphur. Hence we ought to say that these two, quicksilver and sulphur, in their joint mutual operation, are the first principles of metals.

For a time in Latin alchemy there came about a certain division, the Villanovan writers of the early +14th century stressing the role of mercury while those of the

[a] Cf. Leicester (1), pp. 65, 72; Multhauf (5), p. 134; Partington (4), p. 29; Nasr (1), p. 266.

[b] For example, the *De Aluminibus et Salibus* (cf. p. 398 above) says (in the +12th century) that gold and silver are formed in the earth by heat from mercury and sulphur during a thousand years, yet by God-given knowledge the alchemist can perform the process in a day (ch. 27); see Ruska (21) and Steele (2), cf. Multhauf (5), p. 162. How Chinese this was can be seen from p. 244 above.

[c] E.g. *De Investigat. Perfect.* chs. 3, 5, tr. Darmstädter (1), pp. 97, 99.

[d] *Pretiosa Margarita Novella*, tr. Waite (7), pp. 191ff.

Lullian Corpus in the late + 14th emphasised rather that of sulphur.[a] But the two principles continued in explanatory vogue until the early + 16th century, when Paracelsus, adding salt, formed the celebrated Tria Prima of that chemistry which Boyle destroyed.[b] Later, van Helmont, Sylvius and Tachenius brought in two more principles, phlegm and earth, but the destiny of sulphur was far from accomplished, for Paracelsian sulphur became in the system of J. J. Becher (+ 1635 to + 1682) *terra pinguis* or 'fatty earth', something found particularly in organic materials and leaving them when they were burnt.[c] This then generated, in the hands of his pupil G. E. Stahl (+ 1660 to + 1734), the concept of phlogiston, on which historians of modern chemistry have written so many pages. It was used to explain all the phenomena which we now think of as concerned with oxidation–reduction, though in an opposite sense to ours, yet in spite of this it has been considered 'the first great unifying principle in chemistry' because it embodied a transfer principle, some kind of component being donated by one substance and received by another.[d] By the end of the eighteenth century the phlogiston theory had been killed stone dead by Lavoisier and his colleagues, but from its body sprang some of the most important ideas of the revolutionary modern chemistry.[e] Even the other member of the pair, mercury, still had a part to play, for the ancient archetype of contraries combining never ceased to haunt the minds of chemists, and doubtless facilitated the general acceptance of the electrochemical theory of affinity introduced by J. J. Berzelius (+ 1779 to 1848), most influential of the chemists of the first half of the nineteenth century.[f] The mercury–sulphur theory, therefore, had quite a career.[g]

It has occurred to many that the natural properties of sulphur and mercury uniquely fitted them for occupying such central positions in proto-chemical thought.[h] Sulphur

[a] Leicester (1), p. 87.

[b] Leicester, *op. cit.*, p. 97.

[c] See Leicester's summary (1), p. 121; Multhauf (5), pp. 277–8.

[d] Leicester, *op. cit.*, pp. 122–3. Also the monographs of White (1); Metzger (1).

[e] Leicester, *op. cit.*, pp. 142ff.

[f] Leicester, *op. cit.*, p. 168. For the background of this see Multhauf (5), pp. 299ff.

[g] Before the exhaustive work of Dobbs (4) there was little realisation of the extent to which the alchemical work of Isaac Newton himself was dominated by this theory (cf. pp. 82, 128, 134ff., 145, 150, 160, 181, 221). She knew of its Arabic origin (pp. 135, 220) but went no further back. It is now generally appreciated that Newton spent at least as much of his time in the 'chymical elaboratory' which he had in Trinity College as in thinking about optics and celestial mechanics (cf. Vol. 5, pt. 2, pp. 34–6). There he worked to 'open' metals and extract their 'mercury' (Dobbs (4), pp. 145, 198); in elixir iatro-chemistry he was not interested at all. Searching for a unified science of Nature, he was assuredly engaged in what Dobbs calls a 'chemicalisation' of alchemy, and although he may not have got very far with that, he favoured (like Boyle) a corpuscularian chemical philosophy which would include gravitational and magnetic forces beyond the purely mechanical impacts of Descartes (pp. xi, 88–9, 211). All this was in the period from + 1668 to + 1685 and later. With Newton, mercury and sulphur found one of their ultimate incarnations in what he called particles of 'earth' and 'acid', but so penetrating was his insight that these sound almost like protons and electrons, the sub-atomic particles out of which all sorts of matter—'one catholick matter', as Boyle put it (pp. 199ff.)—would be built by variants of their stable configurations. This would involve many levels of size, degrees of complexity, and differences in density, as Figala (1) has described. It is exciting to find the *shui yin* and the *liu huang* of ancient Chinese alchemy coming through thus to the threshold of modern science.

[h] For example, Mahdihassan (16), pp. 19ff., 23–4, (18), p. 42, (21), p. 196, (25), p. 42, (26), p. 19 (28), pp. 100–1, (59). The late Prof. J. R. Partington often used to emphasise in conversation the origin of the phlogiston theory from the sulphur of the sulphur–mercury theory (e.g. priv. comm. Feb. 1959); and Prof. J. D. Bernal, in a lecture of about 1937, pointed out how reasonable it had been to take sulphur as an elementary principle of burning, and mercury as an elementary principle of 'metallicity'.

is a solid, yellow like the sun, arousing thought-associations of raucous, stifling heat, therefore obviously male.[a] By contrast mercury is a white metallic liquid, cold, smooth and insinuating, therefore obviously female.[b] At the very beginning of this Section attention was drawn to the immense importance of the colour red, the colour of blood and life, in the proto-chemical thought of all the ancient civilisations (pt. 3, pp. 2–3). Hence it was of great significance that the combination of these two primary substances produced a blood-red substance, cinnabar. Furthermore each of them alone would produce a red thing, for sulphur heated to 180 °C turns to a dark orange-red liquid, while mercury heated in air to 300 °C forms the bright red oxide.[c] And it was from cinnabar that Li Shao-Chün[1] in the −2nd century set out to make that artificial gold which would confer immortality upon his emperor (pt. 3, pp. 29, 31 above). Besides, it has been pointed out that though both sulphur and mercury were powerful reagents in the vaporous state, the former was eminently combustible and therefore invited identification as the spirit of the element Fire, while the latter, eminently fusible and alone among the metals liquid at room temperatures, constituted naturally the spirit of the element Water.[d] Hence the combination of the two, and any process which could be analogised with it, was a *conjunctio oppositorum* (cf. pt. 3, pp. 69, 145 and above, pp. 121, 363).[e] 'Marry the male and the female' is the theme repeated endlessly, and passages based on it can be read in numerous ancient proto-chemical and alchemical texts. In Olympiodorus:[f]

> He who knows the secret art of *chumeia* says to them: 'How can one understand transmutation?[g] How can water and fire, inimical and contrary the one to the other, be united in the same body, be made of one mind in grace and friendship? What a paradoxical *krasis*! Whence comes this unexpected amity of foes?'

And passages of very similar character occur in the Arabic Ostanes text,[h] the *Kitāb al-Ḥabīb*[i] and many other Arabic sources. After all, Lactantius in the +4th century had said that the very creation itself had been just this, the combination of *calor* and

He enlarged upon this is his Beard Lectures at Oxford (1), p. 203, and more recently, in lectures posthumously published, (2), p. 113, where he is at his most provocative in saying that 'the real origin of chemistry came from China'. He is referring to the combination of Yin mercury and Yang sulphur to make blood-red cinnabar, and adds: 'if we now turn it into our physical terms, we are dealing with a superfluity of electrons in mercury, a lack of electrons in sulphur, and a balance of electrons—the sulphide'. His conclusion is that the sulphur–mercury theory was essentially Chinese, and adopted by the Arabs.

[a] The Yang dragon (Yang *lung*[2]) as in China we would say.

[b] The Yin tiger (Yin *hu*[3]) as it would be in China.

[c] Even that other partner, lead, important, as we know (pp. 254ff. above, and pt. 5), in some Chinese systems, also gave rise on heating to a red thing, minium, red lead, Pb_3O_4.

[d] Hopkins (1), p. 116.

[e] Hammer-Jensen (2), pp. 17ff. One of the Zosimus texts has an interesting passage on the reaction of sulphur and mercury, though rather obscurely worded, *Corp. Alchem. Gr.* III, xlix, 14.

[f] *Corp.* II, iv, 41, tr. Berthelot & Ruelle (1), eng. et mod. auct.

[g] As usual the term employed is the ancestor of our own 'metabolism'.

[h] Berthelot & Houdas (1), pp. 120–1.

[i] Berthelot & Houdas (1), pp. 79, 100.

[1] 李少君 [2] 陽龍 [3] 陰虎

humor;[a] and he was echoed by many other theologians, Christian, Gnostic and Muslim alike.

Let us now look a little more closely at the Arabic point of origin of the sulphur–mercury theory. The idea that all metals are concocted from sulphur (*al-kibrīt*) and mercury (*al-zībaq*) is already found in the texts attributed to Balīnās, especially the *Kitāb Sirr al-Khalīqa*...,[b] which means the first few decades of the +9th century. It cannot be found in the West at any prior time.[c] It then runs throughout the Jābirian Corpus, expounded particularly however in the *Kitāb al-Ghasl* (Book of Washing) and the *Kitāb al-Iḍāḥ al-Ma'rūf bi-Thalāthīn Kalima* (Book of Enlightenment; commonly called, the Thirty Words).[d] After the +9th century it becomes an accepted doctrine of all Arabic writers on alchemy,[e] and is taken over directly into the Latin tongue[f] to fulfil the destiny we have already sketched.

It has been usual to maintain that this theory was derived by the Arabs from the two terrestrial exhalations of Aristotle.[g] One of these vapours (*anathumiaseis*, ἀναθυμιάσεις) given off by the earth under the influence of the sun, was hot and fiery, dry and gaseous (*pneumatōdestera*, πνευματωδεστέρα), the other moist, cool and aqueous (*atmidōdestera*, ἀτμιδωδεστέρα). The former generated the idea of the sulphur component, the latter that of mercury, so many historians of chemistry have thought,[h] though Aristotle himself did not make any connection with these two elements.[i] Some scholars imply that men such as Ibn Sīnā[j] or the Geberian writer[k] explicitly did so, but this we have not been able to confirm by any original text, though of course they clearly stated the theory itself—'All Metallick bodies are compounded of Argentvive and Sulphur'. Other scholars have therefore contested the derivation from the *anathumiaseis*, proposing rather that the idea was originally a Chinese one, or at any

[a] *Div. Inst.* II, 9, 12.

[b] See Ruska (8), p. 151; Kraus (3), p. 283; Multhauf (5), p. 133.

[c] *Pace* Tenney Davis (4).

[d] Kr 183 and Kr 125 respectively. On the dominance of the theory cf. Kraus (3), p. 1. For further examples in Jābirian texts, see Berthelot & Houdas (1), p. 170; Nasr (1), p. 266.

[e] To illustrate this we reproduce (Fig. 1533) a drawing from an Arabic MS. in the British Museum (Add. 25.724) on which Ploss *et al.* (1), p. 116, have commented. It shows the six metals all held firmly under control by sulphur and mercury (or sun and moon, or Yang and Yin, as you will). The text discusses the permanence of substances with perfect *krasis* and the impermanence of those in which it is unbalanced.

[f] Cf. von Lippmann (1), vol. 1, p. 488, vol. 2, p. 180.

[g] *Meteorologica*, I, iv (341*b* 6ff)., II, ix (369*a* 13ff.) and esp. III, vi (378*a* 13ff.); Lee ed. pp. 28, 222, 287. We discussed them in the Sections on meteorology and mineralogy in Vol. 3, pp. 469, 636. It has also, however, been proposed that Dioscorides was in part the author of the theory; Berthelot (1), p. 68, attributing to him the following words: 'Some say that mercury is a constituent of all metals.' But this seems to be only a mistranslation due to the double meaning of *metalla*, etc. in Greek, and the proper rendering ought to be: 'And some say that hydrargyrum is found by itself (i.e. native) in the mines.' See Goodyer's translation, in Gunther (1), p. 638, confirmed by Lenz (1), p. 74; *De Mat. Med.* V, 110.

[h] E.g. Sherwood Taylor (3), p. 80; Darmstädter (1), p. 137. According to von Lippmann (3), vol 2, pp. 109, 149, Pebechius said that there was mercury in all things, but we have not been able to find this in the Hellenistic Corpus.

[i] Aristotle's own view was that the dry exhalation formed all the *fossiles*, i.e. ores, minerals and rocks, while the moist vaporous one formed all the metals.

[j] For example, Leicester (1), p. 70. But the relevant passages in the *Kitāb al-Shifā'* (tr. Holmyard & Mandeville (1), pp. 38ff.) do not contain this identification.

[k] For instance, Leicester (1), p. 85. But we find no supporting passage. Multhauf (5) avoided this statement.

Fig. 1533. Yin and Yang (the Moon and the Sun) as controllers of the Six Metals, an illustration from an Arabic MS. (British Museum Add. MSS 25, 724) of Abū al-Qāsim al-'Irāqī, *c.* + 1280 (cf. p. 404). The text reads: 'Know that (the constituents of) this compound substance (the elixir) possess precise weights which bring them into equilibrium so that the heat does not exceed the cold, nor the dryness the wetness. And whatever attains (such) equilibrium is permanent, and no more subject to change, while all things that do not attain it will be overcome by impermanence and transformation.'

rate something arising from the contact of the Arabic alchemists with the earlier Chinese tradition.[a]

The position here is a little ambiguous. While we cannot call to mind any Chinese alchemical text which explicitly states the theory in the customary way, it will have become abundantly evident to the reader of the earlier parts of this Section (pt. 2, pp. 128, 326ff., pt. 3, pp. 14, 74, 86, 126, etc.) that mercury and sulphur played a much more prominent part in Chinese alchemy than any other substances, and that cinnabar itself, mercuric sulphide, far excelled all other chemicals for prominence in Chinese alchemical song and story. Moreover, the passage from Khung Ying-Ta (*c.* +640) which we quoted on p. 156 above shows clearly that the element Metal was regarded in orthodox Chinese natural philosophy as a mixture of Yin and Yang, with the former

[a] E. g. Huang Tzu-Chhing (2); Mahdihassan (16), pp. 21, 23–4, (26), p. 19, (28), pp. 100–1; Haschmi (5), p. 62. Especially Abrahams (1), p. xix, has stressed the sulphur–mercury theory as a derivate of the idea of Yang and Yin as constituents of all the metals. Chinese dualism, says Subbarayappa (2), had much influence on Indian alchemy also.

predominating; and from there it would have been a very short step to the idea that the metals known to man were different in properties because of the varying proportions of Yin and Yang (mercury and sulphur) which they contained. So if the doctrine just stated was not actually received by any individual Arabic *ḥakīm* from his Chinese *chen jen*,[1] it could have sprung very easily from a knowledge of how the adepts of China conceived of elixir-making and aurifaction. Indeed it hardly amounted to more than saying that all the metals were varieties of cinnabar.[a]

There is a further argument. References to *anathumiasis* are rare in the Jābirian Corpus, but when they do occur they never concern the sulphur–mercury theory. For instance, the *Kitāb al-Ḥāṣil* (Book of the Result)[b] quotes the *Placita Philosophorum* of Pseudo-Plutarch[c] as saying that the *anathumiasis* of the world-soul is damp in itself so that it is of the same kind as those which emanate from living beings on the earth—here the word is rendered *bukhār*.[d] If the Jābirian sulphur–mercury thesis had really been derived from Aristotle's *anathumiaseis* it seems hardly believable that this or some other rendering of the Greek word should never be found in association with it.

The next subject takes us further away from chemistry as ordinarily understood, but it illuminates the relations of Arabic and Chinese proto-scientific thought in a most curious way. At an earlier point, in describing the characteristics of the Jābirian Corpus (p. 394), we had occasion to refer to the Theory of the Balance ('Ilm al-Mīzān) which runs widely through the books and tractates contained in it.[e] This set out to be a science of the quantitative composition of all bodies, but it was 'computational' and numerological, not primarily empirical or experimental. The system is most fully described in the 'Books of the Balances' (*Kutub al-Mawāzīn*),[f] some 144 tractates which may be dated to the neighbourhood of +900, about the middle of the whole period through which the Corpus was written. It was based upon Greek medicine and natural history to the extent that the four qualities (*ṭabā'i'*) or natures (hot, cold, moist and dry) were regarded as the ultimate constituents of all things, whether metals, minerals, plants or animals; these qualities being of course traditionally related to the four Aristotelian elements (earth, fire, air and water), and to the Hippocratic–Galenic humours (blood, black bile, yellow bile and phlegm).[g] Galen's four degrees (*taxeis*, τάξεις) of intensity of each quality in a thing,[h] orginally a pharmacodynamic classification mounting from foods to poisons and powerful drugs, was accepted by the Jābirian

[a] As was acutely remarked by Mahdihassan (16). According to Pelliot (54) our word derives from Ar. *sinjafar* or *zunjafur*, and that from Sogdian **shingafr* through Persian *shangarf*. Cf. Siggel (2), p. 97. But Iranians also said *sīmshangarf*, meaning '(quick-)silver cinnabar', a phrase exactly analogous to the Chinese *yin chu*,[2] quick-silver being *shui yin*.[3] This could argue for ancient mercantile and proto-chemical contact.

[b] Kr 323.

[c] Though Plutarch's name is not mentioned.

[d] See Kraus (3), p. 333.

[e] Brief descriptions can be found in various places, e.g. Multhauf (5), p. 135; Nasr (1), pp. 263ff., but the only profound discussion is still that of Kraus (3), pp. 187ff.

[f] Kr 303 to 446.

[g] Gruman (1) has put it this way: what the Jābirians did 'was to project the Galenic system on to the problems of inorganic chemistry, seeking to identify the characteristic make-up or balance of the qualities in each metal and chemical substance', p. 60.

[h] The chief source for this is the *De Simpl. Med.*

[1] 眞人 [2] 銀硃 [3] 水銀

writers, but in arguing about relative dosages in *dirhams*, etc., they believed that they must go beyond the fallible empirical impressions of the superficial senses, and apply a theoretical system founded essentially on a numerology.[a] A simple exposé of this is seen in Fig. 1534. While the Galenic degrees were all equal, the *martabas* of the Jābirians were related to each other, starting from the lowest, in the proportion of 1, 3, 5 and 8, making a total of 17; and this number was regarded as being the base (*qā'ida*) of the whole theory.[b] Furthermore, taking the first *martaba*, we find that it

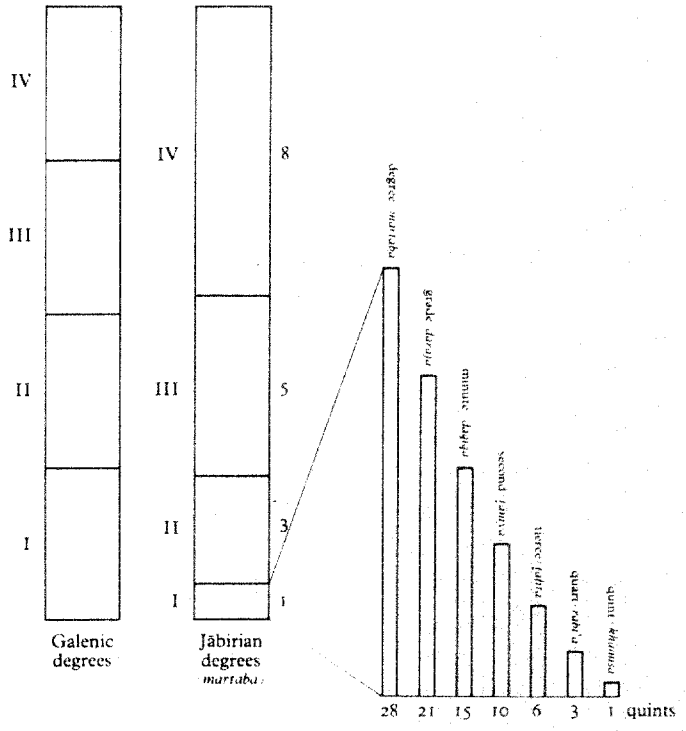

Fig. 1534. Chart of the 'Ilm al-Mīzān (Science of the Balance) of the Jābirian Corpus. Building on the Galenic estimation of pharmaceutical potencies as related to the *krasis* or relative proportions of the Greek elements and humours, the Arabic alchemists of the + 9th and + 10th centuries produced a much more sophisticated, but equally numerological, system of believed component quantities. Perfect balance, if only it could be attained, would exempt men and metals, indeed all things, from change and decay.

was divided into 28 of the smallest units, the quints (*khāmisāt*), five other named units being available for intermediate magnitudes between these two.[c] Thus since there were 17 units equivalent to the first and smallest *martaba* in the whole series, there was a total range of 476 *khāmisāt*, not just simply 4 degrees. This was clearly a more sophisticated parameter.

But it was based neither on observation nor experiment.[d] The Jābirians proceeded

[a] See Kraus (3), pp. 193–4ff.
[b] Kraus, *op. cit.*, p. 227.
[c] On all matters connected with these see Kraus (3), pp. 190, 193–4, 196, 270.
[d] Except in so far as the Jābirians embarked on their computations with a considerable previous knowledge of the properties of the substances in question.

to what we might call, coining a word, a *krasi-gnosis*, an estimate of the relative compositions of substances, by taking the numerical values of their names in Arabic; a kind of glyphomancy[a] known as the *mīzān al-ḥurūf* (balance of the letters).[b] But this *hijā'* (spelling out) gave only the exterior nature of the substance, and the latent, complementary or interior nature had to be found by conjecture (*ḥads*) to make it up to a value of 17.[c] Thus was the *krasis* or equilibrium (*'adl*) found out, and all the operations of alchemy were directed to altering these inner and outer equilibria. Elixirs did precisely this. Spontaneous change could also occur, as in the rusting or corrosion of metals, and in one place this is applied to the evaporation of ammonium carbonate and chloride (*nūshādir*). 'If the natures in a body undergo change', says the text, 'leading to excess or defect,[d] it loses its normal state, breaking down of its own accord.'[e] For all this there were some antecedents in the Hellenistic world, and kabbalistic glyphomancy with marked Jewish connections permeated Arabic thought, but there is no need for us to explore it here.[f] More important questions to ask are first, how far back did its chemical application go, and secondly, where did the numerological succession, 1, 3, 5, 8, 17 and 28 come from?

It seems clear that the theory of the Balance was not well known to the earlier Jābirians, writing the Seventy Books in the middle of the +9th century,[g] nor is there anything much about it in the present text of the book attributed to Balīnās (cf. pp. 369 ff. above), the *Kitāb Sirr al-Khalīqa wa-Ṣan'at al-Ṭabī'a* (Book of the Secret of Creation and the Art (of Reproducing) Nature), *c.* +820 to +830, though the term *mīzān* occurs.[h] But other parts of the Corpus, notably the *Kitāb al-Aḥjār* just mentioned (Kr 307), do attribute to Balīnās a discussion of the six basic numbers,[i] so there is no barrier to believing that the theory was taking shape in the first decade or two of the +9th century. Moreover the Corpus also contains a set of tractates called *'Ashara Kutub 'alā Ra'y Balīnās Ṣāḥib al-Ṭilasmāt* (Ten Books of the Opinions of Balīnās, Lord of Talismans)[j] where the *mīzān* also comes in, but the significant thing in the light of what follows is that these are very Ṣābian texts, dealing with the seven metals, planets and divine images (*aṣnām*). Hence we must suspect (cf. p. 426 above) East Asian connections.

[a] Cf. Vol. 2, p. 364.

[b] An analysis of this kind appears in the translation of the *Kitāb al-Mīzān al-Ṣaghīr* (Kr 369) by Berthelot & Houdas (1), pp. 158–9.

[c] Kraus (3), pp. 223 ff. works out a number of concrete examples. A discussion on the maximum of 17 components occurs in the *Kitāb al-Tajmī'* (Kr 398), tr. Berthelot & Houdas (1), pp. 191, 200, 204.

[d] Cf. Vol. 2, pp. 463, 566.

[e] This is in the *Kutub al-Aḥjār 'alā Ra'y Balīnās* (Books of Minerals according to the Opinions of Balinas), Kr 307 to 310; four in number. See Kraus (3), p. 233.

[f] See further in Kraus (3), pp. 236 ff., 266. Allegro (1) tells us in his 'Dead Sea Scrolls' that the Qumran community, very gnostic and dualistic, believed that the behaviour of each man and woman was determined by the activities of two warring spirits within. They thought that the inheriting of these spirits depended upon the astrological situation at the birth of the individual, and that their proportions could be numerically reckoned up. This he derives (p. 125) from the 'Manual of Discipline', *c.* −1st century. Here then was a much earlier Balance.

[g] Kraus (3), p. 235.

[h] Kraus, *op. cit.*, pp. 283, 289. Needless to say, the system was entirely unknown to the Greeks, notwithstanding the identification of Balīnās with some Apollonius or other.

[i] *Op. cit.*, p. 286. [j] Kr 293 to 302.

Kraus was extremely puzzled about the origin of the numerological succession.[a] He devoted to it an immensely learned disquisition, recalling (not very convincingly) the *Timaeus* and Pythagoras, searching for some connection with the music of the spheres, and alluding to the 17 consonants of the Greek language.[b] But his work in the forties ended with no solution to the problem. During the fifties Stapleton found it in the simplest magic square, a mathematical achievement of ancient China, which Cammann during the sixties has set in its fullest perspective and context.

4	9	2
3	5	7
8	1	6

Stimulated by some earlier papers of Coyaji,[c] Stapleton (4*a*) suggested in 1950 that the mysterious Jābirian numbers could all be derived from the magic square of three.[d] A magic square is an arrangement of numbers in the form of a square or other matrix such that every column, every row, and each of the diagonals adds up to the same figure, the constant.[e] In this simplest case (see inset cut) they all add up to 15. Stapleton then applying what he called gnomonic analysis made it clear that if divided in this way the gnomon's total is 28, while the numbers in the remaining four compartments are the four lowest numbers required, together with their total of 17.[f] If the Jābirians saw in these, as they certainly did, the fundamental numbers of Nature, the reason could well have been that the magic square of three had somewhere sometime been regarded as a numinous cosmic cantrap or diagram of the highest sanctity and solemnity. Stapleton knew that veneration of this kind had been paid to it for centuries in China, and correctly pointed out that it was nothing other than the Lo Shu[1] (Writing from the River Lo), often associated with the Ming Thang[2] (Bright Hall), the cosmic temple of Han times, and with the Chiu Kung[3] (Nine Palaces), a further conception, sometimes celestial, sometimes terrestrial. He therefore asserted that a cardinal influence had been exerted by Chinese cosmism upon Arabic proto-chemistry and alchemy, and indeed it seems that he was right.

In Section 19 we gave a fairly full account of the Lo Shu magic square and its history.[g] As one of the legendary diagrams bestowed by Heaven upon the engineer-emperor Yü the Great it certainly goes back to pre-Confucian times, but not until the latter part of the −4th century do we get evidence (from the *Chuang Tzu* book)[h] that an arrangement of numbers formed the essential point of it. This is reinforced by a passage in the Hsi Tzhu (Great Appendix) of the *I Ching* (Book of Changes) dating

[a] Cf. Kraus (3), p. 297.

[b] See especially Kraus (3), pp. 199, 207, 218. On the music of the spheres, p. 203, the *Timaeus* p. 220, and the Greek alphabet p. 209.

[c] (2–5) but especially (6).

[d] His chief papers on this subject are (2, 3) and the longest (4); for the gnomon see (5). All are very *touffu*, ranging over many subjects from Zoroastrianism to ziggurats, and full of arbitrary judgments, *non sequiturs* and mistakes in fields other than those of Arabic studies—but in this brilliant discovery he was right.

[e] As a general rule for odd-number squares, if n = the base number (the number of cells on one side), m = the number in the central cell, c = the constant (the sum of all the rows and columns and the two principal diagonals), and t = the total sum of all the numbers; then $nm = c$ and $n^2m = t$. Cammann (9), p. 48.

[f] Kraus (3), p. 219, had touched upon the subject of gnomons, but missed the clue that a magic square arrangement was essential.

[g] Vol. 3, pp. 56ff.

[h] Ch. 14, tr. Legge (5), vol. 1, p. 346.

[1] 洛書 [2] 明堂 [3] 九宮

from the −2nd century,[a] and clinched by a quite definite statement in the *Ta Tai Li Chi* datable about +80.[b] To its subsequent history we shall return in a moment. In spite of the criticisms of Cammann (7) we find relatively little that needs alteration in our account of Chinese magic squares, but we record with gratitude his demonstration that Theon of Smyrna (*fl. c.* +130) was a man of straw in this connection.[c] The point is important, because it can now be reliably stated that magic squares were completely unknown in any part of the Hellenistic world, and appear in the West only in the Jābirian period.[d] Cammann (12) assumed that the earliest appearance there of the magic square of three was as a pregnancy and childbirth charm in the Jābirian *Kitāb al-Mīzān al-Ṣaghīr* (Lesser Book of the Balance),[e] datable about +900. He was more uncertain about an earlier appearance in a text of Thābit ibn Qurra (al-Ḥarrānī, +826 to +901),[f] though this has the authority of Suter.[g] But there is a still earlier example in a gynaecological text in the 'Paradise of Wisdom' of 'Alī ibn Sahl Rabbān al-Ṭabarī, who died in +860, again for cosmic aid in difficult labour, discovered by Siggel (6).[h] We must thus conclude that the world-emblem of the magic square of three reached the Arabic West just about the time of the Balīnās books, in the early decades of the +9th century. This agrees strikingly enough with other examples of Chinese influence which we have been examining.

It now seems reasonably certain, wrote Cammann, that the magic square of three was invented in ancient China, first discussed there, and first put to practical use in the philosophy and religion of that culture.[i] Why was it that the Chinese were the foremost to embark on this line of mathematical development, leading ultimately to what is known as combinatorial analysis? Because, as he said,[j] 'the Shang Chinese were apparently the first people in the world who could, and did, consistently express any number, however large, with only nine digits; and they were regularly doing this some two thousand years before the Hindus learnt to do the same thing with the numerals we now call Arabic.' Later Chinese contributions included, as he says, the first magic squares of five, six, seven and nine, the first bordered magic squares, the earliest known composite magic square and probably the first augmented square. The most ingenious solutions for the squares of six and nine ever devised were, and remained, uniquely Chinese. Unquestionably most of these developments were based upon the

[a] Pt. 1, ch. 9, tr. Wilhelm (2), vol. 1, p. 234. [b] Ch. 67.

[c] We were certainly misled by Sarton (1), vol. 1, p. 272, who, like Homer, nodded at times.

[d] Cammann (9), pp. 45–6, confesses to a feeling that the first magic square ought to have been Pythagorean, or rather perhaps that one would expect it first in Babylonia, spreading out both westwards and eastwards—but, as he says, there is no trace of evidence for anywhere but China.

Elsewhere, (7), p. 118, he drew attention to the Arabic acceptance in the +9th century very clearly.

[e] Kr369, see Kraus (2), p. 90, (3), p. 73; Berthelot & Houdas (1), p. 150; Hermelink (1).

[f] Cammann (7), p. 118, (9), p. 46; Noble (1); cf. Mieli (1), 2nd ed., p. 86. Note his Ṣābian origin.

[g] (1), p. 36.

[h] Later mentions are less important for us, e.g. the *Rasā'il Ikhwān al-Ṣafā'* (*c.* +990), in which the first set of magic squares of ascending complexity in the West is found, 'even the construction methods sometimes showing obvious Chinese influence'; Cammann (12), p. 190. The square of three as a childbirth charm turns up again in *Picatrix* and its Arabic original, i.e. by +1056 (Ritter & Plessner (1), p. 407). The many varieties of magic squares of higher orders are beyond the scope of our argument here, but may be followed in Cammann (7, 8, 12, 13).

[i] (8), pp. 52–3. [j] (9), p. 40, following our Vol. 3, p. 15.

Lo Shu[1] diagram already mentioned, so they were probably made during the period when this was a very sacred and esoteric thing,[a] i.e. before the +10th century, when the tradition lost its associations with religious cosmism and came to the surface, turning into a secular commonplace. This point is typified by the work of the Taoist scholar Chhen Thuan[2] (+895 to +989).[b] In subsequent centuries major creativity in this field passed to the Arabs, Byzantines and Indians,[c] but in his book of +1275 Yang Hui[3] preserved a great collection of what had been done in China down to, and including, his own time.[d]

But all this agreed, why did the magic square of three have such a charisma? It might be fair to say that the number nine has been too much overshadowed in our considerations of ancient Chinese thought by the prominence of the classification of everything in fives, following the rise of the Five Element theory after Tsou Yen[4].[e] Nine was always a convenient cosmic number because of the way in which centrality could be surrounded by eight directions of space. Thus in ancient Chinese natural philosophy we find, above, the Nine Spaces of the heavens (Chiu Yeh[5]),[f] below, the Nine Provinces of China (Chiu Chou[6])[g] and the nine cauldrons of the Hsia associated with them (Chiu Ting[7]),[h] the 'well-field' (*ching thien*[8]) arrangement of land allocation in nine lots (*chiu thien*[9]),[i] and, on a broader scale, the Nine Continents (Chiu Chou[6]) of Tsou Yen, of which China was only one.[j] There was also the elusive expression Chiu Kung[10] (Nine Palaces, or Halls), which turns up in all sorts of contexts referring to the heavens, the rooms (*shih*[11]) of the cosmic Ming Thang[12] temple, and the lay-outs of divination devices (*shih*[13,14]),[k] mathematical matrices and boards for chess and proto-chess.[l] In all these uses the theme of microcosm and macrocosm was vital, and the Lo

[a] This was the time of Hsü Yo[15] (*c.* +190) with his *Chiu Kung suan fa*[16] (Nine Hall computing method), as also of his commentator Chen Luan[17] (*c.* +560) who drew upon a lost book entitled *Huang Ti Chiu Kung Ching*[18] (cf. *Sui Shu*, ch. 34, p. 21*a*). See Vol. 3, pp. 58–9 and Cammann (9), pp. 42–3.

[b] Cf. Vol. 3, p. 59 and Cammann (9), p. 76.

[c] See Cammann (12, 13) and literature there cited; also Nasr (3), e.g. p. 211.

[d] This was the *Hsü Ku Chai Chi Suan Fa*[19] (Choice Mathematical Remains collected to preserve the Achievements of Old), analysed by Li Nien (*4*), vol. 3, pp. 59ff., (*21*), vol. 1, p. 175, and Cammann (8).

[e] See Vol. 2, p. 232, also pp. 242, 253ff., 261ff.

[f] *Huai Nan Tzu*, ch. 3, pp. 2*b*, 3*a*, tr. Chatley (1), p. 5. To get in all the 28 lunar mansions (*hsiu*[20]) three were allotted to each Space, including the centre, and four to the northern one. The astronomical background will be understood from Vol. 3, p. 240 and Table 24.

[g] The classical description is in the Yü Kung chapter of the *Shu Ching*, on which see Vol. 3, pp. 500–1.

[h] See Vol. 3, pp. 503–4. The liturgical work *Shang-Chhing Ling-Pao Ta Fa*[21] (*TT*1204–6, cf. Vol. 5, pt. 2, p. 129) depicts the nine cauldrons marked with the Lo Shu numbers (ch. 12, p. 9*a*).

[i] See Vol. 4, pt. 3, pp. 256ff.

[j] An account of this doctrine has been given in Vol. 2, p. 236.

[k] On the connection with the *shih* see Cammann (9), pp. 70ff. Chang Hêng,[22] the great +2nd-century mathematician, physicist and naturalist, is known to have recommended magic squares for divination purposes as a method already old in his time (*Hou Han Shu*, ch. 89, p. 11*b*). On the connection of the *shih* with the history of the magnetic compass, see Sect. 26*i* (4) in Vol. 4, pt. 1.

[l] Many references will be found in Vols. 2, 3 and 4, pt. 1, *passim*.

[1] 洛書 [2] 陳摶 [3] 楊輝 [4] 騶衍 [5] 九野 [6] 九州
[7] 九鼎 [8] 井田 [9] 九田 [10] 九宮 [11] 室 [12] 明堂
[13] 栻 [14] 式 [15] 徐岳 [16] 九宮算法 [17] 甄鸞
[18] 黃帝九宮經 [19] 緝古摘奇算法 [20] 宿 [21] 上清靈寶大法
[22] 張衡

Shu exemplified it to perfection, a magical expression of centrality and universal order, an *imago mundi*, a miniature emblem of the cosmos.[a]

Moreover it was for centuries associated with the worship of one of the greatest deities of Chinese cosmism, the supreme pole-star sky-god Thai I[1,2].[b] How far he was ever regarded as a creator remains obscure because that concept was always very uncharacteristic of Chinese thinking, but a passage in the *Lü Shih Chhun Chhiu* (−239) has Thai I giving rise to the two principles (*liang i*[3]) Yin and Yang, and hence to the myriad things.[c] Liturgical honours for him were suggested to Han Wu Ti in −124 by Miu Chi[4] and carried out at a special altar,[d] but by −113 Thai I had displaced Huang Ti (the Yellow Emperor) from the central position at the imperial sacrifices and was worshipped at a central altar with three concentric levels,[e] the altars of the Five Emperors all being round about. By +7, under Wang Mang, he was universally recognised as the supreme deity,[f] and he it is that we see riding in the chariot of the Great Bear in Han tomb-reliefs such as those of Wu Liang (+147).[g]

But Thai I did not stay otiose in the Purple Forbidden Enclosure of the circumpolar stars. He was believed to go round on an annual tour of visitations through the spaces of the universe, a peregrination represented on the Lo Shu by the order 5–1–2–3–4–5, then rest awhile, then 5–6–7–8–9–5. This eternal cyclical balanced rhythm is first described in Han prognostication books such as the *I Wei Chhien Tso Tu*[5] (Apocryphal Treatise on the (Book of) Changes; a Penetration of the Regularities of Chhien),[h] datable in the +1st or +2nd century.[i] But it had a long innings, for Taoist talismans of precisely this complicated array, as it traces out on the Lo Shu magic square, are depicted in the *Tao Fa Hui Yuan*,[6] a Thang encyclopaedia of Taoist liturgy and apotropaics (see Fig. 1535).[j] By +1116, when Yuan Miao-Tsung[7] finished his *Thai-*

[a] Since odd numbers were Yang and even ones Yin it embodied an expression of their ever-changing balance, as also of the generations and destructions of the five elements; and there were ingenious correlations with the trigrams and hexagrams of the *I Ching*. All these have been most fully worked out by Cammann (9), cf. esp. pp. 46, 50, 56, 65, 73. Although he tends to regard the Lo Shu symbolism as essentially celestial, the terrestrial aspects surely always clung to it also. For example, it was certainly understood as terrestrial by such adepts of Chinese cosmism as Hsiao Chi[8] in his *Wu Hsing Ta I*[9] (Main Principles of the Five Elements), *c.* +600, who there laid out the sacred mountains and great rivers of China in the framework of the Lo Shu cells (ch. 1, pp. 28*a*ff.). This might, with further study, throw light on the *fên yeh*[10] system of cartography in the Thang; see Vol. 3, p. 545.

[b] Also written Thai I[11, 12] like Thai-shan. Literally translated, the words mean 'Great Unity'. It was the name of an asterism which may have been one of the most ancient of Chinese pole-stars; cf. Vol. 3, pp. 260–1.

[c] Ch. 22 (vol. 1, p. 44).

[d] *Shih Chi*, ch. 28, p. 23*b*, tr. Chavannes (1), vol. 3, p. 467. Also *Chhien Han Shu*, ch. 25A p. 20*a*.

[e] Like the traditional later Altar of Heaven, still to be seen at Peking (cf. Vol. 3, p. 257). Cf. Chavannes (1), vol. 3, p. 490. Purple vestments replaced the former yellow, in correlation with the Purple Palace of the circumpolar stars (cf. Vol. 3, pp. 259ff.). One can see how the ancient connection between pole-star and emperor was at work here. See also Loewe (6), p. 11.

[f] Cammann (9), p. 63. Cf. *CHS*, ch. 99B, p. 13*a*.

[g] Vol. 3, Fig. 90, p. 241.

[h] See Tables 13 and 14 in Vol. 2; the first of the *kua* (trigrams and hexagrams).

[i] Ch. 2, p. 3*a*; the passage is translated in Vol. 3, p. 58. It is quoted also in the *I Wei Ho Thu Shu*[13] (in *Ku Wei Shu*, ch. 16, p. 2*a*); and, with Chêng Hsüan's valuable commentary, in *Hou Han Shu*, ch. 89, p. 11*b*, the biography of Chang Hêng.

[j] Ch. 94, p. 7*a*, ch. 98, p. 15*a*, *b*.

[1] 太一 [2] 太乙 [3] 兩義 [4] 謬忌 [5] 易緯乾鑿度
[6] 道法會元 [7] 元妙宗 [8] 蕭吉 [9] 五行大義 [10] 分野 [11] 泰一
[12] 泰乙 [13] 易緯河圖數

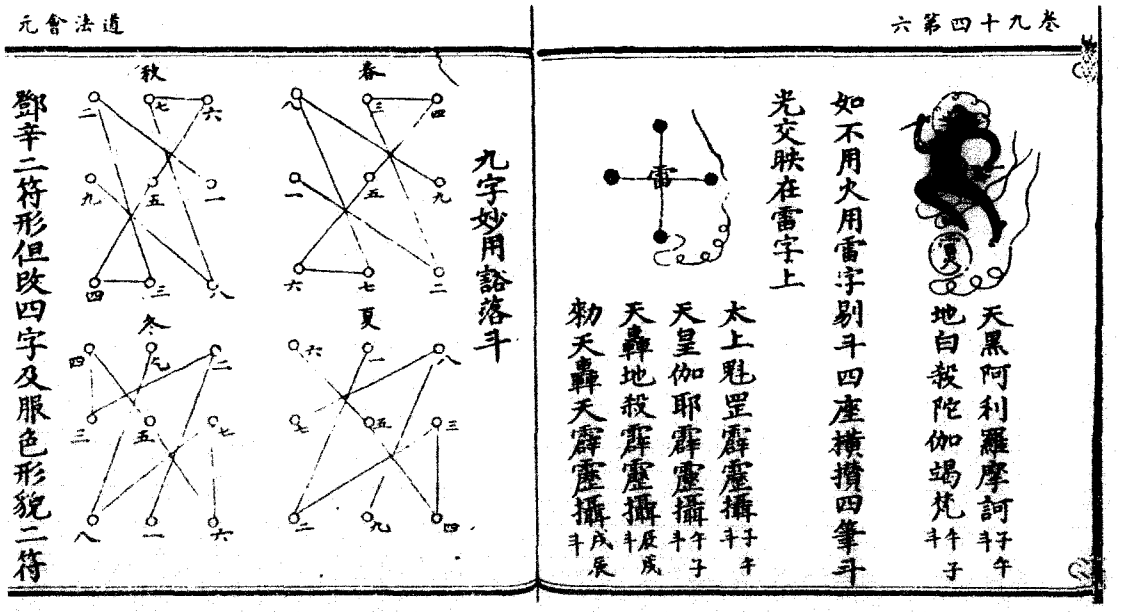

Fig. 1535. The tours of the god Thai I through the spaces of the universe represented by the nine cells of the magic square of three; from the Thang and Sung liturgical encyclopaedia *Tao Fa Hui Yuan*, ch. 94, p. 7*a*. The four diagrams give the routes for each of the four seasons. The caption calls it 'the mystery of the nine words of the *huo lo tou*'.

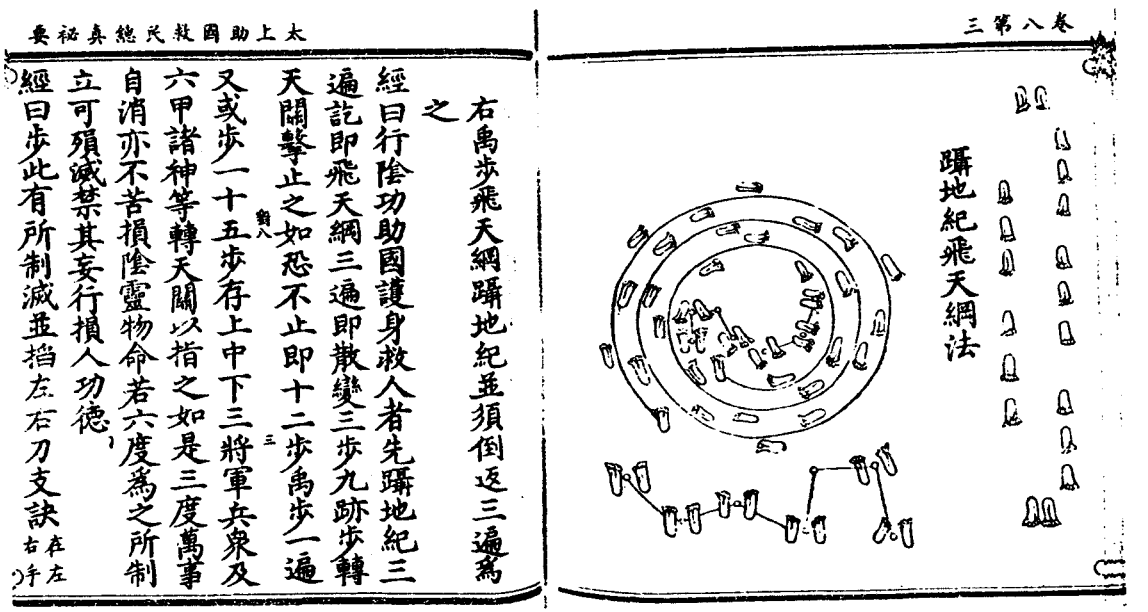

Fig. 1536. Directions for a Taoist ritual dance symbolising the circling of the Great Bear (*pei tou*) in the heavens; from the *Thai-Shang Chu Kuo Chiu Min Tsung Chen Pi Yao* (+ 1116), ch. 8, p. 3*b*. The caption calls it 'rules for treading the earth in memory of the flight of the (vehicle) Thien Kang' (cf. Vol. 3, Fig. 90, p. 241). An exactly similar notation of footsteps is used on p. 10*b* in 'the rule for dancing the *huo lo tou*', i.e. the route of the god Thai I through the universe during the winter quarter. The names of the nine cells of the magic square are given beside the footsteps, and the text of the appropriate chant to be sung during the ritual is provided alongside.

Shang Chu Kuo Chiu Min Tsung Chen Pi Yao,[1] a similar prayer-book or missal, the steps are marked out with drawings of footprints, thus showing that the idea of the progression had generated a liturgical dance.[a] Like the 'Pace of Yü', this was part of what came to be called *tha kang pu tou*,[2] 'treading the *kang* and stepping the *tou*', the former being the box of the Great Bear and the latter the whole constellation. These were the activities of Taoists, but the imperial court was still engaged in elaborate ritual representations of the processions of Thai I, and sacrifices to him, throughout the +8th century;[b] and the last known enacting of these did not take place until after the beginning of the Sung, in +1008.[c]

Thus to sum it all up, the scholars of ancient China saw in the numbers of the Lo Shu the two forces of Yin and Yang at work, the cycles of the Four Seasons and the Five Elements, and the deployment of the Nine Directions of space, emphasis always remaining on cosmic centrality like a kind of power-house. So cosmic a symbol was bound to be thaumaturgic, needing care lest it should get into the wrong hands—hence the secrecy which surrounded the magic square of three down to the end of the Thang. Though mentioned so much in texts, it seems never to have been seen in public.[d] Only after the fall of that dynasty, with Chhen Thuan's work in the Wu Tai period, did it enter into general knowledge and circulation.

Accordingly when the Arabic alchemists came into possession of the Lo Shu magic square about the beginning of the +9th century, they were receiving a cosmic symbol loaded with a great weight of reverent belief, eight centuries' worth in fact of numinous well thought out natural philosophy. There seems little cause for surprise that the Jābirians should have taken it as a great secret of the universe, whence they could extract those numbers which they believed would be found at the basis of the constitution of all natural substances.[e] There are still some obscurities in the whole transaction,[f] and we have no concrete evidence as to how the handing over came

[a] Ch. 8, p. 10*b*. See Fig. 1536.

[b] An account of these, with references, is given by Cammann (9), pp. 74–5, largely based on *Thang Hui Yao*, ch. 10B (pp. 256ff.). The *Chiu Kung than*[3] or Altar of the Nine Halls, with nine 'flying thrones' (*fei wei*[4]), was used for the services, and Thai I and the other gods were perhaps impersonated by actors, as in 'live chess'. The connections with chess are always in the background, and need further investigation, as e.g. in the case of the curious writings mentioned in Vol. 3, p. 542.

[c] There may also have been important repercussions in Japan. During the Heian period it was considered impious and dangerous to travel in certain directions at particular times of year, since it meant opposing the 'divinités ambulantes' (*yu hsing shen*[5]), as Frank (1) calls them in his monograph on the subject. Thus there were 'direction-prohibitions' (*kata-imi*[6]) and 'direction-disobedience' (*kata-tagae*[7]).

[d] Unless it was pictured in the full versions of some of the apocryphal Han prognostication books (*Chhan Wei shu*[8]), most of which were destroyed in literary inquisitions such as that of +605, and none of which are available to us now.

[e] It may be of interest to remark that attempts at the quantification of the Galenic qualities were still going on as late as Elizabethan times, as witness the study of John Dee's grading mathematics by Clulee (1). On Dee himself (+1527 to +1608) see French (1).

[f] For example, why one gnomon should have been chosen out of the possible four. Also magic squares do not seem to have played any very significant part in Chinese alchemy, though of course invisibly represented in *kua* arrangements. They were prominent, however, in Burmese alchemy of the +15th century; Htin Aung (1), p. 54. Could this imply Arabic influence?

[1] 太上助國救民總眞秘要 [2] 踏罡步斗 [3] 九宮壇 [4] 飛仗
[5] 遊行神 [6] 方忌 [7] 方違 [8] 讖緯書

about,[a] but when one remembers the opportunities for intercourse both in Central Asia and in the coastal cities of China (cf. pp. 417, 422 ff. above), one can see that it would have taken hardly more than a brace of well-educated merchants in Ferghana, or a couple of intelligent Arab physicians in Canton,[b] who happened to fall in with a milieu of Taoist literati, to imagine how the entire gift might have been conveyed. Of course the use made of it was different, but the magic square was the same, and it looks as if here the Arabs owed much more to Taoists than to Pythagoreans.

We have now seen reasons for believing that both the sulphur–mercury theory of metals and the use of the Lo Shu numbers as the fundamental 'constants' in Arabic alchemy originated from intercourse with the earlier alchemy of China. But any reader with a Chinese background who studies attentively the available translations and descriptions of Arabic texts acquires gradually an uneasy feeling of *déjà vu*. Certain ideas and expressions seem unexpectedly familiar. It is therefore greatly to be hoped that much further work may be done, preferably by scholars who are masters both of Arabic and Chinese as well as having some acquaintance with chemical science, on the similarities which thus present themselves. Here we can do no more than draw attention to some of them. What needs to be done is the converse of that which was accomplished for the Greek sources by Kraus (3), namely to find out what Chinese sources there could have been for Jābirian ideas, and try to pin-point which of these are more easily explicable from the Chinese than from the Greek angle.

For example, the structure of the implicit natural philosophy should be examined carefully. What connection could there have been between the Chinese Five Elements[c] and the continuing Arabic predilection for speaking of a pentad of principles? 'Five elements or kinds of matter', it has been said, 'are consistently differentiated by Arabic writers'[d]—and with many variations this is true from al-Kindī in the +9th century through al-Rāzī and al-Fārābī in the +10th to Solomon ben Gabīrōl[e] in the +11th and beyond.[f] Moreover there are passages speaking of the mutual generation and destruction of the elements.[g] Then maleness and femaleness, recalling so strongly the Yang and Yin, is found throughout the Arabic texts;[h] even to such statements as: 'once it has arrived at its maximum of perfection, a thing can only decrease.'[i] The metals were divided into two groups, gold, iron, tin, lead and *khārṣīnī* being male; silver, copper and mercury female.[j] So also were other chemical substances; for example there were two forms of *maghnīsiyā*, one female and the other male.[k] Only

[a] There have been two obvious hints pointing to the Ṣābians and Ḥarrān in the preceding pages.

[b] One could even hazard a guess that they were gynaecologists in view of the frequency with which the Lo Shu appears in Arabic texts from the beginning as a childbirth charm.

[c] Cf. Vol. 2, pp. 242ff., 253ff.

[d] Multhauf (5), p. 147, cf. p. 121. On the five principles, found alongside the four Aristotelian elements in the Jābirian Corpus, see Kraus (3), p. 137.

[e] More often known as Ibn Gabirol or Avicebron (+1021 to *c.* +1058).

[f] On some of the later Arabic alchemical writers cf. Taslimi (1); Razuq (1).

[g] Berthelot & Houdas (1), pp. 78, 100 (*K. al-Ḥabīb*).

[h] For example, Berthelot & Houdas (1), p. 69 (*K. al-Qarāṭīs*), 76–7, 79, 103 (*K. al-Ḥabīb*), 121 (Ar. Ostanes), 131 (*Kitāb al-Mulk*, Book of Royalty, Kr 454). Cf. Multhauf (5), p. 132 on Balīnās.

[i] Berthelot & Houdas (1), p. 77 (*K. al-Ḥabīb*).

[j] Cf. Siggel (3); Multhauf (5), p. 133. Mercury was sometimes judged to be hermaphrodite.

[k] Stapleton & Azo (1), p. 57 (after al-Khwārizmī al-Kāṭī and the *Rasā'il* of the Brethren of Sincerity).

those with a command of the whole range of Arabic texts will be able to tell us whether this Yin–Yang mentality is wholly capable of explanation from the Mediterranean background; meanwhile we suspect at least a Chinese contribution. And from time to time there are the strangest of Taoist echoes—the superiority of movement to rest (the 'unrestingness of the sage'),[a] the cosmogonic procession of numbers (as in the *Tao Tê Ching*),[b] and similarly the overcoming of the strong by the weak.[c]

The Yin–Yang differentiation comes in again with regard to the two spiritual entities envisaged by Arabic naturalists as intrinsic to all things and substances.[d] There was the *rūḥ* 'spirit', the male 'animus' tending to return upwards to the heavens, and the *nafs* 'soul', the female 'anima' tending to sink into the earth below.[e] The former assured continuity (hence also, later, longevity), the latter moulded the visible form and the individuality; but there was much variation in usage, so that *rūḥ* could be applied, for example, to distillate vapours. In the Jābirian period *rūḥ* normally translated Greek *pneuma* (πνεῦμα)[f] and *nafs* Greek *psychē* (ψυχή),[g] but chemically the former signified the group of volatile substances, sometimes five, sometimes eleven in number,[h] i.e. the *arwāḥ*. Two of these, however, sulphur and arsenic, were at times distinguished as *nafs*, together with the volatile essential oils. In the Corpus we find three tractates on *rūḥ*[i] and one on *nafs*.[j] The question is, how far can all this be accounted for purely on Hellenistic, Syriac and Persian grounds, and whether the possibility of some parallelisms with the *hun*[1] and *pho*[2] theories of Chinese naturalism would not be well worth investigating (cf. pt. 2, pp. 85ff. above).[k]

The same considerations present themselves at the more practically chemical level. The relations of cinnabar to gold are sometimes spoken of in a very Chinese way,[l] and 'our gold is better than that of the vulgar',[m] just as Pao Phu Tzu would have said (cf. pt. 2, pp. 68ff. above). Of natural sympathies and antipathies there is a great deal

[a] Berthelot & Houdas (1), p. 76 (*K. al-Ḥabīb*). Cf. Vol. 4, pt. 1, p. 61.

[b] *Op. cit.*, p. 91, from the same book. [c] *Op. cit.*, p. 105, again from the same book.

[d] Attention was drawn to this by Mahdihassan in a number of papers: (31), pp. 24, 31, (32), pp. 335, 339, 343, (33), p. 82, (34), p. 81. Massignon (5) made a special study of it.

[e] A typical passage showing how these ideas were used may be seen in the Jābirian *Kitāb al-Zībaq al-Sharqī* (Book of the Eastern Mercury), Kr 470, tr. Berthelot & Houdas (1), p. 208.

[f] Hence it equated also with *chhi*.[3]

[g] See Kraus (3), pp. 153, 160, 166, 285 for *rūḥ*, pp. 21, 330 for *nafs*.

[h] Sulphur, arsenic, mercury, sal ammoniac (cf. p. 435 above), and camphor were the standard five, but elsewhere sulphur was differentiated into four kinds, the red, the yellow, the black and the white; arsenic into its two sulphides, the red and the yellow; while both mercury and sal ammoniac were considered to come in two forms, the 'mineral' or natural, and the 'derived' or artificial. The former could not have differed, but the latter doubtless distinguished between the chloride and the carbonate, cf. p. 432 above.

[i] The *Kitāb al-Rūḥ* (Kr 25); the *K. al-Rūḥ fī'l-Mawāzīn* (Book of the Animus and the (Science of the) Balances), Kr 1009; and *K. Rawḥ al-Arwāḥ* (Book of the Repose of the Animi), Kr 1007, presumably on the condensation of volatile substances.

[j] *Kitāb al-Nafs wa'l-Manfūs* (Book of the Anima and the Animate), Kr 822.

[k] Both in Neo-Platonic and later Latin medieval thought there is much to be pondered on in this context. For example Pagel (18) has examined the concepts of archaeus, astral body, entelechy, ochema, sophic fire, and the like, in the Gnostic and Hermetic background of Paracelsus.

[l] Berthelot & Houdas (1), p. 87, *K. al-Ḥabīb* again.

[m] *Op. cit.*, p. 181 (*K. al-Raḥma al-Kabīr*, Kr 5)

[1] 魂 [2] 魄 [3] 氣

in the Jābirian Corpus as elsewhere,[a] but only a detailed and wide-ranging analysis would enable us to decide how much of this goes back to Bolus of Mendes and how much to the Prince of Huai-Nan.[b] This was no doubt the pseudo-science out of which came the earliest conceptions of chemical affinity and reaction, so it is interesting to find general statements[c] recalling the Chinese 'categories' which we studied at an earlier point.[d] Lastly, the usage of 'cover-names' was universal among the Arabs just as it was among the Chinese. At one place we have the practice admitted very clearly,[e] at another we find names reminiscent of Chinese imagery, such as 'clouds-and-rain' for mercury.[f]

Here we are very near the borders of magic and divination; and there is evidence that some of this came westwards from China to Arabic culture also. Ibn Khaldūn in his *Muqaddima* (+1377) was very interested in a method of divination called *zā'iraja*.[g] One form of this was performed on a chart called *zā'irajat al-'ālam* or 'table of the universe', said to have been introduced by one Aḥmad al-Sabtī of Ceuta in the +12th century. It had a matrix system 55 compartments in breadth and 131 in length superimposed upon concentric circles representing the spheres and elements of the sublunary world as well as that of the spirits. Highly complex calculations done in connection with this started out from the astrological situation at the time, but then followed principles depending on the numerical values of the letters of the Arabic alphabet; so there was clearly a certain connection with the 'science of the balance' (p. 459 above) used in Jābirian alchemy. An exposition of the system is given by Dunlop,[h] who regards it as a good example of Arabic science in decline, though the *'ilm al-mīzān* of the Jābirian flowering-time was surely not much better. Interest for us lies rather in the fact that one variant of the technique was called the *zā'iraja Khiṭā'iyya*, and said to be due to one 'Umar ibn Aḥmad ibn 'Alī al-Khiṭā'i, presumably a Chinese from the borderlands who lived his life as a Muslim.[i] One would not be at all surprised to find that complex magic squares had played a part somewhere in the development of these systems.

There may have been another contact much earlier, judging from what we learn of the divination books associated with the name of the Sixth Imām, Ja'far al-Ṣādiq (p. 390 above). Ruska gives a table of 'elegant sand divination' (*qur'at raml laṭīfa*) with long and short lines, taken from one of these traditional books;[j] the symbols are distinctly reminiscent of the trigrams and hexagrams of the *I Ching*[1] (Book of

[a] *Op. cit.*, pp. 150ff. (*K. al-Mīzān al-Ṣaghīr*, Kr 369). Cf. Kraus (3), pp. 61ff., 65ff.

[b] Cf. pp. 311ff. above.

[c] Berthelot & Houdas (1), pp. 53, 58 (*K. al-Qarāṭīs*), 78 (*K. al-Ḥabīb*).

[d] Cf. pp. 305ff. above.

[e] Berthelot & Houdas (1), p. 214 (*Kitāb al-Zībaq al-Gharbī*, Book of the Western Mercury, Kr 471). Western mercury was a cover-name for water, and eastern mercury for oil.

[f] Siggel (3), p. 27.

[g] Tr. Rosenthal (1), vol. 3, pp. 182 to 227, with MS. illustration, pp. 204–5.

[h] (6), pp. 242ff. It has been used within living memory in Egypt; Lane (1), p. 239.

[i] This we know from the great Turkish bibliographer Ḥajī Khalīfa, who in his *Kashf al-Ẓunūn* (Discovery of the Thoughts) lists four books on it; Flügel (2) ed., vol. 3, pp. 532–3. We are much indebted to Professor D. M. Dunlop, who was curious about the Chinese connection, for bringing this subject to our knowledge.

[j] (5), pp. 26ff., 28.

[1] 易經

Changes),[a] or even more, perhaps, of the series of 81 tetragrams developed by Yang Hsiung[1] in his *Thai Hsüan Ching*[2] (Manual of the Great Mystery) around +10.[b] There would have been plenty of time for such ideas to have passed to the Arabs by the time of Ja'far, *c.* +740.

All such possibilities are doubtless somewhat nebulous and require much further investigation, but we have said enough in the preceding pages to suggest, if not indeed to prove, that theoretical influences more than negligible were exerted upon Arabic alchemy from the Chinese culture-area. Some were proto-science, paralleling the real knowledge of actual substances which also came, and others were pseudo-science, but even these last were straws on the stream to show the way the current was flowing. We have left till the last the most important influence of all, the name and concept of elixir, and it is to this that we are now in a position to turn.

(v) *The name and concept of 'elixir'*

In Arabic alchemical thought, *al-iksīr* was a substance which when added in projection (*ṭarḥ*) to any imperfect thing brought about a change for the better in the balance or *krasis* of its qualities, i.e. a transmutation (*qalb or iqlāb*).[c] Even a change to the perfect equilibration seen in gold was possible. Living things also were capable of a similar perfection, which in their case meant health and longevity, so that the *iksīrs* were naturally thought of as drugs, the 'medicines of man as well as of metals'.[d] And just as *iksīrs* would powerfully work on plants, animals and human beings no less than on mineral or metallic substances, so in their turn they could be prepared by art from any of the three natural kingdoms—a Chinese rather than a Hellenistic trait. The different schools (*ṭawā'if*) which emphasised one or other of these realms as raw material starting-points were discussed at length in one of the books of the Jābirian Corpus, the *Kitāb al-Lāhūt* (Book of Divine Grace).[e] In another work, perhaps older, the 'Opinions of Balīnās on Mineral Substances' (*Kitāb al-Aḥjār 'alā Ra'y Balīnās*),[f] it is declared that there are seven types of *iksīrs*, three uncombined, three with constituents drawn from two of the realms in different combinations, and one made of substances taken from all three realms. Processes of distillation nearly always enter into the preparations.[g]

[a] See Vol. 2, pp. 304ff. [b] Vol. 2, p. 329.

[c] The best account is still that of Kraus (3), pp. 2ff. It seems hardly necessary to say that the word occurs consistently from the very beginning of Arabic alchemical writing—as in the Balīnās texts (Ruska, 8) and the *Kitāb Qarāṭīs al-Ḥakīm* (Book of Crates), on which see Berthelot & Houdas (1), pp. 65, 66, 70.

[d] 'The idea of the medical use of elixirs,' wrote Kraus, 'so widespread in (later) Latin and Indian alchemy, seems to have been unknown to the Greeks'.

[e] Kr 123, cf. Berthelot (12), p. 310. [f] Kr 307 to 310.

[g] It is interesting to see the forerunners here of the fire-decomposition processes purporting to prove Aristotelian element-theory which were so devastatingly criticised by Robert Boyle in the 'Sceptical Chymist'. Fire was represented by gases (*nār* or *ṣibgh*) from the combustible material, Air by the condensable vapours or oils (*duhn*), Water naturally by the aqueous fraction (*muḥallil*), and Earth by the mineral residue or *caput mortuum* (*arḍ*). This is common to al-Rāzī and most of the other Arabic writers.

[1] 揚雄 [2] 太玄經

The provenance of the word *al-iksīr* has given rise to a good deal of discussion, for it has no obvious Arabic root.[a] Little help is available from the Jābirian writers themselves, who engage in the manner of their time in fanciful etymologies. For example, the *Kitāb al-Raḥma al-Kabīr* says:[b]

> *Al-iksīr* was thus named because it has so great a power over the substances on which it is projected, transforming them and conferring its own nature upon them.[c] Others aver that the name originated because the elixir breaks and divides itself up;[d] and others yet again say that it got its name because of its nobility and superiority.[e]

It is probable, however, that the second of these suggestions was fairly near the mark. For since the first proposal of Fleischer in 1836 it has been generally assumed that *iksīr* was taken wholly from the Greek word *xērion* (*ξήριον*), found quite often in the Hellenistic Corpus.[f] In one clear statement of Olympiodorus (+6th century) this is identified as the 'dry powder of projection' (*epiballeis to xērion*, *ἐπιβάλλεις τὸ ξηρίον*, said of adding arsenic to copper);[g] but in many other occurrences the word 'projection' was supplied, not unreasonably, by Berthelot & Ruelle.[h] There is even a fragment entitled *Peri Xēriou* (*περὶ ξηρίου*, On the Powder), presumably part of a lost tractate,[i] in which it is said that the truest powder (*alēthestaton xērion*, *ἀληθέστατον ξηρίον*) has three powers, those of penetration, tincture and fixation. And it is interesting that the word, which originally probably meant any dry powder, had slight medical undertones, for the physicians used it to signify styptic preparations suitable for strewing on open wounds.[j]

In the Syriac texts of the +7th to the +9th centuries but based largely on early material in Greek, the word is perfectly recognisable in its new forms—*ksyra*, *ksirin*,

[a] For example, *kasr* (reduction, breaking up) would have given rather *taksīr* (priv. comm. from Dr Said Durrani).

[b] Kr 5, tr. Berthelot & Houdas (1), p. 181 (para. 46).

[c] Here the pun seems to be on *qūwa* (power).

[d] This must be the derivation already mentioned from *kasr* (reduction, division into pieces), however unconvincing.

[e] Here several alternative words seem to be available for consideration as roots, and one cannot tell which the writer had in mind. Thus we have *qāhira* (noble, superior; as in Cairo); *qudra* (capability, competence); and *kathīr* (manifold, numerous, multipotent). The translation of Houdas here, as often elsewhere, is a mere précis of the richness of the Arabic text, as we have had occasion to appreciate in the study of this passage with Dr Muhammad N. Yacout of Caius, to whom warmest thanks are due.

[f] For example see Singer (8), p. 49. And the derivation is given as standard in various modern dictionaries.

[g] *Corp. Alchem. Gr.* II, iv, 12.

[h] For example, *Corp.* III, vi, 11 and xxix, 24 (Zosimus, *c.* +300, speaking of the qualities of the powder); *Corp.* IV, xix, 9 (Iamblichus, also *c.* +300); *Corp.* VI, xv, 9 (Philosophus Anonymus, late +7th cent.); *Corp.* VI, xvii, 1 (a fragment of obscure origin, perhaps late); *Corp.* VI, xx, 12, 13, 17 (Nicephoras Blemmydes, +13th cent.).

[i] *Corp.* III, xxxi, included by the editors among the Zosimus material.

[j] The earliest occurrence of this is not, as sometimes said, in Galen, but in the Oxyrhynchus Papyrus 1142.7 (+3rd cent.), thereafter in Aetius, 6, 65 and Alexander of Tralles, 1, 15 (both of the +6th century). Galen recommends (in *De Meth. Med.*, Kuhn ed., vol. 10, pp. 320–1) a mixture of incense gum and bitter aloes as a styptic; according to Schleifer (1), p. 350 it is probable that this passage was the model for one in the Syriac 'Book of Medicines' (see Budge (6), vol. 1 (Syriac), p. 43, vol. 2 (Eng.), p. 41). But here the word *ksyryn* is used, though *xērion* is not in Galen. Budge missed the point, and translated 'powdered aloes'. We gratefully acknowledge discussions with Dr Sebastian Brock on these matters.

ksyryn, *iksirin*, *eksirin*—and in association with projection (*arma*, from *rma*, to throw).[a] Indeed it is used even more frequently. But it seems no longer to mean a dry powder only, for it is said to be like honey, like ice, like a metal, like rust, or a distillate, or even an oil. This suggests that by the beginning of the +8th century an inflow of other ideas was entering the Arabic world from some quite different quarter, accompanied perhaps by a similar sound which was identified with the *x* or *ks* phoneme, and carried with it a powerful reinforcement of the idea (so strong as to be essentially a new thing), that the elixir partook of the nature of a medicine.

This consideration leads us to see some value in the proposals which have been made to derive *iksīr* from Chinese roots, just as in the case of 'chem-' which we examined earlier (pp. 351 ff.). Dissatisfied with the purely Arabic or Greek derivations, Mahdihassan in 1957 suggested that Chinese phrases such as *yao chi*,[1] 'medicinal dose', or *yao chih*,[2] 'medicinal mushroom',[b] should be perpended.[c] The Thang pronunciation of the former would have been something like **iäk-dziei*, and that of the latter perhaps **iäk-tsi*,[d] but unfortunately neither phrase is at all a classical one.[e] Some years later Mahdihassan changed his mind and proposed the more unlikely *i chhi*,[3] which would mean something like 'unitary pneuma' (medieval pronunciation **ik-si*), not a phrase with any very close proto-chemical connections.[f] Soon afterwards the eminent sinologist Dubs came in with yet another suggestion, namely *i chih*,[4] literally 'essence of a juice', or as he took it, 'the substance of a fluid secretion';[g] the Thang pronunciation of which would have been something like **iäk-ts'iət*. There, apart from criticisms by Mahdihassan,[h] the matter has rested. The suggestion as a whole does not carry the weight which, as we saw, can be attached to *chin*[5] (*kim*), gold, as the origin of 'chem-', but it deserves perhaps to be retained for a while if only as a possible case of an erroneous but suggestive linguistic identification. If one visualises an Arab merchant of the +8th century in Canton or Hangchow or Sinkiang discussing alchemy with agreeable Taoist contacts, one can imagine his interest at finding a phrase which sounded so like the Syriac *iksirin* or Arabic *iksīr* with which he was already familiar, and we know how easy it always is in such cases to make an unjustifiable judgment of identity. 'How extraordinary—that's just what *we* say!' But imperceptibly of course he was absorbing a number of things which had not previously been said

[a] In Berthelot & Duval (1), for the main Syriac MS. see instances on pp. 41, 42 ff., 46, 48 ff., 51 ff., 55, 76, 95–6; and for the Cambridge Syriac MS., p. 258. In the Arabic MS. of rather later date, written in Syriac script, see pp. 142, 168, 182–3. Here it always appears as *al-iksīr*.

[b] On this aspect of Chinese alchemical symbolism cf. pt. 2, pp. 116, 121, 125 above.

[c] (9), p. 128. [d] Cf. Karlgren (1), esp. 800*n*.

[e] For example neither appears in the *Pao Phu Tzu* concordances of Ware and Schipper.

[f] (17), p. 75, (20), (21), pp. 197–8. Mahdihassan picked the phrase up from a reference by Li Chhiao-Phing (1), p. 17 to the *chen i chih chhi*,[6] the *chhi* of the primary vital unity; and this was in a way a misunderstanding since Li was speaking of a book of physiological alchemy, the *Huang Pai Ching*[7] (cf. pt. 5) under the impression that it was talking about proto-chemical processes. Cf. pt. 3, pp. 216 ff. above.

[g] (34), p. 35. Correct *RBS*, 1968, vol. 7, no. 755, where the situation is wrongly stated.

[h] (19) and (25), pp. 49 ff. He suggests, it is not quite clear why, that *kīmiyā'* travelled westwards by sea and *iksīr* overland.

[1] 藥劑 [2] 藥芝 [3] 一氣 [4] 液汁 [5] 金
[6] 眞一之氣 [7] 黃白經

among the Greeks, Syrians and Arabs, namely e.g. that the powder of projection was also a mighty medicine, the panacea of man as well as metals.[a]

In order to prove that this was how the Arabs saw the affair it will be necessary to give a number of direct quotations. Gruman (1), to whom we owe the best monograph on the history of macrobiotics, or what he called prolongevity, in all the Old World cultures, was disappointed in what he could find about such elixir effects in the translated texts which were available to him.[b] I think we can show that the harvest is not so disappointing, and that we come into the presence of macrobiotic medicines before the end of the century which saw the death of the Prophet. Let us start with two records of this early period, one which may imply only aurifaction though the word elixir is used, and one which unquestionably refers to a longevity drug.

The latter comes from the *Kitāb al-Imāma wa'l-Siyāsa* (Book of the Religious and Civil Authority) attributed to Ibn Qutayba who died in +889, but perhaps rather by one of his contemporaries.[c] The Caliph 'Abd al-Malik (r. +685 to +705) appointed his brother Bishr ibn Marwān as Governor of Basra, with Mūsā ibn Nuṣair as his principal adviser. Now Bishr was fond of pleasure and handed over the conduct of all affairs to Mūsā. While thus withdrawn from business:

> One of the men of Iraq came before him, and said: 'In God's name, is it your wish that I give you a drink which will cause you never to grow old, subject to certain conditions which I shall lay upon you?' 'What are these conditions?' asked Bishr. 'That you do not allow yourself to be angry, do not mount a horse, and have no dealings with women, nor yet take any bath, for forty (days and) nights.' Bishr accepted these conditions, and drank what was given to him, shutting himself up from all men, near and far, and remaining secluded in his palace. And so he continued, till news suddenly reached him that he had been given the Governorship of Kufa as well as of Basra. At this, his joy and delight could not be contained. He called for a horse to go to Kufa, but the same man appeared and urged him not to set forth, and not to stir by the least movement from his place. But Bishr would not listen to him. When the man saw his determination, he said: 'Bear me witness against yourself that you have disobeyed me!' And Bishr did so, testifying that the man was free of blame.
>
> Then he rode out to Kufa, but he had not gone many miles when, having placed his hand upon his beard, lo! it fell away in his hand.[d] Seeing this he turned back to Basra, but remained there not many days until he died. When the news of the death of Bishr reached 'Abd al-Malik, he sent al-Ḥajjāj ibn Yūsuf as Governor in his room.

There may be some degree of the fictional in this story, but the fact that it was current so soon after the event suggests at the least that people were talking about elixirs of perpetual youth or life around the time of the death of Bishr ibn Marwān, which can be fixed at +694. The remarkable story is repeated in a work indubitably written by Ibn Qutayba, the *Kitāb al-Ma'ārif* (Book of Knowledge in General), where he says that Bishr died after drinking the remedy called *idhrīṭūs* or *adhrīṭūs*.

[a] That Arabic alchemy had a far more medical character than Hellenistic proto-chemistry was noted long ago by Temkin (3), and we agree with him rather than with Ullmann (1), p. 150; cf. Vol. 5, pt. 2, p. 15. But it is even more true of Chinese alchemy, where, as we have seen in Vol. 5, pt. 3, the great majority of adepts were physicians too.

[b] Pp. 59ff.

[c] What follows is in the words of Dunlop (6), pp. 208–9 and (7), pp. 3–4, with minor modifications.

[d] As Professor Darbishire pointed out at Guelph University, Ontario, this would suggest the presence of arsenic, lead or thallium in the elixir.

The identification of this term was solved by Dunlop (8), who suggested that the statement: 'a night spent at Ḥīrah is more healthful and profitable than the taking of a draught of the sherbet of Theodoretus'[a] had nothing to do with the +5th-century theologian,[b] but referred again to *ahdrīṭūs* (*thādurīṭūs*), and that this was most probably just the Greek *adōrētos* (ἀδώρητος), 'not given'. And indeed the word does occur in the Zosimus writings, applied to some kind of agent used for blanching or whitening metal surfaces—a far cry from life elixirs. The passage runs thus:[c]

> This is the uncommunicated mystery which none of the prophets dared to divulge in words but revealed only to the initiated. In their symbolical scriptures they called it the stone which is not a stone, the thing unknown yet known to everyone, the despised thing of great price, the thing given by God and yet not given (*ton adōrēton kai theodōrēton*, τὸν ἀδώρητον καὶ θεοδώρητον). For my part I shall praise it under the name of the thing given by God and yet not given, for in all our works it is the only thing which dominates matter. Such is the drug of power (*to pharmakon to tēn dynamin echon*, τὸ φάρμακον τὸ τὴν δύναμιν ἔχον), the mithriac mystery.[d]

Thus the terminology here must have been of Greek origin, taken from a passage which even ends with a poetical reference to a drug. But the idea of a medicine of eternal youth was exceedingly un-Greek, and what is more, the story includes some remarkably typical Chinese features, especially the injunctions to refrain from all the passions during the course of the treatment or training—vital, as we shall find (pt. 5 below) in physiological alchemy, and very likely to have been stipulated by Taoist adepts offering life elixirs. Of course there is no need to suppose that the physician-alchemist in this case was actually Chinese, only that he must have been in contact with Chinese culture; and this could have been true of one man whose participation in the events has been suggested by Dunlop already, namely Māsarjawayh, the Syriac-speaking Jewish physician of Basra (*fl.* +683 to +717), later frequently referred to by Arabic men of science, and certainly living in a great trading centre where Chinese contacts in depth may well have been likely.[e]

The other story from this early period concerns a Jacobite bishop of the +8th century, Isaac of Ḥarrān, and comes from an anonymous Syriac fragment edited and translated by Brooks (1).[f] This Isaac was a bad character, a *budmāsh*, irregularly instituted in the first place; to him came a strange wandering monk, who performed an

[a] From near the end of the 6th book of *Annals* of Ḥamza al-Iṣfahānī, dealing with +7th-century events.

[b] However, in the time of Paul of Aegina (*fl.* +640, cf. Sarton (1), vol. 1, p. 479) there really was an antidote called Theodoretus (see Adams tr. (2), vol. 3, p. 520) made up with or without anacardia. It only meant 'God-given'. Paul stayed in Alexandria after the fall of the city, and had great influence on Arabic medicine.

[c] *Corp.* III, ii, 1.

[d] I.e. Mithraic, a *hapax legomenon* in the Corpus, but interesting for its Persian background.

[e] Hitti (1), 2nd ed., p. 255; Dunlop (6), p. 213. He was one of the earliest of the translators from Greek and Syriac into Arabic, as we saw on p. 411.

[f] Parallel texts are those of Michael the Syrian, *Chronicle*, XI, 25 (Chabot ed., vol. 2, pp. 523ff.) and Bar Hebraeus, *Chron. Ecclesiast.* (ed. Abbeloos–Lamy, vol. 1, p. 315). Both translate the Syriac word *eksirin* wrongly as *secretum*. The significance of Isaac's birthplace and background (cf. pp. 426ff.) will not be overlooked. We are much indebted to Dr Sebastian Brock for communicating to us knowledge of this fragmentary chronicle, in which further references to alchemy in one form or another occur.

aurifaction in his presence using an elixir. A day or two later, Isaac, accompanying him on his way, murdered him by throwing him down a well, but found in his cloak neither a supply of the *eksirin* nor instructions for making it. Isaac eventually got himself made some kind of patriarch because of his pretended art, but when he proved unable to teach it to the secular Muslim ruler, the emir had him executed in +756. Here there is nothing overt about macrobiotics save the name of the substance, but the story has an uncanny similarity to a hundred others found in Chinese texts of earlier as well as subsequent times.[a]

Hardly more than half a century later we are at the beginning of the Jābirian Corpus, which contains a good deal more about the idea of human imperishability than has sometimes been thought. Here everything resolves round the conception of *'adl* or *krasis*, that perfect heavenly equilibrium, if only it could be attained. Though the idea is in part very Greek, very Galenic, it is also in part very Chinese,[b] since perfection of equilibrium between Yin and Yang had been the highest longed-for good in that culture since the middle of the – 1st millennium. Thus

I have shown you by examples [says the writer of the *Kitāb al-Mīzān al-Ṣaghīr*][c] the necessity of the equilibrium of the qualities in the performance of the Great Work; apart from that it does not often matter so much. You must know that this equilibrium is indispensable in the Science of the Balance and the practice of the Work; one way may be easier than the other but the principle is identical. Thus I have told you about waters, equilibrium, synthesis, analysis, softening and the like, I have shown you everything if you have eyes to see—but if you have eyes and see not, the fault cannot be attributed to me.

In the 'Book of the Concentration' (*Kitāb al-Tajmī'*)[d] I wrote that 'if we could take a man, dissect him in such a way as to balance his qualities, and then restore him to life, he would no longer be subject to death.' Admit the good sense of the argument—have I not said that living beings need an equilibration of their qualities? This once obtained, they are no more affected by change and decay, and undergo no further modifications, so that neither they nor their children can ever perish. By God's grace no longer need they fear diseases such as leprosy or elephantiasis. He who does not know this knows nothing, and there is no science in him.

Similar notes are struck in many Jābirian texts. The *Kitāb al-Raḥma al-Kabīr*, for example, says that the death of a man is always due to one of the humours (the qualities) overwhelming another, or all the others; this is why the soul has to leave the body.[e] Elsewhere in the same book we read:[f]

The least fragile things are those which have the least opposition (of qualities) within themselves. They are the best equilibrated, the best composed, they last longer than others and are less liable to dissolution. They resist best all destructive forces tending to the separation of the spiritual and corporeal elements. Now those things which suffer most from

[a] Cf. pt. 3, pp. 106, 212, 215 above.

[b] Cf. pp. 226, 253 above. Another Arabic term which could be used for *krasis* was *i'tidāl*, perfect proportion or equilibrium (Bürgel (1); Ullmann (1), p. 173).

[c] Kr 369, tr. Berthelot & Houdas (1), pp. 147–8, eng. auct. adjuv. Gruman (1), p. 60.

[d] Kr 398. This is the book which contains so much on the principles and practice of artificial generation; cf. p. 396 above and pp. 485 ff. below.

[e] Kr 5, tr. Berthelot & Houdas (1), p. 174. One of the earliest of the texts.

[f] Tr. Berthelot & Houdas (1), p. 173, eng. auct., adjuv. Gruman (1), pp. 60–1.

internal oppositions are the living beings, animals and especially man. So long as the qualities are balanced in their oppositions, he remains in a state of health, but if one of them gains over the others he falls ill and the gravity of his illness is proportional to the excess of one of the qualities over the others. If it dominates them too violently death will ensue and the soul will separate from the body. Thus was it that God created man; if He had wanted him to live for ever He would have planted in his being only concordant elements, not warring ones. Since He did not do this He must have intended every living thing to die. And since God did not want any living being to subsist for ever, he afflicted man with this diversity of the four qualities which leads to death...

As Gruman says, this is rather different from the confident tone of Ko Hung and the alchemists of China,[a] but something must be allowed for the conventionalities of Muslim piety.[b] Of course no other culture had the Chinese belief in a distinctively material immortality, but it was possible for that to turn into a belief in extreme longevity when it found its way into the monotheistic lands of the 'People of the Book', who had always before them the examples of the Old Testament patriarchs. This point we must return to shortly, here more is to be said about the elixir as a medicine both metallurgical and human.

The 'fevers' of metals are cured by the elixir. In the same *Kitāb al-Raḥma* we are told that red and yellow copper are patients suffering from a hot fever of the yellow bile and blood, while tin and mercury have a cold fever due to the black bile and the phlegm.[c] This is imagery for which there are some slight echoes in the Hellenistic Corpus,[d] but in other places the term 'remedy' is freely applied to reagents affecting transformations in the appearance or composition of metals and alloys.[e] In another book, the *Kitāb al-Zībaq al-Gharbī* (Book of the Western Mercury), this mysterious substance is apostrophised in words which recall the metaphorical rhapsodies of the Hellenistic Corpus (cf. pt. 2, p. 72 above) and yet suggest the presence of something newer and more concrete, certainly not much constrained by the piety we have just encountered.[f]

Know that this 'water' has been named Divine because it brings the qualities out from among the qualities and revivifies the dead; therefore it has been called the 'Water of Living Things', just as the stone has been called the 'Animate Stone'. It is the Water of Life, and he that has drunk of it can never more die...

This is phraseology which we find often repeated in later Arabic writers.

[a] In another place (Berthelot & Houdas tr., p. 188) it is suggested that the union of 'souls' (volatile substances) with 'bodies' (non-volatile substances) is a model for the dead whom God will resurrect at the last day. They will then be complete and immortal, but some destined for heaven and some for hell.

[b] Islamic theologians may well have doubted the legitimacy of interfering with an individual's allotted life-span. Hence perhaps the *Responsum de Longævitate* in the *Kitāb al-Ajal* of Moshe ben Maimōn (Maimonides) in the +12th century; the great Jewish philosopher opined that longevity techniques counselled by physicians were not an infringement of divine authority because God would already have known and planned both the consultation and the actions. There is a translation by Weil (1), for knowledge of which we are indebted to Prof. F. Klein-Franke. A corresponding non-theistic paradox faced by the Taoists has been discussed in pt. 2, p. 83.

[c] See Berthelot & Houdas (1), p. 172.

[d] E.g. a Zosimus text, *Corp.* III, xix, 2, where the aurifaction of copper by polysulphide films is compared with the healthful effects of balanced food and drink on men.

[e] Berthelot & Houdas (1), p. 181.

[f] Kr 471, tr. Berthelot & Houdas, p. 213.

But where the Arabs went far beyond anything earlier in the West was their actual administration of elixir preparations to desperately sick human beings—a proceeding which brought them completely into line with the lineage of Chinese alchemist-physicians. Three striking Jābirian stories have been translated out of many more, and they are worth giving entire, both for their colour and for their revolutionary nature. All these come from the *Kitāb al-Khawāṣṣ al-Kabīr*.[a]

One day [saith Jābir], when my renown as a learned man and true disciple of my Master had already become known, I found myself at the house of Yaḥyā ibn Khālid. This man had a noble slave-girl endowed with perfect beauty, intelligent, well brought up, and good at music; nobody else had anyone like her. But being afflicted by some illness she had taken a purgative which made her so sick that in view of her constitution it seemed doubtful whether she could recover. She vomited so much that she could hardly breathe or speak.

Yaḥyā having been informed of her state by a messenger asked me what I thought of the case. As I could not see her I recommended cold water treatment, for at that time I knew nothing better for use against poisons. However, it did no good, nor hot treatment either, for I had counselled warming her abdomen with hot salt and bathing her feet with hot water.

As she continued to get worse, Yaḥyā took me to see her, and I found her half dead and greatly exhausted. Now I had with me a little of this elixir, and I made her drink two grains of it with three ounces of pure *sakanjabīn*.[b] By God and by my Master, it was not long before I had to cover my face before this girl, for in less than half an hour she regained all her beauty.

Then Yaḥyā prostrated himself before me and embraced my feet, at which I begged him, as a brother, to give over. So he asked me about this medicinal elixir, and I offered him the rest of what I had with me. However, he would not take it, but from that time began to study and practise the sciences until he had acquired much knowledge. Yet his son Ja'far went beyond him in intelligence and learning.[c]

On the exact historicity of this account there is no need to insist, what matters is the conviction that chemicals could be used in this way. 'Jābir' had a similar experience with a slave-girl of his own.[d]

According to what she said, she had taken unwittingly as much as an ounce of yellow arsenic. I could not find any remedy for her condition though I tried all the antidotes I knew. Finally I made her drink a grain of this elixir in honey and water. No sooner had it entered into her body than she vomited the arsenic and was restored to health.

And thirdly, there was a case of snake-bite poisoning.[e]

As I went out one morning to go to the house of my Master Ja'far (may the blessing of God be upon him), I came upon a man whose whole right side was dreadfully swollen, without exaggeration as green as a beetroot, and in some places already blue. I asked what the matter was, and he answered that this had come on after he had been bitten by a viper. I therefore obliged him to take two grains of this elixir dissolved in cold water, for I believed

[a] Kr 1900. What follows is from the translation of Kraus (2), p. xxxviii, eng. auct., adjuv. Gruman (1), p. 61; Temkin (3), p. 145.

[b] Oxymel, vinegar and honey evaporated to a syrup; cf. Browne (1), pp. 41, 87.

[c] This is the putative teacher of Jābir ibn Ḥayyān discussed on p. 390 above.

[d] Tr. Kraus (2), p. xxxix, eng. auct., adjuv. Gruman (1), p. 61.

[e] Tr. Kraus, *loc. cit.*, eng. auct., adjuv. Gruman, *loc. cit.*

him to be on the point of death. By God, the green and blue discolorations disappeared and were replaced by the natural colour of the body; and after some time the swelling went down and his side became normal. Having recovered his speech he got up and went home, entirely cured.

One cannot help being reminded of the indiscriminate use of the term *tan*[1] in Chinese for elixir and compounded medicine.

Another feature of the Jābirian writers is that from time to time they actually have to do with adepts of incredible longevity. Ḥarbī the Ḥimyarite is a case in point. In the *Kitāb al-Ḥāṣil* (Book of the Result),[a] it is said, in connection with the glyphomantic part of the Balance Theory, that 'Jābir' learnt the names of the metals in the Ḥimyaritic language from this shaikh who was aged 463 years. They could then take their place in a table of such names along with Arabic, Greek, 'Alexandrian'[b] and Persian. Ḥarbī, who appears again in a number of other Jābirian books,[c] is claimed by Jābir as his master, and actually appears in the title of one of them,[d] so that he must have been, or was credited with having been, an alchemical adept himself. A macrobiotic shaikh of this kind ranks almost as a *hsien*.[2] And have not certain scholars,[e] greatly daring, ventured to suggest that *djinn* (*jinn*) was a loan-word derived from *hsien*? We would not like to be committed to following them, for the accepted etymology is from *djanna*, 'covered, veiled', a term in Semitic languages for poetic and prophetic possession as well as madness, and hence for the spirits so possessing.[f] Nevertheless the idea is suggestive.

After the end of the Jābirian Corpus period, i.e. towards the end of the +10th century, the doctrine of '*adl* (*krasis*) in relation to longevity and immortality was again very clearly stated by Ibn Bishrūn. His 'Epistle on Alchemy' has survived only because it was incorporated by Ibn Khaldūn in his *Muqaddima* or 'Introduction to History' (+1377).[g] What Ibn Bishrūn wrote was this:

It should be understood and realised that all philosophers have praised the soul and have thought that it governs, sustains and defends the body in which it is active. For when the soul leaves the body it dies and grows cold, unable any more to move or defend itself because there is no life in it and no light. I have mentioned the body and soul only because this craft (alchemy) is similar to the body of man, which is built up by regular meals and which persists and is perfected by the living luminous soul, that soul which enables the body to do those great and mutually contradictory things that only its informing presence can authorise. Man

[a] Kr 323, one of the *Kutub al-Mawāzīn*. See Kraus (3), p. 261.

[b] Presumably demotic Egyptian, Coptic.

[c] For example, *Kitāb Uṣṭuqus al-Uss al-Thālith* (Third Book of the Elements of the Foundation), Kr 8; *Kitāb al-Rāhib* (Book of the Hermit), Kr 630; *Kitāb al-Tajmīʿ* (Book of the Concentration), Kr 398; *Kitāb al-Dhahab* (Book of Gold), Kr 947.

[d] The *Kitāb Muṣaḥḥaḥāt Ḥarbī* (Book of the Rectifications of Harbi'), Kr 211. In other places he is called Ḥarbī al-Yemenī (Stapleton & Azo (2), p. 72). Ḥimyar was part of the Yemen.

[e] Tenney Davis (4); Mahdihassan (9, 11). The latter draws attention also to the parallelism between *yü nü*[3] and *houris*.

[f] See Wensinck (3). The old derivation from Lat. *genius* is now discredited.

[g] Tr. Rosenthal (1), vol. 3, pp. 230ff. The letter was written, somewhere about +1000, by Abū Bakr ibn Bishrūn to Ibn al-Samḥ, both having been pupils of Maslama al-Majrīṭī (cf. p. 401) in Spain. The passage quoted is on p. 232 of Rosenthal's translation, mod. auct.

[1] 丹 [2] 仙 [3] 玉女

suffers from the disharmony of his component elements. If his elements were in complete harmony, and thus not affected by accidents and inner contradictions, the soul would never be able to leave the body. Man would then live eternally. Praised be He who governs all things—exalted is He.

Here the last conclusion is essentially identical with that of the Jābirian passages with which we began. But there is something curious about the third sentence, for why should Ibn Bishrūn compare the alchemical craft with the human body if he was not implying that the latter could be so improved, so equilibrated, as to fix and retain the soul in perpetuity—or even, conceivably, so perfected in its constitution as to need the aid of the soul no more.[a] The 'regular meals' would have been a way of referring to the contagious transmission of the elixir's perfect equilibration to whatever it was made to work upon,[b] whether base metal or flesh and blood. Just as the equilibration of the qualities in the metals was the essence of the aurifactive process, so once again we see the 'imperishable' metal a model for the everlasting man.[c]

It was about this time (+1010) that the great Iranian poet Firdawsī was completing Persia's national epic, the *Shāhnāma*. In this there are clear references to life and health elixirs, as has been pointed out by Sarwar & Mahdihassan (1).[d] In Firdawsī's writing, the word *al-kīmiyā'* (cf. pp. 351, 355 above) has a variety of meanings, including (*a*) sagacity, stratagem, plot, plan, (*b*) fraud, deceit, (*c*) the art of alchemy, (*d*) an actual substance, the elixir or philosophers' stone,[e] and (*e*) a plant of immortality. At one place an urgent request is sent for an elixir made from sal ammoniac which restores the wounded to health, at another there is an account of how the dead on a battlefield were not resuscitated by a vegetable elixir brought from India. It would be worth while pursuing further the pioneer work of Sarwar & Mahdihassan. A few decades later there was produced in Egypt the *Ta'widh al-Ḥākim bi-'amri'llāh* already referred to (pp. 391, 436), an alchemical work which contains a good deal about the 'Water of Life' or 'Divine Water' bringing resurrection to everlasting life.[f] But as this kind of language occurs in the close context of chemical operations it may be a late echo of Hellenistic allegory rather than Chinese materialism and concreteness.

[a] This point was overlooked by Gruman (1), p. 60, who quoted only the penultimate three sentences.

[b] This is enlarged upon in a later passage of the same text, Rosenthal tr., p. 268.

[c] It may be worth pointing out that if the idea of *i'tidāl* (*krasis*) was near to modern physiology and endocrinology, it was singularly far distant from the modern classical concept of chemical purity. Probably this could never have arisen before the age of atomic chemistry, with its populations of molecules all chemically identical and free from 'interlopers'. Nor would it have seemed strange to ancient and medieval proto-chemists that their ethically 'purest' substance, the Philosophers' Stone or Elixir (for there is always a psychological undertone about 'purity'), should be a chemically 'impure' mixture. We remember Ko Hung thinking that aurifactive gold was in some sense a compound body (Vol. 5, pt. 2, p. 2). Of course in modern times definitions of chemical purity have all had to be revised in the light of our new knowledge of large molecules of biological origin; as Pirie (2) has said: 'purity is a concept that has no meaning except with reference to the methods and assumptions used in studying the substance under discussion'. See also Pirie (3). Thanks are due to Dr Brian Cragg of Toronto for raising this question.

[d] Cf. also Mahdihassan (15), p. 84.

[e] This is the sense in which we find the word in the *Kīmiyā' al-Sa'āda* (Elixir of Blessedness), title of a notable book of ethical and devotional character by the religious philosopher al-Ghazālī al-Ṭūsī (+1059 to +1111), tr. Ritter (3).

[f] See Ruska (5), pp. 84, 119–20. This is one of the Pseudo-Ja'far texts.

The way people's minds were working can sometimes be appreciated better from poetry than from expository prose. For this reason the writings of Ibn 'Alī al-Ḥusain al-Ṭughā'ī (p. 402) are of considerable interest.[a] Besides his treatises, this alchemist (d. +1121) has a poem in the *Maṣābīḥ al-Ḥikma* about a king who was childless and who sought successfully upon an island (as it might be Phêng-Lai)[b] the Water of Life which cured him. This is also in the *dīwān* of al-Ṭughrā'ī (*al-Maqāṭī' fī'l-Ṣan'a*), where we find poems too on the curing of an impotent king, and the restoration of youth to an old one. There is further an alchemical dream experienced by the author himself—a vision of a bottle of the Water of Life and a silver pot containing the Soil of Paradise; al-Ṭughrā'ī drank some of the former, but was forbidden by the Prophet in person to eat any of the latter.

Among the representatives of late Arabic alchemy we may take Ibn Aidamur al-Jildakī, who died in +1342. His remarkable work *Nihāyat al-Ṭalab* (The End of the Search)[c] was essentially a commentary on the *Kitāb al-'Ilm al-Muktasab*... (Book of Acquired Knowledge in the Cultivation of Gold) written by Abū'l-Qāsim al-Sīmawī al-'Irāqī about +1270, always referred to by al-Jildakī as 'the Shaikh'.[d] But although so respected, it has been shown that al-'Irāqī lifted much of his material bodily from Ibn Umail's +10th-century *Kitāb al-Mā' al-Waraqī* (cf. p. 401 above)—at any rate this assures us of being in the presence of a single long and continuous tradition. In al-Jildakī's works it is easy to find traces of life-elixir ideas. He comments, for instance, on passages from the Jābirian 'Book of the Western Mercury' such as the following:[e]

Western mercury is considered by the sages to be the soul, for it is cold and moist. It is also the Divine Water, since it liquefies the parts and prevents fire from burning. Its coldness is due to its whiteness and to moisture, for it is a water, and every water is cold and moist. Some of the sages have said that it is dry, for it does not respond to the smelting-fire, and in comparison with oil it actually is dry. Some other sages have stated that it is moist, and what they meant was that the tincture will not penetrate unless it is dissolved in it....

Mercury is soul,[f] and there is nothing of the same status in the world. It is the living soul which on mixing with a body animates it and transforms it from one state to another and from one colour to the next.[g] It is the Water of Life and the spring of vitality from which whoever drinks never dies....

[al-J.: Understand the words of this learned teacher, whose eminence, in theory as in practice, has been matched by no one, either among those who preceded him or those who have come after him.][h]

[a] See the monograph by Razuq (1), especially pp. 161, 185, 245, 255 and 268 for the points referred to.

[b] As regards Eastern influences, all the names of 58 previous alchemists given by al-Ṭughrā'ī are Greek, Jewish, Syriac, Arabic or Persian, but he does mention one Asfīdiyūs who was the first of five philosophical ministers of an Indian king incongruously named Adriyānūs. And a work existed with the title *Kitāb al-Wuzarā' al-Khamsa li-Malik al-Hind.*

[c] On this there is a detailed monographic study by Taslimi (1), pp. 134–5, 189, 202, 374, 540–1 and 547 of which document the points made immediately below.

[d] On al-'Irāqī see Mieli (1), 2nd ed., p. 156.

[e] Cf. pp. 404, 471 above. Parts of this quotation were omitted by Berthelot & Houdas (1), pp. 212 ff.

[f] Surely a reference to its volatility, or an idea derived from that.

[g] This sounds rather like the Hellenistic colour succession, cf. pt. 2, pp. 22 ff. above.

[h] We were led to this passage in Taslimi, pp. 134–5 by a reference in Mahdihassan (32), p. 346.

Elsewhere al-Jildakī speaks of the preparation of a 'foodstuff' from sulphur and mercury as the secret of success in the Art, reminiscent of the 'regular meals' of life elixir to which Ibn Bishrūn referred (p. 480). And he goes on to say that 'the difficulty lies in combining "mercury" and "sulphur" in such a way as to form a simple homogeneous substance.' When this is done it resembles milk, and is called 'the Divine Water, preserving all those who taste of it from death, the Water of Life, the First Child, Viper's Saliva, Red Blood, and Birds' Milk.' This is the Water which helped Shaiṭān to expel Adam and Eve from the 'Middle Sphere', it 'kills the living and reanimates the dead, blackens the white and whitens the black.' Al-Jildakī often repeats such phrases and one begins with him to hear the apocalyptic tone of medieval Latin alchemy. But he emphasises the role of the elixir in medicine.

> The philosophers' gold, when applied three times to the eyes of a person suffering from continuous flow of tears, cures him; if an eyelash is plucked with a pair of tweezers made of this gold it will grow no more;[a] if a plate of this gold is placed on the heart of someone suffering from palpitations he is sure to recover; and if this gold is dissolved and taken, it will cure all atrabilious diseases. Common gold exhibits none of these properties....
>
> The philosophers' silver cures hot fevers, and in solution in date-wine constitutes a remedy for atrabilious diseases, while common silver does none of these things....
>
> The elixir cures patients suffering from leprosy if it is applied to his sores and given him to drink as a potion. The sores burst and effuse a yellow water, after which new skin develops and no mark is left on the body...[b]

Finally, al-Jildakī warns his reader never to taste or smell the elixir, and to avoid its vapour at the time of projection, for it is a very dangerous poison, and that is the reason why it can subdue the poison of leprosy and other bodily diseases. But one can dilute the toxic nature of the elixir by mixing it with other drugs, and in this way it can be put to many good uses.

Our last witness can come from the +14th century, like al-Jildakī after the time of Latin Geber—Muḥammad ibn al-Akfānī al-Sakhāwī (d. +1348) who wrote in Egypt. The entry for alchemy in his encyclopaedia *Irshād al-Qāṣid ilā Asnā al-Maqāṣid* (Guide for the Struggling, on the Highest Questions) has been studied by Wiedemann. There he says that 'the elixir changes substances just as a poison does in a living body, but it changes them to health.'[c] And he also says:

> The elixir is furthermore used in medical practice, bringing results beyond those of all ordinary drugs. It heals epilepsy and leprosy and suchlike diseases, just as Ḥunain ibn Isḥāq [+809 to +877] says it does in his 'Discussion' (*Maqāla*) on this question.[d]

As we have read through these various excerpts one particular point has become more and more noticeable, namely the conception of the elixir as poison. When Berthelot noticed this in the early *Kitāb Qarāṭīs* (Book of Crates),[e] he was reminded of the *ios* (*iós*) or *virus* often referred to in the Corpus and other writings of Hellenistic

[a] This was an old attribute of *khārṣīnī*, cf. p. 431 above.
[b] Al-Jildakī gives his own eye-witness account of a case of this kind.
[c] (21), p. 106. [d] *Op. cit.*, p. 107.
[e] In Berthelot & Houdas (1), pp. 54–5, 65, 67.

times, and was tempted to relate the 'fiery poison' of 'Crates'[a] to the 'fiery drug' (*to pyrinon pharmakon*, *τὸ πύρινον φάρμακον*) of Mary the Jewess.[b] But *ios* was an extremely vague and confused word in Greek; it could mean smells, odours and 'virtues', magnetic attraction, pharmacological active property, but also rusts and oxides, as well as violet or purple colorations, and even refining processes in general.[c] We have no need to deny that the idea of poison was present in Hellenistic proto-chemistry—how could anyone work with the vapours of mercury and arsenic and not have it? But the conception of the elixir as supremely beneficial both to inorganic and to organic things, and at the same time supremely poisonous, has an especially good parallel in Chinese thought, where *tu*,[1] so often wrongly translated 'poison', had for the pharmaceutical naturalists throughout the ages the meaning rather of 'active principle', active for good or evil according to the conditions. Many of them, indeed, would have warmly appreciated the great dictum of Paracelsus already referred to (pt. 3, p. 135) that whether or not a thing is a dangerous poison depends entirely on the dose.[d] The poison principle runs down through all Arabic alchemy, as has been seen, and thence directly into that of the Latins. At one end the Jābirian writer says:[e]

> The result we have sought to obtain is that the elixir when fully prepared should be a light, subtle, spiritual and corporeal poison.... It is called poison because of its subtlety and penetration (like the wafting of perfumes), and fiery because it resists the fire.[f]

At the other end Petrus Bonus is saying in +1330: 'sic et hic lapis efficit in metallis leprosis, et ideo quandoque venenum quandoque theriaca dicitur (thus also this Stone works in leprous metals, and therefore it is sometimes called 'poison' and sometimes "universal antidote")'.[g] And he quotes from Arabic and quasi-Arabic sources. Haly speaks of the 'fiery poison' (*toxicum igneum*);[h] and Morienus says: 'unde a quibusdam venenum appellari solet, quia sicut venenum in corpore humano ita elixir in corpore metallino...(hence (the Stone) is often called "poison" by some, because in the body of metals it works just as poisons do in the body of man).'[i] Thus did the tradition come down until the end of alchemy itself.

[a] It comes again in *Kitāb al-Ḥabīb*, *op. cit.*, p. 93. And in the MS. written in Syriac script; Berthelot & Duval (1), p. 182.

[b] See *Corp.* II, iv, 54 and III, xxviii, 8. The identification seems rather doubtful.

[c] Berthelot (1), pp. 61, 178, (2), pp. 13–14, 133, 254–5.

[d] Dritte Defension in 'Sieben Defensiones' (+1537 or a year later), ed. Sudhoff, vol. 11, p. 138. Our thanks are due to Dr Walter Pagel for the exact location of the statement.

[e] *K. al-Raḥma al-Kabīr*, tr. Berthelot & Houdas (1), pp. 174–5, 181.

[f] Similar statements are in the two *Kutub al-Zībaq*, Berthelot & Houdas, *op. cit.*, pp. 208, 213.

[g] *Pretiosa Margarita Novella*, in Manget, *Bibliotheca Chemica Curiosa*, +1702 ed., vol. 2, p. 49. The passage was noted by Stapleton (1), pp. 36–7 and App., p. ii.

[h] 'Et Haly in suis Secretis:...' Presumably this was a confusion between the advice to monarchs given in the *Secretum Secretorum* of Pseudo-Aristotle (cf. p. 368), or something in the alchemical work of al-Rāzī, *Kitāb Sirr al-Asrār* (Book of the Secret of Secrets), already often mentioned (pp. 195, 398), and some text of Haly Abbas, i.e. 'Alī ibn al-'Abbās al-Majūsī (the Mage) who died in +994, one of the greatest physicians of Islam (see Mieli (1), 2nd ed., pp. 120ff.; Sarton (1), vol. 1, pp. 677–8). Al-Rāzī certainly shared the ideas about the poisonous nature of the elixir (Ruska (14), p. 75). As for 'Alī ibn al-'Abbās, he wrote no 'Secrets' so far as we know, but one of the titles of his canon of medicine was *Kitāb al-Malakī*, in Latin *Liber Regius*, the Royal Book, so the mistaken attribution is understandable.

[i] On the Morienus book see pp. 390, 403 above.

[1] 毒

We have now seen that there is in fact a great deal in the Arabic alchemical literature on elixirs of life and everlasting life. Of course it is different in general character and also in details from anything which we find in the Chinese texts—that would be expected—but evidently the atmosphere in the Arab world from +700 onward is radically different from that of Hellenistic proto-chemistry. If this can be sensed only on the basis of texts which have been studied in modern research and translated into Western languages, what may we expect when the literally thousands of Arabic alchemical books not yet examined are placed at the disposal of the world republic of learning? But there is one final point to be made. Immortality or longevity elixir ideas did not have to reach Europe only through Islamic culture. If Gruman's pessimism had proved to be more justified than in fact it seems to have been this would have been even more important, but it always has to be remembered. Nestorian contacts and transmissions sometimes took place directly,[a] the Armenian kingdoms could sometimes be foci for ideas,[b] and in the travels of the magnetic compass we have already seen one vivid possibility of transmission through the +12th-century Western Liao kingdom, the Qarā-Khiṭāi.[c] The mid +13th century was not at all too late for direct influences, and that was just the time when Franciscans like William de Rubruquis (Ruysbroeck) were discussing sphygmology in China,[d] and Odoric of Pordenone disputing with Mahāyanist *ho-shang* (monks) about reincarnation.[e] The Italian merchants at Yangchow in the +14th century might have been a little on the late side, and even Marco Polo and his contemporaries too, but that there were channels short-circuiting both Islam and India we need be in no doubt. How far they carried the ideas with which we are here concerned remains to be seen.

There is one very important theme of Arabic alchemy which seems never before to have been set properly in the context of elixir doctrine, though Kraus gave it close and learned study.[f] This was the so-called Science of Generation ('Ilm al-Takwīn), concerned not only with the production of ores and minerals in Nature and in the laboratory, including the generation of the noble metals from the base, but also with the artificial asexual *in vitro* generation of plants, animals and even human beings.[g] It will not do to dismiss such ideas as merely 'medieval nonsense'. They often give deep insight into the minds of the men of that age, and they also illuminate what passed from one lot of men to another.

Let us therefore take a closer look at this extraordinary development, as we find it in the most explicit source, the *Kitāb al-Tajmī'* in the Jābirian Corpus.[h] The artificial

[a] There are many examples from the +5th to the +9th century, and later there was the epic of Rabbān Bar Sauma described in Vol. 1, pp. 221, 225. Cf. Budge (2).

[b] Cf. Vol. 1, p. 224. Also the Radhanite Jews and the Khazars (Vol. 3, pp. 681 ff.).

[c] Vol. 4, pt. 1, p. 332.

[d] Vol. 1, p. 224; we shall be returning to him in Sect. 44.

[e] Vol. 1, p. 190. A particularly delicate subject in the present context. Odoric might have talked with Taoists as well.

[f] (3), pp. 97 ff.

[g] We have already referred to it in the sketch of Jābirian alchemy on p. 396 above.

[h] 'Book of the Concentration' (Kr 398), cf. p. 435 above. There is also some discussion of artificial generation in the *Kitāb al-Ikhrāj mā fī'l-Qūwa ilā'l-Fi'l* (Book of the Passage from Potentiality to Actuality), Kr 331, tr. Rex (2); as well as many references in other books of the Corpus.

creation of minerals (*takwīn al-aḥjār*), of plants (*takwīn al-nabāt*), of animals (*takwīn al-ḥayawān*) and even of men and prophets (*takwīn aṣḥāb al-nawāmīs*),[a] by human artisanal action (*ṣāni'*), imitating the demiurge (*bāri'*) or creator of the world,[b] was a cardinal belief of the +9th century. These were the two sorts of generation (*kawn*) or creation (*khalq*) distinguished in the Balīnās texts, the first (*al-kawn al-awwal*), by God, the second (*al-kawn al-thānī*), by man.[c] A Jābirian writer, speaking of the elixir, says:[d]

> If you can succeed in composing (or organising) the isolated things, you will assume the very place of the (World-) Soul in relation to Substance,[e] the isolated things occupying in relation to yourself the place of the (four) qualities (or natures)—thus you will be able to transform them into anything you wish.

And aurifaction was only one special case of this general principle. In Ibn Khaldūn's definition,[f] alchemy

> is a science that studies the substance (the elixir) through which the generation of gold and silver may be artificially accomplished, and comments on the operation leading to it.

Moreover, the possibility of an artificial generation (*takwīn*) of plants and animals was not confined to Jābirian circles, itwas widely believed and discussed. Ibn al-Waḥshīya's *Kitāb al-Ta'fīn* (Book of Putrefaction),[g] *c.* +930, has much on it, and it was well known at the farther end of the Mediterranean in Muslim Spain, as is shown by the *Kitāb Ghāyat al-Ḥakīm* of Maslama al-Majrīṭī (or Pseudo-Majrīṭī), *c.* +1050 or a few years later. It was of course connected with the idea of natural spontaneous generation, prominent in the *Kitāb Sirr al-Khalīqa* (*c.* +820). Perhaps significantly, the *Rasā'il Ikhwān al-Ṣafā'* and many other texts attribute that idea to India (or the Further Indies) and even place the creation of the first man by this means in India or Ceylon.[h] One has therefore to take the whole matter seriously. And the practical directions include some fascinating detail.

What sort of thing did they involve? In one procedure, in the *Kitāb al-Tajmī'*, a theromorphic glass vessel, shaped according to the animal intended,[i] contained the semen, blood, and samples of many parts of the organism[j] to be reproduced,[k] together

[a] Or legislators.

[b] Cf. Kraus (3), pp. 99, 104, 126.

[c] *Kitāb al-Aḥjār* (Book of Minerals), Kr 40. See also *Kitāb al-Mīzān al-Ṣaghīr* (Lesser Book of the Balance), Kr 369.

[d] In *Kitāb Maydān al-'Aql* (Book of the Arena of the Intelligence), Kr 362. Tr. Kraus (3), eng. auct.

[e] Note how well this justifies our interpretation of the passage from Ibn Bishrūn quoted on p. 480 above.

[f] *Muqaddima*, Rosenthal tr., vol. 3, p. 227.

[g] Also entitled *Kitāb Asrār al-Shams wa'l-Qamar* (Book of the Secrets of the Sun and the Moon).

[h] Cf. Kraus (3), p. 121.

[i] This was the 'form' (*ṣūra*), 'mould' (*miṭāl*) or 'effigy' (*ṣanam*).

[j] For birds the egg-white of the species was to be used, and *nūshādir* (sal ammoniac) combined with added dyeing materials to give to the feathers any colour desired. Cf. Kraus (3), p. 109.

[k] It was even thought possible to produce animals not existing in Nature. For example the sperm of a bird in a human mould would give rise to a winged man (Kraus (3), p. 116). How strange it is to reflect that in modern experimental embryology it has become possible to do this kind of thing, as also to mix a variety of tissue-rudiments and have them sort themselves out into a considerable measure of individuated organisation.

with drugs and chemicals[a] chosen in kind and quantity according to the method of the Balance;[b] all this enclosed at the centre of a cosmic model, a celestial sphere (*kura*), globular, latticed, or armillary,[c] set in continuous perpetual motion by a mechanical device.[d] Meanwhile a fire of the first, or unit, intensity (i.e. a mild one) was kept burning underneath.[e] If the exactly correct time was not reached, or if it was exceeded, no success whatever would be achieved. Other schools were partisans of 'putrefaction' (*sēpsis*, σῆψις, *ta'fīn*), or stressed the importance of aeration and stronger heat, or considered that blood was more essential than the chemicals;[f] some said that semen was indispensable if the new being were to have the power of speech, and parts of the brain if it were to be endowed with thought, memory and imagination. It was even averred that higher beings would come forth from the apparatus equipped already with the knowledge of all the sciences.[g] There can be no question that the origin of the famous homunculus of Paracelsus[h] lies here, but how far Aldous Huxley would have been surprised to find his 'Brave New World' of separated totipotent blastomeres and artificially incubated 'test-tube babies' anticipated in the dreams of these Arabic alchemists we would not undertake to say.[i]

A parallel passage about a perpetually rotating spherical cosmic model within which the transmutation of all the base metals into gold was performed, occurs in the *Kitāb al-Rāwūq* (Book of the Filter),[j] and may be read in the translations of Said Husain Nasr[k] and Kraus.[l]

All these constructions seem very un-Hellenistic, but they do signally recall the Chinese armillary spheres and celestial globes kept in continuous rotation by water-power, instruments which derived from polar-equatorial, not ecliptic-planetary, astronomy, and came into use much earlier than anything of the kind in the West.[m]

[a] Some constituents specified had an Eastern (Iranian) provenance.

[b] N.B. an elixir mixture.

[c] Instructions for making this are said to have been given in the *Ta'ālīm al-Handasa* (Teachings of Geometry), Kr 2805.

[d] In some instructions the central reaction-vessel also had to be made to rotate.

[e] For variant processes see Kraus (3), pp. 109, 110, 111ff., 115, 117.

[f] It will be remembered that in Arabic alchemy elixirs were prepared not only from inorganic but also from plant and animal substances.

[g] Cf. Kraus (3), pp. 115–19.

[h] The main passage is in *De Nat. Rerum*, I, vi, Sudhoff ed., vol. 11, pp. 316ff. The procedure is clearly derivative, for human semen was to be allowed to 'putrefy' in a cucurbit for forty days, then 'fed' cautiously with the arcanum of human blood for forty weeks (cf. Needham (2), p. 65). The theme recurs in Goethe's 'Faust', Pt. II, Act ii, Sc. 2, the laboratory. Earlier Latin allusions of intermediate date occur in the writings of William of Auvergne (d. +1249), a theologian much given to the study of magic, and in the *De Essentiis* of Pseudo-Thomas Aquinas (perhaps *c.* +1310) which attributes artificial generation processes to al-Rāzī (Thorndike (1), vol. 2, p. 353, vol. 3, p. 139). The origin of the homunculus has been sought in the 'little man' or *anthroparion* (ἀνθρωπάριον) who appears, with a 'silver man' and a 'gold man', in the visions of Zosimus (*Corp.* III, i, 2, 5); but as usual the term seems purely allegorical, no presage of the Jābirian cosmic incubators—in spite of Berthelot (1), pp. 60, 180; von Lippmann (20), pp. 35–6; Kraus (3), pp. 120–1.

[i] Two interesting papers have been consecrated by von Schwarzenfeld (1, 2) to the magical and alchemical activities of Rudolf II at Prague, and especially the objects in his collections still preserved in the Hradschin Castle. We did not expect to be able to illustrate a homunculus, but one of Rudolf's, actually a human figure of blown glass enclosed in a prismatic block of glass, perhaps only a model of what one should expect, appears in Fig. 1537.

[j] Kr 140. [k] (1), p. 260. [l] (3), p. 57 in French.

[m] See Vol. 4, pt. 2, pp. 481ff. and its background in Vol. 3, Sect. 20.

Similar Indian ideas, especially concerning perpetual motion, are also recalled.[a] On alchemical cosmic models as such there are plenty of Chinese analogues and predecessors, as we have duly seen.[b] So much for the rotating cosmic shell.

As for the central vivification, Kraus' ingenuity was much exercised to find Hellenistic antecedents, but little was available save spontaneous generation, automata, and rituals for the animation of religious images, none of which is very much to the point. Artificial generation in the Arabic sense was, Kraus admitted, unknown in Greek writings.[c] Spontaneous generation on the other hand was of course widely believed, as of bees from the corpses of lions, and so on throughout the European centuries, faith in it dying out only with the growth of modern biology in the Enlightenment period.[d] It was equally widespread in Chinese culture.[e] But it was uncontrollable by men. As for moving and singing automata or puppets there is surely no need to refer to the works of the Alexandrian mechanicians,[f] but there were other more uncanny Graeco-Egyptian stories of speaking statues[g] and ever-rotating columns, which the Arabs inherited.[h] However, honours are about even here again, for Chinese culture also had a wealth of legends concerning automata, some of which, like the Taoist robot of King Mu of the Chou,[i] came very near indeed to being artificial flesh and blood. On the third point 'Jābir' connects the artificial generation schools with the image-makers (*eidōlopoioi*, εἰδωλοποιοί, *muṣawwirūn*),[j] raising therefore the matter of theurgic animation techniques. It was not a question necessarily of causing statues of the gods to move, but rather preparing them in such a way as to serve as the real abodes of the spirits which were to be worshipped through them, to assure the real

[a] See Vol. 4, pt. 2, p. 539 and Needham, Wang, & Price (1); also Lynn White (14), p. 70, (15).

[b] Pp. 279ff. above.

[c] (3), pp. 119, 123. It is true that 'Jābir' often claims to be only commenting on a 'Book of (Artificial) Generation' (*Kitāb al-Tawlīd* = *Peri Genneseōs*, περὶ γεννήσεως) by Porphyry of Tyre, the Neo-Platonist (b. +223), but it must be apocryphal as there is no such title among the well-authenticated books of that philosopher.

[d] See Needham (2), *passim*, and the classical monograph of von Lippmann (20). In the present context Kraus (3), pp. 106ff.

[e] Cf. Vol. 2, p. 421 and *passim*, also Sect. 39 in Vol. 6.

[f] See Vol. 4, pt. 2, pp. 156ff. and the translation of Woodcroft (1); with Diels (1), pp. 62ff., the basic contributions of A. G. Drachmann, and much other well-known literature. On Daedalus' wooden Aphrodite, moved, it was said, by mercury, see Aristotle, *De Anima*, I, 3 (406 *b* 12).

[g] One sometimes wonders whether there could have been any Ṣābian influence on the Arabic system of artificial generation; remembering especially the Martian sacrifice of the speaking head (p. 427 above). Here might be relevant also the later Jewish tradition of the *golem*, on which the chief study is a rare monograph by K. Mueller (1).

[h] In Egypt, it was reported, there were two statues borne by a column of iron which spontaneously and perpetually rotated on a mirror; the Jābirians said that this was discussed with other similar things in the *Kitāb al-Ashkāl al-Ṭabī'iyya* (Book of Natural Figures), Kr 2655. Other stories spoke of a leaning column perpetually rotating. Kraus (3), p. 113, surmised confusions with the famous Memnon statues whistling in the dawn wind, the fabled mirror of the Pharos at Alexandria, and the concave sundial or scaphe (cf. Vol. 3, pp. 301–2) with its inclined gnomon and ever-moving shadow. See also Reitzenstein (4); and Carra de Vaux (5), translating the *Mukhtaṣar al-'Ajā'ib* (Breviary of Marvels) of Pseudo-Mas'ūdī (*c.* +970), notably pp. 161, 198ff., 272, 278. Further in Dodds (2), pp. 194–5.

[i] See Vol. 2, pp. 53–4, translating a passage from the *Lieh Tzu* book well worth re-reading.

[j] It was strange that all this should have arisen in Islam, for the Prophet was severe, in one of his *ḥadīth* saying: 'On the Day of Resurrection the makers of images will receive the heaviest of punishments, and they will be told, "Give life to that which you have created".' See Suhrawardy (1) and other collections; Kraus (3), pp. 123–4, 134.

Fig. 1537. **Esoteric objects still** extant from the collections of Rudolf II in Prague (von Schwarzenfeld, 1, 2). On the left, a homunculus, or 'devil in a glass', actually a glass-blown figure enclosed in a prismatic block of glass. In the centre two mandrakes or mandrake-like objects; on the right a bell of Tibetan flavour. From the Curiosa of the Hradschin Castle, Prague.

presence, as it were, of these gods and spirits. The Neo-Platonists accepted the idea and wrote much on the practice;[a] from one source we learn that the liturgists observed the heavens to get the right time, and then placed the appropriate herbs, gems and perfumes in the statue, which itself had been moulded from clay mixed with holy water, aromatic plant and other material powdered and sieved, together with comminuted metals and precious stones.[b] But once again there was not much to choose between Hellenistic and East Asian practices, for in China and Japan there was the readying of images for the presence of gods, lokapalas, bodhisattvas, etc., even to the insertion of model viscera to make them complete,[c] then their formal consecration by the dotting in of the pupil of the eye.[d] One can only conclude that the Arabs did not have to rely exclusively on Hellenistic culture for what they knew (or thought they knew) about spontaneous generation, mechanically operated simulacra, or the animation of religious images. All this may have a certain relevance, yet it does not get to the root of the matter.[e]

[a] See Kraus (3), pp. 127ff.

[b] Porphyry, in his works: 'Philosophy of the Oracles' and 'On Statues', discussed by Bidez (2); as also his 'Letter to Anebo', an Egyptian priest, ed. and tr. (It.) by Sodano (1). Many references will be found in Kraus (3), p. 123, including the interesting book of Weynants-Ronday (1) and the revealing paper of I. Levy (1), esp. p. 129.

[c] A remarkable example of this is still extant at the Seiryo-ji[1] Temple (the Shakadō)[2] at Saga on the outskirts of Kyoto. The statue of Shakyamuni was made at Khaifêng in +985 for the Japanese monk Chōnen[3] and taken back by him to Kyoto. The viscera, in appropriately different colours and shapes, are made of textile materials stuffed, and have much importance for the study of medieval East Asian anatomy. They have been closely studied by Morita Kōmon (*1*); Watanabe Kōzō (*1*, *2*); and Ishihara Akira (*1*, *2*). In 1964 Dr Lu Gwei-Djen and I had the opportunity of examining them personally at the Shakadō, for which our best thanks are due to the Abbot. We shall have more to say about these remarkable objects in Sect. 43 in Vol. 6. On the statue and its history in general see Henderson & Hurvitz (1).

[d] This 'eye-opening ceremony' paralleled a Confucian custom, the adding of one missing character stroke at the dedication of an ancestral tablet, but we do not know how far this goes back.

[e] Kraus suggested, rather awkwardly, (3), p. 134, that the artificial generation system was mainly the

[1] 清涼寺 [2] 釋迦堂 [3] 斎然

No, the fundamental feature of the Arabic creation of the rabbit out of the hat lay, as we see it, in those chemical substances which were added to the animal materials in the central container, for they represented nothing other than the *al-iksīr* of life, and the entire pattern of pseudo-scientific operations—how far ever tried out in practice remains somewhat obscure—was simply a new and original Arabic exercise using the powers of the life-giving *tan*.[1] The Chinese elixir idea was at the centre, and the Chinese perpetual-motion cosmic model surrounded it;[a] beyond this some part was doubtless played by earlier Mediterranean ideas on the subjects just discussed. In general, therefore, this giving of life to the lifeless, by chemical means, was, we conclude, a particular Arabic application of a characteristically East Asian conception, the giving of eternal life to the living, by chemical means. It reminds one of Kungsun Cho[2] in the −4th century, saying with typical Chinese optimism: 'I can heal hemiplegia. If I were to give a double dose of the same medicine I could probably raise the dead!'[b]

Summing it all up, we think one could say that Arabic alchemical theory was a marriage between the Taoist idea of longevity or immortality brought about by the ingestion of chemical substances and the Galenic rating of pharmacal potency in accordance with the *krasis* or balance of the four primary qualities (the natures). Gruman was quite right in remarking[c] that Arabic alchemists generally emphasised their ties with Hellenistic literature and traditions; that is indeed the dominant impression one gets in studying their writings—but perhaps if those were the books they read, the Persian, Indian and especially Chinese ideas and practices were what they talked about, few or no texts from those lands being available in Arabic translation at any time. The macrobiotics of China seems to have come westwards through a filter, as it were, leaving behind inevitably the concept of material immortality on earth or among the clouds and stars; after all, Paradise for Muslims was quite similar to the Heaven of the Christians, irretrievably subject to 'ethical polarisation' (cf. pt. 2, p. 80 above). Nevertheless some vital smaller molecules filtered through—(i) the conviction of the possibility of a chemically induced longevity, validated always by the example of the Old Testament patriarchs, (ii) hope in a similar conservation or restoration of youth, (iii) speculation on what the achievement of a perfect balance of qualities might be able to accomplish, (iv) the enlargement of the life-extension idea to life-donation in artificial generation systems, and (v) the uninhibited application of elixir chemicals in the medical treatment of disease. This last new development was the subject of a classical paper by Temkin (3), who perceived that the whole course of Hellenistic proto-chemistry was primarily metallurgical (aurifictive and aurifactive as we should

old theory of the animation of statues transformed by a strictly monotheist environment. This does not seem very convincing.

[a] It is curious that in the *Picatrix* of the mid +11th century (cf. pp. 313, 427–8) the artificial generation of monsters is ascribed to the 'Indians' (Ritter & Plessner (1), p. liv, pp. 288–90). This may always mean the Further Indies, but perpetual motion ideas were prominent in India proper, as already noted.

[b] Cf. Vol. 2, p. 72.

[c] (1), p. 59.

[1] 丹 [2] 公孫綽

say), while Arabic joined with Chinese alchemy in the profoundly medical nature of its preoccupations. Ko Hung, Thao Hung-Ching and Sun Ssu-Mo had glorious successors of the same cast of mind in al-Kindī, the Jābirians, al-Rāzī and Ibn Sīnā. Temkin found no link between chemistry and medicine in Greek until the poems of Theophrastes (*c.* +620) and Heliodorus (*c.* +716),[a] for although Dioscorides and Paul of Aegina of course knew of mineral medicines, Gnostic philosophy was as oil and water with the Hippocratic tradition, and chemical macrobiotics quite foreign to the Hellenistic world (cf. pt. 2, pp. 71 ff. above). Then eventually the first two of the ideas just listed, together with the fifth, passed through into the Latin culture of Western Europe at the time of the translations in the + 12th century. If nothing living was ever seen to step forth from Jābir ibn Ḥayyān's cosmic incubators, chemo-therapy with all its marvellous achievements of today was assuredly born from the Chinese–Arabic tradition, with Paracelsus as its midwife.[b]

(3) Macrobiotics in the Western World

Returning now at last to our own European home, we are not in duty bound, we feel, in view of our responsibilities to the civilisation of China, to document in detail the attitudes of the Latin alchemists and the Renaissance hygienists and Paracelsians to longevity and material immortality. There is too great a cloud of witnesses available to everyone with knowledge of the European tongues. Suffice it to say, with Gruman,[c] that prolongevity had remained a neglected theme, hardly indeed perceptible, in the West throughout antiquity and far into the Middle Ages, till suddenly in the + 13th century there appears full-fledged a macrobiotic alchemy. It must have been brewing from the middle of the previous century onwards, as the translations from the Arabic multiplied,[d] but after about +1230 the idea in one form or another was generally accepted.

Take Albertus Magnus for example, Albert of Bollstadt (+1206 to +1280), that

[a] It is possible that these two may have been only one person, at the later date; their background is rather obscure. Cf. p. 327 above.

[b] These words are reminiscent of those with which Wilson (*2e*), p. 619, concluded his one-man symposium in 1940. Much credit is due to the past pioneers in the history of chemistry who have reached similar conclusions, often with more insight than evidence at their disposal. An eloquent statement of the case was made by Edkins (17) already in 1855, and elaborated by Martin (8) in 1871. Thirty years later Martin's convictions were still the same, (2), pp. 24, 44ff., 52, 61, 63, 69. Other remarkable pioneers were Hjortdahl (1) in 1909 who got the essence of the pattern right in a few pages, and Holgen (1) in 1917. The twenties brought the classical statement of Campbell (1), pp. 53–4, and the weak but epoch-making book of Johnson (1). Waley (14) and Partington (*8c*) added their weight in the thirties, and since then there have been the studies of Dubs (5), pp. 84–5; Sherwood Taylor (3), p. 71, (7), pp. 32–3; Tenney Davis (2, 3, 4); Figurovsky (1); Chang Tzu-Kung (1); Haschmi (6); Bernal (1), p. 203; Arntz (1), pp. 203, 208; and Mahdihassan in many papers. We may also mention the interesting reviews of Debus (4), pp. 44–5, (24). Among Chinese scholars of high repute the same convictions have not infrequently obtained, as witness Li Thao (*12*), p. 212, (*14*), p. 112; Fêng Chia-Shêng (5), p. 120; Wang Chi-Min (*1*), p. 11 and Hsing Tê-Kang (*1*), p. 252. See also Anon. (*83*), p. 50; (*167*), p. 455. Miki Sakae (*2*), p. 20, traces the line, just as we should, from Ko Hung through Jābir to Paracelsus; and Florkin (1), p. 58, in his general history of biochemistry, recognises that the macrobiotic theme of Chinese alchemy was transmitted through the Arabs to join the transmutative theme of Hellenistic proto-chemistry. So did Seligman (2) and Kroeber (3).

[c] (1), p. 49.

[d] Cf. Dronke (2) on the School of Chartres, so open to Arabic learning. And the classic book of Haskins (2).

outstanding medieval naturalist so fortunate as to be beatified by historians of science as well as by the Church. He does not speak much of artificial longevity, but he knows the medical value of elixirs. In the *De Mineralibus* he says:[a]

We do not intend to show how a certain *istorum* is transmitted into another, or how by means of a medical antidote, which the alchemists call elixir, diseases are healed, and men's secrets revealed, or conversely their open knowledge is concealed, but rather to show that the stones (i.e. solid chemical substances) are compounded from the elements, and how each one is constituted in its own species...

In other words, he intends to talk about natural minerals and gems, not about alchemy, but in the meantime lets slip that elixirs do something more than aurifaction. As for *istorum*, Dunlop thought it might be a corruption of an Arabic form, perhaps *'unṣur* (pl. *'anāṣir*) which means element, quality or nature in Jābir, matter in Balīnās; perhaps *iss*, i.e. principle.[b]

Far more daringly does Roger Bacon (+1214 to +1292) affirm time after time that when men have unravelled all the secrets of alchemy there is almost no limit to the longevity that they will be able to attain.[c] It was but a part, of course, of his general scientific and technological optimism that makes him seem so modern a figure, so far ahead of his time. Towards the end of his *Opus Majus*, addressed to Clement IV in +1266 or +1267, there is a section entitled 'Capitulum de secunda praerogativa scientiae experimentalis'.[d] Here, in the second 'Example', he says:[e]

Another example can be given in the field of medicine, and it concerns the prolongation of human life, for which the medical art has nothing to offer except regimens of healthy living. In fact, there are possibilities for a far greater extension of the span of life. In the beginning of the world the lives of men were much longer than now, when life has been unduly shortened...

Bacon goes on to say that many believe that this has been according to the will of heaven, adding dubious astrological arguments about the senescence of the world, but he will have none of this, and recommends not only hygienic regimen but also marvellous medicines, some already known and some yet to be found out.

Although the regimen of health [he says] should be observed from infancy onwards, in food and drink, in sleeping and waking, in motion and rest, in evacuation and retention, in the disposition of the airs and the control of the passions, no one wishes to give thought to these things, not even physicians, among whom hardly one in a thousand can order such matters gently and surely. Very rarely does it happen that anyone pays sufficient heed to the rules of health. No one does so in his youth, but sometimes one in three thousand thinks of these matters when he is old and approaching death....

Sins also weaken the powers of the soul, so that it becomes incompetent for the natural control of the body; therefore the powers of the body are enfeebled and life is shortened.

[a] I, i (*Opera*, Jammy ed., vol. 2, p. 210).

[b] (7), p. 72, cf. Kraus (3), pp. 110, 165, 285.

[c] On this in general see Thorndike (1), vol. 2, pp. 655ff.; Ganzenmüller (2), pp. 80, 181ff.; Frankowska (1), pp. 43, 88–9, 107.

[d] This follows upon the 12th chapter of Part VI.

[e] Jebb ed., p. 466, tr. Burke (1), vol. 2, pp. 617–18; this and the following passages will be found in the edition of Bridges (1), vol. 2, pp. 205ff., 210–12. On the genuine (and spurious) alchemical writings of Roger Bacon see D. W. Singer (2).

Thus a weakened constitution is passed down from fathers to sons, and so transmitted further.

These are the two natural causes on account of which the longevity of man does not follow the natural order established in the beginning. It is praeternaturally abbreviated.

But now it is proved by certain experiments that many things can retard this hastening and decline; and secrets found out by experiment show that longevity can be prolonged by many years. Many authors have written on these things, and the possibility of remedies against this ruin ought to be known.[a]

The whole macrobiotic system of Roger Bacon is enshrined on this page.[b] He did not disparage the Hippocratic and Galenic systems of regimen which had come down from antiquity,[c] and he added a reference to the effects of sin, possibly out of respect for his cloth though not devoid of psychological validity; yet what was uppermost in his mind was the actual prolongation of the human life-span by material and chemical means. The traditional hygiene had aimed simply at fulfilling the 'natural' span of life; what Bacon offered was, as Gruman says, something radically new in the Western world, a methodical rationale for the prolonging of human life beyond its 'natural' span.

After all, it was agreed throughout Christendom that the soul was immortal. Why should it not be retained by art a good while longer in its mortal husk? As Bacon wrote elsewhere:[d]

> The possibility of the prolongation of life is confirmed by the consideration that the soul is naturally immortal and not capable of dying. So, after the Fall, a man might live for a thousand years; only since then has the length of life gradually shortened. Therefore it follows that this shortening is accidental and may be remedied wholly or in part.

Here the reference is to Methuselah's 969 years, but there is no doubt from other passages that Roger Bacon took heart from the examples of all the Old Testament patriarchs, just as the Arabic alchemists had done before him.[e] In this way could the material immortality of China find a foothold in Europe. In that Western part of the world there were, as Gruman has worked out in detail,[f] three main types of legend which helped the acculturation; the antediluvian type, the hyperborean type and the fountain type. The patriarchs naturally belonged to the first of these. The second pictured certain very far parts of the earth as peopled by extremely long-lived races.[g] The third, analogous to certain Chinese Taoist paradise descriptions,[h] spoke of rivers

[a] Jebb ed., pp. 467–8, tr. Burke (1), vol. 2, *loc. cit.*, mod. auct.

[b] Other passages of much interest are to be found in his *De Retardatione Accidentium Senectutis*, tr. Browne (1), pp. 53ff., 136. His criticism of reliance upon hygienic regimen alone was that no one can be protected against all environmental hazards (Browne tr., pp. 13–14, cit. Gruman (1), p. 65). Something more was needed—the 'admirable virtues' in things, not yet fully discovered (Browne tr., pp. 46–7).

[c] Mem. the translation of Galen's *De Sanitate Tuenda* by R. M. Green (1).

[d] *Epistola de Mirab. Potest.*, tr. Davis (16), p. 35.

[e] Gen. 9. One of the best studies of patriarchal longevity and the puzzlement of Renaissance thinkers as to how to take it is that of Egerton (1). Explanations were mythical, denying all validity to the tradition, or metaphorical, taking the patriarchs as symbols of tribes or dynasties, or literal—even as early as Josephus changes of diet were invoked. We should look upon it now simply as a variety of golden-age primitivism (Vol. 2, pp. 127ff.), cf. Boas (1); Lovejoy & Boas (1). On the other hand Roger Bacon could—and probably did—cite the prophecies of Isaiah, e.g. 65. 17, 20, where in the new heaven and the new earth no one will be less than centenarian.

[f] (1), pp. 20ff.

[g] This goes back as far as Pindar, *Pyth. Odes*, 10, and has marked Indian connections.

[h] Cf. Vol. 2, p. 142.

or fountains of life or youth, powerfully restorative and preservative if anyone could find them and bathe in them.[a] The role of all these in Baconian and Paracelsian optimism remains to be determined more fully.

A few pages further on Roger Bacon takes up the powers of alchemy.[b] A paragraph full of burning enthusiasm ends as follows:[c]

> And the experimental science (of the future) will know, from the 'Secret of Secrets' of Aristotle,[d] how to produce gold not only of twenty-four degrees but of thirty or forty or however many desired. This was why Aristotle said to Alexander 'I wish to show you the greatest of secrets', and indeed it is the greatest. For not only will it conduce to the well-being of the State, and provide everything desirable that can be bought for abundant supplies of gold, but what is infinitely more important, it will give the prolongation of human life. For that medicine which would remove all the impurities and corruptions of baser metal so that it should become silver and the purest gold, is considered by the wise to be able to remove the corruptions of the human body to such an extent that it will prolong life for many centuries. And this is the body composed with an equal temperament of the elements, about which I spoke previously.

Here then is Ko Hung (and Jābir too) in Latin dress at last. The final sentence strikes a note familiar to us, and indeed Bacon explicitly reproduces the Arabic doctrine of perfect equilibration, which must have reached him through the translators in Spain and Catalonia. What he had said a page or two earlier was this:[e]

> Now if truly the elements should be prepared and purified in some sort of mixture so that there should be no nocive action (*infectio*) of one element on another, but that all should be reduced to a pure simplicity, then the wisest men have judged that they would have the highest and most perfect medicine. For in this way the elements would be on an equality....
>
> This condition will exist in our bodies after the resurrection. For an equalisation of the elements in these bodies excludes corruption for all eternity. For equality is the ultimate end-in-view or final cause of all natural matter in mixed bodies, since it is the most noble of states, soothing and quietening all appetite in matter so that it desires no other thing.
>
> The body of Adam did not possess a full equality of the elements, for there were in him the actions and passions of contradictory elements, so that waste occurred and food was necessary to make it good. And this was why it was told him that he should not eat of the fruit of life. But since the elements in him approached equality there was very little waste in him; and hence he was fit for immortality, which he could have secured if he had eaten always of the fruit of the tree of life. For that fruit is considered to have the elements in a condition approaching equality, and it could have continued the incorruptibility of Adam—which would have happened, if he had not sinned.
>
> The wise have therefore laboured to reduce the elements in various forms of food and drink to an equality, or nearly so, and have taught means to this end.

From this it is evident that the ideas of Ibn Bishrūn and his colleagues were fully at

[a] This may have originated in part from Hebrew legend, cf. Gen. 2. 10, Psalms, 36. 9 continued in Rev. 22. 1. It certainly comes in several versions of the Alexander-Romance (cf. Cary (1); P. Meyer (1), pp. 174ff.). General studies of the 'Fountain of Youth' motif are those of Hopkins (4); Masson (1). Apparently it was what Juan Ponce de León, the conqueror of Florida, was looking for in +1513; Beauvois (1). Cf. Wünsche (1).

[b] In the third Exemplum.

[c] *Opus Majus*, Jebb ed., p. 472, Burke tr., vol. 2, p. 627, mod. auct.

[d] This is Pseudo-Aristotle, *Kitāb Sirr al-Asrār*, the book of advice to kings, edited by Roger Bacon himself (cf. Steele, 1). It originated probably about +800. Cf. p. 297 above, and p. 497 below.

[e] *Opus Majus*, Jebb, ed., pp. 470–1, Burke tr. vol. 2, pp. 624–5.

work among the Latin alchemists, even though there might have been some raised eyebrows among the theologians studying Roger Bacon's interpretations of Genesis.

This comes out in another way in other books.[a] Thus in the *Opus Tertium* (+1267) there is an interesting passage[b] on speculative and operational alchemy[c] which treats explicitly 'of the generation of things from their elements', not only inanimate minerals and metals but also plants and animals.[d] This is the very idea of the Arabic *takwīn*, and now and then we can even catch Roger Bacon in the use of Arabic phrases so typical as 'if God wills'.[e] There was nothing very new in the belief that Art could produce in a single day what Nature takes a thousand years to accomplish,[f] but we ought not to miss the point that Roger was also extremely interested in the possibility of perpetual motion machines,[g] probably to be achieved with magnets, as indeed his friend Pierre de Maricourt was constantly occupied in attempting.[h] Here then were the two components of the Arabic artificial generation system, though Bacon probably never knew its full details; he would have been very excited if he had, and would certainly have found some ingenious way of reconciling it with Christian theology.

Finally, he adduced a number of case histories to demonstrate the possibility of extraordinary longevity, and if they sound very unconvincing to us they may have carried more weight with his contemporaries. The 'oriental' reference is significant—Artephius, for instance, wandered all over the east seeking knowledge, much of which he got from Tantalus the teacher of a King of India, so that he was enabled to live for 1025 years, by 'secret experiments on the nature of things'.[i] Bacon was always quoting the story of the Sicilian farmer:[j]

In the time of King William of Sicily a man was found who renewed the period of his youth in strength and sagacity beyond all human calculation for about sixty years, and from

[a] Statements about elixirs, and gold elixirs (*chin tan*[1]!) in particular, are scattered everywhere in Bacon's books. Cf. *Opus Minus*, Brewer ed., pp. 314–15, 375, where we hear that gold *per magisterium* is better than natural gold; or again *De Secretis Operibus Naturae...*, Brewer ed., pp. 538ff. A further source on elixirs is the rather muddled group of tractates attributed to Roger Bacon and published as *De Arte Chymiae* in +1603, the title beginning *Sanioris Medicinae Magistri...* (cf. Multhauf (5), p. 190). In this see especially pp. 285–291. Here elixirs restore sight, and potable gold brings back youthfulness even when a man is at the point of death. The authenticity is disputable, but many ideas close to Bacon's are present in the book.

[b] Ch. XII, text in Brewer (1), pp. 39ff., partial tr., p. lxxx.

[c] He deplores at the conclusion that there are so few skilled practical men who understand how to conduct chemical operations.

[d] The passage repeats the valuation of alchemy as so beneficial for the State treasury, but better still as a means of prolonging life, which is unduly short because of lack of regimen and the inheritance of corrupt constitutions.

[e] E.g. *Opus Minus*, text in Brewer (1), pp. 314–15. Here again we read of the equilibration of the qualities, which is what, if accomplished, will prolong life beyond the single century.

[f] *Opus Minus*, *loc. cit.*

[g] See the *De Secretis Operibus Naturae...*, (before +1250), Brewer ed., p. 537. This is the place which refers to Pierre de Maricourt as 'Experimentator tamen fidelis et magnificus'. See also *Opus Majus*, Jebb ed., pp. 465–6, the first Exemplum.

[h] Cf. Vol. 4, pt. 2, pp. 540–1. There are many warm mentions of Peter de Maharn-Curia the Picard in Roger Bacon; cf. Brewer (1), pp. xxxvii, lxxv, 35, 43, 46, e.g.

[i] *Opus Majus*, Jebb ed., p. 469; *De Mirab. Potest.*, Davis tr., pp. 34–5. Thorndike (1), vol. 2, p. 354, identifies Artephius with al-Tughrā'ī, on whom see p. 402 above.

[j] *Opus Majus*, Jebb ed., p. 469, Burke tr., vol. 2, p. 622; *De Retardat. Accid. Senectut.*, Browne tr. p. 75; *De Mirab. Potest.*, Davis tr., pp. 33–4.

[1] 金丹

a rustic ploughman became a messenger of the king. While ploughing in the fields he found hidden in the earth a golden vessel which contained an excellent liquor. Thinking that this liquor was dew from the sky he drank of it, and washed his face, and was restored in mind and body beyond all measure.

There are many other reports of the same kind in Bacon's writings,[a] further study of which we may omit, but this one deserves particular mention because he used it explicitly to recommend potable gold.[b]

And a good experimenter says in his book on the regimen of the aged that if one took that which is tempered (or equilibrated) in the fourth degree (i.e. the highest), and what swims in the sea, and what grows in the air, and what is thrown up by the sea, and a certain plant of the Indies, and that which is found in the viscera of long-lived animals, and the two creeping things that live in the lands of the Tyrians and the Ethiopians, all prepared and elaborated as they ought to be with the treasure of a noble animal, then it would be possible to prolong the duration of human life by many times, delaying the onset of old age and mitigating the affections of senility.

Now truly that which is tempered in the fourth degree is gold, as is said in the book *De Spiritibus et Corporibus*, the greatest friend of nature above all others. And if by a certain experiment this could be made as good as possible (which would be far better than natural gold),[c] as the alchemical art has power to do, like the vessel which the farmer found, and if it could be dissolved into a liquid like that which the ploughman drank—then a marvellous operation would take place in the body of man...

If one compares all this with the hopes of Han Wu Ti and his Taoist advisers (pt. 3, pp. 29ff. above) the coincidence is striking.

This last passage contains some rather mysterious allusions, but they are cleared up in other Baconian writings, notably the tractate *De Retardatione Accidentium Senectutis*, which can be dated between +1236 and +1245.[d] There the seven *occulta* turn out to be as follows, first gold (as just stated), second ambergris or spermaceti (that which swims on the sea or is cast up by it),[e] third the flesh of vipers or lizards, 'dragons', from Ethiopia, fourth rosemary, sixth a bone believed to come from the heart of the stag, and seventh lign-aloes[f] (the 'plant' from India).[g] The fifth proves to be something more remarkable than any of these, namely *fumus juventutis*, i.e. the exhalations

[a] See, for example, *Opus Minus*, Brewer ed., pp. 373ff. William of Sicily reappears, together with many other cases, in *De Secretis Operibus Naturae...*, Brewer ed., pp. 538ff.

[b] *Opus Majus*, Jebb ed., pp. 469–70, Burke tr., vol. 2, p. 623, mod. auct. Gruman (1), p. 63 remarks, quite rightly, that the thought here is strikingly similar to that of Li Shao-Chün in the −2nd century.

[c] What did Ko Hung say in +315? See pt. 3, p. 2.

[d] I shall always remember the astonishment I experienced when first reading the text and exposé of this work by Little & Withington (1), so Taoist in its implications. What follows is based upon pp. 15, 57ff., 140ff. of their study.

[e] On ambergris see pt. 2, p. 142 above. Spermaceti wax is not an intestinal concretion but a product from the heads of a number of whales and dolphins; Bacon seems not to have distinguished between them. Ambergris had been used as an aphrodisiac traditionally among the Arabs and perhaps also in China (cf. Davenport (1), pp. 37ff.).

[f] On the perfumed aloes-wood see Vol. 5, pt. 2, p. 141 above.

[g] Nearly four hundred years later quite a similar list of medicines conducive to longevity was given by Francis Bacon in his *Historia Vitae et Mortis* (+1623). They include gold in all its forms, pearls, emerald, hyacinth, bezoar, ambergris and lign-aloes (Montagu ed., vol. 10, pp. 178ff.). Frequent blood-letting was to be avoided. Cf. Walker (3).

or effluvia of healthy young persons. As the *Secretum Secretorum* says:[a] 'Si sentis dolorem in stomacho...tunc medicina necessaria tibi est amplecti puellam calidam et speciosam'. This was a kind of contagion, for Bacon also says: 'Infirmitas hominis in hominem transit, ita est sanitas.' The geriatric benefit supposedly derived from proximity to a healthy and beautiful young girl, with the absorption of her breath, is an idea presumably as old as King David,[b] and it was certainly still current in the +16th, +17th and +18th centuries;[c] but when we go on to read that coitus entirely destroys the effect we can no longer forbear from recalling that Chinese physiological alchemy (*nei tan*[1]) which will be the subject of the following sub-sections in pt. 5, and it looks as if Bacon was recommending the transfer of *chhi*,[2] for what else could *fumus juventutis* mean? Strangely also, if this happy solution was unattainable, Roger Bacon recommended as a substitute some kind of arcanum prepared from human blood.[d] For more reasons than one, therefore, he probably felt it necessary to be as discreet as possible in discussing elixirs with the Pope or with his Franciscan colleagues. But his texts remain for us the supreme and first great example of *hsien*[3] medicines and *hsien*[3] hagiography in the Western world.

Any intimations of chemical macrobiotics which one can find in Europe reinforcing Roger Bacon's convictions during the following half century or so are obviously of great interest for the theme of transfer from the East. Hence we should not overlook a striking passage in Marco Polo which occurs in his account of India (Malabar).[e] Speaking of men whom we might think of as *sadhus* he says:[f]

> And these Braaman (Brahmins) live more (i.e. longer) than any other people in the world, and this comes about through little eating and drinking and through great abstinence which they practise more than any other people....
>
> Moreover they have among them regulars and orders of monks according to their faith, who serve the churches where their idols are; who are called 'ciugui'[g] (and) who certainly

[a] Steele ed. (1), p. 73, tr., p. 198. This was the Arabic 'Book of the Secret of Secrets' again, i.e. advice to kings, Pseudo-Aristotle addressing Alexander, edited by Roger Bacon about +1255 with an introduction added by him some twenty years later. Cf. pp. 297, 368, 494 above.

[b] I Kings, 1. 1–4, Abishag the Shunamite.

[c] In +1573 our own second founder, Dr John Caius, adopted some such technique in his last illness, though it may also have been connected with a diet of human milk for his disordered stomach, perhaps due to a carcinoma. In the following century the same was reported of our William Harvey by John Aubrey in his 'Brief Lives' (Dick ed., p. 213). So also Thomas Sydenham praised the balsamic exhalations 'ex sano et athletico corpore'; and Francis Bacon had said 'Neque negligenda sunt fomenta ex corporibus vivis', going on to speak of King David (*Hist. Vit. et Mort.*, Montagu ed., vol. 10, p. 244; cf. Grmek (2), pp. 44–5). And in the +18th century came Cohausen's book on the subject, which we shall discuss in pt. 5 below. One can hardly forbear from adding a reference to Nabokov's famous novel, 'Lolita'.

[d] This recalls the conjecture of Multhauf (5), pp. 190, 192, that Roger Bacon belonged to a school of Latin alchemists which firmly believed in what they had learnt from Arabic sources, the preparing of elixirs from organic materials. Multhauf suggests that the majority, more faithful perhaps to Hellenistic traditions, accepted only mineral and metallic magisteries, abhorring the others. Further research may be expected to throw more light on this.

[e] Attention was drawn to it by Berthelot (10), p. 201.

[f] Ch. 177, Moule & Pelliot tr., vol. 1, pp. 403–4, text, vol. 2, p. lxxxii. The omitted sentences enlarge on the remarkably good teeth of these sages, who do not bleed themselves or others, and whose food is mainly bread, rice and milk.

[g] I.e. yogi (Pelliot (47), p. 391).

[1] 內丹 [2] 氣 [3] 仙

live more than all others in the world, for they commonly live from 150 years to 200. And yet they are all quite capable in their bodies so that they are well able to go and come wherever they wish, and they do well all the service which is needed for their monastery and for their idols, and though they are so old they render it as well as if they were younger....

And again I tell you that these ciugui who live so long time...eat also what I shall explain, and it will seem indeed a great thing to you, very strange to hear. I tell you that they take quicksilver and sulphur and mix them together with water and make a drink of them; and they drink it and say that it increases their life, and they live longer by it. They do it twice in the week, and sometimes twice each month, and you may know that those people use this drink from their infancy (so as) to live longer, and without mistake those who live so long use this drink of sulphur and of quicksilver....[a]

And he goes on to expatiate on the gymnosophists. The passage is particularly interesting because the dietetic-hygienic element and the elixir-pharmaceutic element are both so prominently present; Li Shao-Chün's cinnabar is living again in Rusticianus' Latin. Marco Polo was a contemporary of Roger Bacon's; he reached China in +1275 and left for India in the year of Bacon's death, +1292, returning to Italy by +1295, so that the dictating of his reminiscences belongs to the ensuing decade. Of course Marco's information did not spread with the rapidity of a mass-produced paperback of the present day, but it attained diffusion in a considerable number of manuscripts which were widely read,[b] and what he reported of the chemically-induced longevity of Asian saints and sages must at least have chimed in with those other notes which emanated from specifically Arabic sources.[c]

After this time the theme of elixirs goes continuously on. In the following century the Villanovan Corpus has a *Liber de Conservatione Juventutis et Retardatione Senectutis*.[d] About +1320 John Dastin wrote a letter on alchemy to John XXII which opens as follows:[e]

[a] Whatever the true facts may have been, Marco Polo is borne out by a text two hundred years older than himself, the *Rasārṇavakalpa*. There we read that 'half a *pala* of sulphur and one *pala* of mercury, taken for a year, bestows a longevity of three hundred years' (Roy & Subbarayappa tr., p. 85).

[b] For example, there is an evident echo in Francis Bacon's *Hist. Vit. et. Mort.* (+1623): 'Etiam Seres, Indorum populus, cum vino suo ex palmis, longaevi habiti sunt, usque ad annum centesimum tricesimum' (Montagu ed., vol. 10, pp. 164–5).

[c] Some of the ideas in the foregoing passage had, to be sure, been current in Europe a long time before Marco Polo, for they can be found in the Alexander-Romance, that corpus of legend about Alexander the Great which first took form in the +3rd or +4th century. We have had occasion to refer to it before, in connection with aerial cars (Vol. 4, pt. 2, p. 572), diving-bells (Vol. 4, pt. 3, p. 674) and the Great Wall (Vol. 4, pt. 3, pp. 56–7). Its Sino-Indian element occurs especially in the *Commonitorium Palladii* (ed. Pfister (1); cf. Cary (1), pp. 12ff.; Derrett (1); Ross (1), pp. 30ff.; Coedès (1), pp. 98ff.). There we find mention of (*a*) Serica, the land of the silk-producing Seres, (*b*) the Isles of the Blest (like Phêng-Lai), (*c*) the capture of ships with iron nails by magnetic rocks (cf. Vol. 4, pt. 1, p. 235), (*d*) the longevity of the brahmins, never less than 150 years, (*e*) their simplicity, piety and vegetarian diet. Palladius, who must have written his account by +375, did not claim to have gone to India or the Further Indies himself, but got much information from one Thebeus Scholasticus, who had been there from +356 to +362. Those who collect pepper, he says, get it from troglodytic dwarfs in the uttermost islands, little men who share the virtues and the longevity of the brahmins. Among the echoes of this story is the dwarf-motif in the +11th-century German poem 'Ruodlieb' (Werner Braun). But the mercury and sulphur are in Marco Polo alone. Cf. p. 483 above.

We have to thank Dr Peter Dronke for illuminating discussions on these subjects.

[d] Cf. Little & Withington (1). Arnold died in +1311, but this would be rather later.

[e] Josten (1), p. 43; cf. Ferguson (1), vol. 1, p. 199.

This is the secret of secrets, the priceless treasure, the very true and infallible work concerning the composition of the most noble matter (the philosophers' stone) which, according to the tradition of all philosophers, transforms any metallic body into very pure gold and silver, which conserves (bodies in their) essence, and fortifies (them) in (their) virtue, which makes an old man young, and drives out all sickness from the body.

And after a disquisition on equilibration of temperament, sulphur and mercury, ferment and the like, he ends by saying that lastly

it is incerated so that the spirit may be incorporated and fixed in the body, until it becomes one with it, standing, penetrating and perfusing, tingeing and remaining—of which, according to the philosopher, one part converts a million parts of any body you may choose into the most genuine gold and silver respectively, depending on which of the two elixirs you have prepared. And it has effective virtue over all other medicines of the philosophers to cure all infirmity, because, if it were an illness of one month it cures it within one day, but if it were an illness of a year it cures it in twelve days. But if it were an inveterate illness (like old age) it cures it in a month. And therefore this medicine ought to be sought for by all men everywhere, and before all other medicines in this world.[a]

By this time alcohol had become widely known and used.[b] John of Rupescissa (*fl.* +1345) was perhaps the first to identify it with the quintessence or missing fifth element,[c] and though gold leaf suspended in alcohol was more impressive as an elixir symbolically than effectually, the new solvent did give access to higher concentrations of many active substances from the plant and animal world.[d]

Henceforward the elixir idea becomes a universal commonplace. Thomas Norton, speaking of the Ruby Stone of the Philosophers in his *Ordinall of Alchemy*, *c.* +1440, wrote:[e]

> Whereof said Mary, sister of Aaron
> 'Life is short, and Science is full long',
> Natheless it greately retardeth Age
> When it is ended (accomplished) by strong Courage...

And we may end this phase of the story by the inevitable quotation from Ben Jonson.[f]

> *Mamm*: Ha!
> Do you think I fable with you? I assure you,
> He that has once the Flower of the Sun,
> The perfect Ruby, which we call Elixir,
> Not only can do that, but by its Vertue,
> Can confer Honour, Love, Respect, Long Life,
> Give Safety, Valour, yea, and Victory,
> To whom he will. In eight and twenty days

[a] *Op. cit.*, p. 51.
[b] For an account of the discovery of alcohol and its spread cf. pp. 122ff. above.
[c] Cf. Leicester (1), p. 89; Multhauf (5), p. 211.
[d] See on the history of the quintessence Sherwood Taylor (6).
[e] Holmyard (12), p. 87, facsimile of 1652.
[f] *The Alchemist*, 1610, p. 372. Cf. pt. 3, p. 214. After all this, and with the background we now have, it hardly comes as any surprise to find that a work on cinnabar as a drug was published by Gabriel Clauder at Jena in +1684.

I'll make an old Man, of Fourscore, a Child.
Surly: No doubt, he's that already. *Mamm*: Nay, I mean,
Restore his Years, renew him, like an Eagle,
To the fifth Age; make him get Sons and Daughters,
Young Giants; as our Philosophers have done
(The antient Patriarchs afore the Flood)
But taking, once a week, on a Knives Point,
The quantity of a Grain of Mustard of it:
Become stout Marses, and beget young Cupids...

If the general picture so far outlined is approximately correct, namely that there was a passage of the elixir idea from the Arabic alchemists to the Latins, reaching full acceptance by them, according to their lights, in the time of Roger Bacon; then it might be expected that similar macrobiotic hopes would have become known in Byzantine culture a couple of centuries earlier. This is exactly what we find. If we open the history of fourteen Byzantine rulers written by Michael Psellus about +1063, his *Chronographia*, we can read a very peculiar passage about the reign of the Empress Theodora (+1055 to +1056). Psellus wrote:[a]

The extremely generous persons [installed by her in positions of authority in the church][b] who surpassed all bounds of liberality with their munificent gifts, were not angels carrying messages to her from God, but men, who imitated the angelic beings in outward appearance, yet at heart were hypocrites. I am referring to the Naziraeans of our time.[c] These men model themselves on the Divine, or rather they have a code of laws which is, superficially, based on the imitation of the Divine. While still subject to the limitations of human nature, they behave as though they were demigods among us. For the other attributes of Divinity they affect utter contempt. There is no effort to harmonise the soul with heavenly things, no repression of the human desires, no attempt by the use of oratory to hold in check some men and goad on others. These things they regard as of minor importance. Some of them utter prophecies with the assurance of an oracle, solemnly declaring the will of God. Others profess to change natural laws, cancelling some altogether and extending the scope of others; they claim to make immortal the dissoluble human body and to arrest the natural changes which affect it. To prove these assertions they say that they always wear armour, like the ancient Acarnanians;[d] and for long periods of time walk in the air—descending very rapidly, however, when they smell savoury meat on earth! I know their kind and I have often seen them. Well, these were the men who led the empress astray, telling her that she would live for ever; and through their deceit she very nearly came to grief herself and brought ruin on the Empire as well.

They predicted for her a life going on centuries without end. Yet in fact she was already nearing the day which Fate had decreed should be her last. I ought not to use such an expression—what I mean is that she had nearly finished her life and the end was at hand. As a matter of fact she was assailed by a very terrible illness....

And indeed she died in the summer of the second year of her reign, aged 76.

[a] Theodora sect., paras. XVIII, XIX, cf. also XV, Sathas ed., pp. 186–7; Renauld ed., vol. 2, pp. 80–1; Sewter tr. p. 269.

[b] The grammar is faulty here but the reference seems to be to ecclesiastical promotions mentioned in a just preceding paragraph.

[c] I.e. monks, from Heb. *nazir*, separated.

[d] An allusion to Thucydides, I, 5, speaking of a semi-civilised people.

From this it seems clear that Theodora was under the influence of a group of monks who claimed to be in possession of macrobiotic techniques.[a] Though these are not described, they could well have been psycho-physiological as well as chemo-therapeutic, and the whole passage has a very Taoist, or perhaps one should say rather at such a time and place, a Sufi, or even Siddhi, character. Walking on air is just what one expects of a Taoist *hsien*, and the remark about the failure to repress human desires might be an obscure reference to something like that physiological alchemy which will be the subject of the remainder of this Section.[b] Unfortunately none of the commentators has anything whatever to say about this strange group of Christian monks, so we can only record their existence.[c]

The name of Michael Psellus ought to strike a familiar note in the mind of anyone who has patiently followed our exposition from the beginning of Vol. 5.[d] For he was indeed none other than that Psellus who addressed an 'Epistle on the Chrysopoia' to the Patriarch of Byzantium in +1045 or +1046.[e] He wrote a preface to the Greek proto-chemical Corpus, and may indeed have been its first collector.[f] He was in touch with Arab scholars, and had Arabs among his pupils, this at a time when many Arabic writings were being translated into Greek.[g] In another place in the *Chronographia* he has an interesting passage on the chemical interests of the Empress Zoe, who died in +1050 aged 72 under Constantine IX; she turned her apartments into a veritable laboratory and never tired of investigating the properties of perfumes and their combinations.[h] Thus here we end, as we began, with Michael Psellus, a polymathic man whose life and times would repay, it seems, much further study by historians of science.

After this there is little more for us to say by way of conclusion. In the field of macrobiotics with which we are concerned there were two great movements during the scientific revolution. First, the ancient Greek tradition of medical hygiene, which had by no means been repudiated by Roger Bacon and the alchemists who followed him, gained from their elixir beliefs a new impetus and a new lease of life. In +1550 Luigi Cornaro published his *Discorsi della Vita Sobria*;[i] this, though largely dietetic, laid much emphasis on the avoidance of psychological strains and submission to the passions.[j] In these ways the innate moisture could be conserved.[k] Widely translated

[a] Of course it was customary for Byzantine ecclesiastics favoured by the emperor to predict long life for him, and length of days, just as they threatened an ill-disposed one with an early death through the assured wrath of God—but here there seems to be something more than these usual reactions.

[b] In pt. 5.

[c] The Hesychasts, of course, borrowed meditation techniques from Buddhism or Hinduism, but their movement was much later, in the first half of the +14th century.

[d] Pt. 2, p. 17, and p. 328 above. There is now a biography by Pingree (2).

[e] See Bidez (1), which includes an Italian translation. The Patriarch in question was apparently Michael Cerularius, not Psellus' friend Joannes Xiphilinus, as has often been stated.

[f] Cf. Berthelot (1), pp. 102, 248–9, 279.

[g] Bidez (1), p. 23.

[h] Sewter tr., pp. 186–7.

[i] Cornaro (+1467 to +1565) was a friend of Fracastoro. On him and his work see Sigerist (2); Walker (1). No less than nine English translations had appeared by 1825.

[j] This was strikingly similar to Chinese physiological alchemy; cf. pt. 5 below.

[k] This was Aristotelian and Galenic orthodoxy (cf. Gruman (1), pp. 15ff.) yet it reminds one of the necessity for the conservation of the *ching*.[l]

[l] 精

and approved, Cornaro's book had many successors, notably Lessius' *Hygiasticon* of +1614[a] and Sir William Temple's essay on health and longevity (+1770).[b] In +1796 came Christopher Hufeland's *Art of Prolonging Life*, in which the term macrobiotics was first used, appearing indeed in the original German version of the title. The influence of Hufeland, who was a friend of Goethe, Schiller and Herder, extended all over the world, and his prescriptions for longevity, in themselves very reasonable, passed into Japanese literature in the translations of Ogata Kōan[1],[c] as has been shown by Achiwa Gorō (*1*) in his interesting study of the theory of nature-healing in the Rangaku period. Hufeland also exerted a great effect on many nineteenth-century writers on medical hygiene and macrobiotics,[d] following the ideas of William Godwin and A. N. de Condorcet.

The other great movement just mentioned was of course that of iatro-chemistry, especially as it developed to the fullness of the Paracelsian form. This was the great empirical phase of chemistry developing in opposition to Galilean–Newtonian mechanicism, along with movements of lesser scope such as that of the biologically-minded Cambridge Platonists.[e] Necessarily it too had Pythagorean and Neo-Platonic, not to say Gnostic and Hermetic, roots.[f] How far it could have had certain East Asian roots, transmitted either through the Arabs or by way of more direct contacts in the +13th century and later, would be very hard to say, yet it really is the case that much of the Paracelsian thought-world has a strangely Chinese air.[g] For example, the very idea of an organic universe, with an interconnectedness of all things,[h] the prominence of the macrocosm–microcosm analogy,[i] and the readiness to conceive of action at a distance, based on resonance and 'magneticall' phenomena[j]—in all these things one has to speak at least of a parallelism with traditional Chinese world-views. But there are more detailed and disturbing similarities. The Paracelsians spoke of two kinds of

[a] English translation (Cambridge) by +1634. [b] *Works*, vol. 3, p. 266.

[c] For example, *Byogaku Tsūron*[2] (Survey of Pathology), and *Hushi Keiken Ikun*[3] (Mr Hu's Well-Tested Advice to Posterity).

[d] Notably Sweetser (1), who was the first to speak of 'mental hygiene' (1867), Jacques (1), who emphasised the will of the individual in determining his own fate, and Thoms (1), who collected as much evidence as possible about human longevity from historical records. The term 'folk-lore' was coined by him. 'Gerontology' was introduced by Metchnikov in 1903, and 'geriatrics' by Nascher in 1909.

[e] Cf. Vol. 2, pp. 296, 503–4, where we have touched on the Chinese parallelisms before.

[f] Particular attention has been paid to these by Pagel (28) and Pagel & Winder (1, 2). Gnostics and Paracelsians both had a predilection for classifying celestial–terrestrial beings, processes and elements in groups of eight. This recalls the eight trigrams (*pa kua*[4]) of the *I Ching* (on which see Vol. 2, p. 313). Hearsay about these might have strengthened the ogdoad tendencies in the West, but it would have to have happened quite early.

[g] The fact that the Paracelsian pharmaceutical revolution, lucidly sketched by Debus (25), used mineral drugs in defiance of the herbal *idée fixe* of the Galenical Colleges, was alone enough to unite it with the age-old tradition of Chinese pharmacy (cf. pt. 3, p. 46 above, and Needham (64), p. 284), and cannot but suggest some trains of influence. Lach (5), vol. 2, pt. 3, pp. 422 ff., considers the tradition that Paracelsus stayed some time with the Tartars in Russia, and ponders on how their name entered chemical terminology.

[h] Cf. Debus (2), p. xxxiv on Elias Ashmole, and (18), pp. 19, 86, (26) on the Paracelsians.

[i] Cf. Debus (6), p. 391, (7), p. 47, for comparison with Vol. 2, pp. 294 ff. and *passim*. Cf. Zippert (1); Pagel (28), pp. 38, 124.

[j] Cf. Debus (6), p. 390 and 400–1 on Kenelm Digby, as also Dobbs (1); and Gelbart (1) on Walter Charleton.

[1] 緒方洪庵 [2] 病學通論 [3] 扶氏經驗遺訓 [4] 八卦

fire,[a] strangely echoing the Chinese division of that element into 'princely fire' (*chün huo*[1]) and 'ministerial fire' (*hsiang huo*[2]).[b] Sexuality was very prominent in their thinking,[c] as it had been in that of all proto-chemists and alchemists from the beginning.[d] Robert Fludd coined the words 'volunty' and 'nolunty',[e] the former to express sympathy, light, warmth, life and expansion, the latter to express antipathy, dark, cold, death and contraction—can they have been anything other than Yang[3] and Yin[4] respectively? By this time Jesuit-transmitted knowledge could have been coming in, a phase of contact which might also have been responsible for the play which he made of the 'light' and 'heavy' antithesis (*chhing*,[5] *cho*[6]) in cosmogony.[f] After such parallelisms it is hardly surprising to find Fludd engaging in symbolic correlations between spatial directions and the viscera of the body;[g] while every Paracelsian wrote on sympathies and antipathies,[h] categories of reactivity,[i] and numerology rather than mathematics.[j] Pervading all was their characteristic empiricism[k] and their emphasis on the medical and macrobiotic side of alchemy.[l] We are not saying that all these traits were marks of the future that modern science had before it, obviously in many ways the exact reverse was the case, but among them certain great convictions stand out, notably that chemo-therapy in unimagined power was a realisable goal for man;[m] and if indeed there were East Asian contributions, however indirect, to these ideas, then some invaluable sense came through along with the nonsense.[n] About the intermediation of the Arabs enough has already been said; for this period one should perhaps look for more direct contacts (Fig. 1538).

[a] See Pagel (28), p. 70; Pagel & Winder (1), (2), pp. 102ff. This was gnostic, rabbinic and kabbalistic doctrine, so if there was any connection it must have been much earlier than the +16th century.

[b] Cf. Vol. 4, pt. 1, p. 65, and for a full explanation, Vol. 6. The doubling came about in China because of the necessity of meeting the need of medical philosophy for a sixfold rather than the fivefold classification.

[c] See Pagel (28), pp. 62ff.

[d] Cf. pp. 363ff. above.

[e] See Debus (6), p. 405. This was in Fludd's *Philosophia Moysaica*, published posthumously in +1638. The idea of positive and negative here was applied by him to magnetism, following William Gilbert; and as time went on to electricity by +18th-century physicists. Polarity also played a great part in the Naturphilosophie school (cf. Pagel (1), pp. 291–2).

[f] Cf. Debus (8), p. 266.

[g] Cf. Debus (8), p. 272, (18), p. 116.

[h] Cf. Debus (6), p. 391, (18), p. 90.

[i] Cf. Debus (6), p. 407.

[j] Cf. Debus (7), p. 49.

[k] Debus, *op. cit.*, p. 43.

[l] Cf. Debus (18), pp. 23, 146, (21, 22, 23).

[m] The fact that I am sitting here writing these words is in itself an indication of what we all owe to the elixir alchemists and the Paracelsians. Without public hygiene, sulpha-drugs, immunology and antibiotics I should have been carried away thirty years ago or more. In Roger Bacon's time old age began at 45.

[n] For those interested in 'nonsense' (and who ever knows what may come out of it?) an interesting study might be the comparison of the cosmic-chemical charts of different cultures. Singer, Anderson & Addis reproduced one of these from a +15th-century alchemical MS. (BM, Egerton 845, (1), their no. 440), and Heym (1) gave another from an early +18th-century work on mystical alchemy, the *Aurea Catena Homeri*. It is very likely that the Kabbalah literature had something to do with this, for it delighted in charts of creation (the 'Sephirothic Tree'), as may be seen in such works as Athanasius Kircher's *Oedipus Aegyptiacus* as well as the Hebrew originals (cf. e.g. Hall (1), pl. CXXIII); to this we drew attention in Vol. 2, p. 297 in connection with the influence of Chinese organic and correlative thinking on Europe. Indeed the first model for all subsequent cosmic-chemical charts could conceivably have been the Neo-Confucian *Thai Chi Thu*, described and discussed in Vol. 2, p. 461. Thanks are due to Mrs Alice Howell of Westbury, L.I., for raising this point.

[1] 君火 [2] 相火 [3] 陽 [4] 陰 [5] 清 [6] 濁

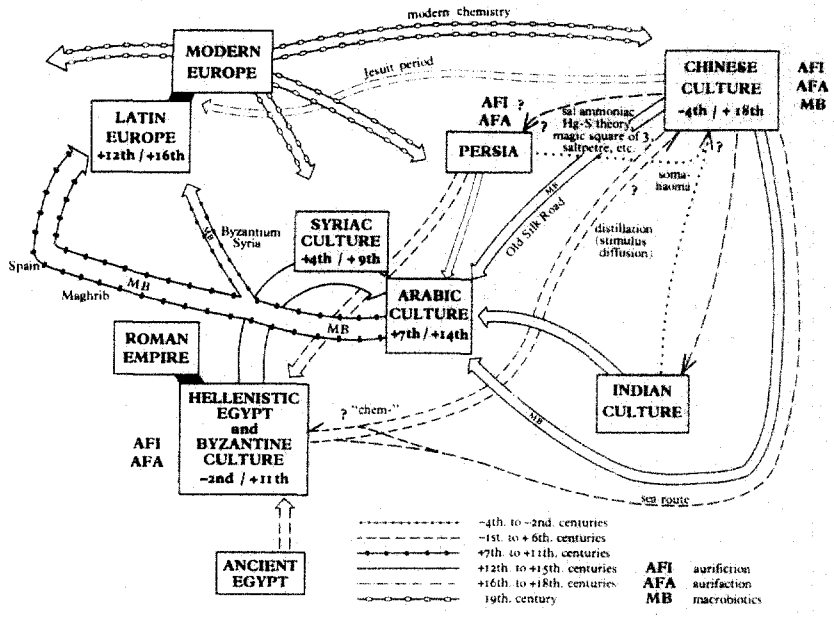

Fig. 1538. Chart to illustrate the multi-focal origins of proto-chemistry.

This chart is to be seen as superimposed roughly upon a map of the Old World, allowance being made for diagrammatic displacements occasioned by the different time-periods of the cultures. Single or double arrow-heads mark the arrival of well-established influences; less certain ones are qualified by interrogation marks. The pattern itself may also be visualised in depth, as the older lines of influence are drawn underneath the later ones at places where they cross.

The phrase 'multi-focal' is that of Sheppard (6), but since we define alchemy as macrobiotics+ aurifaction we find it applicable not to alchemy but to proto-chemistry. It is now unquestionably clear that there were two foci of aurifiction and aurifaction, Hellenistic Egypt and China; perhaps there were four if Persia and India should be included as well, their independence remaining still in some doubt. But there was only one focus of chemical macrobiotics, China, hence the home of all alchemy *sensu stricto*; and one can see this influence spreading westwards when the time came through Arabic and Byzantine culture to the Latin West, and therefore into Paracelsian iatro-chemistry and modern chemotherapy.

The stimuli which may have acted upon Chinese culture in ancient times with the generation of the *hsien tan* complex are very obscure, but two dotted lines are shown to indicate the possible role of *soma haoma* ideas and practices. Gilgamesh's herb of immortality, back in the −3rd millennium, might have been the ancestor of these, but Ancient Mesopotamia has been excluded from the chart for the sake of simplicity, since geographically it would underlie the Arabic culture. Moreover, we still have very little sure information about the chemical knowledge of the Babylonians and Assyrians. Presumably the technology of the precious metals, glass, ceramics, fermentations, bitumens, perfumes and the like, should be shown by a series of dashes influencing the Hellenistic, Byzantine and Syriac cultures, as has been done to indicate the influence of the traditional technology of Ancient Egypt; but none of this demonstrates either aurifiction or aurifaction, still less chemical macrobiotics.

Lastly, it will be seen that Indian culture is drawn in a rather isolated position. This is not because we believe that it really was so, but because Indian philology and archaeology are as yet so undeveloped that the dating of texts (and therefore of ideas and practices) presents grave difficulties, while at the same time the study of ancient artifacts has so much more yet to tell us. Almost the only things that can be said for certain are that Indian medicine, mineralogy and other sciences exerted a great influence on the Arabic world from the + 7th century onwards, and that Chinese macrobiotics influenced India to some extent at a rather earlier date.

It was not common for the +17th-century mystical chymists to make any direct reference to the ideas of the Chinese, but one such allusion does occur in Thomas Vaughan's *Magia Adamica* (+1650).[a] Here, however, the justification claimed was not because of any priority of theirs, but rather by their recognition and confirmation of a universally valid *philosophia aeterna*. Vaughan was arguing that natural magic was the way in which God himself, as the Holy Spirit, worked and had worked in creation, that it was essentially chemical in nature, a vivification of matter, that man can use the same creative forces if he is in tune with the divine Word or Logos, and that the Kabbalah as well as Greek and Egyptian magic were only imperfect anticipations of Christian magic. If the Christian cosmology thus superseded all others, then all peoples should accept it once it was called to their attention, in proof of which he adduced the Nestorian Stone, that famous stele erected near Sian in +781 recording the development of the Church in China since Bishop Alopên's coming in +635.[b] The imperial favour which the religion received, and its approbation by many of the learned of the empire, demonstrated, Vaughan thought, the universal truth of 'Christian chemical creation'.

Thomas Vaughan, no doubt, was rather on the fringes of the iatro-chemical movement. Before leaving it we ought to take one more look at the central doctrine taught by Paracelsus. From the opening of Vol. 5, pt. 2 onwards we have emphasised his great watchword that the business of alchemy was not to make gold but to prepare medicines, showing that this was in a direct line of descent from the elixir ideas of Li Shao-Chün and Ko Hung. What then were the actual words of Paracelsus? The first statement,[c] that alchemy is not aurifaction, occurs in the *Paragranum* (+1530):[d]

> It is not as the praters maintain, that alchemy is to make gold, and to make silver; the grand principle is that it is to make arcana,[e] and to direct them against diseases—that is the aim and target of all true Alchemy.[f]

In another passage, he says that alchemy is purificatory chemistry, its true task the liberation of the medicinal substances contained in the crude materials. So in his *Labyrinthus Medicorum Errantium* (+1538) he wrote:[g]

> If you see a herb, a stone or a tree, you see only the husk, the gangue or the slag, and underneath that lies the drug. You must take out the drug and separate it from the dross;

[a] Vaughan (2), repr. in Waite (4, 5). The passage occurs on pp. 176–7 of the 1968 edition of (4). Thanks are due to Mr David Hallam for calling this to our attention.

[b] Cf. Vol. 1, p. 128. For a full account see Saeki (1, 2). The exact nature of the sources used by Thomas Vaughan presents a somewhat puzzling problem, but knowledge of the Stone and its inscription had been circulating in Europe since Nicholas Trigault's first translation in +1625.

[c] An excellent study of the main views of Paracelsus is that of Walden (4).

[d] Sudhoff ed., vol. 8, p. 185; Strebel ed., vol. 5, p. 114.

[e] Compound or simple medicines endowed with the divine power of the Creator, embodying astral virtues, and prepared by chemical means. The concept was complex; further exposition will be found in Pagel (10).

[f] The temptation is irresistible to give one or two of these passages in the extremely colourful +16th-century German that Paracelsus wrote. So here: '...entgegen den Schwätzern, die sagen: die Alchimia mache Gold, mache Silber; hie ist das fürnemen: mach Arcana und richte dieselbigen gegen den Krankheiten. Das ist Zweck und Ziel der wahren Alchimie.' Even with the varying degrees of modernisation that editors have provided, the vitality of Paracelsus always impresses.

[g] Sudhoff ed., vol. 11, pp. 187–8; Strebel ed., vol. 1, p. 192.

only then will you have it. That is Alchemy. And the task of the apothecary and the operator in the elaboratory is the same as that of Vulcan.[a]

And a page or two further on he wrote:[b]

Alchemy is what brings to its perfection that which is not yet perfect.[c] Those who draw lead from its ore, and work it up, are alchemists of metals. So also there are alchemists of minerals, sulphur, vitriol and salt. If you ask what Alchemy is, know that it is simply the art of purifying the impure by fire. Alchemists of wood are like carpenters who make wood into a house; so also the wood-carver chips out from wood, and throws away, what does not belong to it, and thus creates a figure. Just so there are alchemists of drugs, who purge away from the drug all that which is not drug. See then what kind of an art is Alchemy—that which separates the useless from the useful, and brings this last to its final matter and its final perfection.[d]

And again, in the *Paramirum*:[e]

Whoever takes what Nature has generated that can be useful to man, and brings it to that place and estate that Nature has appointed for it, that man is an Alchemist.[f]

And finally:[g]

No physician can do without alchemy; if he ignores it he will be but a sluttish scullion compared with the master-cook of a princely palace.[h]

In such sayings Paracelsus linked the Chinese medieval alchemists with the biochemical pharmacologists of modern times, extracting a few milligrams of a substance from a ton or a gallon of raw material.[i] Yet alchemy still embraced, in Paracelsus' thought, the chemistry and metallurgy of gold, in so far as it contributed to that remedy in which he still believed, the *aurum potabile*.[j] In +1526 he had written, in his book *Von den natürlichen Dingen*:[k]

Aqua salis (hydrochloric acid) is distilled from the calcination to a spirit which dissolves gold to an oil, whereby potable gold can be prepared.

[a] '... sie sehen nur die Schlacke, innen aber unter der Schlacke da liegt die Arznei. Nun muss zuerst die Schlacke der Arznei genommen werden. Dann ist die Arznei da. Das ist Alchimie....'

[b] Sudhoff ed., vol. 11, pp. 188–9; Strebel ed., vol. 1, p. 194.

[c] Paracelsus often compared the alchemist to the archaeus operating in bodily chemical processes; cf. Ganzenmüller (5), p. 430. For example: 'Der Archeus fabriziert als innerer Alchymisten-Geist' (*Paragranum*, Strebel ed., vol. 5, p. 106).

[d] 'Das ist Alchimie, das zum Ende zu bringen, was nicht zu seinem Ende gekommen ist.... So gibt es Alchimisten der Arznei, die von der Arznei das entfernen was nit Arznei ist. Jetzt sehet, welche Kunst die Alchimie ist. Sie ist die Kunst, die das Nutzlose vom Nützlichen entfernt, und es zu der letzten Materie und zum letzten Wesen bringt.'

[e] Sudhoff ed., vol. 8, p. 181; Strebel ed., vol. 5, p. 110.

[f] 'Wer also das, was in der Natur dem Menschen zunutze wächst, dahin bringt, wozu Natur es bestimmt hat, ist ein Alchimist.'

[g] Sudhoff ed., vol. 1, p. 125.

[h] 'Kein Arzt kann ohne die Alchimie sein, sonst ist er wie ein Saukoch gegenüber einem Fürstenkoch.' Cf. the opening of *Labyrinthus*, ch. 5, in Strebel ed., vol. 1, p. 190.

[i] Indeed the Chinese iatro-chemists had done just this from the +11th century onwards when they prepared the steroid hormones from urine (cf. Vol. 5, pt. 5).

[j] Direct descendant of that ancient Chinese conception, *chin i*.[l]

[k] Sudhoff ed., vol. 2, p. 106; Strebel ed., vol. 8, p. 246.

[l] 金液

To sum it up, therefore, Paracelsus was the vital pivot linking Chinese and then Arabic elixir alchemy through iatro-chemistry with the pharmacology and medicine based on modern chemistry. Of course the emphasis on therapy was not entirely new with him because it had come down from Roger Bacon's macrobiotics through such writers as Arnold of Villanova, John of Rupescissa and Michael Savonarola,[a] who all exalted the preparation of medicines for the conservation and prolongation of human life above any dubious aurifaction;[b] in a line of inheritance which (as we have seen) can be traced back to Islam and ultimately to China. But Paracelsus was the definitive figure who broke with aurifaction for ever as the main aim of alchemy, and pointed the way to all later chemistry and pharmacy.[c]

Having come now to the term of our long discussion of laboratory proto-chemistry and alchemy it may be just worth while to look at a few aspects of modern gerontology.[d] Prolongevity, after all, was the main objective of these ancient and medieval sciences.

The greatest ages to which human beings can attain have long been a matter of interest both in East and West.[e] William Harvey himself performed an autopsy on Thomas Parr, who died in +1635 at the supposed age of 152.[f] In recent times there have been some scientific studies of the super-centenarians of the Andes, especially the Vilcabamba Valley in Ecuador, and the conditions of their lives.[g] Here the two oldest men were 123 and 143 respectively, but there were several women of 103 and 105. Another region known for super-centenarians is Abkhasia in Russian Georgia, where the climate of the mountain valleys of the Caucasus may be similar to that of the Andes.[h] Here life-spans of 700 centenarians recently examined ranged up to 141 years. A third well-established longevity area is Hunza in the Karakorum range of the Himalayas.[i] Common to all these regions is a combination of mountain environment and a primarily vegetable diet, often low in calorific value, factors strangely justifying the ideas of the Taoists of old. The oldest human record confirmed by documents in Europe is 130, but lives ending between 100 and 111 years have not been extremely uncommon in England. The conservation of youthful vigour into such seniorities is still a task for the future, but one can easily see how a few super-centenarians in ancient China could have given colour to the conception of the *hsien*.

Perhaps it is more interesting to look at the unquestionable demographic fact that the life-length expectation of men and women has been rising continuously in the

[a] At the castle of Olsztyn in Warmia (Poland), where Nicholas Copernicus was Treasurer between +1516 and +1522, there is preserved among the books of the great astronomer a collection of Villanovan medical tractates bound up with some of the writings of Savonarola. Dr Lu Gwei-Djen and I had the pleasure of studying this in September, 1973.

[b] A good study of this line of succession has been made by Ganzenmüller (5).

[c] I am much indebted to my old friend Dr Walter Pagel for guidance through the *labyrinthus tractatorum Paracelsianorum*.

[d] On the biology of ageing and death in general there are excellent accounts by Grmek (2, 3) and Comfort (1), with references to an extensive literature. The more recent book of Rosenfeld (1) covers what is known about the biochemistry of ageing. On the historical background of gerontology see Burstein (1); Gruman (1, 2); Veith (6).

[e] An interesting book on the subject was published in 1907 by Nakamura Mokukō (1).

[f] Cf. Keynes (2), pp. 219ff.

[g] Davies (1, 2); Halsell (1).

[h] Cf. Benet (1).

[i] A close study of all these three parts of the world has been reported on by Leaf & Launois (1).

Western world since the Middle Ages, with the first rapid increase coming in the +18th century.[a] The following rough table, derived from several well-defined statistical analyses, shows the size of the change.

Date	Life-expectancy at birth, years	
	men	women
+1300	24	33
+1400	24	33
+1500	27	35
+1600	28	36
+1700	32	37
+1800	39	43
+1900	52	60
+1950	65	72

For other parts of the world we have no figures, but the same process must be occurring wherever modern science, medicine and technology, with the fuller understanding of nutrition and hygiene, is penetrating.[b] Though many other factors, such as food supplies, communications, housing and sanitation, have also had leading parts to play, the conviction of those thousands of pioneers, both Chinese, Arabic and European, that greater chemical knowledge could really lead to a lengthening of human life has surely proved true beyond dispute. Seen from Ko Hung's point of view, all hygiene and bacteriology, all pharmacy and nutritional science, would have been but extensions of the chemical knowledge needed for preparing the *tan*. The only failing of the early pioneers was the idea that there was one single substance alone which would be the universal medicine of man as well as metals; yet the elixir conception, from Tsou Yen through Jābir to Roger Bacon, was a veritably great creative dream. The kernel of truth in it was that the human body has a chemistry of its own, like all other compounded bodies whether inorganic or organic, and that if man could gain deep knowledge of that he would be able to prolong his life beyond belief.[c] If *hsien* immortality still eludes us, one begins to wonder whether it will always do so. But what unimaginable changes in human society centuries hence will have to come about to control such knowledge, if we ever attain it!

As a concluding epilogue, let us read the exquisitely Taoist words[d] of one of the

[a] See Hollingsworth (1*a*), p. 358, (1*b*), pp. 56–7, (2); Peller (1), p. 98; Wrigley (1), p. 171; Cipolla (3), p. 101; Russell (1), p. 47; Mols (1), p. 69; Armengaud (1), p. 48.

[b] There has been much debate on the role of medicine in the great +18th-century rise of population. While Griffith (1) attributed much importance to it, McKeown & Brown (1), agreeing with a standpoint of our own (Needham (59), repr. in (64), pp. 406ff.) find that at that stage it was not a leading factor.

[c] We shall pursue this in Vol. 5, pt. 5, on Chinese physiological alchemy and iatrochemistry.

[d] P. 39, tr. Debus (7), p. 46, (18), p. 20, mod. auct.; also quoted by Partington (7), vol. 2, p. 164. As Norpoth (1) has reminded us, this exhortation was completely in accord with the convictions of Paracelsus himself. In the *Sieben Defensiones* he justified his wanderings: 'Die Schrift wird erforscht durch ihre Buchstaben, die Natur aber durch Land zu Land, als oft ein Land, als oft ein Blatt. Also ist Codex Naturae, also muss man ihre Blätter umkehren' (Strebel ed., vol. 1, p. 118).

great Paracelsian physicians, Peter Severinus, archiater to the King of Denmark. In his *Idea Medicinae Philosophicae* (+1571) he wrote of the necessity of replacing book-learning and scholastic philosophy by practical experience of natural phenomena, and practical experimentation. Only so could the inspiring Paracelsian aim be achieved, that alchemists should make not gold but medicines. So to his readers he said:

Sell your lands, your houses, your clothes and your jewellery; burn up your books. Instead of those things, buy yourselves stout shoes and travel to the mountains, search the valleys, the deserts, the shores of the sea and the deepest depressions of the earth; note with care the distinctions between animals, the differences of plants, the various kinds of minerals, and the properties and mode of origin of everything that exists. Be not ashamed to study diligently the astronomy and terrestrial philosophy of the country people. Lastly purchase coal, build furnaces, watch and operate with the fire never wearying. In this way, and in no other, will you arrive at a knowledge of things and their properties.

BIBLIOGRAPHIES

A CHINESE AND JAPANESE BOOKS BEFORE +1800

B CHINESE AND JAPANESE BOOKS AND JOURNAL ARTICLES SINCE +1800

C BOOKS AND JOURNAL ARTICLES IN WESTERN LANGUAGES

In Bibliographies A and B there are two modifications of the Roman alphabetical sequence: transliterated *Chh-* comes after all other entries under *Ch-*, and transliterated *Hs-* comes after all other entries under *H-*. Thus *Chhen* comes after *Chung* and *Hsi* comes after *Huai*. This system applies only to the first words of the titles. Moreover, where *Chh-* and *Hs-* occur in words used in Bibliography C, i.e. in a Western language context, the normal sequence of the Roman alphabet is observed.

When obsolete or unusual romanisations of Chinese words occur in entries in Bibliography C, they are followed, wherever possible, by the romanisations adopted as standard in the present work. If inserted in the title, these are enclosed in square brackets; if they follow it, in round brackets. When Chinese words or phrases occur romanised according to the Wade–Giles system or related systems, they are assimilated to the system here adopted (cf. Vol. 1, p. 26) without indication of any change. Additional notes are added in round brackets. The reference numbers do not necessarily begin with (1), nor are they necessarily consecutive, because only those references required for this volume of the series are given.

Korean and Vietnamese books and papers are included in Bibliographies A and B. As explained in Vol. 1, pp. 21 ff., reference numbers in italics imply that the work is in one or other of the East Asian languages.

ABBREVIATIONS

See also p. xxv

A	*Archeion*
AA	*Artibus Asiae*
AAA	*Archaeologia*
AAAA	*Archaeology*
A/AIHS	*Archives Internationales d'Histoire des Sciences* (continuation of *Archeion*)
AAN	*American Anthropologist*
AAPWM	*Archiv. f. Anat., Physiol., and Wiss. Med.* (Joh. Müller's)
ABAW/PH	*Abhandlungen d. bayr. Akad. Wiss. München* (Phil.-Hist. Klasse)
ACASA	*Archives of the Chinese Art Soc. of America*
ACF	*Annuaire du Collège de France*
ADVC	*Advances in Chemistry*
ADVS	*Advancement of Science* (British Assoc., London)
AEM	*Anuario de Estudios Medievales* (Barcelona)
AEPHE/SHP	*Annuaire de l'Ecole Pratique des Hautes Études* (Sect. Sci. Hist. et Philol.)
AEPHE/SSR	*Annuaire de l'Ecole Pratique des Hautes Études* (Sect. des Sci. Religieuses)
AESC	*Aesculape* (Paris)
AEST	*Annales de l'Est* (Fac. des Lettres, Univ. Nancy)
AF	*Ärztliche Forschung*
AFG	*Archiv. f. Gynäkologie*
AFGR/CINO	*Atti della Fondazione Giorgio Ronchi e Contributi dell'Istituto Nazionale di Ottica* (Arcetri)
AFP	*Archivum Fratrum Praedicatorum*
AFRA	*Afrasian* (student Journal of London Inst. Oriental & African Studies)
AGMN	*Archiv. f. d. Gesch. d. Medizin u. d. Naturwissenschaften* (Sudhoff's)
AGMW	*Abhandlungen z. Geschichte d. Math. Wissenschaft*
AGNT	*Archiv. f. d. Gesch. d. Naturwiss. u. d. Technik* (cont. as *AGMNT*)
AGP	*Archiv. f. d. Gesch. d. Philosophie*
AGR	*Asahigraph*
AGWG/PH	*Abhdl. d. Gesell. d. Wiss. Z. Göttingen* (Phil.-Hist. Kl.)
AHES/AHS	*Annales d'Hist. Sociale*
AHOR	*Antiquarian Horology*
AIENZ	*Advances in Enzymology*
AIP	*Archives Internationales de Physiologie*
AJA	*American Journ. Archaeology*
AJOP	*Amer. Journ. Physiol.*
AJPA	*Amer. Journ. Physical Anthropology*
AJSC	*American Journ. Science and Arts* (Silliman's)
AM	*Asia Major*
AMA	*American Antiquity*
AMH	*Annals of Medical History*
AMS	*American Scholar*
AMY	*Archaeometry* (Oxford)
AN	*Anthropos*
ANATS	*Anatolian Studies* (British School of Archaeol. Ankara)
ANS	*Annals of Science*
ANT	*Antaios* (Stuttgart)
ANTJ	*Antiquaries Journal*
AP	*Aryan Path.*
APH	*Actualités Pharmacologiques*
AP/HJ	*Historical Journal, National Peiping Academy*
APAW/PH	*Abhandlungen d. preuss. Akad. Wiss. Berlin* (Phil.-Hist. Klasse)
APHL	*Acta Pharmaceutica Helvetica*
APNP	*Archives de Physiol. normale et pathologique*
AQ	*Antiquity*
AR	*Archiv. f. Religionswissenschaft*
ARB	*Annual Review of Biochemistry*
ARLC/DO	*Annual Reports of the Librarian of Congress* (Division of Orientalia)
ARMC	*Ann. Reports in Medicinal Chemistry*
ARO	*Archiv Orientalni* (Prague)
ARQ	*Art Quarterly*
ARSI	*Annual Reports of the Smithsonian Institution* (Washington, D.C.)
AS/BIHP	*Bulletin of the Institute of History and Philology, Academia Sinica*
AS/CJA	*Chinese Journal of Archaeology, Academia Sinica*
ASEA	*Asiatische Studien; Études Asiatiques*
ASN/Z	*Annales des Sciences Naturelles; Zoologie* (Paris)
ASSF	*Acta Societatis Scientiarum Fennicae* (Helsingfors)
AT	*Atlantis*
ATOM	*Atomes* (Paris)
AX	*Ambix*
BABEL	*Babel; Revue Internationale de la Traduction*
BCGS	*Bull. Chinese Geological Soc.*
BCP	*Bulletin Catholique de Pékin*
BCS	*Bulletin of Chinese Studies* (Chhêngtu)
BDCG	*Ber. d. deutsch. chem. Gesellschaft.*
BDP	*Blätter f. deutschen Philosophie*

BE/AMG	*Bibliographie d'Études* (*Annales du Musée Guimet*)
BEC	*Bulletin de l'École des Chartes* (Paris)
BEFED	*Bulletin de l'Ecole Française de l'Extrême Orient* (Hanoi)
BGSC	*Bulletin of the Chinese Geological Survey*
BGTI	*Beiträge z. Gesch. d. Technik u. Industrie* (continued as *Technik Geschichte—see BGTI/TG*)
BGTI/TG	*Technik Geschichte*
BHMZ	*Berg und Hüttenmännische Zeitung*
BIHM	*Bulletin of the* (*Johns Hopkins*) *Institute of the History of Medicine* (cont. as *Bulletin of the History of Medicine*)
BJ	*Biochemical Journal*
BJRL	*Bull. John Rylands Library* (Manchester)
BK	*Bunka* (*Culture*), Sendai
BLSOAS	*Bulletin of the London School of Oriental and African Studies*
BM	*Bibliotheca Mathematica*
BMFEA	*Bulletin of the Museum of Far Eastern Antiquities* (Stockholm)
BMFJ	*Bulletin de la Maison Franco–Japonaise* (Tokyo)
BMJ	*British Medical Journal*
BNJ	*British Numismatic Journ.*
BOE	*Boethius; Texte und Abhandlungen d. exakte Naturwissenschaften* (Frankfurt)
BR	*Biological Reviews*
BS	*Behavioural Science*
BSAA	*Bull. Soc. Archéologique d'Alexandrie*
BSAB	*Bull. Soc. d'Anthropologie de Bruxelles*
BSCF	*Bull. de la Société Chimique de France*
BSGF	*Bull. de la Société Géologique de France*
BSJR	*Bureau of Standards Journ. of Research*
BSPB	*Bull. Soc. Pharm. Bordeaux*
BUA	*Bulletin de l'Université de l'Aurore* (Shanghai)
BV	*Bharatiya Vidya* (Bombay)
CA	*Chemical Abstracts*
CALM	*California Medicine*
CBH	*Chūgoku Bungaku-hō* (*Journ. Chinese Literature*)
CCJ	*Chung-Chi Journal* (Chhung-Chi Univ. Coll. Hongkong)
CDA	*Chinesisch-Deutschen Almanach* (Frankfort a/M)
CEM	*Chinese Economic Monthly* (Shanghai)
CEN	*Centaurus*
CHA	*Chemische Apparatur*
CHEMC	*Chemistry in Canada*
CHI	*Cambridge History of India*
CHIM	*Chimica* (Italy)
CHIND	*Chemistry and Industry* (Journ. Soc. Chem. Ind. London)
CHJ	*Chhing-Hua Hsüeh Pao* (*Chhing-Hua* (*Ts'ing-Hua*) *University Journal of Chinese Studies*)
CHJ/T	*Chhing-Hua* (*T'sing-Hua*) *Journal of Chinese Studies* (New Series, publ. Thaiwan)
CHWSLT	*Chung-Hua Wên-Shih Lun Tshung* (*Collected Studies in the History of Chinese Literature*)
CHYM	*Chymia*
CHZ	*Chemiker Zeitung*
CIBA/M	*Ciba Review* (Medical History)
CIBA/MZ	*Ciba Zeitschrift* (Medical History)
CIBA/S	*Ciba Symposia*
CIBA/T	*Ciba Review* (Textile Technology)
CIMC/MR	*Chinese Imperial Maritime Customs* (*Medical Report Series*)
CIT	*Chemie Ingenieur Technik*
CJ	*China Journal of Science and Arts*
CJFC	*Chin Jih Fo Chiao* (*Buddhism Today*), Thaiwan
CLINR	*Clinical Radiology*
CLR	*Classical Review*
CMJ	*Chinese Medical Journal*
CN	*Chemical News*
CNRS	Centre National de la Recherche Scientifique
COCJ	*Coin Collectors' Journal*
COPS	*Confines of Psychiatry*
CP	*Classical Philology*
CQ	*Classical Quarterly*
CR	*China Review* (Hongkong and Shanghai)
CRAS	*Comptes Rendus hebdomadaires de l'Acad. des Sciences* (Paris)
CREC	*China Reconstructs*
CRESC	*Crescent* (Surat)
CRR	*Chinese Recorder*
CRRR	*Chinese Repository*
CS	*Current Science*
CUNOB	*Cunobelin; Yearbook of the British Association of Numismatic Societies*
CUP	Cambridge University Press
CUQ	*Columbia University Quarterly*
CURRA	*Current Anthropology*
CVS	*Christiania Videnskabsselskabet Skrifter*
CW	*Chemische Weekblad*
CWR	*China Weekly Review*
DAZ	*Deutscher Apotheke Zeitung*
DB	*The Double Bond*
DI	*Die Islam*
DK	*Dōkyō Kenkyū* (*Researches in the Taoist Religion*)
DMAB	*Abhandlungen u. Berichte d. Deutsches Museum* (München)
DS	*Desalination* (*International Journ. Water Desalting*) (Amsterdam and Jerusalem, Israel)

DV	*Deutsche Vierteljahrschrift*
DVN	*Dan Viet Nam*
DZZ	*Deutsche Zahnärztlichen Zeit.*
EARLH	*Earlham Review*
EECN	*Electroencephalography and Clinical Neurophysiology*
EG	*Economic Geology*
EHOR	*Eastern Horizon* (Hongkong)
EHR	*Economic History Review*
EI	*Encyclopaedia of Islam*
EMJ	*Engineering and Mining Journal*
END	*Endeavour*
EPJ	*Edinburgh Philosophical Journal* (continued as *ENPJ*)
ERE	*Encyclopaedia of Religion and Ethics*
ERJB	*Eranos Jahrbuch*
ERYB	*Eranos Yearbook*
ETH	*Ethnos*
EURR	*Europaïsche Revue* (Berlin)
EXPED	*Expedition* (*Magazine of Archaeology and Anthropology*), Philadelphia
FCON	*Fortschritte d. chemie d. organischen Naturstoffe*
FER	*Far Eastern Review* (London)
FF	*Forschungen und Fortschritte*
FMNHP/AS	*Field Museum of Natural History* (*Chicago*) *Publications*; Anthropological Series
FP	*Federation Proceedings* (USA)
FPNJ	*Folia Psychologica et Neurologica Japonica*
FRS	*Franziskanischen Studien*
GBA	*Gazette des Beaux-Arts*
GBT	*Global Technology*
GEW	*Geloof en Wetenschap*
GJ	*Geographical Journal*
GR	*Geographical Review*
GRM	*Germanisch-Romanische Monatsschrift*
GUJ	*Gutenberg Jahrbuch*
HCA	*Helvetica Chimica Acta*
HE	*Hesperia* (*Journ. Amer. Sch. Class. Stud. Athens*)
HEJ	*Health Education Journal*
HERM	*Hermes; Zeitschr. f. Klass. Philol.*
HF	*Med Hammare och Fackla* (Sweden)
HHS	*Hua Hsüeh* (*Chemistry*), Ch. Chem. Soc.
HHSTH	*Hua Hsüeh Thung Hsün* (*Chemical Correspondent*), Chekiang Univ.
HITC	*Hsüeh I Tsa Chih* (*Wissen und Wissenschaft*), Shanghai
HJAS	*Harvard Journal of Asiatic Studies*
HMSO	Her Majesty's Stationery Office
HOR	*History of Religion* (Chicago)
HOSC	*History of Science* (annual)
HRASP	*Histoire de l'Acad. Roy. des Sciences, Paris*
HSS	*Hsüeh Ssu* (*Thought and Learning*), Chhêngtu
HU/BML	*Harvard University Botanical Museum Leaflets*
HUM	*Humanist* (RPA, London)
IA	*Iron Age*
IBK	*Indogaku Bukkyōgaku Kenkyū* (*Indian and Buddhist Studies*)
IC	*Islamic Culture* (Hyderabad)
ID	*Idan* (Medical Discussions), Japan
IEC/AE	*Industrial and Engineering Chemistry; Analytical Edition*
IEC/I	*Industrial and Engineering Chemistry; Industrial Edition*
IHQ	*Indian Historical Quarterly*
IJE	*Indian Journ. Entomol.*
IJHM	*Indian Journ. History of Medicine*
IJHS	*Indian Journ. History of Science*
IJMR	*Indian Journ. Med. Research*
IMIN	*Industria Mineraria*
IMW	*India Medical World*
INDQ	*Industria y Quimica* (Buenos Aires)
INM	*International Nickel Magazine*
IPEK	*Ipek; Jahrb. f. prähistorische u. ethnographische Kunst* (Leipzig)
IQB	*Iqbal* (Lahore), later *Iqbal Review* (*Journ. of the Iqbal Academy* or *Bazm-i Iqbal*)
IRAQ	*Iraq* (British Sch. Archaeol. in Iraq)
ISIS	*Isis*
ISTC	*I Shih Tsa Chih* (*Chinese Journal of the History of Medicine*)
IVS	*Ingeniörvidenskabelje Skrifter* (Copenhagen)
JA	*Journal Asiatique*
JAC	*Jahrb. f. Antike u. Christentum*
JACS	*Journ. Amer. Chem. Soc.*
JAHIST	*Journ. Asian History* (*International*)
JAIMH	*Pratibha; Journ. All-India Instit. of Mental Health*
JALCHS	*Journal of the Alchemical Society* (London)
JAN	*Janus*
JAOS	*Journal of the American Oriental Society*
JAP	*Journ. Applied Physiol.*
JAS	*Journal of Asian Studies* (continuation of *Far Eastern Quarterly*, *FEQ*)
JATBA	*Journal d'Agriculture tropicale et de Botanique appliqué*
JBC	*Journ. Biol. Chem.*
JBFIGN	*Jahresber. d. Forschungsinstitut f. Gesch. d. Naturwiss.* (Berlin)
JC	*Jimnin Chūgoku* (*People's China*), Tokyo
JCE	*Journal of Chemical Education*
JCP	*Jahrb. f. class. Philologie*

JCS	*Journal of the Chemical Society*
JEA	*Journal of Egyptian Archaeology*
JEGP	*Journal of English and Germanic Philology*
JEH	*Journal of Economic History*
JEM	*Journ. Exper. Med.*
JFI	*Journ. Franklin Institute*
JGGBB	*Jahrbuch d. Gesellschaft f. d. Gesch. u. Bibliographie des Brauwesens*
JGMB	*Journ. Gen. Microbiol.*
JHI	*Journal of the History of Ideas*
JHMAS	*Journal of the History of Medicine and Allied Sciences*
JHS	*Journal of Hellenic Studies*
JI	*Jissen Igaku* (*Practical Medicine*)
JIM	*Journ. Institute of Metals* (UK)
JIMA	*Journ. Indian Med. Assoc.*
JKHRS	*Journ. Kalinga Historical Research Soc.* (Orissa)
JMBA	*Journ. of the Marine Biological Association* (Plymouth)
JNMD	*Journ. Nervous & Mental Diseases*
JMS	*Journ. Mental Science*
JNPS	*Journ. Neuropsychiatr.*
JOP	*Journ. Physiol.*
JOSHK	*Journal of Oriental Studies* (Hongkong Univ.)
JP	*Journal of Philology*
JPB	*Journ. Pathol. and Bacteriol.*
JPC	*Journ. f. prakt. Chem.*
JPCH	*Journ. Physical Chem.*
JPH	*Journal de Physique*
JPHS	*Journ. Pakistan Historical Society*
JPHST	*Journ. Philos. Studies*
JPOS	*Journal of the Peking Oriental Society*
JRAI	*Journal of the Royal Anthropological Institute*
JRAS	*Journal of the Royal Asiatic Society*
JRAS/B	*Journal of the (Royal) Asiatic Society of Bengal*
JRAS/BOM	*Journ. Roy. Asiatic Soc., Bombay Branch*
JRAS/KB	*Journal* (or *Transactions*) *of the Korea Branch of the Royal Asiatic Society*
JRAS/M	*Journal of the Malayan Branch of the Royal Asiatic Society*
JRAS/NCB	*Journal* (or *Transactions*) *of the Royal Asiatic Society* (North China Branch)
JRAS/P	*Journ. of the (Royal) Asiatic Soc. of Pakistan*
JRIBA	*Journ. Royal Institute of British Architects*
JRSA	*Journal of the Royal Society of Arts*
JS	*Journal des Sçavans* (1665–1778) and *Journal des Savants* (1816–)
JSA	*Journal de la Société des Americanistes*
JSCI	*Journ. Soc. Chem. Industry*
JSHS	*Japanese Studies in the History of Science* (Tokyo)
JUB	*Journ. Univ. Bombay*
JUS	*Journ. Unified Science* (continuation of *Erkenntnis*)
JWCBRS	*Journal of the West China Border Research Society*
JWCI	*Journal of the Warburg and Courtauld Institutes*
JWH	*Journal of World History* (UNESCO)
KHS	*Kho Hsüeh* (*Science*)
KHSC	*Kho-Hsüeh Shih Chi-Khan* (*Ch. Journ. Hist. of Sci.*)
KHTP	*Kho Hsüeh Thung Pao* (*Science Correspondent*)
KHVL	*Kungliga Humanistiska Vetenskapsamfundet i Lund Årsberättelse* (*Bull. de la Soc. Roy. de Lettres de Lund*)
KKD	*Kiuki Daigaku Sekai Keizai Kenkyūjo Hōkoku* (*Reports of the Institute of World Economics at Kiuki Univ.*)
KKTH	*Khao Ku Thung Hsün* (*Archaeological Correspondent*), cont. as *Khao Ku*
KKTS	*Ku Kung Thu Shu Chi Khan* (*Journal of the Imperial Palace Museum and Library*), Thaiwan
KSVA/H	*Kungl. Svenske Vetenskapsakad. Handlingar*
KVSUA	*Kungl. Vetenskaps Soc. i Uppsala Årsbok* (*Mem. Roy. Acad. Sci. Uppsala*)
KW	*Klinische Wochenschrift*
LA	*Annalen d. Chemie* (Liebig's)
LCHIND	*La Chimica e l'Industria* (Milan)
LEC	*Lettres Édifiantes et Curieuses écrites des Missions Étrangères* (Paris, 1702–1776)
LH	*l'Homme; Revue Française d'Anthropologie*
LIN	*L'Institut* (*Journal Universel des Sciences et des Sociétés Savantes en France et à l'Étranger*)
LN	*La Nature*
LP	*La Pensée*
LSYC	*Li Shih Yen Chiu* (*Journal of Historical Research*), Peking
LSYKK	*Li Shih yü Khao Ku* (*History and Archaeology; Bulletin of the Shenyang Museum*), Shenyang
LT	*Lancet*
LYCH	*Lychnos* (*Annual of the Swedish Hist. of Sci. Society*)
MAAA	*Memoirs Amer. Anthropological Association*
MAI/NEM	*Mémoires de l'Académie des Inscriptions et Belles-Lettres*, Paris (*Notices et Extraits des MSS*)
MAIS/SP	*Mémoires de l'Acad. Impériale des Sciences, St Pétersbourg*

MAS/B	*Memoirs of the Asiatic Society of Bengal*
MB	*Monographiae Biologicae*
MBLB	*May and Baker Laboratory Bulletin*
MBPB	*May and Baker Pharmaceutical Bulletin*
MCB	*Mélanges Chinois et Bouddhiques*
MCE	*Metallurgical and Chemical Engineering*
MCHSAMUC	*Mémoires concernant l'Histoire, les Sciences, les Arts, les Mœurs et les Usages, des Chinois, par les Missionnaires de Pékin* (Paris 1776–)
MDGNVO	*Mitteilungen d. deutsch. Gesellsch. f. Natur. u. Volkskunde Ostasiens*
MDP	*Mémoires de la Délégation en Perse*
MED	*Medicus* (Karachi)
MEDA	*Medica* (Paris)
METL	*Metallen* (Sweden)
MGG	*Monatsschrift f. Geburtshilfe u. Gynäkologie*
MGGW	*Mitteilungen d. geographische Gesellschaft Wien*
MGSC	*Memoirs of the Chinese Geological Survey*
MH	*Medical History*
MI	*Metal Industry*
MIE	*Mémoires de l'Institut d'Egypte* (Cairo)
MIFC	*Mémoires de l'Institut Français d'Archéol. Orientale* (Cairo)
MIK	*Mikrochemie*
MIMG	*Mining Magazine*
MIT	Massachusetts Institute of Technology
MJ	*Mining Journal, Railway and Commercial Gazette*
MJA	*Med. Journ. Australia*
MJPGA	*Mitteilungen aus Justus Perthes Geogr. Anstalt* (Petermann's)
MKDUS/HF	*Meddelelser d. Kgl. Danske Videnskabernes Selskab* (Hist.-Filol.)
MM	*Mining and Metallurgy* (New York, contd. as *Mining Engineering*)
MMN	*Materia Medica Nordmark*
MMVKH	*Mitteilungen d. Museum f. Völkerkunde* (Hamburg)
MMW	*Münchener Medizinische Wochenschrift*
MOULA	*Memoirs of the Osaka University of Liberal Arts and Education*
MP	*Il Marco Polo*
MPMH	*Memoirs of the Peabody Museum of American Archaeology and Ethnology, Harvard University*
MRASP	*Mémoires de l'Acad. Royale des Sciences* (Paris)
MRDTB	*Memoirs of the Research Dept. of Tōyō Bunko* (Tokyo)
MRS	*Mediaeval and Renaissance Studies*
MS	*Monumenta Serica*
MSAF	*Mémoires de la Société* (*Nat.*) *des Antiquaires de France*
MSGVK	*Mitt. d. Schlesische Gesellschaft f. Volkskunde*
MSIV/MF	*Memoire di Mat. e. Fis della Soc. Ital.* (Verona)
MSOS	*Mitteilungen d. Seminar f. orientalischen Sprachen* (Berlin)
MSP	*Mining and Scientific Press*
MUJ	*Museum Journal* (Philadelphia)
MUSEON	*Le Muséon* (Louvain)
N	*Nature*
NAGE	*New Age* (New Delhi)
NAR	*Nutrition Abstracts and Reviews*
NARSU	*Nova Acta Reg. Soc. Sci. Upsaliensis*
NC	*Numismatic Chronicle* (*and Journ. Roy. Numismatic Soc.*)
NCDN	*North China Daily News*
NCGH	*Nihon Chūgoku Gakkai-hō* (*Bulletin of the Japanese Sinological Society*)
NCH	*North China Herald*
NCR	*New China Review*
NDI	*Niigata Daigaku Igakubu Gakushikai Kaihō* (*Bulletin of the Medical Graduate Society of Niigata University*)
NFR	*Nat. Fireworks Review*
NHK	Nihon Heibon Keisha (publisher)
NIZ	*Nihon Ishigaku Zasshi* (*Jap. Journ. Hist. Med.*)
NN	*Nation*
NQ	*Notes and Queries*
NR	*Numismatic Review*
NRRS	*Notes and Records of the Royal Society*
NS	*New Scientist*
NSN	*New Statesman and Nation* (London)
NU	*The Nucleus*
NUM/SHR	*Studies in the History of Religions* (Supplements to *Numen*)
NW	*Naturwissenschaften*
OAZ	*Ostasiatische Zeitschrift*
ODVS	*Oversigt over det k. Danske Videnskabernes Selskabs Forhandlinger*
OE	*Oriens Extremus* (Hamburg)
OLZ	*Orientalische Literatur-Zeitung*
ORA	*Oriental Art*
ORCH	*Orientalia Christiana*
ORD	*Ordnance*
ORG	*Organon* (Warsaw)
ORR	*Orientalia* (Rome)
ORS	*Orientalia Suecana*
OSIS	*Osiris*
OUP	Oxford University Press
OUSS	*Ochanomizu University Studies*
OX	*Oxoniensia*

PAAAS	*Proceeding of the British Academy*
PAAQS	*Proceedings of the American Antiquarian Society*
PAI	*Paideuma*
PAKJS	*Pakistan Journ. Sci.*
PAKPJ	*Pakistan Philos. Journ.*
PAPS	*Proc. Amer. Philos. Soc.*
PCASC	*Proc. Cambridge Antiquarian Soc.*
PEW	*Philosophy East and West* (Univ. Hawaii)
PF	*Psychologische Forschung*
PHI	*Die Pharmazeutische Industrie*
PHREV	*Pharmacological Reviews*
PHY	*Physis* (Florence)
PJ	*Pharmaceut. Journal* (*and Trans. Pharmaceut. Soc.*)
PKAWA	*Proc. Kon. Akad. Wetensch. Amsterdam*
PKR	*Peking Review*
PM	*Presse Medicale*
PMG	*Philosophical Magazine*
PMLA	*Publications of the Modern Language Association of America*
PNHB	*Peking Natural History Bulletin*
POLYJ	*Polytechnisches Journal* (Dingler's)
PPHS	*Proceedings of the Prehistoric Society*
PRGS	*Proceedings of the Royal Geographical Society*
PRIA	*Proceedings of the Royal Irish Academy*
PRPH	*Produits Pharmaceutiques*
PRSA	*Proceedings of the Royal Society* (Series A)
PRSB	*Proceedings of the Royal Society* (Series B)
PRSM	*Proceedings of the Royal Society of Medicine*
PSEBM	*Proc. Soc. Exp. Biol and Med.*
PTRS	*Philosophical Transactions of the Royal Society*
QSGNM	*Quellen u. Studien z. Gesch. d. Naturwiss. u. d. Medizin* (continuation of *Archiv. f. Gesch. d. Math., d. Naturwiss. u. d. Technik, AGMNT*, formerly *Archiv. f. d. Gesch. d. Naturwiss. u. d. Technik, AGNT*)
QSKMR	*Quellenschriften f. Kunstgeschichte und Kunsttechnik des Mittelalters u. d. Renaissance* (Vienna)
RA	*Revue Archéologique*
RAA/AMG	*Revue des Arts Asiatiques* (*Annales du Musée Guimet*)
RAAAS	*Reports, Australasian Assoc. Adv. of Sci.*
RAAO	*Revue d'Assyriologie et d'Archéologie Orientale*
RALUM	*Revue de l'Aluminium*
RB	*Revue Biblique*
RBPH	*Revue Belge de Philol. et d'Histoire*
RBS	*Revue Bibliographique de Sinologie*
RDM	*Revue des Mines* (later *Revue Universelle des Mines*)
RGVV	*Religionsgeschichtliche Versuche und Vorarbeiten*
RHR/AMG	*Revue de l'Histoire des Religions* (*Annales du Musée Guimet, Paris*)
RHS	*Revue d'Histoire des Sciences*
RHSID	*Revue d'Histoire de la Sidérurgie* (Nancy)
RIN	*Rivista Italiana di Numismatica*
RKW	*Repertorium f. Kunst. wissenschaft*
RMY	*Revue de Mycologie*
ROC	*Revue de l'Orient Chrétien*
RP	*Revue Philosophique*
RPA	Rationalist Press Association (London)
RPCHG	*Revue de Pathologie comparée et d'Hygiène générale* (Paris)
RPLHA	*Revue de Philol., Litt. et Hist. Ancienne*
RR	*Review of Religion*
RSCI	*Revue Scientifique* (Paris)
RSH	*Revue de Synthèse Historique*
RSI	*Reviews of Scientific Instruments*
RSO	*Rivista di Studi Orientali*
RUB	*Revue de l'Univ. de Bruxelles*
S	*Sinologica* (Basel)
SA	*Sinica* (originally *Chinesische Blätter f. Wissenschaft u. Kunst*)
SAEC	*Supplemento Annuale all'Enciclopedia di Chimica*
SAEP	Soc. Anonyme des Études et Pub. (publisher)
SAM	*Scientific American*
SB	*Shizen to Bunka* (*Nature and Culture*)
SBE	*Sacred Books of the East* series
SBK	*Seikatsu Bunka Kenkyū* (*Journ. Econ. Cult.*)
SBM	*Svenska Bryggareföreningens Månadsblad*
SC	*Science*
SCI	*Scientia*
SCIS	*Sciences; Revue de la Civilisation Scientifique* (Paris)
SCISA	*Scientia Sinica* (Peking)
SCK	*Smithsonian Contributions to Knowledge*
SCM	Student Christian Movement (Press)
SCON	*Studies in Conservation* (*Journ. Internat. Instit. for the Conservation of Museum objects*)
SET	*Structure et Evolution des Techniques*
SGZ	*Shigaku Zasshi* (*Historical Journ. of Japan*)
SHA	*Shukan Asahi*
SHAW/PH	*Sitzungsber. d. Heidelberg. Akad. d. Wissensch.* (Phil.-Hist. Kl.)

SHST/T	*Studies in the History of Science and Technol.* (Tokyo Univ. Inst. Technol.)
SI	*Studia Islamica* (Paris)
SIB	*Sibrium* (*Collana di Studi e Documentazioni, Centro di Studi Preistorici e Archeologici Varese*)
SILL	*Sweden Illustrated*
SK	*Seminarium Kondakovianum* (*Recueil d'Études de l'Institut Kondakov*)
SM	*Scientific Monthly* (formerly *Popular Science Monthly*)
SN	*Shirin* (*Journal of History*), Kyoto
SNM	*Sbornik Nauknych Materialov* (Erivan, Armenia)
SOS	*Semitic and Oriental Studies* (*Univ. of Calif. Publ. in Semitic Philol.*)
SP	*Speculum*
SPAW/PH	*Sitzungsber. d. preuss. Akad. d. Wissenschaften* (Phil.-Hist. Kl.)
SPCK	Society for the Promotion of Christian Knowledge
SPMSE	*Sitzungsberichte d. physik. med. Soc. Erlangen*
SPR	*Science Progress*
SSIP	*Shanghai Science Institute Publications*
STM	*Studi Medievali*
SWAW/PH	*Sitzungsberichte d. k. Akad. d. Wissenschaften Wien* (Phil.-Hist. Klasse), Vienna
TAFA	*Transactions of the American Foundrymen's Association*
TAIME	*Trans. Amer. Inst. Mining Engineers* (continued as *TAIMME*)
TAIMME	*Transactions of the American Institute of Mining and Metallurgical Engineers*
TAPS	*Transactions of the American Philosophical Society* (cf. *MAPS*)
TAS/J	*Transactions of the Asiatic Society of Japan*
TBKK	*Tōhoku Bunka Kenkyūshitsu Kiyō* (*Record of the North-Eastern Research Institute of Humanistic Studies*), Sendai
TCS	*Trans. Ceramic Society* (formerly *Trans. Engl. Cer. Soc.*, contd as *Trans. Brit. Cer. Soc.*)
TCULT	*Technology and Culture*
TFTC	*Tung Fang Tsa Chih* (*Eastern Miscellany*)
TGAS	*Transactions of the Glasgow Archaeological Society*
TG/T	*Tōhō Gakuhō, Tōkyō* (*Tokyo Journal of Oriental Studies*)
TH	*Thien Hsia Monthly* (Shanghai)
THG	*Tōhōgaku* (*Eastern Studies*), Tokyo
TICE	*Transactions of the Institute of Chemical Engineers*
TIMM	*Transactions of the Institution of Mining and Metallurgy*
TJSL	*Transactions* (*and Proceedings*) *of the Japan Society of London*
TLTC	*Ta Lu Tsa Chih* (*Continent Magazine*), Thaipei
TMIE	*Travaux et Mémoires de l'Inst. d'Ethnologie* (Paris)
TNS	*Transactions of the Newcomen Society*
TOCS	*Transactions of the Oriental Ceramic Society*
TP	*T'oung Pao* (*Archives concernant l'Histoire, les Langues, la Géographie, l'Ethnographie et les Arts de l'Asie Orientale*), Leiden
TQ	*Tel Quel* (Paris)
TR	*Technology Review*
TRAD	*Tradition* (*Zeitschr. f. Firmengeschichte und Unternehmerbiographie*)
TRSC	*Trans. Roy. Soc. Canada*
TS	*Tōhō Shūkyō* (*Journal of East Asian Religions*)
TSFFA	*Techn. Studies in the Field of the Fine Arts*
TTT	*Theoria to Theory* (Cambridge)
TYG	*Tōyō Gakuhō* (*Reports of the Oriental Society of Tokyo*)
TYGK	*Tōyōgaku* (*Oriental Studies*), Sendai
TYKK	*Thien Yeh Khao Ku Pao Kao* (*Archaeological Reports*)
UCC	*University of California Chronicle*
UCR	*University of Ceylon Review*
UNASIA	*United Asia* (India)
UNESC	*Unesco Courier*
UNESCO	United Nations Educational, Scientific and Cultural Organisation
UUA	*Uppsala Univ. Årsskrift* (*Acta Univ. Upsaliensis*)
VBA	*Visva-Bharati Annals*
VBW	*Vorträge d. Bibliothek Warburg*
VK	*Vijnan Karmee*
VKAWA/L	*Verhandelingen d. Koninklijke Akad. v. Wetenschappen te Amsterdam* (Afd. Letterkunde)
VMAWA	*Verslagen en Meded. d. Koninklijke Akad. v. Wetenschappen te Amsterdam*
VVBGP	*Verhandhingen d. Verein z. Beförderung des Gewerbefleisses in Preussen*
WA	*Wissenschaftliche Annalen*
WKW	*Wiener klinische Wochenschrift*
WS	*Wên Shih* (*History of Literature*), Peking
WWTK	*Wên Wu* (formerly *Wên Wu Tshan Khao Tzu Liao, Refer-*

	ence Materials for History and Archaeology)
WZNHK	*Wiener Zeitschr. f. Nervenheilkunde*
YCHP	*Yenching Hsüeh Pao (Yenching University Journal of Chinese Studies)*
YJBM	*Yale Journal of Biology and Medicine*
YJSS	*Yenching Journal of Social Studies*
Z	*Zalmoxis; Revue des Études Religieuses*
ZAC	*Zeitschr. f. angewandte chemie*
ZAC/AC	*Angewandte Chemie*
ZAES	*Zeitschrift f. Aegyptische Sprache u. Altertumskunde*
ZASS	*Zeitschr. f. Assyriologie*
ZDMG	*Zeitschrift d. deutsch. Morgenländischen Gesellschaft*
ZGEB	*Zeitschr. d. Gesellsch. f. Erdkunde* (Berlin)
ZMP	*Zeitschrift f. Math. u. Physik*
ZPC	*Zeitschr. f. physiologischen Chemie*
ZS	*Zeitschr. f. Semitistik*
ZVSF	*Zeitschr. f. vergl. Sprachforschung*

ADDENDA TO ABBREVIATIONS

This list is Conflated with that on p. 271 of *SCC*, Vol. 5, part 3. The items which appeared in that list are indicated here by an asterisk.

AAS	*Arts Asiatiques*
**ACTAS*	*Acta Asiatica (Bull. of Eastern Culture, Tōhō Gakkai, Tokyo)*
ADR	*American Dyestuff Reporter*
AGMNT	*Archiv f. d. Geschichte d. Mathematik, d. Naturwiss. u. d. Technik*
AIND	*Ancient India* (Bull. Archaeol. Survey of India)
AOAW/PH	*Anzeiger d. Österr. Aka d. d. Wiss.* (Vienna, Phil.-Hist. Klasse)
BCED	*Biochemical Education*
**BILCA*	*Boletim do Instituto Luis de Camoes* (Macao)
BIOL	*The Biologist*
BJHOS	*Brit. Journ. History of Science*
BSAC	*Bull. de la Soc. d'Acupuncture*
**CFC*	*Cahiers Franco-Chinois* (Paris)
**CHEM*	*Chemistry* (Easton, Pa.)
CLMED	*Classica et Mediaevalia*
**COMP*	*Comprendre* (Soc. Eu. de Culture, Venice)
**CR/MSU*	*Centennial Review of Arts and Science* (Michigan State University)
DZA	*Deutsche Zeitschr. f. Akupunktur*
EB	Encyclopaedia Britannica
**ECB*	*Economic Botany*
ENZ	*Enzymologia*
EPI	*Episteme*
ESSOM	*Esso Magazine*
GERI	*Geriatrics*
GESN	*Gesnerus*
HAHR	*Hispanic American Historical Review*
HAM	*Hamdard Voice of Eastern Medicine* (Organ of the Inst. of Health and Tibbi Research, Karachi)
JARCHS	*Journ. Archaeol. Science*
JJHS	*Japanese Journ. History of Science*
JPMA	*Journ. Pakistan Med. Assoc.*
MAGW	*Mitt. d. Anthropol. Gesellschaft in Wien*
MARCH	*Mediaeval Archaeology*
MLJ	*Mittel-Lateinisches Jahrbuch*
MMLPS	*Memoirs of the Manchester Literary and Philosophical Soc.*
NAMSL	*Nouvelles Archives des Missions Scientifiques et Littéraires*
**NGM*	*National Geographic Magazine*
NT	*Novum Testamentum*
NTS	*New Testament Studies*
PAKARCH	*Pakistan Archaeology*
PAR	*Parabola*
PBM	*Perspectives in Biol. and Med.*
PHYR	*Physical Review*
PIH	*Pharmacy in History*
**POLREC*	*Polar Record*
POPST	*Population Studies*
PRPSG	*Proc. Roy. Philos. Soc. Glasgow*
**PV*	*Pacific Viewpoint* (New Zealand)
RIAC	*Revue Internationale d'Acupuncture*
RTS	Religious Tract Society
SCRM	*Scriptorium*
SHM	*Studies in the History of Medicine*
SOB	*Sobornost*
TCPP	*Transactions and Studies of the College of Physicians of Philadelphia*
ZGNTM	*Zeitschr. f. Gesch. d. Naturwiss., Technik u. Med.*

A. CHINESE AND JAPANESE BOOKS BEFORE +1800

Each entry gives particulars in the following order:
(*a*) title, alphabetically arranged, with characters;
(*b*) alternative title, if any;
(*c*) translation of title;
(*d*) cross-reference to closely related book, if any;
(*e*) dynasty;
(*f*) date as accurate as possible;
(*g*) name of author or editor, with characters;
(*h*) title of other book, if the text of the work now exists only incorporated therein; or, in special cases, references to sinological studies of it;
(*i*) references to translations, if any, given by the name of the translator in Bibliography C;
(*j*) notice of any index or concordance to the book if such a work exists;
(*k*) reference to the number of the book in the *Tao Tsang* catalogue of Wieger (6), if applicable;
(*l*) reference to the number of the book in the *San Tsang* (Tripiṭaka) catalogues of Nanjio (1) and Takakusu & Watanabe, if applicable.

Words which assist in the translation of titles are added in round brackets.

Alternative titles or explanatory additions to the titles are added in square brackets.

It will be remembered (p. 305 above) that in Chinese indexes words beginning *Chh-* are all listed together after *Ch-*, and *Hs-* after *H-*, but that this applies to initial words of titles only.

Where there are any differences between the entries in these bibliographies and those in Vols. 1–4, the information here given is to be taken as more correct.

An interim list of references to the editions used in the present work, and to the *tshung-shu* collections in which books are available, has been given in Vol. 4, pt. 3, pp. 913 ff., and is available as a separate brochure.

ABBREVIATIONS

C/Han	Former Han.
E/Wei	Eastern Wei.
H/Han	Later Han.
H/Shu	Later Shu (Wu Tai).
H/Thang	Later Thang (Wu Tai).
H/Chin	Later Chin (Wu Tai).
S/Han	Southern Han (Wu Tai).
S/Phing	Southern Phing (Wu Tai).
J/Chin	Jurchen Chin.
L/Sung	Liu Sung.
N/Chou	Northern Chou.
N/Chhi	Northern Chhi.
N/Sung	Northern Sung (before the removal of the capital to Hangchow).
N/Wei	Northern Wei.
S/Chhi	Southern Chhi.
S/Sung	Southern Sung (after the removal of the capital to Hangchow).
W/Wei	Western Wei.

A-Nan Ssu Shih Ching 阿難四事經.
Sūtra on the Four Practices spoken to Ānanda.
India.
Tr. San Kuo, betw. +222 and +230 by Chih-Chhien 支謙.
N/696; TW/493.

A-Phi-Than-Phi Po-Sha Lun 阿毘曇毘婆沙論.
Abhidharma Mahāvibhāsha.
India (this recension not much before +600).
Tr. Hsüan-Chuang, +659 玄奘.
N/1263; TW/1546.

Chang Chen-Jen Chin Shih Ling Sha Lun.
See *Chin Shih Ling Sha Lun.*

Chao Fei-Yen Pieh Chuan 趙飛燕別傳.
[= *Chao Hou I Shih.*]
Another Biography of Chao Fei-Yen [historical novelette].
Sung.
Chhin Shun 秦醇.

Chao Fei-Yen Wai Chuan 趙飛燕外傳.
Unofficial Biography of Chao Fei-Yen (d. −6, celebrated dancing-girl, consort and empress of Han Chhêng Ti).
Ascr. Han, +1st.
Attrib. Ling Hsüan 伶玄.

Chao Hou I Shih 趙后遺事.
A Record of the Affairs of the Empress Chao (−1st century).
See *Chao Fei-Yen Pieh Chuan.*

Chao Hun 招魂.
The Summons of the Soul [ode].
Chou (Chhu), *c.* −240.
Prob. Ching Chhai 景差.
Tr. Hawkes (1), p. 103.

Chen Chhi Huan Yuan Ming 眞氣還元銘.
The Inscription on the Regeneration of the Primary Chhi.
Thang or Sung, must be before the mid +13th century.
Writer unknown.
TT/261.

Chen Chung Chi 枕中記.
[= *Ko Hung Chen Chung Shu.*]
Pillow-Book (of Ko Hung).
Ascr. Chin, *c.* +320, but actually not earlier than the +7th century.
Attrib. Ko Hung 葛洪.
TT/830.

Chen Chung Chi 枕中記.
See *Shê Yang Chen Chung Chi.*

Chen-Chung Hung-Pao Yuan-Pi Shu 枕中鴻寶苑祕書.
The Infinite Treasure of the Garden of Secrets; (Confidential) Pillow-Book (of the Prince of Huai-Nan).
See *Huai-Nan Wang Wan Pi Shu.*
Cf. Kaltenmark (2), p. 32.

Chen Hsi 眞系.
The Legitimate Succession of Perfected, or Realised, (Immortals).
Thang, +805.
Li Po 李渤.
In *YCCC*, ch. 5, pp. 1*a* ff.

Chen Kao 眞誥.
Declarations of Perfected, or Realised, (Immortals) [visitations and revelations of the Taoist pantheon].
Chin and S/Chhi. Original material from +364 to +370, collected from +484 to +492 by Thao Hung-Ching (+456 to +536), who provided commentary and postface by +493 to +498; finished +499.
Original writers unknown.
Ed. Thao Hung-Ching 陶弘景.
TT/1004.

Chen Yuan Miao Tao Hsiu Tan Li Yen Chhao 眞元妙道修丹歷驗抄.
[= *Hsiu Chen Li Yen Chhao Thu.*]
A Document concerning the Tried and Tested (Methods for Preparing the) Restorative Enchymoma of the Mysterious Tao of the Primary (Vitalities) [physiological alchemy].
Thang or Sung, before +1019.
Tung Chen Tzu (ps.) 洞眞子.
In *YCCC*, ch. 72, pp. 17*b* ff.

Chen Yuan Miao Tao Yao Lüeh 眞元妙道要畧.
Classified Essentials of the Mysterious Tao of the True Origin (of Things) [alchemy and chemistry].
Ascr. Chin, +3rd, but probably mostly Thang, +8th and +9th, at any rate after +7th as it quotes Li Chi.
Attrib. Chêng Ssu-Yuan 鄭思遠.
TT/917.

Chêng I Fa Wên (Thai-Shang) Wai Lu I 正一法文太上外籙儀.
The System of the Outer Certificates, a Thai-Shang Scripture.
Date unknown, but pre-Thang.
Writer unknown.
TT/1225.

Chêng Lei Pên Tshao 證類本草.
See *Ching-Shih Chêng Lei Pei-Chi Pên Tshao* and *Chhung-Hsiu Chêng-Ho Ching-Shih Chêng Lei Pei-Yung Pên Tshao*

Chêng Tao Pi Shu Shih Chung 證道秘書十種.
Ten Types of Secret Books on the Verification of the Tao.
See Fu Chin-Chhüan (6)

Chi Hsiao Hsin Shu 紀效新書.
A New Treatise on Military and Naval Efficiency.
Ming, *c.* +1575.
Chhi Chi-Kuang 戚繼光.

Chi Hsien Chuan 集仙傳.
Biographies of the Company of the Immortals.
Sung, *c.* +1140.
Tsêng Tshao 曾慥.

Chi I Chi 集異記.
A Collection of Assorted Stories of Strange Events.
Thang.
Hsüeh Yung-Jo 薛用弱.

Chi Ni Tzu 計倪子.
[=*Fan Tzu Chi Jan* 范子計然.]
The Book of Master Chi Ni.
Chou (Yüeh), −4th century.
Attrib. Fan Li 范蠡, recording the philosophy of his master Chi Jan 計然.

Chi Shêng Fang 濟生方.
Prescriptions for the Preservation of Health.
Sung, *c.* +1267.
Yen Yung-Ho 嚴用和.

Chi Than Lu 劇談錄.
Records of Entertaining Conversations.
Thang, *c.* +885.
Khang Phien 康駢 or 軿.

Chi Yün 集韻.
Complete Dictionary of the Sounds of Characters [cf. *Chhieh Yün* and *Kuang Yün*].
Sung, +1037.
Compiled by Ting Tu 丁度 *et al.*
Possibly completed in +1067 by Ssuma Kuang 司馬光.

Chia-Yu Pên Tshao 嘉祐本草.
See *Chia-Yu Pu-Chu Shen Nung Pên Tshao.*

Chia-Yu Pu-Chu Shen Nung Pên Tshao 嘉祐補註神農本草.
Supplementary Commentary on the *Pharmacopoeia of the Heavenly Husbandman*, commissioned in the Chia-Yu reign-period.
Sung, commissioned +1057, finished +1060.
Chang Yü-Hsi 掌禹錫,
Lin I 林億,
& Chang Tung 張洞.

Chiang Huai I Jen Lu 江淮異人錄.
Records of (Twenty-five) Strange Magician-Technicians between the Yangtze and the Huai River (during the Thang, Wu and Nan Thang Dynasties, *c.* +850 to +950).
Sung, *c.* +975.
Wu Shu 吳淑.

Chiang Wên-Thung Chi 江文通集.
Literary Collection of Chiang Wên-Thung (Chiang Yen).
S/Chhi, *c.* +500.
Chiang Yen 江淹.

Chiao Chhuang Chiu Lu 蕉窗九錄.
Nine Dissertations from the (Desk at the) Banana-Grove Window.
Ming, *c.* +1575.
Hsiang Yuan-Pien 項元汴.

Chien Wu Chi 漸悟集.
On the Gradual Understanding (of the Tao).
Sung, mid +12th century.
Ma Yü 馬鈺.
TT/1128.

Chih Chen Tzu Lung Hu Ta Tan Shih 至眞子龍虎大丹詩.
Song of the Great Dragon-and-Tiger Enchymoma of the Perfected-Truth Master.

Chi Chen Tzu Lung Hu Ta Tan Shih (*cont.*)
Sung, +1026.
Chou Fang (Chih Chen Tzu) 周方.
Presented to the throne by Lu Thien[-Chi] 盧天騭, *c.* +1115.
TT/266.

Chih-Chhuan Chen-Jen Chiao Chêng Shu 稚川眞人校證術.
Technical Methods of the Adept (Ko) Chih-Chhuan (i.e. Ko Hung), with Critical Annotations [and illustrations of alchemical apparatus].
Ascr. Chin, *c.* +320, but probably later.
Attrib. Ko Hung 葛洪.
TT/895.

Chih Chih Hsiang Shuo San Chhêng Pi Yao 直指詳說三乘秘要.
See *Wu Chen Phien Chih Chih Hsiang Shuo San Chhêng Pi Yao.*
Cf. Davis & Chao Yün-Tshung (6).

Chih-Chou hsien-sêng Chin Tan Chih Chih 紙舟先生金丹直指.
Straightforward Indications about the Metallous Enchymoma by the Paper-Boat Teacher.
Sung, prob. +12th.
Chin Yüeh-Yen 金月巖.
TT/239.

Chih Hsüan Phien 指玄篇.
A Pointer to the Mysteries [psycho-physiological alchemy].
Sung, *c.* +1215.
Pai Yü-Chhan 白玉蟾.
In *Hsiu Chen Shih Shu* (*TT*/260), chs. 1–8.

Chih Kuei Chi 指歸集.
Pointing the Way Home (to Life Eternal); a Collection.
Sung, *c.* +1165.
Wu Wu 吳悟.
TT/914.
Cf. Chhen Kuo-Fu (1), vol. 2, pp. 389, 390.

Chih Tao Phien 旨道篇 (or 編).
A Demonstration of the Tao.
Sui or just before, *c.* +580.
Su Yuan-Ming (or -Lang) 蘇元明(朗) = Chhing Hsia Tzu 青霞子.
Now extant only in quotations.

Chih Tshao Thu 芝草圖.
See *Thai-Shang Ling-Pao Chih Tshao Thu.*

Chin Hua Chhung Pi Tan Ching Pi Chih 金華冲碧丹經祕旨.
Confidential Instructions on the Manual of the Heaven-Piercing Golden Flower Elixir [with illustrations of alchemical apparatus].
Sung, +1225.
Phêng Ssu 彭耜 & Mêng Hsü 孟煦 (pref. and ed. Mêng Hsü).
Received from Pai Yü-Chhan 白玉蟾 and Lan Yuan-Lao 闌元老.
TT/907.
The authorship of this important work is obscure. In his preface Mêng Hsü says that in +1218 he met in the mountains Phêng Ssu, who transmitted to him a short work which Phêng himself had received from Pai Yü-Chhan. This is ch. 1 of the present book. Two years later Mêng met an adept named Lan Yuan-Lao, who claimed to be an avatar of Pai Yü-Chhan and transmitted to Mêng a longer text; this is the part which contains descriptions of the complicated alchemical apparatus and appears as ch. 2 of the present work.
The name of the book is taken from that of the alchemical elaboratory of Lan Yuan-Lao, which was called Chin Hua Chhung Pi Tan Shih 金華冲碧丹室.

Chin Hua Tsung Chih 金華宗旨
[= *Thai-I Chin Hua Tsung Chih*, also entitled *Chhang Shêng Shu*; former title: *Lü Tsu Chhuan Shou Tsung Chih.*]
Principles of the (Inner) Radiance of the Metallous (Enchymoma) [a Taoist *nei tan* treatise on meditation and sexual techniques, with Buddhist influence].
Ming and Chhing, *c.* +1403, finalised +1663, but may have been transmitted orally from an earlier date. Present title from +1668.
Writer unknown. Attrib. Lü Yen 呂岩 (Lü Tung-Pin) and his school, late +8th.
Commentary by Tan Jan-Hui 澹然懸 (1921).
Prefaces by Chang San-Fêng 張三峯 (*c.* +1410) and several others, some perhaps apocryphal.
See also *Lü Tsu Shih Hsien-Thien Hsü Wu Thai-I Chin Hua Tsung Chih.*
Cf. Wilhelm & Jung (1).

Chin Hua Yü I Ta Tan 金華玉液大丹.
The Great Elixir of the Golden Flower (or, Metallous Radiance) and the Juice of Jade.
Date unknown, probably Thang.
Writer unknown.
TT/903.

Chin Hua Yü Nü Shuo Tan Ching 金華玉女說丹經.
Sermon of the Jade Girl of the Golden Flower about Elixirs and Enchymomas.
Wu Tai or Sung.
Writer unknown.
In *YCCC*, ch. 64, pp. 1*a* ff.

Chin I Huan Tan Pai Wên Chüeh 金液還丹百問訣.
Questions and Answers on Potable Gold (Metallous Fluid) and Cyclically-Transformed Elixirs and Enchymomas.
Sung.
Li Kuang-Hsüan 李光玄.
TT/263.

Chin I Huan Tan Yin Chêng Thu 金液還丹印證圖.
Illustrations and Evidential Signs of the Regenerative Enchymoma (constituted by, or elaborated from) the Metallous Fluid:
Sung, prob. +12th, perhaps *c.* +1218, date of preface.
Lung Mei Tzu (ps.) 龍眉子.
TT/148.

Chin Ku Chhi Kuan 今古奇觀.
Strange Tales New and Old.
Ming, *c.* +1620; pr. betw. +1632 and +1644.
Fêng Mêng-Lung 馮夢龍.
Cf. Pelliot (57).

Chin Mu Wan Ling Lun 金木萬靈論.
Essay on the Tens of Thousands of Efficacious (Substances) among Metals and Plants.
Ascr. Chin, *c.* +320. Actually prob. late Sung or Yuan.
Attrib. Ko Hung 葛洪.
TT/933.

Chin Pi Wu Hsiang Lei Tshan Thung Chhi 金碧五相類參同契.
Gold and Caerulean Jade Treatise on the Similarities and Categories of the Five (Substances) and the *Kinship of the Three* [a poem on physiological alchemy].
Ascr. H/Han, *c.* +200.
Attrib. Yin Chhang-Shêng 陰長生.
TT/897.
Cf. Ho Ping-Yü (12).
Not to be confused with the *Tshan Thung Chhi Wu Hsiang Lei Pi Yao*, q.v.

Chin Shih Ling Sha Lun 金石靈砂論.
A Discourse on Metals, Minerals and Cinnabar (by the Adept Chang).
Thang, between +713 and +741.
Chang Yin-Chü 張隱居.
TT/880.

Chin Shih Pu Wu Chiu Shu Chüeh 金石譜五九數訣.
Explanation of the Inventory of Metals and Minerals according to the Numbers Five (Earth) and Nine (Metal) [catalogue of substances with provenances, including some from foreign countries].
Thang, perhaps *c.* +670 (contains a story relating to +664).
Writer unknown.
TT/900.

Chin Shih Wu Hsiang Lei 金石五相類.
[= *Yin Chen Chün Chin Shih Wu Hsiang Lei.*]
The Similarities and Categories of the Five (Substances) among Metals and Minerals (sulphur, realgar, orpiment, mercury and lead) (by the Deified Adept Yin).
Date unknown (ascr. +2nd or +3rd century).
Attrib. Yin Chen-Chün 陰眞君 (Yin Chhang-Shêng).
TT/899.

Chin Tan Chen Chuan 金丹眞傳.
A Record of the Primary (Vitalities, regained by) the Metallous Enchymoma.
Ming, +1615.
Sun Ju-Chung 孫汝忠.

Chin Tan Chêng Li Ta Chhüan 金丹正理大全
Comprehensive Collection of Writings on the True Principles of the Metallous Enchymoma [a florilegium].
Ming, *c.* +1440.
Ed. Han Chhan Tzu 涵蟾子.
Cf. Davis & Chao Yün-Tshung (6).

Chin Tan Chieh Yao 金丹節要.
Important Sections on the Metallous Enchymoma.
Part of *San-Fêng Tan Chüeh* (q.v.).

Chin Tan Chih Chih 金丹直指.
Straightforward Explanation of the Metallous Enchymoma.
Sung, prob. +12th.
Chou Wu-So 周無所.
TT/1058.
Cf. *Chih-Chou hsien-sêng Chin Tan Chih Chih.*
See Chhen Kuo-Fu (1), vol. 2, pp. 447 ff.

Chin Tan Chin Pi Chhien Thung Chüeh 金丹金碧潛通訣.
Oral Instructions explaining the Abscondite Truths of the Gold and Caerulean Jade (Components of the) Metallous Enchymoma.
Date unknown, not earlier than Wu Tai.
Writer unknown.
Incomplete in *YCCC*, ch. 73, pp. 7*a* ff.

Chin Tan Fu 金丹賦.
Rhapsodical Ode on the Metallous Enchymoma.
Sung, +13th.
Writer unknown.
Comm. by Ma Li-Chao 馬涖昭.
TT/258.
Cf. *Nei Tan Fu*, the text of which is very similar.

Chin Tan Lung Hu Ching 金丹龍虎經.
Gold Elixir Dragon and Tiger Manual.
Thang or early Sung.
Writer unknown.
Extant only in quotations, as in *Chu Chia Shen Phin Tan Fa*, q.v.

Chin Tan Pi Yao Tshan Thung Lu 金丹秘要參同錄.
Essentials of the Gold Elixir; a Record of the Concordance (or Kinship) of the Three.
Sung.
Mêng Yao-Fu 孟要甫.
In *Chu Chia Shen Phin Tan Fa*, q.v.

Chin Tan Ssu Pai Tzu 金丹四百字.
The Four-Hundred Word Epitome of the Metallous Enchymoma.

Chin Tan Ssu Pai Tzu (*cont.*)
Sung, *c.* +1065.
Chang Po-Tuan 張伯端.
In *Hsiu Chen Shih Shu* (*TT*/260), ch. 5, pp. 1*a* ff.
TT/1067.
Comms. by Phêng Hao-Ku and Min I-Tê in *Tao Tsang Hsü Pien* (*Chhu chi*), 21.
Tr. Davis & Chao Yün-Tshung (2).

Chin Tan Ta Chhêng 金丹大成.
Compendium of the Metallous Enchymoma.
Sung, just before +1250.
Hsiao Thing-Chih 蕭廷芝.
In *TTCY* (*mao chi*, 4), and in *TT*/260, *Hsiu Chen Shih Shu*, chs. 9–13 incl.

Chin Tan Ta Yao 金丹大要.
[=*Shang Yang Tzu Chin Tan Ta Yao.*]
Main Essentials of the Metallous Enchymoma; the true Gold Elixir.
Yuan, +1331 (pref. +1335).
Chhen Chih-Hsü 陳致虛 (Shang Yang Tzu 上陽子).
In *TTCY* (*mao chi*, 1, 2, 3).
TT/1053.

Chin Tan Ta Yao Hsien Phai (*Yuan Liu*) 金丹大要仙派源流.
[=*Shang Yang Tzu Chin Tan Ta Yao Hsien Phai.*]
A History of the Schools of Immortals mentioned in the *Main Essentials of the Metallous Enchymoma; the true Gold Elixir.*
Yuan, *c.* +1333.
Chhen Chih-Hsü 陳致虛 (Shang Yang Tzu 上陽子).
In *TTCY*, *Chin Tan Ta Yao*, ch. 3, pp. 40 ff.
TT/1056.

Chin Tan Ta Yao Lieh Hsien Chih 金丹大要列仙誌.
[=*Shang Yang Tzu Chin Tan Ta Yao Lieh Hsien Chih.*]
Records of the Immortals mentioned in the *Main Essentials of the Metallous Enchymoma; the true Gold Elixir.*
Yuan, *c.* +1333.
Chhen Chih-Hsü 陳致虛 (Shang Yang Tzu 上陽子).
TT/1055.

Chin Tan Ta Yao Pao Chüeh 金丹大藥寶訣.
Precious Instructions on the Great Medicines of the Golden Elixir (Type).
Sung, *c.* +1045.
Tshui Fang 崔昉.
Preface preserved in *Kêng Tao Chi*, ch. 1, p. 8*b*, but otherwise only extant in occasional quotations.
Perhaps the same book as the *Wai Tan Pên Tshao* (q. v.).

Chin Tan Ta Yao Thu 金丹大要圖.
[=*Shang Yang Tzu Chin Tan Ta Yao Thu.*]
Illustrations for the *Main Essentials of the Metallous Enchymoma; the true Gold Elixir.*
Yuan, +1333.
Chhen Chih-Hsü 陳致虛 (Shang Yang Tzu 上陽子).
Based on drawings and tables of the +10th century onwards by Phêng Hsiao 彭曉, Chang Po-Tuan 張伯端 (hence the name *Tzu Yang Tan Fang Pao Chien Thu*), Lin Shen-Fêng 林神鳳 and others.
In *TTCY* (*Chin Tan Ta Yao*, ch. 3, pp. 26*a* ff.).
TT/1054.
Cf. Ho Ping-Yü & Needham (2).

Ching Chhu Sui Shih Chi 荊楚歲時記.
Annual Folk Customs of the States of Ching and Chhu [i.e. of the districts corresponding to those ancient States; Hupei, Hunan and Chiangsi].
Prob. Liang, *c.* +550, but perhaps partly Sui, *c.* +610.
Tsung Lin 宗懍.
See des Rotours (1), p. cii.

Ching-Shih Chêng Lei Pei-Chi Pên Tshao 經史證類備急本草.
The Classified and Consolidated Armamentarium of Pharmaceutical Natural History.
Sung, +1083, repr. +1090.
Thang Shen-Wei 唐愼微.

Ching Shih Thung Yen 警世通言.
Stories to Warn Men.
Ming, *c.* +1640.
Fêng Mêng-Lung 馮夢龍.

Ching Tien Shih Wên 經典釋文.
Textual Criticism of the Classics.
Sui, *c.* +600.
Lu Tê-Ming 陸德明.

Ching Yen Fang 經驗方.
Tried and Tested Prescriptions.
Sung, +1025.
Chang Shêng-Tao 張聲道.
Now extant only in quotations.

Ching Yen Liang Fang 經驗良方.
Valuable Tried and Tested Prescriptions.
Yuan.
Writer unknown.

Chiu Chêng Lu 就正錄.
Drawing near to the Right Way; a Guide [to physiological alchemy].
Chhing, prefs. +1678, +1697.
Lu Shih-Chhen 陸世忱.
In *Tao Tsang Hsü Pien* (*Chhu chi*), 8.

Chiu Chuan Chhing Chin Ling Sha Tan 九轉青金靈砂丹.
The Ninefold Cyclically Transformed Caerulean Golden Numinous Cinnabar Elixir.
Date unknown.
Writer unknown, but much overlap with *TT*/886.
TT/887.

Chiu Chuan Ling Sha Ta Tan 九轉靈砂大丹.

Chiu Chuan Ling Sha Ta Tan (*cont.*)
The Great Ninefold Cyclically Transformed Numinous Cinnabar Elixir.
Date unknown.
Writer unknown.
TT/886.

Chiu Chuan Ling Sha Ta Tan Tzu Shêng Hsüan Ching 九轉靈砂大丹資聖玄經.
Mysterious (or Esoteric) Sagehood-Enhancing Canon of the Great Ninefold Cyclically Transformed Numinous Cinnabar Elixir (or Enchymoma).
Date unknown, probably Thang; the text is in sūtra form.
Writer unknown.
TT/879.

Chiu Chuan Liu Chu Shen Hsien Chiu Tan Ching 九轉流珠神仙九丹經.
Manual of the Nine Elixirs of the Holy Immortals and of the Ninefold Cyclically Transformed Mercury.
Not later than Sung, but contains material from much earlier dates.
Thai-Chhing Chen Jen 太清眞人.
TT/945.

Chiu Huan Chin Tan Erh Chang 九還金丹二章.
Two Chapters on the Ninefold Cyclically Transformed Gold Elixir.
Alternative title of *Ta-Tung Lien Chen Pao Ching*, *Chin Huan Chin Tan Miao Chüeh* (q.v.).
In *YCCC*, ch. 68, pp. 8*a* ff.

Chiu Phu 酒譜.
A Treatise on Wine.
Sung, +1020.
Tou Phing 竇苹.

Chiu Shih 酒史.
A History of Wine.
Ming, +16th (but first pr. +1750).
Fêng Shih-Hua 馮時化.

Chiu Thang Shu 舊唐書.
Old History of the Thang Dynasty [+618 to +906].
Wu Tai (H/Chin), +945.
Liu Hsü 劉昫.
Cf. des Rotours (2), p. 64.
For translations of passages see the index of Frankel (1).

Chiu Ting Shen Tan Ching Chüeh
See *Huang Ti Chiu Ting Shen Tan Ching Chüeh.*

Cho Kêng Lu 輟耕錄.
[Sometimes *Nan Tshun Cho Kêng Lu.*]
Talks (at South Village) while the Plough is Resting.
Yuan, +1366.
Thao Tsung-I 陶宗儀.

Chou Hou Pei Chi Fang 肘後備急方.
[= *Chou Hou Tsu Chiu Fang*
or *Chou Hou Pai I Fang*
or *Ko Hsien Ong Chou Hou Pei Chi Fang.*]
Handbook of Medicines for Emergencies.
Chin, *c.* +340.
Ko Hung 葛洪.

Chou Hou Pai I Fang 肘後百一方
See *Chou Hou Pei Chi Fang.*

Chou Hou Tsu Chiu Fang 肘後卒救方
See *Chou Hou Pei Chi Fang.*

Chou I Tshan Thung Chhi 周易參同契.
See also titles under *Tshan Thung Chhi.*

Chou I Tshan Thung Chhi Chieh 周易參同契解.
The *Kinship of the Three and the Book of Changes*, with Explanation.
Text, H/Han, *c.* +140.
Comm., Sung, +1234.
Ed. & comm. Chhen Hsien-Wei 陳顯微.
TT/998.

Chou I Tshan Thung Chhi Chu 周易參同契註.
The *Kinship of the Three and the Book of Changes*, with Commentary.
Text, H/Han, *c.* +140.
Comm. ascr. H/Han, *c.* +160, but probably Sung.
Attrib., ed. and comm. Yin Chhang-Shêng 陰長生.
TT/990.

Chou I Tshan Thung Chhi Chu 周易參同契註.
The *Kinship of the Three and the Book of Changes*, with Commentary.
Text, H/Han, *c.* +140.
Comm. probably Sung.
Ed. and comm. unknown.
TT/991.

Chou I Tshan Thung Chhi Chu 周易參同契註.
The *Kinship of the Three and the Book of Changes*, with Commentary.
Text, H/Han, *c.* +140.
Comm. probably Sung.
Ed. and comm. unknown.
TT/995.

Chou I Tshan Thung Chhi Chu 周易參同契註.
The *Kinship of the Three and the Book of Changes*, with Commentary.
Text, H/Han, *c.* +140.
Comm., Sung, *c.* +1230.
Ed. & comm. Chhu Hua-Ku 儲華谷.
TT/999.

Chou I Tshan Thung Chhi Chu (*TT*/992).
Alternative title for *Tshan Thung Chhi Khao I* (Chu Hsi's) q.v.

Chou I Tshan Thung Chhi Fa Hui 周易參同契發揮.
Elucidations of the *Kinship of the Three and the Book of Changes* [alchemy].
Text, H/Han, *c.* +140.
Comm., Yuan, +1284.
Ed. & comm. Yü Yen 俞琰.
Tr. Wu & Davis (1).
TT/996.

Chou I Tshan Thung Chhi Fên Chang Chu (*Chieh*) 周易參同契分章註(解).
The *Kinship of the Three and the Book of Changes* divided into (short) chapters, with Commentary and Analysis.

Chou I Tshan Thung Chhi Fên Chang Chu (*Chieh*) (*cont.*)
Text, Han, *c.* +140.
Comm., Yuan, *c.* +1330.
Comm. Chhen Chih-Hsü 陳致虛 (Shang Yang Tzu 上陽子).
TTCY pên 93.

Chou I Tshan Thung Chhi Fên Chang Thung Chen I 周易參同契分章通眞義.
The *Kinship of the Three and the Book of Changes* divided into (short) chapters for the Understanding of its Real Meanings.
Text, H/Han, *c.* +140.
Comm., Wu Tai +947.
Ed. & comm. Phêng Hsiao 彭曉.
Tr. Wu & Davis (1).
TT/993.

Chou I Tshan Thung Chhi Shih I 周易參同契釋疑.
Clarification of Doubtful Matters in the *Kinship of the Three and the Book of Changes.*
Yuan, +1284.
Ed. & comm. Yü Yen 俞琰.
TT/997.

Chou I Tshan Thung Chhi Su Lüeh 周易參同契疏略.
Brief Explanation of the *Kinship of the Three and the Book of Changes.*
Ming, +1564.
Ed. & comm. Wang Wên-Lu 王文祿.

Chou I Tshan Thung Chhi Ting Chhi Ko Ming Ching Thu 易周參同契鼎器歌明鏡圖.
An Illuminating Chart for the Mnemonic Rhymes about Reaction-Vessels in the *Kinship of the Three and the Book of Changes.*
Text, H/Han, *c.* +140 (*Ting Chhi Ko* portion only).
Comm., Wu Tai, +947.
Ed. & comm. Phêng Hsiao 彭曉.
TT/994.

Chu Chêng Pien I 諸證辨疑.
Resolution of Diagnostic Doubts.
Ming, late +15th.
Wu Chhiu 吳球.

Chu Chhüan Chi 竹泉集.
The Bamboo Springs Collection [poems and personal testimonies on physiological alchemy].
Ming, +1465.
Tung Chhung-Li *et al.* 董重理.
In *Wai Chin Tan* (q.v.), ch. 3.

Chu Chia Shen Phin Tan Fa 諸家神品丹法.
Methods of the Various Schools for Magical Elixir Preparations (an alchemical anthology).
Sung.
Mêng Yao-Fu 孟要甫 (Hsüan Chen Tzu 玄眞子) *et al.*
TT/911.

Chu Fan Chih 諸蕃志.
Records of Foreign Peoples (and their Trade).
Sung, *c.* +1225. (This is Pelliot's dating; Hirth & Rockhill favoured between +1242 and +1258.)
Chao Ju-Kua 趙汝适.
Tr. Hirth & Rockhill (1).

Chu Yeh Thing Tsa Chi 竹葉亭雜記.
Miscellaneous Records of the Bamboo Leaf Pavilion.
Chhing, begun *c.* +1790 but not finished till *c.* 1820.
Yao Yuan-Chih 姚元之.

Chuan Hsi Wang Mu Wo Ku Fa 傳西王母握固法.
[= *Thai-Shang Chuan Hsi Wang Mu Wo Ku Fa.*]
A Recording of the Method of Grasping the Firmness (taught by) the Mother Goddess of the West.
[Taoist heliotherapy and meditation. 'Grasping the firmness' was a technical term for a way of clenching the hands during meditation.]
Thang or earlier.
Writer unknown.
Fragment in *Hsiu Chen Shih Shu* (*TT*/260), ch. 24, p. 1*a* ff.
Cf. Maspero (7), p. 376.

Chuang Lou Chi 妝樓記.
Records of the Ornamental Pavilion.
Wu Tai or Sung, *c.* +960.
Chang Mi 張泌.

Chün-Chai Tu Shu Chih 郡齋讀書志.
Memoir on the Authenticities of Ancient Books, by (Chhao) Chün-Chai.
Sung, +1151.
Chhao Kung-Wu 晁公武.

Chün-Chai Tu Shu Fu Chih 郡齋讀書附志.
Supplement to Chün-Chai's (Chhao Kung-Wu's) *Memoir on the Authenticities of Ancient Books.*
Sung, *c.* +1200.
Chao Hsi-Pien 趙希弁.

Chün-Chai Tu Shu Hou Chih 郡齋讀書後志.
Further Supplement to Chün-Chai's (Chhao Kung-Wu's) *Memoir on the Authenticities of Ancient Books.*
Sung, pref. +1151, pr. +1250.
Chhao Kung-Wu 晁公武, re-compiled by Chao Hsi-Pien 趙希弁, from the edition of Yao Ying-Chi 姚應績.

Chün Phu 菌譜.
A Treatise on Fungi.
Sung, +1245.
Chhen Jen-Yü 陳仁玉.

Chung Hua Ku Chin Chu 中華古今注.
Commentary on Things Old and New in China.
Wu Tai (H/Thang), +923 to +926.
Ma Kao 馬縞.
See des Rotours (1), p. xcix.

Chung Huang Chen Ching 中黃眞經
[= *Thai-Chhing Chung Huang Chen Ching* or *Thai Tsang Lun*.]
True Manual of the Middle (Radiance) of the Yellow (Courts), (central regions of the three parts of the body) [Taoist anatomy and physiology with Buddhist influence].
Prob. Sung, +12th or +13th.
Chiu Hsien Chün (ps.) 九仙君.
Comm. Chung Huang Chen Jen (ps). 中黃眞人.
TT/810.
Completing *TT*/328 and 329 (Wieger).
Cf. Maspero (7), p. 364.

Chung Lü Chuan Tao Chi 鍾呂傳道集.
Dialogue between Chungli (Chhüan) and Lü (Tung-Pin) on the Transmission of the Tao (and the Art of Longevity, by Rejuvenation).
Thang, +8th or +9th.
Attrib. Chungli Chhüan 鍾離權 and Lü Yen 呂岩.
Ed. Shih Chien-Wu 施肩吾.
In *Hsiu Chen Shih Shu* (*TT*/260), chs.14–16 incl.

Chung Shan Yü Kuei Fu Chhi Ching 中山玉櫃服氣經.
Manual of the Absorption of the Chhi, found in the Jade Casket on Chung-Shan (Mtn). [Taoist breathing exercises.]
Thang or Sung, +9th or +10th.
Attrib. Chang Tao-Ling (Han) 張道陵 or Pi-Yen Chang Tao-chê 碧巖張道者 or Pi-Yen hsien-sêng 碧巖先生.
Comm. by Huang Yuan-Chün 黃元君.
In *YCCC*, ch. 60, pp. 1*a* ff.
Cf. Maspero (7), pp. 204, 215, 353.

Chungli Pa Tuan Chin Fa 鍾離八段錦法.
The Eight Elegant (Gymnastic) Exercises of Chungli (Chhüan).
Thang, late +8th.
Chungli Chhüan 鍾離權.
In *Hsiu Chen Shih Shu* (*TT*/260), ch. 19.
Tr. Maspero (7), pp. 418 ff.
Cf. Notice by Tsêng Tshao in *Lin Chiang Hsien* (*TT*/260, ch. 23, pp. 1*b*, 2*a*) dated +1151. This says that the text was inscribed by Lü Tung-Pin himself on stone and so handed down.

Chhang Chhun Tzu Phan-Hsi Chi 長春子潘溪集.
Chhiu Chhang-Chhun's Collected (Poems) at Phan-Hsi.
Sung, *c.* +1200.
Chhiu Chhu-Chi 邱處機.
TT/1145.

Chhang Shêng Shu 長生術.
The Art and Mystery of Longevity and Immortality.
Alternative title of *Chin Hua Tsung Chih* (q.v.).

Chhen Wai Hsia Chü Chien 塵外遐舉牋.
Examples of Men who Renounced Official Careers and Shook off the Dust of the World [the eighth and last part (ch. 19) of *Tsun Shêng Pa Chien*, q.v.].
Ming, +1591.
Kao Lien 高濂.

Chhi Chü An Lo Chien 起居安樂牋.
On (Health-giving) Rest and Recreations in a Retired Abode [the third part (Chs. 7, 8) of *Tsun Shêng Pa Chien*, q.v.].
Ming, +1591.
Kao Lien 高濂.

Chhi Fan Ling Sha Ko 七返靈砂歌.
Song of the Sevenfold Cyclically Transformed Numinous Cinnabar (Elixir).
See *Chhi Fan Tan Sha Chüeh*.

Chhi Fan Ling Sha Lun 七返靈砂論.
On Numinous Cinnabar Seven Times Cyclically Transformed.
Alternative title for *Ta-Tung Lien Chen Pao Ching, Hsiu Fu Ling Sha Miao Chüeh* (q.v.).
In *YCCC*, ch. 69, pp. 1*a* ff.

Chhi Fan Tan Sha Chüeh 七返丹砂訣.
[= *Wei Po-Yang Chhi Fan Tan Sha Chüeh* or *Chhi Fan Ling Sha Ko*.]
Explanation of the Sevenfold Cyclically Transformed Cinnabar (Elixir), (of Wei Po-Yang).
Date unknown (ascr. H/Han).
Writer unknown (attrib. Wei Po-Yang).
Comm. by Huang Thung-Chün 黃童君.
Thang or pre-Thang, before +806.
TT/881.

Chhi Hsiao Liang Fang 奇效良方.
Effective Therapeutics.
Ming, *c.* +1436, pr. +1470.
Fang Hsien 方賢.

Chhi Kuo Khao 七國考.
Investigations of the Seven (Warring) States.
Chhing, *c.* +1660.
Tung Yüeh 董說.

Chhi Lu 七錄.
Bibliography of the Seven Classes of Books.
Liang, +523.
Juan Hsiao-Hsü 阮孝緒.

Chhi Min Yao Shu 齊民要術.
Important Arts for the People's Welfare [lit. Equality].
N/Wei (and E/Wei or W/Wei), between +533 and +544.
Chia Ssu-Hsieh 賈思勰.
See des Rotours (1), p.c; Shih Shêng-Han (1).

Chhi Yün Shan Wu Yuan Tzu Hsiu Chen Pien Nan (*Tshan Chêng*) 棲雲山梧元子修眞辯難參證.
See *Hsiu Chen Pien Nan* (*Tshan Chêng*).

Chhieh Yün 切韻.
Dictionary of the Sounds of Characters [rhyming dictionary].
Sui, +601.
Lu Fa-Yen 陸法言
See *Kuang Yün*.

Chhien Chin Fang Yen I 千金方衍義.
Dilations upon the *Thousand Golden Remedies.*
Chhing, +1698.
Chang Lu 張璐.

Chhien Chin I Fang 千金翼方.
Supplement to the *Thousand Golden Remedies* [i.e. Revised Prescriptions saving lives worth a Thousand Ounces of Gold].
Thang, between +660 and +680.
Sun Ssu-Mo 孫思邈.

Chhien Chin Shih Chih 千金食治.
A Thousand Golden Rules for Nutrition and the Preservation of Health [i.e. Diet and Personal Hygiene saving lives worth a Thousand Ounces of Gold], (included as a chapter in the *Thousand Golden Remedies*).
Thang, +7th (*c.* +625, certainly before +659).
Sun Ssu-Mo 孫思邈.

Chhien Chin Yao Fang 千金要方.
A Thousand Golden Remedies [i.e. Essential Prescriptions saving lives worth a Thousand Ounces of Gold].
Thang, between +650 and +659.
Sun Ssu-Mo 孫思邈.

Chhien Han Shu 前漢書.
History of the Former Han Dynasty [−206 to +24].
H/Han (begun about +65), *c.* +100.
Pan Ku 班固, and (after his death in +92) his sister Pan Chao 班昭.
Partial trs. Dubs (2), Pfizmaier (32–34, 37–51), Wylie (2, 3, 10), Swann (1).
Yin-Tê Index, no. 36.

Chhien Hung Chia Kêng Chih Pao Chi Chhêng 鉛汞甲庚至寶集成.
Complete Compendium on the Perfected Treasure of Lead, Mercury, Wood and Metal [with illustrations of alchemical apparatus].
On the translation of this title, cf. Vol. 5, pt. 3.
Has been considered Thang, +808; but perhaps more probably Wu Tai or Sung. Cf. p. 276.
Chao Nai-An 趙廼庵.
TT/912.

Chhien Khun Pi Yün 乾坤秘韞.
The Hidden Casket of Chhien and Khun (kua, i.e. Yang and Yin) Open'd.
Ming, *c.* +1430.
Chu Chhüan 朱權.
(Ning Hsien Wang 寧獻王, prince of the Ming.)

Chhien Khun Shêng I 乾坤生意.
Principles of the Coming into Being of Chhien and Khun (kua, i.e. Yang and Yin).
Ming, *c.* +1430.
Chu Chhüan 朱權.
(Ning Hsien Wang 寧獻王, prince of the Ming.)

Chhih Shui Hsüan Chu 赤水玄珠.
The Mysterious Pearl of the Red River [a system of medicine and iatro-chemistry].
Ming, +1596.
Sun I-Khuei 孫一奎.

Chhih Shui Hsüan Chu Chhüan Chi 赤水玄珠全集.
The Mysterious Pearl of the Red River; a Complete (Medical) Collection.
See *Chhih Shui Hsüan Chu.*

Chhih Shui Yin 赤水吟.
Chants of the Red River.
See Fu Chin-Chhüan (*1*).

Chhih Sung Tzu Chou Hou Yao Chüeh 赤松子肘後藥訣.
Oral Instructions of the Red-Pine Master on Handy (Macrobiotic) Prescriptions.
Pre-Thang.
Writer unknown.
Part of the *Thai-Chhing Ching Thien-Shih Khou Chüeh.*
TT/876.

Chhih Sung Tzu Hsüan Chi 赤松子玄記.
Arcane Memorandum of the Red-Pine Master.
Thang or earlier, before +9th.
Writer unknown.
Quoted in *TT*/928 and elsewhere.

Chhin Hsüan Fu 擒玄賦.
Rhapsodical Ode on Grappling with the Mystery.
Sung, +13th.
Writer unknown.
TT/257.

Chhing Hsiang Tsa Chi 青箱雜記.
Miscellaneous Records on Green Bamboo Tablets.
Sung, *c.* +1070.
Wu Chhu-Hou 吳處厚.

Chhing Hsiu Miao Lun Chien 清修妙論牋.
Subtile Discourses on the Unsullied Restoration (of the Primary Vitalities) [the first part (chs. 1, 2) of *Tsun Shêng Pa Chien*, q.v.].
Ming, +1591.
Kao Lien 高濂.

Chhing I Lu 清異錄.
Records of the Unworldly and the Strange.
Wu Tai, *c.* +950.
Thao Ku 陶穀.

Chhing-Ling Chen-Jen Phei Chün (Nei) Chuan 清靈眞人裴君內傳.
Biography of the Chhing-Ling Adept, Master Phei.
L/Sung or S/Chhi, +5th, but with early Thang additions.
Têng Yün Tzu 鄧雲子
(Phei Hsüan-Jen 裴玄仁 was a semi-legendary immortal said to have been born in −178).

Chhing-Ling Chen-Jen Phei Chün (Nei) Chuan (cont.)
In *YCCC*, ch. 105.
Cf. Maspero (7), pp. 386 ff.

Chhing Po Tsa Chih 清波雜志.
Green-Waves Memories.
Sung, +1193.
Chou Hui 周輝.

Chhing Wei Tan Chüeh (or *Fa*) 清微丹訣(法).
Instructions for Making the Enchymoma in Calmness and Purity [physiological alchemy].
Date unknown, perhaps Thang.
Writer unknown.
TT/275.

Chhiu Chhang-Chhun Chhing Thien Ko 邱長春青天歌.
Chhiu Chhang-Chhun's Song of the Blue Heavens.
Sung, *c.* +1200.
Chhiu Chhu-Chi 邱處機.
TT/134.

Chhu Chhêng I Shu 褚澄遺書.
Remaining Writings of Chhu Chhêng.
Chhi, *c.* +500, probably greatly remodelled in Sung.
Chhu Chhêng 褚澄.

Chhü Hsien Shen Yin Shu 臞仙神隱書.
Book of Daily Occupations for Scholars in Rural Retirement, by the Emaciated Immortal.
Ming, *c.* +1430.
Chu Chhüan 朱權.
(Ning Hsien Wang 寧獻王, prince of the Ming.)

Chhu Hsüeh Chi 初學記.
Entry into Learning [encyclopaedia].
Thang, +700.
Hsü Chien 徐堅.

Chhü I Shuo Tsuan 祛疑說纂.
Discussions on the Dispersal of Doubts.
Sung, *c.* +1230.
Chhu Yung 儲泳.

Chhüan-Chen Chi Hsüan Pi Yao 全眞集玄秘要.
Esoteric Essentials of the Mysteries (of the Tao), according to the Chhüan-Chen (Perfect Truth) School [the Northern School of Taoism in Sung and Yuan times].
Yuan, *c.* +1320.
Li Tao-Shun 李道純.
TT/248.

Chhüan-Chen Tso Po Chieh Fa 全眞坐鉢捷法.
Ingenious Method of the Chhüan-Chen School for Timing Meditation (and other Exercises) by a (Sinking-) Bowl Clepsydra.
Sung or Yuan.
Writer unknown.
TT/1212.

Chhüan Ching 拳經.
Manual of Boxing.
Chhing, +18th.
Chang Khung-Chao 張孔昭.

Chhun Chhiu Fan Lu 春秋繁露.
String of Pearls on the *Spring and Autumn Annals*.
C/Han, *c.* −135.
Tung Chung-Shu 董仲舒.
See Wu Khang (1).
Partial trs. Wieger (2); Hughes (1); d'Hormon (1) (ed.).
Chung-Fa Index no. 4.

Chhun Chhiu Wei Yuan Ming Pao 春秋緯元命苞.
Apocryphal Treatise on the *Spring and Autumn Annals*; the Mystical Diagrams of Cosmic Destiny [astrological-astronomical].
C/Han, *c.* −1st.
Writer unknown.
In *Ku Wei Shu*, ch. 7.

Chhun Chhiu Wei Yün Tou Shu 春秋緯運斗樞
Apocryphal Treatise on the *Spring and Autumn Annals*; the Axis of the Turning of the Ladle (i.e. the Great Bear).
C/Han, −1st or later.
Writer unknown.
In *Ku Wei Shu*, ch. 9, pp. 4*b* ff. and *YHSF*, ch. 55, pp. 22*a* ff.

Chhun Chu Chi Wên 春渚紀聞.
Record of Things Heard at Spring Island.
Sung, *c.* +1095.
Ho Wei 何薳.

Chhun-yang etc.
See *Shun-yang*.

Chhung-Hsiu Chêng-Ho Ching-Shih Chêng Lei Pei-Yung Pên Tshao 重修政和經史證類備用本草.
New Revision of the Pharmacopoeia of the Chêng-Ho reign-period; the Classified and Consolidated Armamentarium.
(A Combination of the *Chêng-Ho . . . Chêng Lei . . . Pên Tshao* with the *Pên Tshao Yen I*.)
Yuan, +1249; reprinted many times afterwards, esp. in the Ming, +1468, with at least seven Ming editions, the last in +1624 or +1625.
Thang Shen-Wei 唐愼微.
Khou Tsung-Shih 寇宗奭.
Pr. (or ed.) Chang Tshun-Hui 張存惠.

Chhung-Yang Chhüan Chen Chi 重陽全眞集.
(Wang) Chhung-Yang's [Wang Chê's] Records of the Perfect Truth (School).
Sung, mid +12th cent.
Wang Chê 王嚞.
TT/1139.

Chhung-Yang Chiao Hua Chi 重陽敎化集.
Memorials of (Wang) Chhung-Yang's [Wang Chê's] Preaching.
Sung, mid +12th cent.
Wang Chê 王嚞.
TT/1140.

Chhung-Yang Chin-Kuan Yü-Suo Chüeh 重陽金關玉鎖訣.

Chhung-Yang Chin-Kuan Yü-Suo Chüeh (cont.)
(Wang) Chhung-Yang's [Wang's Chê's] Instructions on the Golden Gate and the Lock of Jade.
Sung, mid +12th cent.
Wang Chê 王嘉.
TT/1142.

Chhung-Yang Fên-Li Shih-Hua Chi 重陽分梨十化集.
Writings of (Wang) Chhung-Yang [Wang Chê] (to commemorate the time when he received a daily) Ration of Pears, and the Ten Precepts of his Teacher.
Sung, mid +12th cent.
Wang Chê 王嘉.
TT/1141.

Chhung-Yang Li-Chiao Shih-Wu Lun 重陽立教十五論.
Fifteen Discourses of (Wang) Chhung-Yang [Wang Chê] on the Establishment of his School.
Sung, mid +12th cent.
Wang Chê 王嘉.
TT/1216.

Đai-Viêt Sú-ký Toàn-thú 大越史記全書.
The Complete Book of the History of Great Annam.
Vietnam, *c.* +1479.
Ngô Si-Liên 吳士連.

Fa Yen 法言.
Admonitory Sayings [in admiration, and imitation, of the *Lun Yü*].
Hsin, +5.
Yang Hsiung 揚雄.
Tr. von Zach (5).

Fa Yuan Chu Lin 法苑珠林.
Forest of Pearls from the Garden of the [Buddhist] Law.
Thang, +668, +688.
Tao-Shih 道世.

Fan Tzu Chi Jan 范子計然.
See *Chi Ni Tzu.*

Fang Hu Wai Shih 方壺外史.
Unofficial History of the Land of the Immortals, Fang-hu. (Contains two *nei tan* commentaries on the *Tshan Thung Chhi*, +1569 and +1573.)
Ming, *c.* +1590.
Lu Hsi-Hsing 陸西星.
Cf. Liu Tshun-Jen (1, 2).

Fang Yü Chi 方輿記.
General Geography.
Chin, or at least pre-Sung.
Hsü Chiai 徐鍇.

Fei Lu Hui Ta 斐錄彙答.
Questions and Answers on Things Material and Moral.
Ming, +1636.
Kao I-Chih (Alfonso Vagnoni) 高一志.
Bernard-Maître (18), no. 272.

Fên Thu 粉圖.
See *Hu Kang Tzu Fên Thu.*

Fêng Su Thung I 風俗通義.
The Meaning of Popular Traditions and Customs.
H/Han, +175.
Ying Shao 應劭.
Chung-Fa Index, no. 3.

Fo Shuo Fo I Wang Ching 佛說佛醫王經
Buddha Vaidyarāja Sātra; or *Buddha-prokta Buddha-bhaiṣajyarāja Sūtra* (Sūtra of the Buddha of Healing, spoken by Buddha).
India.
Tr. San Kuo (Wu) +230.
Trs. Liu Yen (Vinayātapa) & Chih-Chhien. 支謙.
N/1327; TW/793.

Fo Tsu Li Tai Thung Tsai 佛祖歷代通載.
General Record of Buddhist and Secular History through the Ages.
Yuan, +1341.
Nien-Chhang (monk) 念常.

Fu Chhi Ching I Lun 服氣精義論.
Dissertation on the Meaning of 'Absorbing the Chhi and the Ching' (for Longevity and Immortality), [Taoist hygienic, respiratory, pharmaceutical, medical and (originally) sexual procedures].
Thang, *c.* +715.
Ssuma Chhêng-Chên 司馬承貞.
In *YCCC*, ch. 57.
Cf. Maspero (7), pp. 364 ff.

Fu Hung Thu 伏汞圖.
Illustrated Manual on the Subduing of Mercury.
Sui, Thang, J/Chin or possibly Ming.
Shêng Hsüan Tzu 昇玄子.
Survives now only in quotations.

Fu Nei Yuan Chhi Ching 服內元氣經.
Manual of Absorbing the Internal Chhi of Primary (Vitality).
Thang, +8th, probably *c.* +755.
Huan Chen hsien-sêng (Mr Truth-and-Illusion) 幻眞先生.
TT/821, and in *YCCC*, ch. 60, pp. 10*b* ff.
Cf. Maspero (7), p. 199.

Fu Shih Lun 服石論.
Treatise on the Consumption of Mineral Drugs.
Thang, perhaps Sui.
Writer unknown.
Extant only in excerpts preserved in the *I Hsin Fang* (+982).

Fu Shou Tan Shu 福壽丹書.
A Book of Elixir-Enchymoma Techniques for Happiness and Longevity.
Ming, +1621.
Chêng Chih-Chhiao 鄭之僑 (at least in part).
Partial tr. of the gymnastic material, Dudgeon (1).

Fusō Ryakuki 扶桑畧記.
Classified Historical Matters concerning the Land of Fu-Sang (Japan) [from +898 to +1197].
Japan (Kamakura) +1198.
Kōen (monk).

Genji Monogatari 源氏物語.
The Tale of (Prince) Genji.
Japan, +1021.
Murasaki Shikibu 紫式部.

Hai Yao Pên Tshao 海藥本草.
[= *Nan Hai Yao Phu.*]
Materia Medica of the Countries Beyond the Seas.
Wu Tai (C/Shu), *c.* +923.
Li Hsün 李珣.
Preserved only in numerous quotations in *Chêng Lei Pên Tshao* and later pandects.

Han Fei Tzu 韓非子.
The Book of Master Han Fei.
Chou, early −3rd century.
Han Fei 韓非.
Tr. Liao Wên-Kuei (1).

Han Kuan I 漢官儀.
The Civil Service of the Han Dynasty and its Regulations.
H/Han +197.
Ying Shao 應劭.
Ed. Chang Tsung-Yuan 張宗源 (+1752 to 1800).
Cf. Hummel (2), p. 57.

Han Kung Hsiang Fang 漢宮香方.
On the Blending of Perfumes in the Palaces of the Han.
H/Han, +1st or +2nd.
Genuine parts preserved *c.* +1131 by Chang Pang-Chi 張邦基.
Attrib. Tung Hsia-Chou 董遐周.
Comm. by Chêng Hsüan 鄭玄.
'Restored', *c.* +1590, by Kao Lien 高濂.

Han Thien Shih Shih Chia 漢天師世家.
Genealogy of the Family of the Han Heavenly Teacher.
Date uncertain.
Writers unknown.
With Pu Appendix, 1918, by Chang Yuan-Hsü 張元旭 (the 62nd Taoist Patriarch, Thien Shih).
TT/1442.

Han Wei Tshung-Shu 漢魏叢書.
Collection of Books of the Han and Wei Dynasties [first only 38, later increased to 96].
Ming, +1592.
Ed. Thu Lung 屠隆.

Han Wu (Ti) Ku Shih 漢武(帝)故事.
Tales of (the Emperor) Wu of the Han (r. −140 to −87).
L/Sung and Chhi, late +5th.
Wang Chien 王儉.
Perhaps based on an earlier work of the same kind by Ko Hung 葛洪.
Tr. d'Hormon (1).

Han Wu (Ti) Nei Chuan 漢武(帝)內傳.
The Inside Story of (Emperor) Wu of the Han (r. −140 to −87).
Material of Chin, L/Sung, Chhi, Liang and perhaps Chhen date, +320 to +580, probably stabilised about +580.
Attrib. Pan Ku, Ko Hung, etc.
Actual writer unknown.
TT/289.
Tr. Schipper (1).

Han Wu (Ti) Nei Chuan Fu Lu 漢武(帝)內傳附錄.
See *Han Wu (Ti) Wai Chuan.*

Han Wu (Ti) Wai Chuan 漢武(帝)外傳.
[= *Han Wu (Ti) Nei Chuan Fu Lu.*]
Extraordinary Particulars of (Emperor) Wu of the Han (and his collaborators), [largely biographies of the magician-technicians at Han Wu Ti's court].
Material of partly earlier date collected and stabilised in Sui or Thang, early +7th century.
Writers and editor unknown.
Introductory paragraphs added by Wang Yu-Yen 王游巖 (+746).
TT/290.
Cf. Maspero (7), p. 234, and Schipper (1).

Hei Chhien Shui Hu Lun 黑鉛水虎論.
Discourse on the Black Lead and the Water Tiger.
Alternative title of *Huan Tan Nei Hsiang Chin Yo Shih*, q.v.

Ho Chi Chü Fang 和劑局方.
Standard Formularies of the (Government) Pharmacies [based on the *Thai-Phing Shêng Hui Fang* and other collections].
Sung, *c.* +1109.
Ed. Chhen Chhêng 陳承, Phei Tsung-Yuan 裴宗元, & Chhen Shih-Wên 陳師文.
Cf. *SIC*, p. 974.

Honan Chhen Shih Hsiang Phu 河南陳氏香譜.
See *Hsiang Phu* by Chhen Ching.

Honan Chhêng Shih I Shu 河南程氏遺書.
Remaining Records of Discourses of the Chhêng brothers of Honan [Chhêng I and Chhêng Hao, +11th-century Neo-Confucian philosophers].
Sung, +1168, pr. *c.* +1250.
Chu Hsi (ed.) 朱熹.
In *Erh Chhêng Chhüan Shu*, q.v.
Cf. Graham (1), p. 141.

Honan Chhêng Shih Tshui Yen 河南程氏粹言.
Authentic Statements of the Chhêng brothers of Honan [Chhîng I and Chhêng Hao, +11th-century Neo-Confucian philosophers. In fact more altered and abridged than the other sources, which are therefore to be preferred.]

Honan Chhêng Shih Tshui Yen (cont.)
Sung, first collected *c.* +1150, supposedly ed. +1166, in its present form by *c.* +1340.
Coll. Hu Yin 胡寅.
Supposed ed. Chang Shih 張栻.
In *Erh Chhêng Chhüan Shu*, q.v., since +1606.
Cf. Graham (1), p. 145.

Honzō-Wamyō 本草和名.
Synonymic Materia Medica with Japanese Equivalents.
Japan, +918.
Fukane no Sukehito 深根輔仁.
Cf. Karow (1).

Hou Han Shu 後漢書.
History of the Later Han Dynasty [+25 to +220].
L/Sung, +450.
Fan Yeh 范曄.
The monograph chapters by Ssuma Piao 司馬彪 (d. +305), with commentary by Liu Chao 劉昭 (*c.* +510), who first incorporated them in the work.
A few chs. tr. Chavannes (6, 16); Pfizmaier (52, 53).
Yin-Tê Index, no. 41.

Hou Tê Lu 厚德錄.
Stories of Eminent Virtue.
Sung, early +12th.
Li Yuan-Kang 李元綱.

Hu Kang Tzu Fên Thu 狐剛子粉圖.
Illustrated Manual of Powders [Salts], by the Fox-Hard Master.
Sui or Thang.
Hu Kang Tzu 狐剛子.
Survives now only in quotations; originally in *TT* but lost. Cf. Vol. 4, pt. 1, p. 308.

Hua Tho Nei Chao Thu 佗佗內照圖.
Hua Tho's Illustrations of Visceral Anatomy.
See *Hsüan Mên Mo Chüeh Nei Chao Thu.*
Cf. Miyashita Saburo (1).

Hua-Yang Thao Yin-Chü Chuan 華陽陶隱居傳.
A Biography of Thao Yin-Chü (Thao Hung-Ching) of Huayang [the great alchemist, naturalist and physician].
Thang,
Chia Sung 賈嵩.
TT/297.

Hua Yen Ching 華嚴經.
Buddha-avataṃsaka Sūtra; The Adornment of Buddha.
India.
Tr. into Chinese, +6th century.
TW/278, 279.

Huai Nan Hung Lieh Chieh 淮南鴻烈解.
See *Huai Nan Tzu.*

Huai Nan Tzu 淮南子.
[= *Huai Han Hung Lieh Chieh* 淮南鴻烈解.]
The Book of (the Prince of) Huai-Nan [compendium of natural philosophy].
C/Han, *c.* −120.
Written by the group of scholars gathered by Liu An (prince of Huai-Nan) 劉安.
Partial trs. Morgan (1); Erkes (1); Hughes (1); Chatley (1); Wieger (2).
Chung-Fa Index, no. 5.
TT/1170.

Huai-Nan (Wang) Wan Pi Shu 淮南(王)萬畢術.
[Prob. = *Chen-Chung Hung-Pao Yuan-Pi Shu* and variants.]
The Ten Thousand Infallible Arts of (the Prince of) Huai-Nan [Taoist magical and technical recipes].
C/Han, −2nd century.
No longer a separate book but fragments contained in *TPYL*, ch. 736 and elsewhere
Reconstituted texts by Yeh Tê-Hui in *Kuan Ku Thang So Chu Shu*, and Sun Fêng-I in *Wên Ching Thang Tshung-Shu.*
Attrib. Liu An 劉安.
See Kaltenmark (2), p. 32.
It is probable that the terms *Chen-Chung* 枕中 Confidential Pillow-Book; *Hung-Pao* 鴻寶 Infinite Treasure; *Wan-Pi* 萬畢 Ten Thousand Infallible; and *Yuan-Pi* 苑祕 Garden of Secrets; were originally titles of parts of a *Huai-Nan Wang Shu* 淮南王書 (Writings of the Prince of Huai-Nan) forming the Chung Phien 中篇 (and perhaps also the Wai Shu 外書) of which the present *Huai Nan Tzu* book (q.v.) was the Nei Shu 內書.

Huan Chen hsien-sêng, etc. 幻眞先生.
See *Thai Hsi Ching* and *Fu Nei Yuan Chhi Ching.*

Huan Chin Shu 還金述.
An Account of the Regenerative Metallous Enchymoma.
Thang, probably +9th.
Thao Chih 陶植.
TT/915, also excerpted, in *YCCC*, ch. 70, pp. 13*a* ff.

Huan Tan Chou Hou Chüeh 還丹肘後訣.
Oral Instructions on Handy Formulae for Cyclically Transformed Elixirs [with illustrations of alchemical apparatus].
Ascr. Chin, *c.* +320.
Actually Thang, including a memorandum of +875 by Wu Ta-Ling 仵達靈, and the rest probably by other hands within a few years of this date.
Attrib. Ko Hung 葛洪.
TT/908.

Huan Tan Chung Hsien Lun 還丹衆仙論.
Pronouncements of the Company of the Immortals on Cyclically Transformed Elixirs.
Sung, +1052.
Yang Tsai 楊在.
TT/230.

Huan Tan Fu Ming Phien 還丹復命篇.
Book on the Restoration of Life by the Cyclically Transformed Elixir.
Sung, +12th cent., *c.* +1175.
Hsüeh Tao-Kuang 薛道光.
TT/1074.

Huan Tan Nei Hsiang Chin Yo Shih 還丹內象金鑰匙.
[= *Hei Chhien Shui Hu Lun* and *Hung Chhien Huo Lung Lun*.]
A Golden Key to the Physiological Aspects of the Regenerative Enchymoma.
Wu Tai, *c.* +950.
Phêng Hsiao 彭曉.
Now but half a chapter in *YCCC*, ch. 70, pp. 1*a* ff., though formerly contained in the *Tao Tsang*.

Huan Tan Pi Chüeh Yang Chhih-Tzu Shen Fang 還丹祕訣養赤子神方.
The Wondrous Art of Nourishing the (Divine) Embryo (lit. the Naked Babe) by the use of the secret Formula of the Regenerative Enchymoma [physiological alchemy].
Sung, probably late +12th.
Hsü Ming-Tao 許明道.
TT/229.

Huan Yü Shih Mo 寰宇始末.
On the Beginning and End of the World [the Hebrew-Christian account of creation, the Four Aristotelian Causes, Elements, etc.].
Ming, +1637.
Kao I-Chih (Alfonso Vagnoni) 高一志.
Bernard-Maître (18), no. 283.

Huan Yuan Phien 還原篇.
Book of the Return to the Origin [poems on the regaining of the primary vitalities in physiological alchemy].
Sung, *c.* +1140.
Shih Thai 石泰.
TT/1077. Also in *Hsiu Chen Shih Shu* (*TT*/260), ch. 2.

Huang Chi Ching Shih Shu 皇極經世書.
Book of the Sublime Principle which governs All Things within the World.
Sung, *c.* +1060.
Shao Yung 邵雍]
TT/1028. Abridged in *Hsing Li Ta Chhüan* and *Hsing Li Ching I*.

Huang Chi Ho Pi Hsien Ching 皇極闔關仙經.
[= *Yin Chen Jen Tung-Hua Chêng Mo Huang Chi Ho Pi Chêng Tao Hsien Ching*.]
The Height of Perfection (attained by) Opening and Closing (the Orifices of the Body); a Manual of the Immortals [physiological alchemy, *nei tan* techniques].
Ming or Chhing.
Attrib. Yin chen jen (Phêng-Thou) 尹眞人(蓬頭).
Ed. Min I-Tê 閔一得, *c.* 1830.
In *Tao Tsang Hsü Pien* (*Chhu chi*), 2, from a MS. preserved at the Blue Goat Temple 青羊宮 (Chhêngtu).

Huang Pai Ching 黃白鏡.
Mirror of (the Art of) the Yellow and the White [physiological alchemy].
Ming, +1598.
Li Wên-Chu 李文燭.
Comm. Wang Chhing-Chêng 王清正.
In *Wai Chin Tan* coll., ch. 2 (*CTPS*, *pên* 7).

Huang-Thien Shang-Chhing Chin Chhüeh Ti Chün Ling Shu Tzu-Wên Shang Ching 皇天上清金闕帝君靈書紫文上經.
Exalted Canon of the Imperial Lord of the Golden Gates, Divinely Written in Purple Script; a Huang-Thien Shang-Chhing Scripture.
Chin, late +4th, with later revisions.
Writer unknown.
TT/634.

Huang Thing Chung Ching Ching 黃庭中景經.
[= *Thai-Shang Huang Thing Chung Ching Ching*.]
Manual of the Middle Radiance of the Yellow Courts (central regions of the three parts of the body) [Taoist anatomy and physiology].
Sui.
Li Chhien-Chhêng 李千乘.
TT/1382, completing *TT*/398–400.
Cf. Maspero (7), pp. 195, 203.

Huang Thing Nei Ching Wu Tsang Liu Fu Pu Hsieh Thu 黃庭內景五臟六府補瀉圖
Diagrams of the Strengthening and Weakening of the Five Yin-viscera and the Six Yang-viscera (in accordance with) the (*Jade Manual of the*) *Internal Radiance of the Yellow Courts*.
Thang, *c.* +850.
Hu An 胡愔.
TT/429.

Huang Thing Nei Ching Wu Tsang Liu Fu Thu 黃庭內景五臟六府圖.
Diagrams of the Five Yin-viscera and the Six Yang-viscera (discussed in the *Jade Manual of the*) *Internal Radiance of the Yellow Courts* [Taoist anatomy and physiology; no illustrations surviving, but much therapy and pharmacy].
Thang, +848.
Hu An 胡愔 (title: Thai-pai Shan Chien Su Nü) 太白山見素女.
In *Hsiu Chen Shih Shu* (*TT*/260), ch. 54.
Illustrations preserved only in Japan, MS. of before +985.
SIC, p. 223; Watanabe Kozo (1), pp. 112 ff.

Huang Thing Nei Ching Yü Ching 黃庭內景玉經.
[= *Thai-Shang Huang Thing Nei Ching Yü Ching*.]
Jade Manual of the Internal Radiance of the Yellow Courts (central regions of the

Huang Thing Nei Ching Yü Ching (*cont.*)
three parts of the body) [Taoist anatomy and physiology]. In 36 *chang*.
L/Sung, Chhi, Liang or Chhen, +5th or +6th. The oldest parts date probably from Chin, about +365.
Writer unknown. Allegedly transmitted by immortals to the Lady Wei (Wei Fu Jen), i.e. Wei Hua-Tshun 魏華存.
TT/328.
Paraphrase by Liu Chhang-Shêng 劉長生 (Sui), *TT*/398.
Comms. by Liang Chhiu Tzu 梁丘子 (Thang), *TT*/399, and Chiang Shen-Hsiu 蔣愼修 (Sung), *TT*/400.
Cf. Maspero (7), p. 239.

Huang Thing Nei Ching Yü Ching Chu 黃庭內景玉經注.
Commentary on (and paraphrased text of) the *Jade Manual of the Internal Radiance of the Yellow Courts*.
Sui.
Liu Chhang-Shêng 劉長生.
TT/398.

Huang Thing Nei Ching (*Yü*) *Ching Chu* 黃庭內景(玉)經注.
Commentary on the *Jade Manual of the Internal Radiance of the Yellow Courts*.
Thang, +8th or +9th.
Liang Chhiu Tzu (ps.) 梁丘子.
TT/399, and in *Hsiu Chen Shih Shu* (*TT*/260), chs. 55–57; and in *YCCC*, chs. 11, 12 (where the first 3 *chang* (30 verses) have the otherwise lost commentary of Wu Chhêng Tzu 務成子).
Cf. Maspero (7), pp. 239 ff.

Huang Thing Nei Wai Ching Yü Ching Chieh 黃庭內外景玉經解.
Explanation of the *Jade Manuals of the Internal and External Radiances of the Yellow Courts*.
Sung.
Chiang Shen-Hsiu 蔣愼修.
TT/400.

Huang Thing Wai Ching Yü Ching 黃庭外景玉經.
[= *Thai-Shang Huang Thing Wai Ching Yü Ching*.]
Jade Manual of the External Radiance of the Yellow Courts (central regions of the three parts of the body) [Taoist anatomy and physiology]. In 3 *chüan*.
H/Han, San Kuo or Chin, +2nd or +3rd. Not later than +300.
Writer unknown.
TT/329.
Comms. by Wu Chhêng Tzu 務成子 (early Thang) *YCCC*, ch. 12; Liang Chhiu Tzu 梁丘子 (late Thang), *TT*/260, chs. 58–60; Chiang Shen-Hsiu 蔣愼修 (Sung), *TT*/400.
Cf. Maspero (7), pp. 195 ff., 428 ff.

Huang Thing Wai Ching Yü Ching Chu 黃庭外景玉經註.
Commentary on the *Jade Manual of the External Radiance of the Yellow Courts*.
Sui or early Thang, +7th.
Wu Chhêng Tzu (ps.) 務成子.
In *YCCC*, ch. 12, pp. 30*a* ff.
Cf. Maspero (7), p. 239.

Huang Thing Wai Ching Yü Ching Chu 黃庭外景玉經註.
Commentary on the *Jade Manual of the External Radiance of the Yellow Courts*.
Thang, +8th or +9th.
Liang Chhiu Tzu (ps.) 梁丘子.
In *Hsiu Chen Shih Shu* (*TT*/260), chs. 58–60.
Cf. Maspero (7), pp. 239 ff.

Huang Ti Chiu Ting Shen Tan Ching Chüeh 黃帝九鼎神丹經訣.
The Yellow Emperor's Canon of the Nine-Vessel Spiritual Elixir, with Explanations.
Early Thang or early Sung, but incorporating as ch. 1 a canonical work probably of the +2nd cent.
Writer unknown.
TT/878. Also, abridged, in *YCCC*, ch. 67, pp. 1*a* ff.

Huang Ti Nei Ching, Ling Shu 黃帝內經靈樞.
The Yellow Emperor's Manual of Corporeal (Medicine), the Vital Axis [medical physiology and anatomy].
Probably C/Han, *c.* −1st century.
Writers unknown.
Edited Thang, +762, by Wang Ping 王冰.
Analysis by Huang Wên (1).
Tr. Chamfrault & Ung Kang-Sam (1).
Commentaries by Ma Shih 馬蒔 (Ming) and Chang Chih-Tshung 張志聰 (Chhing) in *TSCC*, *I shu tien*, chs. 67 to 88.

Huang Ti Nei Ching, Ling Shu, Pai Hua Chieh
See Chhen Pi-Liu & Chêng Cho-Jen (1).

Huang Ti Nei Ching, Su Wên 黃帝內經素問.
The Yellow Emperor's Manual of Corporeal (Medicine); Questions (and Answers) about Living Matter [clinical medicine].
Chou, remodelled in Chhin and Han, reaching final form *c.* −2nd century.
Writers unknown.
Ed. & comm., Thang (+762), Wang Ping 王冰; Sung (*c.* +1050), Lin I 林億.
Partial trs. Hübotter (1), chs. 4, 5, 10, 11, 21; Veith (1); complete, Chamfrault & Ung Kang-Sam (1).
See Wang & Wu (1), pp. 28 ff.; Huang Wên (1).

Huang Ti Nei Ching Su Wên I Phien 黃帝內經素問遺篇.
The Missing Chapters from the *Questions and Answers* of the *Yellow Emperor's Manual of Corporeal (Medicine)*.
Ascr. pre-Han.
Sung, preface, +1099.

Huang Ti Nei Ching Su Wên I Phien (*cont.*)
Ed. (perhaps written by) Liu Wên-Shu 劉溫舒.
Often appended to his *Su Wên Ju Shih Yün Chhi Ao Lun* (q.v.) 素問入式運氣奧論.

Huang Ti Nei Ching Su Wên, Pai Hua Chieh
See Chou Fêng-Wu, Wang Wan-Chieh & Hsü Kuo-Chhien (*1*).

Huang Ti Pa-shih-i Nan Ching Tsuan Thu Chü Chieh 黃帝八十一難經纂圖句解.
Diagrams and a Running Commentary for the *Manual of* (*Explanations Concerning*) *Eighty-one Difficult* (*Passages*) *in the Yellow Emperor's* (*Manual of Corporeal Medicine*).
Sung, +1270 (text H/Han, +1st).
Li Kung 李鬨.
TT/1012.

Huang Ti Pao Tsang Ching 黃帝寶藏經.
Perhaps an alternative name for *Hsien-Yuan Pao Tsang* (*Chhang Wei*) *Lun*, q.v.

Huang Ti Yin Fu Ching 黃帝陰符經.
See *Yin Fu Ching*.

Huang Ti Yin Fu Ching Chu 黃帝陰符經註.
Commentary on the *Yellow Emperor's Book on the Harmony of the Seen and the Unseen*.
Sung.
Liu Chhu-Hsüan 劉處玄.
TT/119.

Huang Yeh Fu 黃冶賦.
Rhapsodic Ode on 'Smelting the Yellow' [alchemy].
Thang, *c.* +840.
Li Tê-Yü 李德裕.
In *Li Wên-Jao Pieh Chi*, ch. 1.

Huang Yeh Lun 黃冶論.
Essay on the 'Smelting of the Yellow' [alchemy].
Thang, *c.* +830.
Li Tê-Yü 李德裕.
In *Wên Yuan Ying Hua*, ch. 739, p. 15*a*, and *Li Wên-Jao Wai Chi*, ch. 4.

Hui Ming Ching 慧命經.
[= *Tsui-Shang I Chhêng Hui Ming Ching*, also entitled *Hsü Ming Fang*.]
Manual of the (Achievement of) Wisdom and the (Lengthening of the) Life-Span.
Chhing, +1794.
Liu Hua-Yang 柳華陽.
Cf. Wilhelm & Jung (1), editions after 1957.

Hung Chhien Huo Lung Lun 紅鉛火龍論.
Discourse on the Red Lead and the Fire Dragon.
Alternative title of *Huan Tan Nei Hsiang Chin Yo Shih*, q.v.

Hung Chhien Ju Hei Chhien Chüeh 紅鉛入黑鉛訣.
Oral Instructions on the Entry of the Red Lead into the Black Lead.
Probably Sung, but some of the material perhaps older.
Compiler unknown.
TT/934.

Huo Kung Chhieh Yao 火攻挈要.
Essentials of Gunnery.
Ming, +1643.
Chiao Hsü 焦勗.
With the collaboration of Thang Jo-Wang (J. A. Schall von Bell) 湯若望.
Bernard-Maître (18), no. 334.

Huo Lien Ching 火蓮經.
Manual of the Lotus of Fire [physiological alchemy].
Ming or Chhing.
Attrib. Liu An, 劉安 (Han).
In *Wai Chin Tan*, coll., ch. 1 (*CTPS*, *pên* 6).

Huo Lung Ching 火龍經.
The Fire-Drake (Artillery) Manual.
Ming, +1412.
Chiao Yü 焦玉.
The first part of this book, in three sections, is attributed fancifully to Chuko Wu-Hou (i.e. Chuko Liang), and Liu Chi 劉基 (+1311 to +1375) appears as co-editor, really perhaps co-author.
The second part, also in three sections, is attributed to Liu Chi alone, but edited, probably written, by Mac Hsi-Ping 毛希秉 in +1632.
The third part, in two sections, is by Mao Yuan-I 毛元儀 (*fl.* +1628) and edited by Chuko Kuang-Jung 諸葛光榮 whose preface is of +1644, Fang Yuan-Chuang 方元壯 & Chung Fu-Wu 鍾伏武.

Huo Lung Chüeh 火龍訣.
Oral Instructions on the Fiery Dragon [proto-chemical and physiological alchemy].
Date uncertain, ascr. Yuan, +14th.
Attrib. Shang Yang Tsu Shih 上陽祖師.
In *Wai Chin Tan* (coll.), ch. 3 (*CTPS*, *pên* 8).

Hupei Thung Chih 湖北通志.
Historical Geography of Hupei Province.
Min Kuo, 1921, but based on much older records.
See Yang Chhêng-Hsi (ed.) (*1*) 楊承禧.

Hsi Chhi Tshung Hua 西溪叢話 (*SKCS* has *Yü* 語).
Western Pool Collected Remarks.
Sung, *c.* +1150.
Yao Khuan 姚寬.

Hsi Chhing Ku Chien 西清古鑑.
Hsi Chhing Catalogue of Ancient Mirrors (and Bronzes) in the Imperial Collection.
(The collection was housed in the Library of Western Serenity, a building in the southern part of the Imperial Palace).
Chhing, +1751.
Liang Shih-Chêng 梁詩正.

Hsi Shan Chhun Hsien Hui Chen Chi 西山羣仙會眞記.
A True Account of the Proceedings of the Company of Immortals in the Western Mountains.
Thang, *c.* +800.
Shih Chien-Wu 施肩吾.
TT/243.

Hsi Shang Fu Than 席上腐談.
Old-Fashioned Table Talk.
Yuan, *c.* +1290.
Yü Yen 俞琰.

Hsi Wang Mu Nü Hsiu Chêng Thu Shih Tsê 西王母女修正途十則.
The Ten Rules of the Mother (Goddess) Queen of the West to Guide Women (Taoists) along the Right Road of Restoring (the Primary Vitalities) [physiological alchemy].
Ming or Chhing.
Attrib. Lü Yen 呂岩 (+8th century).
Shen I-Ping *et al.* 沈一炳.
Comm. Min I-Tê 閔一得 (*c.* 1830).
In *Tao Tsang Hsü Pien* (*Chhu chi*), 19.

Hsi-Yang Huo Kung Thu Shuo 西洋火攻圖說.
Illustrated Treatise on European Gunnery.
Ming, before +1625.
Chang Tao 張燾 & Sun Hsüeh-Shih 孫學詩.

Hsi Yo Hua-Shan Chih 西嶽華山誌.
Records of Hua-Shan, the Great Western Mountain.
Sung, *c.* +1170.
Wang Chhu-I 王處一.
TT/304.

Hsi Yo Tou hsien-sêng Hsiu Chen Chih Nan 西嶽竇先生修眞指南.
Teacher Tou's South-Pointer for the Regeneration of the Primary (Vitalities), from the Western Sacred Mountain.
Sung, probably early +13th.
Tou hsien-sêng 竇先生.
In *Hsiu Chen Shih Shu* (*TT*/260), ch. 21, pp. 1*a* to 6*b*.

Hsi Yu Chi 西遊記.
A Pilgrimage to the West [novel].
Ming, *c.* +1570.
Wu Chhêng-Ên 吳承恩.
Tr. Waley (17).

Hsi Yu Chi.
See *Chhang-Chhun Chen Jen Hsi Yu Chi.*

Hsi Yü Chiu Wên 西域舊聞.
Old Traditions of the Western Countries [a conflation, with abbreviations, of the *Hsi Yü Wên Chien Lu* and the *Shêng Wu Chi*, q.v.].
Chhing, +1777 and 1842.
Chhun Yuan Chhi-shih-i Lao-jen 椿園七十一老人 & Wei Yuan 魏源.
Arr. Chêng Kuang-Tsu (1843) 鄭光祖.

Hsi Yü Thu Chi 西域圖記.
Illustrated Record of Western Countries.
Sui, +610.
Phei Chü 裴矩.

Hsi Yü Wên Chien Lu 西域聞見錄.
Things Seen and Heard in the Western Countries.
Chhing, +1777.
Chhun Yuan Chhi-shih-i Lao-jen 椿園七十一老人.
[The 71-year-old Gentleman of the Cedar Garden.]
Bretschneider (2), vol. 1, p. 128.

Hsi Yuan Lu 洗寃錄.
The Washing Away of Wrongs (i.e. False Charges) [treatise on forensic medicine].
Sung, +1247.
Sung Tzhu 宋慈.
Partial tr., H. A. Giles (7).

Hsiang Chhêng 香乘.
Records of Perfumes and Incense [including combustion-clocks].
Ming, betw. +1618 and +1641.
Chou Chia-Chou 周嘉胄.

Hsiang Chien 香箋.
Notes on Perfumes and Incense.
Ming, *c.* +1560.
Thu Lung 屠隆.

Huang Kuo 香國.
The Realm of Incense and Perfumes.
Ming.
Mao Chin, 毛晉.

Hsiang Lu 香錄.
[= *Nan Fan Hsiang Lu.*]
A Catalogue of Incense.
Sung, +1151.
Yeh Thing-Kuei 葉廷珪.

Hsiang Phu 香譜.
A Treatise on Aromatics and Incense [-Clocks].
Sung, *c.* +1073.
Shen Li 沈立.
Now extant only in the form of quotations in later works.

Hsiang Phu 香譜.
A Treatise on Perfumes and Incense.
Sung, *c.* +1115.
Hung Chhu 洪芻.

Hsiang Phu 香譜.
[= *Hsin Tsuan Hsiang Phu* or *Honan Chhen shih Hsiang Phu.*]
A Treatise on Perfumes and Aromatic Substances [including incense and combustion-clocks].
Sung, late +12th or +13th; may be as late as +1330.
Chhen Ching 陳敬.

Hsiang Phu 香譜.
A Treatise on Incense and Perfumes.
Yuan, +1322.
Hsiung Phêng-Lai 熊朋來.

Hsiang Yao Chhao 香藥抄.
Memoir on Aromatic Plants and Incense.
Japan, *c.* +1163.
Kuan-Yu (Kanyu) 觀祐.MS. preserved at the 滋賀石山寺 Temple. Facsim. reprod. in Suppl. to the Japanese Tripiṭaka, vol. 11.

Hsieh Thien Chi 泄天機.
A Divulgation of the Machinery of Nature (in the Human Body, permitting the Formation of the Enchymoma).

Hsieh Thien Chi (cont.)
Chhing, *c.* +1795.
Li Ong (Ni-Wan shih) 李翁 (Mr Ni-Wan).
Written down in 1833 by Min Hsiao-Kên 閔小艮.
In *Tao Tsang Hsü Pien* (*Chhu chi*), 4.

Hsien Lo Chi 仙樂集.
(Collected Poems) on the Happiness of the Holy Immortals.
Sung, late +12th cent.
Liu Chhu-Hsüan 劉處玄.
TT/1127.

Hsien-Yuan Huang Ti Shui Ching Yao Fa 軒轅黃帝水經藥法.
(Thirty-two) Medicinal Methods from the Aqueous (Solutions) Manual of Hsien-Yuan the Yellow Emperor.
Date uncertain.
Writer unknown.
TT/922.

Hsien-Yuan Pao Tsang Chhang Wei Lun 軒轅寶藏暢微論.
The Yellow Emperor's Expansive yet Detailed Discourse on the (Contents of the) Precious Treasury (of the Earth) [mineralogy and metallurgy].
Alternative title of *Pao Tsang Lun*, q.v.

Hsien-Yuan Pao Tsang Lun 軒轅寶藏論.
The Yellow Emperor's Discourse on the Contents of the Precious Treasury (of the Earth).
See *Pao Tsang Lun*.

Hsin Hsiu Pên Tshao 新修本草.
The New (lit. Newly Improved) Pharmacopoeia.
Thang, +659.
Ed. Su Ching (= Su Kung) 蘇敬 (蘇恭) and a commission of 22 collaborators under the direction first of Li Chi 李勣 & Yü Chih-Ning 于志寧, then of Chhangsun Wu-Chi 長孫無忌. This work was afterwards commonly but incorrectly known as *Thang Pên Tshao*. It was lost in China, apart from MS. fragments at Tunhuang, but copied by a Japanese in +731 and preserved in Japan though incompletely.

Hsin Lun 新論.
New Discussions.
H/Han, *c.* +10 to +20, presented +25.
Huan Than 桓譚.
Cf. Pokora (9).

Hsin Lun 新論.
New Discourses.
Liang, *c.* +530.
Liu Hsieh 劉勰.

Hsin Thang Shu 新唐書.
New History of the Thang Dynasty [+618 to +906].
Sung, +1061.
Ouyang Hsiu 歐陽修 & Sung Chhi 宋祁.
Cf. des Rotours (2), p. 56.
Partial trs. des Rotours (1, 2); Pfizmaier (66–74). For translations of passages see the index of Frankel (1).
Yin-Tê Index, no. 16.

Hsin Tsuan Hsiang Phu 新纂香譜.
See *Hsiang Phu* by Chhen Ching.

Hsin Wu Tai Shih 新五代史.
New History of the Five Dynasties [+907 to +959].
Sung, *c.* +1070.
Ouyang Hsiu 歐陽修.
For translations of passages see the index of Frankel (1).

Hsin Yü 新語.
New Discourses.
C/Han, *c.* −196.
Lu Chia 陸賈.
Tr. v. Gabain (1).

Hsing Li Ching I 性理精義.
Essential Ideas of the Hsing-Li (Neo-Confucian) School of Philosophers [a condensation of the *Hsing Li Ta Chhüan*, q.v.].
Chhing, +1715.
Li Kuang-Ti 李光地.

Hsing Li Ta Chhüan (*Shu*) 性理大全 (書).
Collected Works of (120) Philosophers of the Hsing-Li (Neo-Confucian) School [*Hsing* = human nature; *Li* = the principle of organisation in all Nature].
Ming, +1415.
Ed. Hu Kuang *et al.* 胡廣.

Hsing Ming Kuei Chih 性命圭旨.
A Pointer to the Meaning of (Human) Nature and the Life-Span [physiological alchemy; the *kuei* is a pun on the two kinds of *thu*, central earth where the enchymoma is formed].
Ascr. Sung, pr. Ming and Chhing, +1615, repr. +1670.
Attrib. Yin Chen Jen 尹眞人.
Written out by Kao Ti 高第.
Prefs. by Yü Yung-Ning *et al.* 余永寧.

Hsing Shih Hêng Yen 醒世恒言.
Stories to Awaken Men.
Ming, *c.* +1640.
Fêng Mêng-Lung 馮夢龍.

Hsiu Chen Chih Nan 修眞指南.
South-Pointer for the Regeneration of the Primary (Vitalities).
See *Hsi Yo Tou hsien-sêng Hsiu Chen Chih Nan*.

Hsiu Chen Li Yen Chhao Thu 修眞歷驗鈔圖.
[= *Chen Yuan Miao Tao Hsiu Tan Li Yen Chhao*.]
Transmitted Diagrams illustrating Tried and Tested (Methods of) Regenerating the Primary Vitalities [physiological alchemy].
Thang or Sung, before +1019.
No writer named but the version in *YCCC*, ch. 72, has Tung Chen Tzu (ps.) 洞眞子.
TT/149.

Hsiu Chen Nei Lien Pi Miao Chu Chüeh 修眞內煉秘妙諸訣.
Collected Instructions on the Esoteric Mysteries of Regenerating the Primary (Vitalities) by Internal Transmutation.
Sung or pre-Sung.
Writer unknown.
Perhaps identical with *Hsiu Chen Pi Chüeh* (q.v.); now extant only in quotations.

Hsiu Chen Pi Chüeh 脩眞秘訣.
Esoteric Instructions on the Regeneration of the Primary (Vitalities).
Sung or pre-Sung, before +1136.
Writer uncertain.
In *Lei Shuo*, ch. 49, pp. 5*a* ff.

Hsiu Chen Pien Nan (Tshan Chêng) 修眞辯難參證.
[*Chhi Yün Shan Wu Yuan Yzu Hsiu Chen Pien Nan Tshan Chêng.*]
A Discussion of the Difficulties encountered in the Regeneration of the Primary (Vitalities) [physiological alchemy]; with Supporting Evidence.
Chhing, +1798.
Liu I-Ming 劉一明 (Wu Yuan Tzu 悟元子).
Comm., Min I-Tê 閔一得 (*c.* 1830).
In *Tao Tsang Hsü Pien* (*Chhu chi*), 23.

Hsiu Chen Shih Shu 修眞十書.
A Collection of Ten Tractates and Treatises on the Regeneration of the Primary (Vitalities) [in fact, many more than ten].
Sung, *c.* +1250.
Editor unknown.
TT/260.
Cf. Maspero (7), pp. 239, 357.

Hsiu Chen Thai Chi Hun Yuan Thu 修眞太極混元圖.
Illustrated Treatise on the (Analogy of the) Regeneration of the Primary (Vitalities) (with the Cosmogony of) the Supreme Pole and Primitive Chaos.
Sung, *c.* +1100.
Hsiao Tao-Tshun 蕭道存.
TT/146.

Hsiu Chen Thai Chi Hun Yuan Chih Hsüan Thu 修眞太極混元指玄圖.
Illustrated Treatise Expounding the Mystery of the (Analogy of the) Regeneration of the Primary (Vitalities) (with the Cosmogony of) the Supreme Pole and Primitive Chaos.
Thang, *c.* +830.
Chin Chhüan Tzu 金全子.
TT/147.

Hsiu Chen Yen I 修眞演義.
A Popular Exposition of (the Methods of) Regenerating the Primary (Vitalities) [Taoist sexual techniques].
Ming, *c.* +1560.
Têng Hsi-Hsien 鄧希賢 (Tzu Chin Kuang Yao Ta Hsien 紫金光耀大仙.
See van Gulik (3, 8).

Hsiu Hsien Pien Huo Lun 修仙辨惑論.
Resolution of Doubts concerning the Restoration to Immortality.
Sung, *c.* +1220.
Ko Chhang-Kêng 葛長庚 (Pai Yü-Chhan 白玉蟾).
In *TSCC*, *Shen i tien*, ch. 300, *i wên*, pp. 11*a* ff.

Hsiu Lien Ta Tan Yao Chih 修鍊大丹要旨.
Essential Instructions for the Preparation of the Great Elixir [with illustrations of alchemical apparatus].
Probably Sung or later.
Writer unknown.
TT/905.

Hsiu Tan Miao Yung Chih Li Lun 修丹妙用至理論.
A Discussion of the Marvellous Functions and Perfect Principles of the Practice of the Enchymoma.
Late Sung or later.
Writer unknown.
TT/231.
Refers to the Sung adept Hai-Chhan hsien-sêng 海蟾先生 (Liu Tshao 劉操).

Hsü Chen-Chün Pa-shih-wu Hua Lu 許眞君八十五化錄.
Record of the Transfiguration of the Adept Hsü (Hsün) at the Age of Eighty-five.
Chin, +4th cent.
Shih Tshên 施岑.
TT/445.

Hsü Chen-Chün Shih Han Chi 許眞君石函記.
The Adept Hsü (Sun's) Treatise, found in a Stone Coffer.
Ascr. Chin, +4th cent., perhaps *c.* +370.
Attrib. Hsü Hsün 許遜.
TT/944.
Cf. Davis & Chao Yün-Tshung (6).

Hsü Hsien Chuan 續仙傳.
Further Biographies of the Immortals.
Wu Tai (H/Chou), between +923 and +936.
Shen Fên 沈汾.
In *YCCC*, ch. 113.

Hsü Ku Chai Chi Suan Fa 續古摘奇算法.
Choice Mathematical Remains Collected to Preserve the Achievements of Old [magic squares and other computational examples].
Sung, +1275.
Yang Hui 楊輝.
(In *Yang Hui Suan Fa.*)

Hsü Kuang-Chhi Shou Chi 徐光啓手跡.
Manuscript Remains of Hsü Kuang-Chhi [facsimile reproductions].
Shanghai, 1962.

Hsü Ming Fang 續命方.
Precepts for Lengthening the Life-span.
Alternative title of *Hui Ming Ching* (q.v.).

Hsü Po Wu Chih 續博物志.
Supplement to the *Record of the Investigation of Things* (cf. *Po Wu Chih*).
Sung, mid +12th century.
Li Shih 李石.

Hsü Shen Hsien Chuan 續神仙傳.
Supplementary Lives of the Hsien (cf. *Shen Hsien Chuan*).
Thang.
Shen Fên 沈汾.

Hsü Shih Shih 續事始.
Supplement to the *Beginnings of All Affairs* (cf. *Shih Shih*).
H/Shu, *c.* +960.
Ma Chien 馬鑑.

Hsü Yen-Chou Shih Hua 許彥周詩話.
Hsü Yen-Chou's Talks on Poetry.
Sung, early +12th, prob. *c.* +1111.
Hsü Yen-Chou 許彥周.

Hsüan Chieh Lu 懸解錄.
See *Hsüan Chieh Lu* 玄解錄.

Hsüan Chieh Lu 玄解錄.
The Mysterious Antidotarium [warnings against elixir poisoning, and remedies for it].
Thang, anonymous preface of +855, prob. first pr. between +847 and +850.
Writer unknown, perhaps Hokan Chi 紀干泉.
The first printed book in any civilisation on a scientific subject.
TT/921, and in *YCCC*, ch. 64, pp. 5*a* ff.

Hsüan Fêng Chhing Hui Lu 玄風慶會錄.
Record of the Auspicious Meeting of the Mysterious Winds [answers given by Chhiu Chhu-Chi (Chhang-Chhun Chen Jen) to Chingiz Khan at their interviews at Samarqand in +1222].
Sung, +1225.
Chhiu Chhu-Chi 邱處機.
TT/173.

Hsüan-Ho Po Ku Thu Lu 宣和博古圖錄.
[= *Po Ku Thu Lu.*]
Hsüan-Ho reign-period Illustrated Record of Ancient Objects [catalogue of the archaeological museum of the emperor Hui Tsung].
Sung, +1111 to +1125.
Wang Fu 王黼 or 甫 *et al.*

Hsüan Kuai Hsü Lu 玄怪續錄.
The *Record of Things Dark and Strange*, continued.
Thang.
Li Fu-Yen 李復言.

Hsüan Mên Mo Chüeh Nei Chao Thu 玄門脈訣內照圖.
[= *Hua Tho Nei Chao Thu.*]
Illustrations of Visceral Anatomy, for the Taoist *Sphygmological Instructions*.
Sung, +1095, repr. +1273 by Sun Huan 孫煥 with the inclusion of Yang Chieh's illustrations.
Attrib. Hua Tho 華佗.
First pub. Shen Chu 沈鉥.
Cf. Ma Chi-Hsing (*2*).

Hsüan Ming Fên Chuan 玄明粉傳.
On the 'Mysterious Bright Powder' (purified sodium sulphate, Glauber's salt).
Thang, *c.* +730.
Liu Hsüan-Chen 劉玄眞.

Hsüan Nü Ching 玄女經.
Canon of the Mysterious Girl [or, the Dark Girl].
Han.
Writer unknown.
Only as fragment in *Shuang Mei Ching An Tshung Shu*, now conflated with *Su Nü Ching*, q.v.
Partial trs., van Gulik (3, 8).

Hsüan Phin Lu 玄品錄.
Record of the (Different) Grades of Immortals.
Yuan.
Chang Thien-Yü 張天雨.
TT/773.
Cf. Chhen Kuo-Fu (*1*), 1st ed., p. 260.

Hsüan Shih Chih 宣室志.
Records of Hsüan Shih.
Thang, *c.* +860.
Chang Tu 張讀.

Hsüan Shuang Chang Shang Lu 玄霜掌上錄.
Mysterious Frost on the Palm of the Hand; or, Handy Record of the Mysterious Frost [preparation of lead acetate].
Date unknown.
Writer unknown.
TT/ 938.

I Chen Thang Ching Yen Fang 頤眞堂經驗方.
Tried and Tested Prescriptions of the True-Centenarian Hall (a surgery or pharmacy).
Ming, prob. +15th, *c.* +1450.
Yang shih 楊氏.

I Chi Khao 醫籍考.
Comprehensive Annotated Bibliography of Chinese Medical Literature.
See Taki Mototane (*1*).

I Chai Ta Fa 醫家大法.
See *I Yin Thang I Chung Ching Kuang Wei Ta Fa.*

I Chien Chih 夷堅志.
Strange Stories fom I-Chien.
Sung, *c.* +1185.
Hung Mai 洪邁.

I Chin Ching 易筋經.
Manual of Exercising the Muscles and Tendons [Buddhist].
Ascr. N/Wei.
Chhing, perhaps +17th.
Attrib. Ta-Mo (Bodhidharma) 達磨
Author unknown.
Reproduced in Wang Tsu-Yuan (*1*).

I Ching 易經.
The Classic of Changes [Book of Changes].
Chou with C/Han additions.
Compilers unknown.
See Li Ching-Chih (*1*, *2*); Wu Shih-Chhang (1).
Tr. R. Wilhelm (2); Legge (9); de Harlez (1).
Yin-Tê Index, no. (suppl.) 10.

I Hsin Fang (*Ishinhō*) 醫心方.
The Heart of Medicine [partly a collection of ancient Chinese and Japanese books].
Japan, +982 (not printed till 1854).
Tamba no Yasuyori 丹波康頼.

I Hsüeh Ju Mên 醫學入門.
Janua Medicinae [a general system of medicine].
Ming, +1575.
Li Chhan 李梴.

I Hsüeh Yuan Liu Lun 醫學源流論.
On the Origins and Progress of Medical Science.
Chhing, +1757.
Hsü Ta-Chhun 徐大椿.
(In *Hsü Ling-Thai I Shu Chhüan Chi*.)

Mên Pi Chih 醫門秘旨.
Confidential Guide to Medicine.
Ming, +1578.
Chang Ssu-Wei 張四維.

I Shan Tsa Tsuan 義山雜纂.
Collected Miscellany of (Li) I-Shan [Li Shang-Yin, epigrams].
Thang, *c.* +850.
Li Shang-Yin 李商隱.
Tr. Bonmarchand (1).

I Shih 逸史.
Leisurely Histories.
Thang.
Lu Shih 盧氏.

I Su Chi 夷俗記.
Records of Barbarian Customs.
Alternative title of *Pei Lu Fêng Su*, q.v.

I Thu Ming Pien 易圖明辨.
Clarification of the Diagrams in the (*Book of*) *Changes* [historical analysis].
Chhing, +1706.
Hu Wei 胡渭.

I Wei Chhien Tso Tu 易緯乾鑿度.
Apocryphal Treatise on the (*Book of*) *Changes*; a Penetration of the Regularities of Chhien (the first *kua*).
C/Han, −1st or +1st century.
Writer unknown.

I Wei Ho Thu Shu 易緯河圖數.
Apocryphal Treatise on the (*Book of*) *Changes*; the Numbers of the Ho Thu (Diagram).
H/Han.
Writer unknown.

I Yin Thang I Chung Ching Kuang Wei Ta Fa 伊尹湯液仲景廣爲大法.
[= *I Chia Ta Fa* or *Kuang Wei Ta Fa*.]
The Great Tradition (of Internal Medicine) going back to I Yin (legendary minister) and his Pharmacal Potions, and to (Chang) Chung-Ching (famous Han physician).
Yuan, +1294.
Wang Hao-Ku 王好古.
ICK, p. 863.

Ishinhō
See *I Hsin Fang*.

Jih Chih Lu 日知錄.
Daily Additions to Knowledge.
Chhing, +1673.
Ku Yen-Wu 顧炎武.

Jih Hua Chu Chia Pên Tshao 日華諸家本草.
The Sun-Rays Master's Pharmaceutical Natural History, collected from Many Authorities.
Wu Tai and Sung, *c.* +972.
Often ascribed by later writers to the Thang, but the correct dating was recognised by Thao Tsung-I in his *Cho Kêng Lu* (+1366) ch. 24, p. 17*b*.
Ta Ming 大明.
(Jih Hua Tzu 日華子 the Sun-Rays Master.)
(Perhaps Thien Ta-Ming 田大明).

Jih Yüeh Hsüan Shu Lun 日月玄樞論.
Discourse on the Mysterious Axis of the Sun and Moon [i.e. Yang and Yin in natural phenomena; the earliest interpretation (or recognition) of the *Chou I Tshan Thung Chhi* (q.v.) as a physiological rather than (or, as well as) a proto-chemical text].
Thang, *c.* +740.
Liu Chih-Ku 劉知古.
Now extant only as quotations in the *Tao Shu* (q.v.), though at one time contained in the *Tao Tsang* separately.

Ju Yao Ching 入藥鏡.
Mirror of the All-Penetrating Medicine (the enchymoma), [rhyming verses].
Wu Tai, *c.* +940.
Tshui Hsi-Fan 崔希範.
TT/132, and in *TTCY* (*hsü chi*, 5).
With commentaries by Wang Tao-Yuan 王道淵 (Yuan); Li Phan-Lung 李攀龍 (Ming) & Phêng Hao-Ku 彭好古 (Ming).
Also in *Hsiu Chen Shih Shu* (*TT*/260), ch. 13, pp. 1*a* ff. with commentary by Hsiao Thing-Chih 蕭廷芝 (Ming).
Also in *Tao Hai Chin Liang*, pp. 35*a* ff., with comm. by Fu Chin-Chhüan 傅金銓 (Chhing).
See also *Thien Yuan Ju Yao Ching*.
Cf. van Gulik (8), pp. 224 ff.

Kan Chhi Shih-liu Chuan Chin Tan 感氣十六轉金丹.
The Sixteen-fold Cyclically Transformed Gold Elixir prepared by the 'Responding

Kan Chhi Shih-liu Chuan Chin Tan (cont.)
to the Chhi' Method [with illustrations of alchemical apparatus].
Sung.
Writer unknown.
TT/904.

Kan Ying Ching 感應經.
On Stimulus and Response (the Resonance of Phenomena in Nature).
Thang, *c.* +640.
Li-Shun-Fêng 李淳風.
See Ho & Needham (2).

Kan Ying Lei Tshung Chih 感應類從志.
Record of the Mutual Resonances of Things according to their Categories.
Chin, *c.* +295.
Chang Hua 張華.
See Ho & Needham (2).

Kao Shih Chuan 高士傳.
Lives of Men of Lofty Attainments.
Chin, *c.* +275.
Huangfu Mi 皇甫謐.

Kêng Hsin Yü Tshê 庚辛玉册.
Precious Secrets of the Realm of Kêng and Hsin (i.e. all things connected with metals and minerals, symbolised by these two cyclical characters) [on alchemy and pharmaceutics. Kêng-Hsin is also an alchemical synonym for gold].
Ming, +1421.
Chu Chhüan 朱權, (Ning Hsien Wang 寧獻王, prince of the Ming).
Extant only in quotations.

Kêng Tao Chi 庚道集.
Collection of Procedures of the Golden Art (Alchemy).
Sung or Yuan, date unknown but after +1144
Writers unknown.
Compiler, Mêng Hsien chü shih 蒙軒居士.
TT/946.

Khai-Pao Hsin Hsiang-Ting Pên Tshao 開寶新詳定本草.
New and More Detailed Pharmacopoeia of the Khai-Pao reign-period.
Sung, +973.
Liu Han 劉翰, Ma Chih 馬志, and 7 other naturalists, under the direction of Lu To-Hsün 盧多遜.

Khai-Pao Pên Tshao 開寶本草.
See *Khai-Pao Hsin Hsiang-Ting Pên Tshao*.

Khun Yü Ko Chih 坤輿格致.
Investigation of the Earth [Western mining methods based on Agricola's *De Re Metallica*].
Ming, +1639 to 1640, perhaps never printed.
Têng Yü-Han (Johann Schreck) 鄧玉函 & (or) Thang Jo-Wang 湯若望 (John Adam Schall von Bell).

Khung Chi Ko Chih 空際格致.
A Treatise on the Material Composition of the Universe [the Aristotelian Four Elements, etc.].
Ming, +1633.
Kao I-Chih (Alfonso Vagnoni) 高一志.
Bernard-Maître (18), no. 227.

Khung shih Tsa Shuo 孔氏雜說.
Mr Khung's Miscellany.
Sung, *c.* +1082.
Khung Phing-Chung 孔平仲.

Ko Chih Ching Yuan 格致鏡原.
Mirror of Scientific and Technological Origins.
Chhing, +1735.
Chhen Yuan-Lung 陳元龍.

Ko Chih Tshao 格致草.
Scientific Sketches [astronomy and cosmology; part of *Han Yü Thung*, q.v.].
Ming, +1620, pr. +1648.
Hsiung Ming-Yü 熊明遇.

Ko Hsien Ong Chou Hou Pei Chi Fang 葛仙翁肘後備急方.
The Elder-Immortal Ko (Hung's) Handbook of Medicines for Emergencies.
Alt. title of *Chou Hou Pei Chi Fang* (q.v.).
TT/1287.

Ko Hung Chen Chung Shu 葛洪枕中書.
Alt. title of *Chen Chung Chi* (q.v.).

Ko Ku Yao Lun 格古要論.
Handbook of Archaeology, Art and Antiquarianisn.
Ming, +1387, enlarged and reissued +1459.
Tshao Chao 曹昭.

Ko Wu Tshu Than 格物麤談.
Simple Discourses on the Investigation of Things.
Sung, *c.* +980.
Attrib. wrongly to Su Tung-Pho 蘇東坡.
Actual writer (Lu) Tsan-Ning (陸)贊寧 (Tung-Pho hsien-sêng). With later additions, some concerning Su Tung-Pho.

Konjaku Monogatari 今昔物語.
Tales of Today and Long Ago (in three collections: Indian, 187 stories and traditions, Chinese, 180, and Japanese, 736).
Japan (Heian), +1107.
Compilers unknown.
Cf. Anon. (103), pp. 97 ff.

Konjaku Monogatarishū 今昔物語集.
See *Konjaku Monogatari*.

Ku Chin I Thung (Ta Chhüan) 古今醫統(大全).
Complete System of Medical Practice, New and Old.
Ming, +1556.
Hsü Chhun-Fu 徐春甫.

Ku Thung Thu Lu 鼓銅圖錄.
Illustrated Account of the (Mining), Smelting and Refining of Copper (and other Non-Ferrous Metals).
See Masuda Tsuna (*1*).

Ku Wei Shu 古微書.
Old Mysterious Books [a collection of the apocryphal Chhan-Wei treatises].
Date uncertain, in part C/Han.
Ed. Sun Chio 孫瑴 (Ming).

Ku Wên Lung Hu Ching Chu Su 古文龍虎經註疏 and *Ku Wên Lung Hu Shang Ching Chu* 古文龍虎上經註.
See *Lung Hu Shang Ching Chu.*

Ku Wên Tshan Thung Chhi Chi Chieh 古文參同契集解.
See *Ku Wên Chou I Tshan Thung Chhi Chu.*

Ku Wên Tshan Thung Chhi Chien Chu Chi Chieh 古文參同契箋註集解.
See *Ku Wên Chou I Tshan Thung Chhi Chu*

Ku Wên Chou I Tshan Thung Chhi Chu 古文周易參同契註.
Commentary on the Ancient Script Version of the *Kinship of the Three.*
Chhing, +1732.
Ed. and comm. Yuan Jen-Lin 袁仁林.
See Vol. 5, pt. 3.

Ku Wên Tshan Thung Chhi San Hsiang Lei Chi Chieh 古文參同契三相類集解.
See *Ku Wên Chou I Tshan Thung Chhi Chu.*

Kuan Khuei Pien 管窺編.
An Optick Glass (for the Enchymoma).
See Min I-Tê (1).

Kuan Yin Tzu 關尹子.
[= *Wên Shih Chen Ching.*]
The Book of Master Kuan Yin.
Thang, +742 (may be Later Thang or Wu Tai). A work with this title existed in the Han, but the text is lost.
Prob. Thien Thung-Hsiu 田同秀.

Kuang Chhêng Chi 廣成集.
The Kuang-chhêng Collection [Taoist writings of every kind; a florilegium].
Thang, late +9th; or early Wu Tai, before +933.
Tu Kuang-Thing 杜光庭.
TT/611.

Kuang Wei Ta Fa 廣爲大法.
See *I Yin Thang I Chung Ching Kuang Wei Ta Fa.*

Kuang Ya 廣雅.
Enlargement of the *Erh Ya*; *Literary Expositor* [dictionary].
San Kuo (Wei) +230.
Chang I 張揖.

Kuang Yün 廣韻.
Enlargement of the *Chhieh Yün*; *Dictionary of the Sounds of Characters.*
Sung.
(A completion by later Thang and Sung scholars, given its present name in +1011.)
Lu Fa-Yen *et al.* 陸法言.

Kuei Chung Chih Nan 規中指南.
A Compass for the Internal Compasses; or, Orientations concerning the Rules and Measures of the Inner (World) [i.e. the preparation of the enchymoma in the microcosm of man's body].
Sung or Yuan, +13th or +14th.
Chhen Chhung-Su 陳沖素 (Hsü Pai Tzu 盧白子).
TT/240, and in *TTCY* (*shang mao chi*, 5).

Kungyang Chuan 公羊傳.
Master Kungyang's Tradition (or Commentary) on the *Spring and Autumn Annals.*
Chou (with Chhin and Han additions), late −3rd and early −2nd centuries.
Attrib. Kungyang Kao 公羊高 but more probably Kungyang Shou 公羊壽.
See Wu Khang (1); van der Loon (1).

Kuo Shih Pu 國史補.
Emendations to the National Histories.
Thang, *c.* +820.
Li Chao 李肇.

Kuo Yü 國語.
Discourses of the (ancient feudal) States.
Late Chou, Chhin and C/Han, containing much material from ancient written records.
Writers unknown.

Lao Hsüeh An Pi Chi 老學庵筆記.
Notes from the Hall of Learned Old Age.
Sung, *c.* +1190.
Lu Yu 陸游.

Lao Tzu Chung Ching 老子中經.
The Median Canon of Lao Tzu [on physiological micro-cosmography].
Writer unknown.
Pre-Thang.
In *YCCC*, ch. 18.

Lao Tzu Shuo Wu Chhu Ching 老子說五厨經.
Canon of the Five Kitchens [the five viscera] Revealed by Lao Tzu [respiratory techniques].
Thang or pre-Thang.
Writer unknown.
In *YCCC*, ch. 61, pp. 5*b* ff.

Lei Chen Chin Tan 雷震金丹.
Lei Chen's Book of the Metallous Encyhmoma.
Ming, after +1420.
Lei Chen (ps. ?) 雷震.
In *Wai Chin Tan*, ch. 5 (*CTPS*, *pên* 10).

Lei Chen Tan Ching 雷震丹經.
Alternative title of *Lei Chen Chin Tan* (q.v.).

Lei Chêng Phu Chi Pên Shih Fang 類證普濟本事方.
Classified Fundamental Prescriptions of Universal Benefit.
Sung, +1253.
Attrib. Hsü Shu-Wei 許叔微 (*fl.* +1132)

Lei Ching Fu I 類經附翼.
Supplement to the Classics Classified; (the Institutes of Medicine).
Ming, +1624.
Chang Chieh-Pin 張介賓.

Lei Kung Phao Chih 雷公炮製.
(Handbook based on the)*Venerable Master Lei's* (*Treatise on*) *the Preparation* (*of Drugs*).
L/Sung, *c.* +470.

Lei Kung Phao Chi (*cont.*)
Lei Hsiao 雷敩.
Ed. Chang Kuang-Tou 張光斗 (Chhing), 1871.

Lei Kung Phao Chih Lun 雷公炮炙論.
The Venerable Master Lei's Treatise on the Decoction and Preparation (of Drugs).
L/Sung, *c.* +470.
Lei Hsiao 雷敩.
Preserved only in quotations in *Chêng Lei Pên Tshao* and elsewhere, and reconstituted by Chang Chi 張鼒.
LPC, p. 116.

Lei Kung Phao Chih Yao Hsing (*Fu*) *Chieh* 雷公炮製藥性(賦)解.
(Essays and) Studies on the *Venerable Master Lei's* (*Treatise on*) *the Natures of Drugs and their Preparation.*
First four chapters J/Chin, *c.* +1220.
Li Kao 李杲.
Last six chapters Chhing, *c.* 1650.
Li Chung-Tzu 李中梓.
(Contains many quotations from earlier Lei Kung books, +5th century onwards.)

Lei Kung Yao Tui 雷公藥對.
Answers of the Venerable Master Lei (to Questions) concerning Drugs.
Perhaps L/Sung, at any rate before N/Chhi.
Attrib. Lei Hsiao 雷敩.
Later attrib. a legendary minister of Huang Ti.
Comm. by Hsü Chih-Tshai 徐之才, N/Chhi +565.
Now extant only in quotations.

Lei Shuo 類說.
A Classified Commonplace-Book [a great florilegium of excerpts from Sung and pre-Sung books, many of which are otherwise lost].
Sung, +1136.
Ed. Tsêng Tshao 曾慥.

Li Chi 禮記.
[= *Hsiao Tai Li Chi*.]
Record of Rites [compiled by Tai the Younger].
(Cf. *Ta Tai Li Chi*.)
Ascr. C/Han, *c.* −70/−50, but really H/Han, between +80 and +105, though the earliest pieces included may date from the time of the *Analects* (*c.* −465 to −450).
Attrib. ed. Tai Shêng 戴聖.
Actual ed. Tshao Pao 曹褒.
Trs. Legge (7); Couvreur (3); R. Wilhelm (6).
Yin-Tê Index, no. 27.

Li Hai Chi 蠡海集.
The Beetle and the Sea [title taken from the proverb that the beetle's eye view cannot encompass the wide sea—a biological book].
Ming, late +14th century.
Wang Khuei 王逵.

Li Sao 離騷.
Elegy on Encountering Sorrow [ode].
Chou (Chhu), *c.* −295, perhaps just before −300. Some scholars place it as late as −269.
Chhü Yuan 屈原.
Tr. Hawkes (1).

Li Shih Chen Hsien Thi Tao Thung Chien 歷世眞仙體道通鑑.
Comprehensive Mirror of the Embodiment of the Tao by Adepts and Immortals throughout History.
Prob. Yuan.
Chao Tao-I 趙道一.
TT/293.

Li Tai Ming I Mêng Chhiu 歷代名醫蒙求.
Brief Lives of the Famous Physicians in All Ages.
Sung, +1040.
Chou Shou-Chung 周守忠.

(*Li Tai*) *Shen Hsien* (*Thung*) *Chien* (歷代)神仙(通)鑑.
(Cf. *Shen Hsien Thung Chien*.)
General Survey of the Lives of the Holy Immortals (in all Ages).
Chhing, +1712.
Hsü Tao 徐道 (assisted by Li Li 李理) & Chhêng Yü-Chhi 程毓奇 (assisted by Wang Thai-Su 王太素).

Li Wei Tou Wei I 禮緯斗威儀.
Apocryphal Treatise on the *Record of Rites*; System of the Majesty of the Ladle [the Great Bear].
C/Han, −1st or later.
Writer unknown.

Li Wên-Jao Chi 李文饒集.
Collected Literary Works of Li Tê-Yü (Wên-Jao), (+787 to +849).
Thang, *c.* +855.
Li Tê-Yü 李德裕.

Liang Chhiu Tzu (*Nei* or *Wai*) 梁丘子.
See *Huang Thing Nei Ching* (*Yü*) *Ching Chu* and *Huang Thing Wai Ching* (*Yü*) *Ching Chu*.

Liang Ssu Kung Chi 梁四公記.
Tales of the Four Lords of Liang.
Thang, *c.* +695.
Chang Yüeh 張說.

Liao Yang Tien Wên Ta Pien 遼陽殿問答編.
[= *Yin Chen Jen Liao Yang Tien Wên Ta Pien*.]
Questions and Answers in the (Eastern Cloister of the) Liao-yang Hall (of the White Clouds Temple at Chhing-chhêng Shan in Szechuan) [on physiological alchemy, *nei tan*].
Ming or Chhing.
Attrib. Yin Chen Jen 尹眞人 (Phêng-Thou 蓬頭).
Ed. Min I-Tê 閔一得, *c.* 1830.
In *Tao Tsang Hsü Pien* (*Chhu chi*), 3, from a MS. preserved at the Blue Goat Temple 青羊宮 (Chhêngtu).

Lieh Hsien Chhüan Chuan 列仙全傳.
Complete Collection of the Biographies of the Immortals.
Ming, *c.* +1580.
Wang Shih-Chên 王世貞.
Collated and corrected by Wang Yün-Phêng 汪雲鵬.

Lieh Hsien Chuan 列仙傳.
Lives of Famous Immortals (cf. *Shen Hsien Chuan*).
Chin, +3rd or +4th century, though certain parts date from about −35 and shortly after +167.
Attrib. Liu Hsiang 劉向.
Tr. Kaltenmark (2).

Lin Chiang Hsien 臨江仙.
The Immortal of Lin-chiang.
Sung, +1151.
Tsêng Tshao 曾慥.
In *Hsiu Chen Shih Shu* (*TT*/260), ch. 23, pp. 1*a* ff.

Ling-Pao Chiu Yu Chhang Yeh Chhi Shih Tu Wang Hsüan Chang 靈寶九幽長夜起尸度亡玄章.
Mysterious Cantrap for the Resurrection of the Body and Salvation from Nothingness during the Long Night in the Nine Underworlds; a Ling-Pao Scripture.
Date uncertain.
Writer unknown.
TT/605.

Ling-Pao Chung Chen Tan Chüeh 靈寶衆眞丹訣.
Supplementary Elixir Instructions of the Company of the Realised Immortals, a Ling-Pao Scripture.
Sung, after +1101.
Writer unknown.
TT/416.
On the term Ling-Pao see Kaltenmark (4).

Ling-Pao Wu Fu (Hsü) 靈寶五符(序).
See *Thai-Shang Ling-Pao Wu Fu (Ching)*.

Ling-Pao Wu Liang Tu Jen Shang Phin Miao Ching 靈寶無量度人上品妙經.
Wonderful Immeasurable Highly Exalted Manual of Salvation; a Ling-Pao Scripture.
Liu Chhao, perhaps late +5th, probably finalised in Thang, +7th.
Writers unknown.
TT/1.

Ling Pi Tan Yao Chien 靈祕丹藥牋.
On Numinous and Secret Elixirs and Medicines [the seventh part (chs. 16–18) of *Tsun Shêng Pa Chien*, q.v.).
Ming, +1591.
Kao Lien 高濂.

Ling Piao Lu I 嶺表錄異.
Strange Things Noted in the South.
Thang, *c.* +890.
Liu Hsün 劉恂.

Ling Sha Ta Tan Pi Chüeh 靈砂大丹祕訣.
Secret Doctrine of the Numinous Cinnabar and the Great Elixir.
Sung, after +1101, when the text was received by Chang Shih-Chung 張侍中.
Writer unknown, but edited by a Chhan abbot Kuei-Yen Chhan-shih 鬼眼禪師.
TT/890.

Ling Shu Ching
See *Huang Ti Nei Ching, Ling Shu*.

Ling Wai Tai Ta 嶺外代答.
Information on What is Beyond the Passes (lit. a book in lieu of individual replies to questions from friends).
Sung, +1178.
Chou Chhü-Fei 周去非.

Liu Shu Ching Yün 六書精蘊.
Collected Essentials of the Six Scripts.
Ming, *c.* +1530.
Wei Hsiao 魏校.

Liu Tzu Hsin Lun 劉子新論.
See *Hsin Lun*.

Lo-Fou Shan Chih 羅浮山志.
History and Topography of the Lo-fou Mountains (north of Canton).
Chhing, +1716 (but based on older histories).
Thao Ching-I 陶敬益.

Lu Hsing Ching 顱囟經.
A Tractate on the Fontanelles of the Skull [anatomical-medical].
Late Thang or early Sung, +9th or +10th.
Writer unknown.

Lu Huo Chien Chieh Lu 爐火鑒戒錄.
Warnings against Inadvisable Practices in the Work of the Stove [alchemical].
Sung, *c.* +1285.
Yü Yen 俞琰.

Lu Huo Pên Tshao 爐火本草.
Spagyrical Natural History.
Possible alternative title of *Wai Tan Pên Tshao* (q.v.).

Lü Tsu Chhin Yuan Chhun 呂祖沁園春.
The (Taoist) Patriarch Lü (Yen's) 'Spring in the Prince's Gardens' [a brief epigrammatic text on physiological alchemy]
Thang, +8th (if genuine).
Attrib. Lü Yen 呂岩.
TT/133.
Comm. by Fu Chin-Chhüan 傅金銓 (*c.* 1822).
In *Tao Hai Chin Liang*, p. 45*a*, and appended to *Shih Chin Shih* (*Wu Chen Ssu Chu Phien* ed.).

Lü Tsu Chhuan Shou Tsung Chih 呂祖傳授宗旨.
Principles (of Macrobiotics) Transmitted and Handed Down by the (Taoist) Patriarch Lü (Yen, Tung-Pin).
Orig. title of *Chin Hua Tsung Chih* (q.v.).

Lü Tsu Shih Hsien-Thien Hsü Wu Thai-I Chin Hua Tsung Chih 呂祖師先天虛無太一金華宗旨.
Principles of the (Inner) Radiance of the Metallous (Enchymoma) (explained in terms of the) Undifferentiated Universe, and of all the All-Embracing Potentiality of the Endowment of Primary Vitality, taught by the (Taoist) Patriarch Lü (Yen, Tung-Pin).
Alternative name for *Chin Hua Tsung Chih* (q.v.), but with considerable textual divergences, especially in ch. 1.
Ming and Chhing.
Writers unknown.
Attrib. Lü Yen 呂岩 (Lü Tung-Pin) and his school, late +8th.
Ed. and comm. Chiang Yuan-Thing 蔣元庭 and Min I-Tê 閔一得, *c.* 1830.
In *TTCY* and in *Tao Tsang Hsü Pien* (*Chhu chi*), 1.

Lü Tsu Shih San Ni I Shih Shuo Shu 呂祖師三尼醫世說述.
A Record of the Lecture by the (Taoist) Patriarch Lü (Yen, Tung-Pin) on the Healing of Humanity by the Three Ni Doctrines (Taoism, Confucianism and Buddhism) [physiological alchemy in mutationist terms].
Chhing, +1664.
Attrib. Lü Yen 呂岩 (+8th cent.).
Pref. by Thao Thai-Ting 陶太定.
Followed by an appendix by Min I-Tê 閔一得.
In *Tao Tsang Hsü Pien* (*Chhu chi*), 10, 11.

Lun Hêng 論衡.
Discourses Weighed in the Balance.
H/Han, +82 or +83.
Wang Chhung 王充.
Tr. Forke (4); cf. Leslie (3).
Chung-Fa Index, no. 1.

Lung Hu Chhien Hung Shuo 龍虎鉛汞說.
A Discourse on the Dragon and Tiger, (Physiological) Lead and Mercury, (addressed to his younger brother Su Tzu-Yu).
Sung, *c.* +1100.
Su Tung-Pho 蘇東坡.
In *TSCC*, *Shen i tien*, ch. 300, *i wên*, pp. 6*b* ff.

Lung Hu Huan Tan Chüeh 龍虎還丹訣.
Explanation of the Dragon-and-Tiger Cyclically Transformed Elixir.
Wu Tai, Sung, or later.
Chin Ling Tzu 金陵子.
TT/902.

Lung Hu Huan Tan Chüeh Sung 龍虎還丹訣頌.
A Eulogy of the Instructions for (preparing) the Regenerative Enchymoma of the Dragon and the Tiger (Yang and Yin), [physiological alchemy].
Sung, *c.* +985.
Lin Ta-Ku 林大古 (Ku Shen Tzu 谷神子).
TT/1068.

Lung Hu Shang Ching Chu 龍虎上經註.
Commentary on the *Exalted Dragon-and-Tiger Manual*.
Sung.
Wang Tao 王道.
TT/988, 989.
Cf. Davis & Chao Yün-Tshung (6).

Lung Hu Ta Tan Shih 龍虎大丹詩.
Song of the Great Dragon-and-Tiger Enchymoma.
See *Chih Chen Tzu Lung Hu Ta Tan Shih*.

Lung-Shu Phu-Sa Chuan 龍樹菩薩傳.
Biography of the Bodhisattva Nāgārjuna (+2nd-century Buddhist patriarch).
Prob. Sui or Thang.
Writer unknown.
TW/2047.

Man-Anpō 萬安方.
A Myriad Healing Prescriptions.
Japan, +1315.
Kajiwara Shozen 梶原性全.

Manyōshū 萬葉集.
Anthology of a Myriad Leaves.
Japan (Nara), +759.
Ed. Tachibana no Moroe 橘諸兄. or Ōtomo no Yakamochi 大伴家持.
Cf. Anon. (103), pp. 14 ff.

Mao Shan Hsien Chê Fu Na Chhi Chüeh 茅山賢者服內氣訣.
Oral Instructions of the Adepts of Mao Shan for Absorbing the Chhi [Taoist breathing exercises for longevity and immortality].
Thang or Sung.
Writer unknown.
In *YCCC*, ch. 58, pp. 3*b* ff.
Cf. Maspero (7), p. 205.

Mao Thing Kho Hua 茅亭客話.
Discourses with Guests in the Thatched Pavilion.
Sung, before +1136.
Huang Hsiu-Fu 黃休復.

Mei-Chhi Shih Chu 梅溪詩注.
(Wang) Mei-Chhi's Commentaries on Poetry.
Short title for *Tung-Pho Shih Chi Chu* (q.v.).

Mêng Chhi Pi Than 夢溪筆談.
Dream Pool Essays.
Sung, +1086; last supplement dated +1091.
Shen Kua 沈括.
Ed. Hu Tao-Ching (1); cf. Holzman (1).

Miao Chieh Lu 妙解錄.
See *Yen Mên Kung Miao Chieh Lu*.

Miao Fa Lien Hua Ching 妙法蓮花經.
Sūtra on the Lotus of the Wonderful Law

Miao Fa Lien Hua Ching (*cont.*)
India.
Tr. Chin, betw. +397 and +400 by Kumārajīva (Chiu-Mo-Lo-Shih 鳩摩羅什).
N/134; TW/262.

Ming I Pieh Lu 名醫別錄.
Informal (or Additional) Records of Famous Physicians (on Materia Medica).
Ascr. Liang, *c.* +510.
Attrib. Thao Hung-Ching 陶弘景.
Now extant only in quotations in the pharmaceutical natural histories, and a reconstitution by Huang Yü (*1*).
This work was a disentanglement, made by other hands between +523 and +618 or +656, of the contributions of Li Tang-Chih (*c.* +225) and Wu Phu (*c.* +235) and the commentaries of Thao Hung-Ching (+492) from the text of the *Shen Nung Pên Tshao Ching* itself. In other words it was the non-*Pên-Ching* part of the *Pên Tshao Ching Chi Chu* (q.v.). It may or may not have included some or all of Thao Hung-Ching's commentaries.

Ming Shih 明史.
History of the Ming Dynasty [+1368 to +1643].
Chhing, begun +1646, completed +1736, first pr. +1739.
Chang Thing-Yü 張廷玉 *et al.*

Ming Thang Hsüan Chen Ching Chüeh 明堂玄眞經訣.
[=*Shang-Chhing Ming Thang Hsüan Chen Ching Chüeh.*]
Explanation of the Manual of (Recovering the) Mysterious Primary (Vitalities of the) Cosmic Temple (i.e. the Human Body) [respiration and heliotherapy].
S/Chhi or Liang, late +5th or early +6th (but much altered).
Attrib. to the Mother Goddess of the West, Hsi Wang Mu 西王母.
Writer unknown.
TT/421.
Cf. Maspero (7), p. 376.

Ming Thang Yuan Chen Ching Chüeh 明堂元眞經訣.
See *Ming Thang Hsüan Chen Ching Chüeh.*

Ming Thung Chi 冥通記.
Record of Communication with the Hidden Ones (the Perfected Immortals).
Liang, +516.
Chou Tzu-Liang 周子良.
Ed. Thao Hung-Ching 陶弘景.

Mo Chuang Man Lu 墨莊漫錄.
Recollections from the Estate of Literary Learning.
Sung, *c.* +1131.
Chang Pang-Chi 張邦基.

Mo O Hsiao Lu 墨娥小錄.
A Secretary's Commonplace-Book [popular encyclopaedia].
Yuan or Ming, +14th, pr. +1571.
Compiler unknown.

Mo Tzu (incl. *Mo Ching*) 墨子.
The Book of Master Mo.
Chou, −4th century.
Mo Ti (and disciples) 墨翟.
Tr. Mei Yi-Pao (1); Forke (3).
Yin-Tê Index, no. (suppl.) 21.
TT/1162.

Montoku-Jitsuroku 文德實錄.
Veritable Records of the Reign of the Emperor Montoku [from +851 to +858].
Japan (Heian) +879.
Fujiwara Mototsune 藤原基經.

Nan Fan Hsiang Lu 南蕃香錄.
Catalogue of the Incense of the Southern Barbarians.
See *Hsiang Lu.*

Nan Hai Yao Phu 南海藥譜.
A Treatise on the Materia Medica of the South Seas (Indo-China, Malayo-Indonesia, the East Indies, etc.).
Alternative title of *Hai Yao Pên Tshao*, q.v. (according to Li Shih-Chen).

Nan Tshun Cho Kêng Lu 南村輟耕錄.
See *Cho Kêng Lu.*

Nan Yo Ssu Ta Chhan-Shih Li Shih Yuan Wên 南嶽思大禪師立誓願文.
Text of the Vows (of Aranyaka Austerities) taken by the Great Chhan Master (Hui-) Ssu of the Southern Sacred Mountain.
Chhen, *c.* +565.
Hui-Ssu 慧思.
TW/1933, N/1576.

Nei Chin Tan 內金丹.
[=*Nei Tan Pi Chih* or *Thien Hsien Chih Lun Chhang Shêng Tu Shih Nei Lien Chin Tan Fa.*]
The Metallous Enchymoma Within (the Body), [physiological alchemy].
Ming, +1622, part dated +1615.
Perhaps Chhen Ni-Wan 陳泥丸 (Mr Ni-Wan, Chhen), or Wu Chhung-Hsü 伍冲虛.
Contains a system of symbols included in the text.
CTPS, *pên* 12.

Nei Ching.
See *Huang Ti Nei Ching, Su Wên* and *Huang Ti Nei Ching, Ling Shu.*

Nei Ching Su Wên.
See *Huang Ti Nei Ching, Su Wên.*

Nei Kung Thu Shuo 內功圖說.
See Wang Tsu-Yuan (*1*).

Nei Tan Chüeh Fa 內丹訣法.
See *Huan Tan Nei Hsiang Chin Yo Shih.*

Nei Tan Fu 內丹賦.
[=*Thao Chen Jen Nai Tan Fu.*]
Rhapsodical Ode on the Physiological Enchymoma.

Nei Tan Fu (cont.)
Sung, +13th.
Thao Chih 陶植.
With commentary by an unknown writer.
TT/256.
Cf. *Chin Tan Fu*, the text of which is very similar.

Nei Tan Pi Chih 內丹秘指.
Confidential Directions on the Enchymoma.
Alternative title for *Nei Chin Tan* (q.v.).

Nei Wai Erh Ching Thu 內外二景圖.
Illustrations of Internal and Superficial Anatomy.
Sung, +1118.
Chu Hung 朱肱.
Original text lost, and replaced later; drawings taken from Yang Chieh's *Tshun Chen Huan Chung Thu*.

Nêng Kai Chai Man Lu 能改齋漫錄.
Miscellaneous Records of the Ability-to-Improve-Oneself Studio.
Sung, mid +12th century.
Wu Tshêng 吳曾.

Ni-Wan Li Tsu Shih Nü Tsung Shuang Hsiu Pao Fa 泥丸李祖師女宗雙修寶筏.
See *Nü Tsung Shuang Hsiu Pao Fa*.

Nihon-Koki 日本後記.
Chronicles of Japan, further continued [from +792 to +833].
Japan (Heian), +840.
Fujiwara Otsugu 藤原緒嗣.

Nihon-Koku Ganzai-sho Mokuroku 日本國見在書目錄.
Bibliography of Extant Books in Japan.
Japan (Heian), *c.* +895.
Fujiwara no Sukeyo 藤原佐世.
Cf. Yoshida Mitsukuni (6), p. 196.

Nihon Sankai Meibutsu Zue 日本山海名物圖會.
Illustrations of Japanese Processes and Manufactures (lit., of the Famous Products of Japan).
Japan (Tokugawa), Osaka, +1754.
Hirase Tessai 平瀨徹齋.
Ills. by Hasegawa Mitsunobu 長谷川光 & Chigusa Shinemon 千種屋新右衛門.
Facsim. repr. with introd. notes, Meicho Kankokai, Tokyo, 1969.

Nihon-shoki 日本書記.
See *Nihongi*.

Nihon Ryo-iki 日本靈異記.
Record of Strange and Mysterious Things in Japan.
Japan (Heian), +823.
Writer unknown.

Nihongi 日本記.
[= *Nihon-shoki*.]
Chronicles of Japan [from the earliest times to +696].
Japan (Nara), +720.
Toneri-shinnō (prince), 舍人親王, Ōno Yasumaro, 大安萬呂, Ki no Kiyobito *et al.*
Tr. Aston (1).
Cf. Anon. (103), pp. 1 ff.

Nihongi Ryaku 日本記畧.
Classified Matters from the *Chronicles of Japan*.
Japan.

Nittō-Guhō Junrei Gyōki 入唐求法巡禮行記
Record of a Pilgrimage to China in Search of the (Buddhist) Law.
Thang, +838 to +847.
Ennin 圓仁.
Tr. Reischauer (2).

Nü Kung Chih Nan 女功指南.
A Direction-Finder for (Inner) Achievement by Women (Taoists).
[Physiological alchemy, *nei tan* gymnastic techniques, etc.]
See *Nü Tsung Shuang Hsiu Pao Fa*.

Nü Tsung Shuang Hsiu Pao Fa 女宗雙修寶筏.
[=*Ni-Wan Li Tsu Shih Nü Tsung Shuang Hsiu Pao Fa*, or *Nü Kung-Chih Nan*.]
A Precious Raft (of Salvation) for Women (Taoists) Practising the Double Regeneration (of the primary vitalities, for their nature and their life-span, *hsing ming*), [physiological alchemy].
Chhing, *c.* +1795.
Ni-Wan shih 泥丸氏, Li Ong (late +16th), 李翁, Mr Ni-Wan, the Taoist Patriarch Li.
Written down by Thai-Hsü Ong 太虛翁, Shen I-Ping 沈一炳, Ta-Shih (Taoist abbot), *c.* 1820.
In *Tao Tsang Hsü Pien* (*Chhu chi*), 20.
Cf. *Tao Hai Chin Liang*, p. 34*a*, *Shih Chin Shih*, p. 12*a*.

Pai hsien-sêng Chin Tan Huo Hou Thu 白先生金丹火候圖.
Master Pai's Illustrated Tractate on the 'Fire-Times' of the Metallous Enchymoma.
Sung, *c.* +1210.
Pai Yü-Chhan 白玉蟾.
In *Hsiu Chen Shih Shu* (*TT*/260), ch. 1.

Pao Phu Tzu 抱樸(or 朴)子.
Book of the Preservation-of-Solidarity Master.
Chin, early +4th century, probably *c.* +320.
Ko Hung 葛洪.
Partial trs. Feifel (1, 2); Wu & Davis (2)
Full tr. Ware (5), *Nei Phien* chs. only.
TT/1171–1173.

Pao Phu Tzu Shen Hsien Chin Shuo Ching 抱朴子神仙金汋經.
The Preservation-of-Solidarity Master's Manual of the Bubbling Gold (Potion) of the Holy Immortals.
Ascr. Chin *c.* +320. Perhaps pre-Thang, more probably Thang.

Pao Phu Tzu Shen Hsien Chin Shuo Ching (cont.)
Attrib. Ko Hung 葛洪.
TT/910.
Cf. Ho Ping-Yü (11).

Pao Phu Tzu Yang Shêng Lun 抱朴子養生論.
The Preservation-of-Solidarity Master's Essay on Hygiene.
Ascr. Chin *c.* +320.
Attrib. Ko Hung 葛洪.
TT/835.

Pao Shêng Hsin Chien 保生心鑑.
Mental Mirror of the Preservation of Life [gymnastics and other longevity techniques].
Ming, +1506.
Thieh Fêng chü-shih 鐵峰居士 (The Recluse of Iron Mountain, ps.).
Ed. *c.* +1596 by Hu Wên-Huan 胡文煥.

Pao Shou Thang Ching Yen Fang 保壽堂經驗方.
Tried and Tested Prescriptions of the Protection-of-Longevity Hall (a surgery or pharmacy).
Ming, *c.* +1450.
Liu Sung-shih 劉松石.

Pao Tsang Lun 寶藏論.
[=*Hsien-Yuan Pao Tsang Chhang Wei Lun.*]
(The Yellow Emperor's) Discourse on the (Contents of the) Precious Treasury (of the Earth), [mineralogy and metallurgy].
Perhaps in part Thang or pre-Thang; completed in Wu Tai (S/Han). Tsêng Yuan-Jung (*1*) notes Chhao Kung-Wu's dating of it at +918 in his *Chhun Chai Tu Shu Chih.* Chang Tzu-Kao (*2*), p. 118, also considers it mainly a Wu Tai work.
Attrib. Chhing Hsia Tzu 青霞子.
If Su Yuan-Ming 蘇元明 and not another writer of the same pseudonym, the earliest parts may have been of the Chin time (+3rd or +4th); cf Yang Lieh-Yü (*1*).
Now only extant in quotations.
Cf. *Lo-fou Shan Chih*, ch. 4, p. 13*a*.

Pao Yen Thang Pi Chi 寶顏堂秘笈.
Private Collection of the Pao-Yen Library.
Ming, six collections printed between +1606 and +1620.
Ed. Chhen Chi-Ju 陳繼儒

Pei Lu Fêng Su 北虜風俗.
[=*I Su Chi.*]
Customs of the Northern Barbarians (i.e. the Mongols).
Ming, +1594.
Hsiao Ta-Hêng 蕭大亨.

Pei Mêng So Yen 北夢瑣言.
Fragmentary Notes Indited North of (Lake) Mêng.
Wu Tai (S/Phing), *c.* +950.
Sun Kuang-Hsien 孫光憲.
See des Rotours (4), p. 38.

Pei Shan Chiu Ching 北山酒經.
Northern Mountain Wine Manual.
Sung, +1117.
Chu Hung 朱肱.

Pei Shih 北史.
History of the Northern Dynasties [Nan Pei Chhao period, +386 to +581].
Thang, *c.* +670.
Li Yen-Shou 李延壽.
For translations of passages see the index of Frankel (1).

Pên Ching Fêng Yuan 本經逢原.
(Additions to Natural History) aiming at the Original Perfection of the *Classical Pharmacopoeia* (*of the Heavenly Husbandman*).
Chhing, +1695, pr. +1705.
Chang Lu 張璐.
LPC, no. 93.

Pên Tshao Chhiu Chen 本草求眞.
Truth Searched out in Pharmaceutical Natural History.
Chhing, +1773.
Huang Kung-Hsiu 黃宮繡.

Pên Tshao Ching Chi Chu 本草經集注.
Collected Commentaries on the *Classical Pharmacopoeia* (*of the Heavenly Husbandman*).
S/Chhi, +492.
Thao Hung-Ching 陶弘景.
Now extant only in fragmentary form as a Tunhuang or Turfan MS., apart from the many quotations in the pharmaceutical natural histories, under Thao Hung-Ching's name.

Pên Tshao Hui 本草滙.
Needles from the Haystack; Selected Essentials of Materia Medica.
Chhing, +1666, pr. +1668.
Kuo Phei-Lan 郭佩蘭.
LPC, no. 84.
Cf. Swingle (4).

Pên Tshao Hui Chien 本草彙箋.
Classified Notes on Pharmaceutical Natural History.
Chhing, begun +1660, pr. +1666.
Ku Yuan-Chiao 顧元交.
LPC, no. 83.
Cf. Swingle (8).

Pên Tshao Kang Mu 本草綱目.
The Great Pharmacopoeia; or, The Pandects of Natural History (Mineralogy, Metallurgy, Botany, Zoology etc.), Arrayed in their Headings and Subheadings.
Ming, +1596.
Li Shih-Chen 李時珍.
Paraphrased and abridged tr. Read & collaborators (2–7) and Read & Pak (1) with indexes. Tabulation of plants in Read (1) (with Liu Ju-Chhiang).
Cf. Swingle (7).

Pên Tshao Kang Mu Shih I 本草綱目拾遺.
Supplementary Amplifications for the *Pandects of Natural History* (of Li Shih-Chen).
Chhing, begun *c.* +1760, first prefaced +1765, prolegomena added +1780, last date in text 1803.
Chhing, first pr. 1871.
Chao Hsüeh-Min 趙學敏.
LPC, no. 101.
Cf. Swingle (11).

Pên Tshao Mêng Chhüan 本草蒙筌.
Enlightenment on Pharmaceutical Natural History.
Ming, +1565.
Chhen Chia-Mo 陳嘉謨.

Pên Tshao Pei Yao 本草備要.
Practical Aspects of Materia Medica.
Chhing, *c.* +1690, second ed. +1694.
Wang Ang 汪昂.
LPC, no. 90; ICK, pp. 215 ff.
Cf. Swingle (4).

Pên Tshao Phin Hui Ching Yao 本草品彙精要.
Essentials of the Pharmacopoeia Ranked according to Nature and Efficacity (Imperially Commissioned).
Ming, +1505.
Liu Wên-Thai 劉文泰, Wang Phan 王槃 & Kao Thing-Ho 高廷和.

Pên Tshao Shih I 本草拾遺.
A Supplement for the Pharmaceutical Natural Histories.
Thang, *c.* +725.
Chhen Tshang-Chhi 陳藏器.
Now extant only in numerous quotations.

Pên Tshao Shu 本草述.
Explanations of Materia Medica.
Chhing, before +1665, first pr. +1700.
Liu Jo-Chin 劉若金.
LPC, no. 79.
Cf. Swingle (6).

Pên Tshao Shu Kou Yuan 本草述鉤元.
Essentials Extracted from the *Explanations of Materia Medica.*
See Yang Shih-Thai (*1*).

Pên Tshao Thu Ching 本草圖經.
Illustrated Pharmacopoeia; or, Illustrated Treatise of Pharmaceutical Natural History.
Sung, +1061.
Su Sung 蘇頌 *et al.*
Now preserved only in numerous quotations in the later pandects of pharmaceutical natural history.

Pên Tshao Thung Hsüan 本草通玄.
The Mysteries of Materia Medica Unveiled.
Chhing, begun before +1655, pr. just before +1667.
Li Chung-Tzu 李中梓.
LPC, no. 75.
Cf. Swingle (4).

Pên Tshao Tshung Hsin 本草從新.
New Additions to Pharmaceutical Natural History.
Chhing, +1757.
Wu I-Lo 吳儀洛.
LPC, no. 99.

Pên Tshao Yao Hsing 本草藥性.
The Natures of the Vegetable and Other Drugs in the Pharmaceutical Treatises.
Thang, *c.* +620.
Chen Li-Yen 甄立言 & (perhaps) Chen Chhüan 甄權.
Now extant only in quotations.

Pên Tshao Yen I 本草衍義.
Dilations upon Pharmaceutical Natural History.
Sung, pref. +1116, pr. +1119, repr. +1185, +1195.
Khou Tsung-Shih 寇宗奭.
See also *Thu Ching Yen I Pên Tshao* (*TT*/761).

Pên Tshao Yen I Pu I 本草衍義補遺.
Revision and Amplification of the *Dilations upon Pharmaceutical Natural History.*
Yuan, *c.* +1330.
Chu Chen-Hêng 朱震亨.
LPC, no. 47.
Cf. Swingle (12).

Pên Tshao Yuan Shih 本草原始.
Objective Natural History of Materia Medica; a True-to-Life Study.
Chhing, begun +1578, pr. +1612.
Li Chung-Li 李中立.
LPC, no. 60.

Phan Shan Yü Lu 磻山語錄.
Record of Discussions at Phan Mountain [dialogues of pronouncedly medical character on physiological alchemy].
Sung, prob. early +13th.
Writer unknown.
In *Hsiu Chen Shih Shu* (*TT*/260), ch. 53.

Phêng-Lai Shan Hsi Tsao Huan Tan Ko 蓬萊山西竈還丹歌.
Mnemonic Rhymes of the Cyclically Transformed Elixir from the Western Furnace on Phêng-lai Island.
Ascr. *c.* −98. Probably Thang.
Huang Hsüan-Chung 黃玄鍾.
TT/909.

Phêng Tsu Ching 彭祖經.
Manual of Phêng Tsu [Taoist sexual techniques and their natural philosophy].
Late Chou or C/Han, −4th to −1st.
Attrib. Phêng Tsu 彭祖.
Only extant as fragments in *CSHK* (Shang Ku Sect.), ch. 16, pp. 5*b* ff.

Phu Chi Fang 普濟方.
Practical Prescriptions for Everyman.
Ming, *c.* +1418.
Chu Hsiao 朱橚 (Chou Ting Wang 周定王, prince of the Ming).
ICK, p. 914.

Pi Yü Chu Sha Han Lin Yü Shu Kuei 碧玉朱砂寒林玉樹匱.
On the Caerulean Jade and Cinnabar Jade-Tree-in-a-Cold-Forest Casing Process.
Sung, early +11th cent.
Chhen Ching-Yuan 陳景元.
TT/891.

Pien Huo Pien 辯惑編.
Disputations on Doubtful Matters.
Yuan, +1348.
Hsieh Ying-Fang 謝應芳.

Pien Tao Lun 辨道論.
On Taoism, True and False.
San Kuo (Wei), *c.* +230.
Tshao Chih (prince of the Wei), 曹植.
Now extant only in quotations.

Po Wu Chi 博物記.
Notes on the Investigation of Things.
H/Han, *c.* +190.
Thang Mêng (*b*) 唐蒙.

Po Wu Chih 博物志.
Records of the Investigation of Things (cf. *Hsü Po Wu Chih*).
Chin, *c.* +290 (begun about +270).
Chang Hua 張華.

Pu Wu Yao Lan 博物要覽.
The Principal Points about Objects of Art and Nature.
Ming, *c.* +1560.
Ku Thai 谷泰.

Rokubutsu Shinshi 六物新志.
New Record of Six Things [including the drug mumia]. (In part a translation from Dutch texts.)
Japan, +1786.
Ôtsuki Gentaku 大槻玄澤.

San Chen Chih Yao Yü Chüeh 三眞旨要玉訣.
Precious Instructions concerning the Message of the Three Perfected (Immortals), [i.e. Yang Hsi (*fl.* +370) 楊羲; Hsü Mi (*fl.* +345) 許謐; and Hsü Hui (d. *c.* +370) 許翽].
Taoist heliotherapy, respiration and meditation.
Chin, *c.* +365, edited probably in the Thang.
TT/419.
Cf. Maspero (7), p. 376.

San-Fêng Chen Jen Hsüan Than Chhüan Chi 三峯眞人玄譚全集.
Complete Collection of the Mysterious Discourses of the Adept (Chang) San-Fêng [physiological alchemy].
Ming, from *c.* +1410 (if genuine).
Attrib. Chang San-Fêng 張三峯.
Ed. Min I-Tê (1834) 閔一得.
In *Tao Tsang Hsü Pien* (*Chhu chi*), 17.

San-Fêng Tan Chüeh 三峯丹訣 (includes *Chin Tan Chieh Yao* and *Tshai Chen Chi Yao*, with the *Wu Kên Shu* series of poems, and some inscriptions).
Oral Instructions of (Chang) San-Fêng on the Enchymoma [physiological alchemy].
Ming, from *c.* +1410 (if genuine).
Attrib. Chang San-Fêng 張三峯.
Ed., with biography, by Fu Chin-Chhüan 傅金銓 (Chi I Tzu 濟一子) *c.* 1820.

San Phin I Shen Pao Ming Shen Tan Fang 三品頤神保命神丹方.
Efficacious Elixir Prescriptions of Three Grades Inducing the Appropriate Mentality for the Enterprise of Longevity.
Thang, Wu Tai & Sung.
Writers unknown.
YCCC, ch. 78, pp. 1*a* ff.

San-shih-liu Shui Fa 三十六水法.
Thirty-six Methods for Bringing Solids into Aqueous Solution.
Pre-Thang.
Writer unknown.
TT/923.

San Tshai Thu Hui 三才圖會.
Universal Encyclopaedia.
Ming, +1609.
Wang Chhi 王圻.

San Tung Chu Nang 三洞珠囊.
Bag of Pearls from the Three (Collections that) Penetrate the Mystery [a Taoist florilegium].
Thang, +7th.
Wang Hsüan-Ho (ed.) 王懸河.
TT/1125.
Cf. Maspero (13), p. 77; Schipper (1), p. 11.

San Yen 三言.
See *Hsing Shih Hêng Yen*, *Yü Shih Ming Yen*, *Ching Shih Thung Yen*.

Setsuyō Yoketsu.
See *Shê Yang Yao Chüeh.*

Shan Hai Ching 山海經.
Classic of the Mountains and Rivers.
Chou and C/Han, −8th to −1st.
Writers unknown.
Partial tr. de Rosny (1).
Chung-Fa Index, no. 9.

Shang-Chhing Chi 上清集.
A Literary Collection (inspired by) the Shang-Chhing Scriptures [prose and poems on physiological alchemy].
Sung, *c.* +1220.
Ko Chhang-Kêng 葛長庚 (Pai Yü-Chhan 白玉蟾).
In *Hsiu Chen Shih Shu TT*/260), chs. 37 to 44

Shang-Chhing Ching 上清經.
[Part of *Thai Shang San-shih-liu Pu Tsun Ching*.]
The Shang-Chhing (Heavenly Purity) Scripture.
Chin, oldest parts date from about +316.
Attrib. Wei Hua-Tshun 魏華存, dictated to Yang Hsi 楊羲.
In *TT*/8.

Shang-Chhing Chiu Chen Chung Ching Nei Chüeh 上清九眞中經內訣.
Confidential Explanation of the Interior Manual of the Nine (Adepts); a Shang-Chhing Scripture.
Ascr. Chin, +4th, probably pre-Thang.
Attrib. Chhih Sung Tzu 赤松子 (Huang Chhu-Phing 黃初平).
TT/901.

Shang Chhing Han Hsiang Chien Chien Thu 上清含象劍鑑圖.
The Image and Sword Mirror Diagram; a Shang-chhing Scripture.
Thang, *c.* +700.
Ssuma Chhêng-Chên 司馬承貞.
TT/428.

Shang-Chhing Hou Shêng Tao Chün Lieh Chi 上清後聖道君列紀.
Annals of the Latter-Day Sage, the Lord of the Tao; a Shang-Chhing Scripture.
Chin, late +4th.
Revealed to Yang Hsi 楊羲.
TT/439.

Shang-Chhing Huang Shu Kuo Tu I 上清黃書過度儀.
The System of the Yellow Book for Attaining Salvation; a Shang-Chhing Scripture [the rituale of the communal Taoist liturgical sexual ceremonies, +2nd to +7th centuries].
Date unknown, but pre-Thang.
Writer unknown.
TT/1276.

Shang-Chhing Ling-Pao Ta Fa 上清靈寶大法.
The Great Liturgies; a Shang-Chhing Ling-Pao Scripture.
Sung, +13th.
Chin Yün-Chung 金允中.
TT/1204, 1205, 1206.

Shang-Chhing Ming Thang Hsüan Chen Ching Chüeh 上清明堂玄眞經訣.
See *Ming Thang Hsüan Chen Ching Chüeh.*

Shang-Chhing San Chen Chih Yao Yü Chüeh 上清三眞旨要玉訣.
See *San Chen Chih Yao Yü Chüeh.*

Shang-Chhing Thai-Shang Pa Su Chen Ching 上清太上八素眞經.
Realisation Canon of the Eight Purifications (or Eightfold Simplicity); a Shang-Chhing Thai-Shang Scripture.
Date uncertain, but pre-Thang.
Writer unknown.
TT/423.

Shang-Chhing Thai-Shang Ti Chün Chiu Chen Chung Ching 上清太上帝君九眞中經.
Ninefold Realised Median Canon of the Imperial Lord; a Shang-Chhing Thai-Shang Scripture.
Compiled from materials probably of Chin period, late +4th.
Writers and editor unknown.
TT/1357.

Shang-Chhing Tung-Chen Chiu Kung Tzu Fang Thu 上清洞眞九宮紫房圖.
Description of the Purple Chambers of the Nine Palaces; a Tung-Chen Scripture of the Shang-Chhing Heavens [parts of the microcosmic body corresponding to stars in the macrocosm].
Sung, probably +12th century.
Writer unknown.
TT/153.

Shang-Chhing Wo Chung Chüeh 上清握中訣.
Explanation of (the Method of) Grasping the Central (Luminary); a Shang-Chhing Scripture [Taoist meditation and heliotherapy].
Date unknown, Liang or perhaps Thang.
Writer unknown.
Based on the procedures of Fan Yu-Chhung 范幼沖 (H/Han).
TT/137.
Cf. Maspero (7), p. 373.

Shang Phin Tan Fa Chieh Tzhu 上品丹法節次.
Expositions of the Techniques for Making the Best Quality Enchymoma [physiological alchemy].
Chhing.
Li Tê-Hsia 李德洽.
Comm. Min I-Tê 閔一德, *c.* 1830.
In *Tao Tsang Hsü Pien* (*Chhu chi*), 6.

Shang Shu Ta Chuan 尙書大傳.
Great Commentary on the *Shang Shu* chapters of the *Historical Classic.*
C/Han, *c.* −185.
Fu Shêng 伏勝.
Cf. Wu Khang (1), p. 230.

Shang-Tung Hsin Tan Ching Chüeh 上洞心丹經訣.
An Explanation of the Heart Elixir and Enchymoma Canon; a Shang-Tung Scripture.
Date unknown, perhaps Sung.
Writer unknown.
TT/943.
Cf. Chhen Kuo-Fu (1), vol. 2, pp. 389, 435.

Shang Yang Tzu Chin Tan Ta Yao 上陽子金丹大要.
See *Chin Tan Ta Yao.*

Shang Yang Tzu Chin Tan Ta Yao Hsien Phai (Yuan Liu) 上陽子金丹大要仙派(源流).
See *Chin Tan Ta Yao Hsien Phai (Yuan Liu).*

Shang Yang Tza Chin Tan Ta Yao Lieh Hsien Chih 上陽子金丹大要列仙誌.
See *Chin Tan Ta Yao Lieh Hsien Chih.*

Shang Yang Tzu Chin Tan Ta Yao Thu 上陽子金丹大要圖.
See *Chin Tan Ta Yao Thu.*

Shao-Hsing Chiao-Ting Ching-Shih Chêng Lei Pei-Chi Pên Tshao 紹興校定經史證類備急本草.

Shao-Hsing Chiao-Ting Ching-Shih Chêng Lei Pei-Chi Pên Tshao (cont.)]
The Corrected Classified and Consolidated Armamentarium; Pharmacopoeia of the Shao-Hsing Reign-Period.
S/Sung, pres. +1157, pr. +1159, often copied and repr. especially in Japan.
Thang Shen-Wei 唐愼微 ed. Wang Chi-Hsien 王繼先 *et al.*
Cf. Nakao Manzō (*1*, 1); Swingle (11). Illustrations reproduced in facsimile by Wada (*1*); Karow (2).
Facsimile edition of a MS. in the Library of Ryokoku University, Kyoto 龍谷大學圖書館.
Ed. with an analytical and historical introduction, including contents table and indexes (別册) by Okanishi Tameto 岡西爲人 (Shunyōdō, Tokyo, 1971).

Shê Ta Chhêng Lun Shih 攝大乘論釋.
Mahāyāna-samgraha-bhāshya (Explanatory Discourse to assist the Understanding of the Great Vehicle).
India, betw. +300 and +500.
Tr. Hsüan-Chuang 玄奘, *c.* +650.
N/1171 (4); TW/1597.

(Shê Yang) Chen Chung Chi (or Fang) (攝養)枕中記(方).
Pillow-Book on Assisting the Nourishment (of the Life-Force).
Thang, early +7th.
Attrib. Sun Ssu-Mo 孫思邈.
TT/830, and in *YCCC*, ch. 33.

Shê Yang Yao Chüeh (Setsuyō Yoketsu) 攝養要訣.
Important Instructions for the Preservation of Health conducive to Longevity.
Japan (Heian), *c.* +820.
Mononobe Kōsen (imperial physician) 物部廣泉.

Shen Hsien Chin Shuo Ching 神仙金汋經.
See *Pao Phu Tzu Shen Hsien Chin Shuo Ching*.

Shen Hsien Chuan 神仙傳.
Lives of the Holy Immortals.
(Cf. *Lieh Hsien Chuan* and *Hsü Shen Hsien Chuan*.)
Chin, +4th century.
Attrib. Ko Hung 葛洪.

Shen Hsien Fu Erh Tan Shih Hsing Yao Fa 神仙服餌丹石行藥法.
The Methods of the Holy Immortals for Ingesting Cinnabar and (Other) Minerals, and Using them Medicinally.
Date unknown.
Attrib. Ching-Li hsien-sêng 京里先生.
TT/417.

Shen Hsien Fu Shih Ling-Chih Chhang-Phu Wan Fang 神仙服食靈芝菖蒲丸方.
Prescriptions for Making Pills from Numinous Mushrooms and Sweet Flag (*Calamus*), as taken by the Holy Immortals.
Date unknown
Writer unknown.
TT/837.

Shen Hsien Lien Tan Tien Chu San Yuan Pao Ching Fa 神仙鍊丹點鑄三元寶鏡法.
Methods used by the Holy Immortals to Prepare the Elixir, Project it, and Cast the Precious Mirrors of the Three Powers (or the Three Primary Vitalities), [magical].
Thang, +902.
Writer unknown.
TT/856.

Shen Hsien Thung Chien 神仙通鑑.
(Cf. (*Li Tai*) *Shen Hsien* (*Thung*) *Chien*.)
General Survey of the Lives of the Holy Immortals.
Ming, +1640.
Hsüeh Ta-Hsün 薛大訓.

Shen I Chi 神異記.
(Probably an alternative title of *Shen I Ching*, q.v.)
Records of the Spiritual and the Strange.
Chin, *c.* +290.
Wang Fou 王浮.

Shen I Ching 神異經.
Book of the Spiritual and the Strange.
Ascr. Han, but prob. +3rd, +4th or +5th century.
Attrib. Tungfang Shuo 東方朔.
Probable author, Wang Fou 王浮.

Shen Nung Pên Tshao Ching 神農本草經.
Classical Pharmacopoeia of the Heavenly Husbandman.
C/Han, based on Chou and Chhin material, but not reaching final form before the +2nd century.
Writers unknown.
Lost as a separate work, but the basis of all subsequent compendia of pharmaceutical natural history, in which it is constantly quoted.
Reconstituted and annotated by many scholars; see Lung Po-Chien (*1*), pp. 2 ff., 12 ff.
Best reconstructions by Mori Tateyuki 森立之 (1845), Liu Fu 劉復 (1942).

Shen shih Liang Fang 沈氏良方.
Original title of *Su Shen Liang Fang* (q.v.).

Shen Thien-Shih Fu Chhi Yao Chüeh 申天師服氣要訣.
Important Oral Instructions of the Heavenly Teacher (or Patriarch) Shen on the Absorption of the Chhi [Taoist breathing exercises].
Thang, *c.* +730.
Shen Yuan-Chih 申元之.
Now extant only as a short passage in *YCCC*, ch. 59, pp. 16*b* ff.

Shêng Chi Tsung Lu 聖濟總錄.
Imperial Medical Encyclopaedia [issued by authority].
Sung, *c.* +1111 to +1118.
Ed. by twelve physicians.

Shêng Shih Miao Ching 生尸妙經.
See *Thai-Shang Tung-Hsüan Ling-Pao Mieh Tu* (or *San Yuan*) *Wu Lien Shêng Shih Miao Ching*.

Shêng Shui Yen Than Lu 澠水燕談錄.
Fleeting Gossip by the River Shêng [in Shantung].
Sung, late +11th century (before +1094).
Wang Phi-Chih 王闢之.

Shih Chin Shih 試金石.
On the Testing of (what is meant by) 'Metal' and 'Mineral'.
See Fu Chin-Chhüan (5).

Shih Han Chi 石函記.
See *Hsü Chen Chün Shih Han Chi*.

Shih I Chi 拾遺記.
Memoirs on Neglected Matters.
Chin, *c.* +370.
Wang Chia 王嘉.
Cf. Eichhorn (5).

Shih I Tê Hsiao Fang 世醫得効方.
Efficacious Prescriptions of a Family of Physicians.
Yuan, +1337.
Wei I-Lin 危亦林.

Shih Liao Pên Tshao 食療本草.
Nutritional Therapy; a Pharmaceutical Natural History.
Thang, *c.* +670.
Mêng Shen 孟詵.

Shih Lin Kuang Chi 事林廣記.
Guide through the Forest of Affairs [encyclopaedia].
Sung, between +1100 and +1250; first pr. +1325.
Chhen Yuan-Ching 陳元靚.
(A unique copy of a Ming edition of +1478 is in the Cambridge University Library.)

Shih Ming 釋名.
Explanation of Names [dictionary].
H/Han, *c.* +100.
Liu Hsi 劉熙.

Shih Pien Liang Fang 十便良方.
Excellent Prescriptions of Perfect Convenience.
Sung, +1196.
Kuo Than 郭坦.
Cf. SIC, p. 1119; ICK, p. 813.

Shih Wu Chi Yuan 事物紀原.
Records of the Origins of Affairs and Things.
Sung, *c.* +1085.
Kao Chhêng 高承.

Shih Wu Pên Tshao 食物本草.
Nutritional Natural History.
Ming, +1571 (repr. from a slightly earlier edition).
Attrib. Li Kao 李杲 (J/Chin) or Wang Ying 汪頴 (Ming) in various editions; actual writer Lu Ho 盧和.
The bibliography of this work in its several different forms, together with the questions of authorship and editorship, are complex.
See Lung Po-Chien (*1*), pp. 104, 105, 106; Wang Yü-Hu (*1*), 2nd ed. p. 194; Swingle (1, 10).

Shih Yao Erh Ya 石藥爾雅.
The Literary Expositor of Chemical Physic; or, Synonymic Dictionary of Minerals and Drugs.
Thang, +806.
Mei Piao 梅彪.
TT/894.

Shih Yuan 事原.
On the Origins of Things.
Sung.
Chu Hui 朱繪.

Shoku-Nihongi 續日本記.
Chronicles of Japan, continued [from +697 to +791].
Japan (Nara), +797.
Ishikawa Natari 石川,
Fujiwara Tsuginawa 藤原繼繩,
Sugeno Sanemichi 菅野眞道 *et al.*

Shoku-Nihonkoki 續日本後記.
Chronicles of Japan, still further continued [from +834 to +850].
Japan (Heian), +869.
Fujiwara Yoshifusa 藤原良房.

Shou Yü Shen Fang 壽域神方.
Magical Prescriptions of the Land of the Old.
Ming, *c.* +1430.
Chu Chhüan 朱權 (Ning Hsien Wang 寧獻王, prince of the Ming).

Shu Shu Chi I 數術記遺.
Memoir on some Traditions of Mathematical Art.
H/Han, +190, but generally suspected of having been written by its commentator Chen Luan 甄鸞, *c.* +570. Some place the text as late as the Wu Tai period (+10th. cent.), e.g. Hu Shih; and others such as Li Shu-Hua (*2*) prefer a Thang dating.
Hsü Yo 徐岳.

Shu Yuan Tsa Chi 菽園雜記.
The Bean-Garden Miscellany.
Ming, +1475.
Lu Jung 陸容.

Shuang Mei Ching An Tshung Shu 雙梅景闇叢書.
Double Plum-Tree Collection [of ancient and medieval books and fragments on Taoist sexual techniques].
See Yeh Tê-Hui (*1*) 葉德輝 in Bib. B.

Shui Yün Lu 水雲錄.
Record of Clouds and Waters [iatrochemical].
Sung, *c.* +1125.
Yeh Mêng-Tê 葉夢得.
Extant now only in quotations.

Shun Yang Lü Chen-Jen Yao Shih Chih 純陽呂眞人藥石製.
The Adept Lü Shun-Yang's (i.e. Lü Tung-Pin's) Book on Preparations of Drugs and Minerals [in verses].
Late Thang.
Attrib. Lü Tung-Pin 呂洞賓.
TT/896.
Tr. Ho Ping-Yü, Lim & Morsingh (1).

Shuo Wên.
See *Shuo Wên Chieh Tzu.*

Shuo Wên Chieh Tzu 說文解字.
Analytical Dictionary of Characters (lit. Explanations of Simple Characters and Analyses of Composite Ones).
H/Han, +121.
Hsü Shen 許愼.

So Sui Lu 瑣碎錄.
Sherds, Orts and Unconsidered Fragments [iatro-chemical].
Sung, prob. late +11th.
Writer unknown.
Now extant only in quotations. Cf. *Winter's Tale*, IV, iii, *Timon of Athens*, IV, iii, and *Julius Caesar*, IV, i.

Sou Shen Chi 搜神記.
Reports on Spiritual Manifestations.
Chin, *c.* +348.
Kan Pao 干寶.
Partial tr. Bodde (9).

Sou Shen Hou Chi 搜神後記.
Supplementary Reports on Spiritual Manifestations.
Chin, late +4th or early +5th century.
Thao Chhien 陶潛.

Ssu Khu Thi Yao Pien Chêng 四庫提要辨證.
See Yü Chia-Hsi (1).

Ssu Shêng Pên Tshao 四聲本草.
Materia Medica Classified according to the Four Tones (and the Standard Rhymes), [the entries arranged in the order of the pronunciation of the first character of their names].
Thang, *c.* +775.
Hsiao Ping 蕭炳.

Ssu Shih Thiao Shê Chien 四時調攝牋.
Directions for Harmonising and Strengthening (the Vitalities) according to the Four Seasons of the Year [the second part (chs. 3–6) of *Tsun Shêng Pa Chien*, q.v.].
Ming, +1591.
Kao Lien 高濂.
Partial tr. of the gymnastic material, Dudgeon (1).

Ssu Shih Tsuan Yao 四時纂要.
Important Rules for the Four Seasons [agriculture and horticulture, family hygiene and pharmacy, etc.].
Thang, *c.* +750.
Han O 韓鄂.

Su Nü Ching 素女經.
Canon of the Immaculate Girl.
Han.
Writer unknown.
Only as fragment in *Shuang Mei Ching An Tshung Shu*, now containing the *Hsüan Nü Ching* (q.v.).
Partial trs. van Gulik (3, 8).

Su Nü Miao Lun 素女妙論.
Mysterious Discourses of the Immaculate Girl.
Ming, *c.* +1500.
Writer unknown.
Partial tr. van Gulik (3).

Su Shen Liang Fang 蘇沈良方.
Beneficial Prescriptions collected by Su (Tung-Pho) and Shen (Kua).
Sung, *c.* +1120. Some of the data go back as far as +1060. Preface by Lin Ling-Su 林靈素.
Shen Kua 沈括 and Su Tung-Pho 蘇東坡 (posthumous).
The collection was at first called *Shen shih Liang Fang*, so that most of the entries are Shen Kua's, but as some certainly stem from Su Tung-Pho, the latter were probably added by editors at the beginning of the new century.
Cf. ICK, pp. 737, 732.

Su Wên Ling Shu Ching.
See *Huang Ti Nei Ching, Su Wên* and *Huang Ti Nei Ching, Ling Shu.*

Su Wên Nei Ching.
See *Huang Ti Nei Ching, Su Wên.*

Sui Shu 隋書.
History of the Sui Dynasty [+581 to +617].
Thang, +636 (annals and biographies); +656 (monographs and bibliography).
Wei Chêng 魏徵 *et al.*
Partial trs. Pfizmaier (61–65); Balazs (7, 8); Ware (1).
For translations of passages see the index of Frankel (1).

Sun Kung Than Phu 孫公談圃.
The Venerable Mr Sung's Conversation Garden.
Sung, *c.* +1085.
Sun Shêng 孫升.

Sung Chhao Shih Shih 宋朝事實.
Records of Affairs of the Sung Dynasty.
Yuan, +13th.
Li Yu 李攸.

Sung Shan Thai-Wu hsien-sêng Chhi Ching 嵩山太无先生氣經.
Manual of the (Circulation of the) Chhi, by Mr Grand-Nothingness of Sung Mountain.
Thang, +766 to +779.
Prob. Li Fêng-Shih 李奉時 (Thai-Wu hsien-sêng).
TT/817, and in *YCCC*, ch. 59 (partially), pp. 7*a* ff.
Cf. Maspero (7), p. 199.

Sung Shih 宋史.
History of the Sung Dynasty [+960 to +1279].
Yuan, *c.* +1345.
Tho-Tho (Toktaga) 脫脫 & Ouyang Hsüan 歐陽玄.
Yin-Tê Index, no. 34.

Szechuan Thung Chih 四川通志.
General History and Topography of Szechuan Province.
Chhing, +18th century (pr. 1816).
Ed. Chhang Ming 常明, Yang Fang-Tshan 楊芳燦 *et al.*

Ta Chao 大招.
The Great Summons (of the Soul), [ode].
Chhu (between Chhin and Han), −206 or −205.
Writer unknown.
Tr. Hawkes (1), p. 109.

Ta Chih Tu Lun 大智度論.
Mahā-prajñapāramito-padeśa Śāstra (Commentary on the Great Sūtra of the Perfection of Wisdom).
India.
Attrib. Nāgārjuna, +2nd.
Mostly prob. of Central Asian origin.
Tr. Kumārajīva, +406.
N/1169; TW/1509.

Ta Chün Ku Thung 大鈞鼓銅.
(Illustrated Account of the Mining), Smelting and Refining of Copper [and other Non-Ferrous Metals], according to the Principles of Nature (lit. the Great Potter's Wheel).
See Masuda Tsuna (1).

Ta Fang Kuang Fo Hua Yen Ching 大方廣佛華嚴經.
Avataṁsaka Sūtra.
India.
Tr. Śikshānanda, +699.
N/88; TW/279.

Ta Huan Tan Chao Chien 大還丹照鑑.
An Elucidation of the Great Cyclically Transformed Elixir [in verses].
Wu Tai (Shu), +962.
Writer unknown.
TT/919.

Ta Huan Tan Chhi Pi Thu 大還丹契秘圖.
Esoteric Illustrations of the Concordance of the Great Regenerative Enchymoma.
Thang or Sung.
Writer unknown.
In *YCCC*, ch. 72, pp. 1*a* ff.
Cf. *Hsiu Chen Li Yen Chhao Thu* and *Chin I Huan Tan Yin Chêng Thu.*

Ta-Kuan Ching-Shih Chêng Lei Pei-Chi Pên Tshao 大觀經史證類備急本草.
The Classified and Consolidated Armamentarium; Pharmacopoeia of the Ta-Kuan reign-period.
Sung, +1108; repr. +1211, +1214 (J/Chin), +1302 (Yuan).
Thang Shen-Wei 唐愼微.
Ed. Ai Shêng 艾晟.

Ta Ming I Thung Chih 大明一統志.
Comprehensive Geography of the (Chinese) Empire (under the Ming dynasty).
Ming, commissioned +1450, completed +1461.
Ed. Li Hsien 李賢.

Ta Tai Li Chi 大戴禮記.
Record of Rites [compiled by Tai the Elder] (cf. *Hsiao Tai Li Chi*; *Li Chi*).
Ascr. C/Han, *c.* −70 to −50, but really H/Han, between +80 and +105.
Attrib. ed. Tai Tê 戴德, in fact probably ed. Tshao Pao 曹褒.
See Legge (7).
Trs. Douglas (1); R. Wilhelm (6).

Ta Tan Chhien Hung Lun 大丹鉛汞論.
Discourse on the Great Elixir [or Enchymoma] of Lead and Mercury.
If Thang, +9th, more probably Sung.
Chin Chu-Pho 金竹坡.
TT/916.
Cf. Yoshida Mitsukuni (5), pp. 230–2.

Ta Tan Chi 大丹記.
Record of the Great Enchymoma.
Ascr. +2nd cent., but probably Sung, +13th.
Attrib. Wei Po-Yang 魏伯陽.
TT/892.

Ta Tan Chih Chih 大丹直指.
Direct Hints on the Great Elixir.
Sung, *c.* +1200.
Chhiu Chhu-Chi 邱處機.
TT/241.

Ta Tan Wên Ta 大丹問答.
Questions and Answers on the Great Elixir (or Enchymoma) [dialogues between Chêng Yin and Ko Hung].
Date unknown, prob. late Sung or Yuan.
Writer unknown.
TT/932.

Ta Tan Yao Chüeh Pên Tshao 大丹藥訣本草.
Pharmaceutical Natural History in the form of Instructions about Medicines of the Great Elixir (Type), [iatro-chemical].
Possible alternative title of *Wai Tan Pên Tshao* (q.v.).

Ta-Tung Lien Chen Pao Ching, Chiu Huan Chin Tan Miao Chüeh 大洞鍊眞寶經九還金丹妙訣.
Mysterious Teachings on the Ninefold Cyclically Transformed Gold Elixir, supplementary to the Manual of the Making of the Perfected Treasure; a Ta-Tung Scripture.
Thang, +8th, perhaps *c.* +712.
Chhen Shao-Wei 陳少微.
TT/884. A sequel to *TT*/883, and in *YCCC*, ch. 68, pp. 8*a* ff.
Tr. Sivin (4).

Ta-Tung Lien Chen Pao Ching, Hsiu Fu Ling Sha Miao Chüeh 大洞鍊眞寶經修伏靈砂妙訣.
Mysterious Teachings on the Alchemical Preparation of Numinous Cinnabar, supplementary to the Manual of the Making of the Perfected Treasure; a Ta-Tung Scripture.
Thang, +8th, perhaps *c.* +712.
Chhen Shao-Wei 陳少微.
TT/883. Alt. title: *Chhi Fan Ling Sha Lun*, as in *YCCC*, ch. 69, pp. 1*a* ff.
Tr. Sivin (4).

Ta Yu Miao Ching 大有妙經.
[= *Tung-Chen Thai-Shang Su-Ling Tung-Yuan Ta Yu Miao Ching*.]
Book of the Great Mystery of Existence [Taoist anatomy and physiology; describes the *shang tan thien*, upper region of vital heat, in the brain].
Chin, +4th.
Writer unknown.
TT/1295.
Cf. Maspero (7), p. 192.

Tai I Phien 代疑篇.
On Replacing Doubts by Certainties.
Ming, +1621.
Yang Thing-Yün 楊廷筠.
Preface by Wang Chêng 王徵

Taketori Monogatari 竹取物語.
The Tale of the Bamboo-Gatherer.
Japan (Heian), *c.* +865. Cannot be earlier than *c.* +810 or later than *c.* +955.
Writer unknown.
Cf. Matsubara Hisako (1, 2).

Tan Ching Shih Tu 丹經示讀.
A Guide to the Reading of the Enchymoma Manuals.
See Fu Chin-Chhüan (3).

Tan Ching Yao Chüeh.
See *Thai-Chhing Tan Ching Yao Chüeh.*

Tan Fang Ao Lun 丹房奧論.
Subtle Discourse on the (Alchemical) Elaboratory (of the Human Body, for making the Enchymoma).
Sung, +1020.
Chhêng Liao-I 程了一.
TT/913, and in *TTCY* (*chung mao chi*, 5).

Tan Fang Chien Yuan 丹方鑑源.
The Mirror of Alchemical Processes (and Reagents); a Source-book.
Wu Tai (H/Shu), *c.* +938 to +965.
Tuku Thao 獨孤滔.
Descr. Fêng Chia-Lo & Collier (1).
See Ho Ping-Yü & Su Ying-Hui (1).
TT/918.

Tan Fang Ching Yuan 丹房鏡源.
The Mirror of the Alchemical Elaboratory; a Source-book.
Early Thang, not later than +800.
Writer unknown.
Survives only incorporated in *TT*/912 and in *CLPT*.
See Ho Ping-Yü & Su Ying-Hui (1).

Tan Fang Hsü Chih 丹房須知.
Indispensable Knowledge for the Chymical Elaboratory [with illustrations of apparatus].
Sung, +1163.
Wu Wu 吳懋.
TT/893.

Tan Fang Pao Chien Chih Thu 丹房寶鑑之圖.
[= *Tzu Yang Tan Fang Pao Chien Chih Thu*.]
Precious Mirror of the Elixir and Enchymoma Laboratory; Tables and Pictures (to illustrate the Principles).
Sung, *c.* +1075.
Chang Po-Tuan 張伯端 (Tzu Yang Tzu 紫陽子 or Tzu Yang Chen Jen).
Incorporated later in *Chin Tan Ta Yao Thu* (q.v.)
In *Chin Tan Ta Yao* (*TTCY* ed.), ch. 3, pp. 34*a* ff. Also in *Wu Chen Phien* (in *Hsiu Chen Shih Shu*, *TT*/260, ch. 26, pp. 5*a* ff.).
Cf. Ho Ping-Yü & Needham (2).

Tan I San Chüan 丹扆三卷.
See Pa Tzu-Yuan (1).

Tan Lun Chüeh Chih Hsin Ching 丹論訣旨心鏡 (*Chien* or *Chao* 鑑, 照 occur as tabu forms in the titles of some versions.)
Mental Mirror Reflecting the Essentials of Oral Instruction about the Discourses on the Elixir and the Enchymoma.
Thang, probably +9th.
Chang Hsüan-Tê 張玄德, criticising the teachings of Ssuma Hsi-I 司馬希夷.
TT/928, and in *YCCC*, ch. 66, pp. 1*a* ff.
Tr. Sivin (5).

Tan Thai Hsin Lu 丹臺新錄.
New Discourse on the Alchemical Laboratory.
Early Sung or pre-Sung.
Attrib. Chhing Hsia Tzu 青霞子 or Hsia Yu-Chang 夏有章.
Extant only in quotations.

Tan-Yang Chen Jen Yü Lu 丹陽眞人玉錄.
Precious Records of the Adept Tan-Yang.
Sung, mid +12th cent.
Ma Yü 馬鈺.
TT/1044.

Tan-Yang Shen Kuang Tshan 丹陽神光燦.
Tan Yang (Tzu's Book) on the Resplendent Glow of the Numinous Light.
Sung, mid +12th cent.
Ma Yü 馬鈺.
TT/1136.

Tan Yao Pi Chüeh 丹藥祕訣.
Confidential Oral Instructions on Elixirs and Drugs.
Prob. Yuan or early Ming.
Hu Yen 胡演.
Now only extant as quotations in the pharmaceutical natural histories.

Tao Fa Hsin Chhuan 道法心傳.
Transmission of (a Lifetime of) Thought on Taoist Techniques [physiological alchemy with special reference to microcosm and macrocosm; many poems and a long exposition].
Yuan, +1294.
Wang Wei-I 王惟一.
TT/1235, and *TTCY* (*hsia mao chi*, 5).

Tao Fa Hui Yuan 道法會元.
Liturgical and Apotropaic Encyclopaedia of Taoism.
Thang and Sung.
Writers and compiler unknown.
TT/1203.

Tao Hai Chin Liang 道海津梁.
A Catena (of Words) to Bridge the Ocean of the Tao.
See Fu Chin-Chhüan (*4*).

Tao Shu 道樞.
Axial Principles of the Tao [doctrinal treatise, mainly on the techniques of physiological alchemy].
Sung, early +12th; finished by 1145.
Tsêng Tshao 曾慥.
TT/1005.

Tao Su Fu 擣素賦.
Ode on a Girl of Matchless Beauty [Chao nü, probably Chao Fei-Yen]; or, Of What does Spotless Beauty Consist?
C/Han, *c.* −20.
Pan chieh-yü 班婕妤.
In *CSHK*, Chhien Han Sect., ch. 11, p. 7*a* ff.

Tao Tê Ching 道德經.
Canon of the Tao and its Virtue.
Chou, before −300.
Attrib. Li Erh (Lao Tzu) 李耳(老子).
Tr. Waley (4); Chhu Ta-Kao (2); Lin Yü-Thang (1); Wieger (7); Duyvendak (18); and very many others.

Tao Tsang 道藏.
The Taoist Patrology [containing 1464 Taoist works].
All periods, but first collected in the Thang about +730, then again about +870 and definitively in +1019. First printed in the Sung (+1111 to +1117). Also printed in J/Chin (+1168 to +1191), Yuan (+1244), +1607). and Ming (+1445, +1598 and
Writers numerous.
Indexes by Wieger (6), on which see Pelliot's review (58); and Ong Tu-Chien (Yin-Tê Index, no. 25).

Tao Tsang Chi Yao 道藏輯要.
Essentials of the Taoist Patrology [containing 287 books, 173 works from the Taoist Patrology and 114 Taoist works from other sources].
All periods, pr. 1906 at Erh-hsien-ssu 二仙寺, Chhêngtu.
Writers numerous.
Ed. Ho Lung-Hsiang 賀龍驤 & Phêng Han-Jan 彭瀚然 (Chhing).

Tao Tsang Hsü Phien Chhu Chi 道藏續篇初集.
First Series of a Supplement to the Taoist Patrology.
Chhing, early 19th cent.
Edited by Min I-Tê 閔一得.

Tao Yin Yang Shêng Ching 導引養生經.
[= *Thai-Chhing Tao Yin Yang Shêng Ching*.]
Manual of Nourishing the Life-Force (or, Attaining Longevity and Immortality) by Gymnastics.
Late Thang, Wu Tai, or early Sung.
Writer unknown.
TT/811, and in *YCCC*, ch. 34.
Cf. Maspero (7), pp. 415 ff.

Têng Chen Yin Chüeh 登眞隱訣.
Confidential Instructions for the Ascent to Perfected (Immortality).
Chin and S/Chhi. Original material from the neighbourhood of +365 to +366; commentary (the 'Confidential Instructions' of the title) by Thao Hung-Ching (+456 to +536) written between +493 and +498.
Original writer unknown.
Ed. Thao Hung-Ching 陶弘景.
TT/418, but conservation fragmentary.
Cf. Maspero (7), pp. 192, 374.

Thai-Chhing Chen Jen Ta Tan 太清眞人大丹.
[Alternative later name of *Thai-Chhing Tan Ching Yao Chüeh*.]
The Great Elixirs of the Adepts; a Thai-Chhing Scripture.
Thang, mid +7th (*c.* +640).
Prob. Sun Ssu-Mo 孫思邈.
In *YCCC*, ch. 71.
Tr. Sivin (1), pp. 145 ff.

Thai-Chhing Chin I Shen Chhi Ching 太清金液神氣經.
Manual of the Numinous Chhi of Potable Gold; a Thai-Chhing Scripture.
Ch. 3 records visitations by the Lady Wei Hua-Tshun and her companion divinities mostly paralleling texts in the *Chen Kao*. They were taken down by Hsü Mi's great-grandson Hsü Jung-Ti (d. +435), *c.* +430. Chs 1 and 2 are Thang or Sung, before +1150. If pre-Thang, cannot be earlier than +6th.
Writers mainly unknown.
TT/875.

Thai-Chhing Chin I Shen Tan Ching 太清金液神丹經.
Manual of the Potable Gold (or Metallous Fluid), and the Magical Elixir (or Enchymoma); a Thai-Chhing Scripture.
Date unknown, but must be pre-Liang (Chhen Kuo-Fu (1), vol. 2, p. 419). Contains dates between +320 and +330, but most of the prose is more probably of the early +5th century.

Thai-Chhing Chin I Shen Tan Ching (cont.)
Preface and main texts of *nei tan* character, all the rest *wai tan*, including laboratory instructions.
Writer unknown; chs. variously attributed.
The third chapter, devoted to descriptions of foreign countries which produced cinnabar and other chemical substances, may be of the second half of the +7th century (see Maspero (14), pp. 95 ff.). Most were based on Wan Chen's *Nan Chou I Wu Chih* (+3rd cent.), but not the one on the Roman Orient (Ta-Chhin) translated by Maspero. Stein (5) has pointed out however that the term *Fu-Lin* for Byzantium occurs as early as +500 to +520, so the third chapter may well be of the early +6th century.
TT/873.
Abridged in *YCCC* ch. 65, pp. 1*a* ff.
Cf. Ho Ping-Yü (10).

Thai-Chhing Ching Thien-Shih Khou Chüeh 太清經天師口訣.
Oral Instructions from the Heavenly Masters [Taoist Patriarchs] on the Thai-Chhing Scriptures.
Date unknown, but must be after the mid +5th cent. and before Yuan.
Writer unknown.
TT/876.

Thai-Chhing Chung Huang Chen Ching 太清中黃眞經.
See *Chung Huang Chen Ching*.

Thai-Chhing Shih Pi Chi 太清石壁記.
The Records in the Rock Chamber (lit. Wall); a Thai-Chhing Scripture.
Liang, early +6th, but includes earlier work of Chin time as old as the late +3rd, attributed to Su Yuan-Ming.
Edited by Chhu Tsê hsien-sêng 楚澤先生.
Original writer, Su Yuan-Ming 蘇元明 (Chhing Hsia Tzu 青霞子).
TT/874.
Tr. Ho Ping-Yü (8).
Cf. *Lo-fou Shan Chih*, ch. 4, p. 13*a*.

Thai-Chhing Tan Ching Yao Chüeh 太清丹經要訣.
[= *Thai-Chhing Chen Jen Ta Tan*.]
Essentials of the Elixir Manuals, for Oral Transmission; a Thai-Chhing Scripture.
Thang, mid +7th (*c.* +640).
Prob. Sun Ssu-Mo 孫思邈.
In *YCCC*, ch. 71.
Tr. Sivin (1), pp. 145 ff.

Thai-Chhing Tao Yin Yang Shêng Ching 太清導引養生經.
See *Tao Yin Yang Shêng Ching*.

Thai-Chhing Thiao Chhi Ching 太清調氣經.
Manual of the Harmonising of the Chhi; a Thai-Chhing Scripture [breathing exercises for longevity and immortality].
Thang or Sung, +9th or +10th.
Writer unknown.
TT/813.
Cf. Maspero (7), p. 202.

Thai-Chhing (Wang Lao) (Fu Chhi) Khou Chüeh (or *Chhuan Fa*) 太清王老服氣口訣 (傳法).
The Venerable Wang's Instructions for Absorbing the Chhi; a Thai-Chhing Scripture [Taoist breathing exercises].
Thang or Wu Tai (the name of Wang added in the +11th).
Writer unknown.
Part due to a woman Taoist, Li I 李液.
TT/815, and in *YCCC*, ch. 62, pp. 1*a* ff. and ch. 59, pp. 10*a* ff.
Cf. Maspero (7), p. 209.

Thai-Chhing Yü Pei Tzu 太清玉碑子.
The Jade Stele (Inscription); a Thai-Chhing Scripture [dialogues between Chêng Yin and Ko Hung].
Date unknown, prob. late Sung or Yuan.
Writer unknown.
TT/920.
Cf. *Ta Tan Wên Ta* and *Chin Mu Wan Ling Lun*, which incorporate parallel passages.

Thai-Chi Chen-Jen Chiu Chuan Huan Tan Ching Yao Chüeh 太極眞人九轉還丹經要訣.
Essential Teachings of the Manual of the Supreme-Pole Adept on the Ninefold Cyclically Transformed Elixir.
Date unknown, perhaps Sung on account of the pseudonym, but the Manual (*Ching*) itself may be pre-Sui because its title is in the *Sui Shu* bibliography. Mao Shan influence is revealed by an account of five kinds of magic plants or mushrooms that grow on Mt Mao, and instructions of Lord Mao for ingesting them.
Writer unknown.
TT/882.
Partial tr. Ho Ping-Yü (9).

Thai-Chi Chen-Jen Tsa Tan Yao Fang 太極眞人雜丹藥方.
Tractate of the Supreme-Pole Adept on Miscellaneous Elixir Recipes [with illustrations of alchemical apparatus].
Date unknown, but probably Sung on account of the philosophical significance of the pseudonym.
Writer unknown.
TT/939.

Thai-Chi Ko Hsien-Ong Chuan 太極葛仙翁傳.
Biography of the Supreme-Pole Elder-Immortal Ko (Hsüan).
Prob. Ming.
Than Ssu-Hsien 譚嗣先.
TT/447.

Thai Hsi Ching 胎息經.
Manual of Embryonic Respiration.
Thang, +8th, *c.* +755.

Thai Hsi Ching (*cont.*)
Huan Chen hsien-sêng 幻眞先生 (Mr Truth-and-Illusion).
TT/127, and *YCCC*, ch. 60, pp. 22*b* ff.
Tr. Balfour (1).
Cf. Maspero (7), p. 211.

Thai Hsi Ching Wei Lun 胎息精微論.
Discourse on Embryonic Respiration and the Subtlety of the Seminal Essence.
Thang or Sung.
Writer unknown.
In *YCCC*, ch. 58, pp. 1*a* ff.
Cf. Maspero (7), p. 210.

Thai Hsi Kên Chih Yao Chüeh 胎息根旨要訣.
Instruction on the Essentials of (Understanding) Embryonic Respiration [Taoist respiratory and sexual techniques].
Thang or Sung.
Writer unknown.
In *YCCC*, ch. 58, pp. 4*b* ff.
Cf. Maspero (7), p. 380.

Thai Hsi Khou Chüeh 胎息口訣.
Oral Explanation of Embryonic Respiration.
Thang or Sung.
Writer unknown.
In *YCCC*, ch. 58, pp. 12*a* ff.
Cf Maspero (7), p. 198.

Thai Hsi Shui Fa 泰西水法.
Hydraulic Machinery of the West.
Ming, +1612.
Hsiung San-Pa (Sabatino de Ursis) 熊三拔 & Hsü Kuang-Chhi 徐光啓.

Thai Hsüan Pao Tien 太玄寶典.
Precious Records of the Great Mystery [of attaining longevity and immortality by physiological alchemy, *nei tan*].
Sung or Yuan, +13th or +14th.
Writer unknown.
TT/1022, and in *TTCY* (*shang mao chi*, 5).

Thai-I Chin Hua Tsung Chih 太一(or 乙)金華宗旨.
Principles of the (Inner) Radiance of the Metallous (Enchymoma), (explained in terms of the) Undifferentiated Universe.
See *Chin Hua Tsung Chih*.

Thai-Ku Chi 太古集.
Collected Works of (Ho) Thai-Ku [Ho Ta-Thung].
Sung, *c.* +1200.
Ho Ta-Thung 郝大通.
TT/1147.

Thai Ku Thu Tui Ching 太古土兌經.
Most Ancient Canon of the Joy of the Earth; or, of the Element Earth and the Kua Tui [mainly on the alchemical subduing of metals and minerals].
Date unknown, perhaps Thang or slightly earlier.
Attrib. Chang hsien-sêng 張先生.
TT/942.

Thai Pai Ching 太白經.
The Venus Canon.
Thang, *c.* +800.
Shih Chien-Wu 施肩吾.
TT/927.

Thai Phing Ching 太平經.
[= *Thai Phing Chhing Ling Shu*.]
Canon of the Great Peace (and Equality).
Ascr. H/Han, *c.* +150 (first mentioned +166) but with later additions and interpolations.
Part attrib. Yü Chi 于吉.
Perhaps based on the *Thien Kuan Li Pao Yuan Thai Phing Ching* (*c.* −35) of Kan Chung-Kho 甘忠可.
TT/1087. Reconstructed text, ed. Wang Ming (*2*).
Cf. Yü Ying-Shih (2), p. 84.
According to Hsiung Tê-Chi (*1*) the parts which consist of dialogue between a Heavenly Teacher and a disciple correspond with what the *Pao Phu Tzu* bibliography lists as *Thai Phing Ching* and were composed by Hsiang Khai 襄楷.
The other parts would be for the most part fragments of the *Chia I Ching* 甲乙經, also mentioned in *Pao Phu Tzu*, and due to Yü Chi and his disciple Kung Chhung 宮崇 between +125 and +145.

Thai Phing Chhing Ling Shu 太平清領書.
Received Book of the Great Peace and Purity.
See *Thai Phing Ching*.

Thai-Phing Huan Yü Chi 太平寰宇記.
Thai-Phing reign-period General Description of the World [geographical record].
Sung, +976 to +983.
Yüeh Shih 樂史.

Thai-Phing Hui Min Ho Chi Chü Fang 太平惠民和劑局方.
Standard Formularies of the (Government) Great Peace People's Welfare Pharmacies [based on the *Ho Chi Chü Fang*, etc.].
Sung, +1151.
Ed. Chhen Shih-Wên 陳師文, Phei Tsung-Yuan 裴宗元, and Chhen Chhêng 陳承.
Cf. Li Thao (1, 6); SIC, p. 973.

Thai-Phing Kuang Chi 太平廣記.
Copious Records collected in the Thai-Phing reign-period [anecdotes, stories, mirabilia and memorabilia].
Sung, +978.
Ed. Li Fang 李昉.

Thai-Phing Shêng Hui Fang 太平聖惠方.
Prescriptions Collected by Imperial Benevolence during the Thai-Phing reign-period.
Sung, commissioned +982; completed +992.
Ed. Wang Huai-Yin 王懷隱, Chêng Yen 鄭彥 *et al.*
SIC, p. 921; *Yü Hai*, ch. 63.

Thai-Phing Yü Lan 太平御覽.
Thai-Phing reign-period Imperial Encyclopaedia (lit. the Emperor's Daily Readings).
Sung, +983.
Ed. Li Fang 李昉.
Some chs. tr. Pfizmaier (84–106).
Yin-Tê Index, no. 23.

Thai-Shang Chu Kuo Chiu Min Tsung Chen Pi Yao 太上助國救民總眞秘要.
Arcane Essentials of the Mainstream of Taoism, for the Help of the Nation and the Saving of the People; a Thai-Shang Scripture [apotropaics and liturgy].
Sung +1116.
Yuan Miao-Tsung 元妙宗.
TT/1210.

Thai-Shang Chuan Hsi Wang Mu Wo Ku Fa 太上傳西王母攝固法.
See *Chuan Hsi Wang Mu Wo Ku Fa*.

Thai-Shang Huang Thing Nei (or *Wai* or *Chung*) *Ching* (*Yü*) *Ching* 太上黃庭內(外, 中)景(玉)經.
See *Huang Thing*, etc.

Thai-Shang Lao Chün Yang Shêng Chüeh 太上老君養生訣.
Oral Instructions of Lao Tzu on Nourishing the Life-Force; a Thai-Shang Scripture [Taoist respiratory and gymnastic exercises].
Thang.
Attrib. Hua Tho 華佗 and Wu Phu 吳普.
Actual writer unknown.
TT/814.

Thai-Shang Ling-Pao Chih Tshao Thu 太上靈寶芝草圖.
Illustrations of the Numinous Mushrooms; a Thai-Shang Ling-Pao Scripture.
Sui or pre-Sui.
Writer unknown.
TT/1387.

Thai-Shang Ling-Pao Wu Fu (*Ching*) 太上靈寶五符(經).
(Manual of) the Five Categories of Formulae (for achieving Material and Celestial Immortality); a Thai-Shang Ling-Pao Scripture [liturgical].
San Kuo, mid +3rd.
Writers unknown.
TT/385.
On the term Ling-Pao see Kaltenmark (4).

Thai-Shang Pa-Ching Ssu-Jui Tzu-Chiang (*Wu-Chu*) *Chiang-Shêng Shen Tan Fang* 太上八景四蘂紫蕤(五珠)降生神丹方.
Method for making the Eight-Radiances Four-Stamens Purple-Fluid (Five-Pearl) Incarnate Numinous Elixir; a Thai-Shang Scripture.
Chin, probably late +4th.
Putatively dictated to Yang Hsi 楊羲.
In *YCCC*, ch. 68; another version in *TT*/1357.

Thai-Shang Pa Ti Yuan (*Hsüan*) *Pien Ching* 太上八帝元(玄)變經.
See *Tung-Shen Pa Ti Yuan* (*Hsüan*) *Pien Ching*.

Thai Shang-San-shih-liu pu Tsun Ching 太上三十六部尊經.
The Venerable Scripture in 36 Sections.
TT/8.
See *Shang Chhing Ching*.

Thai-Shang Tung Fang Nei Ching Chu 太上洞房內經注.
Esoteric Manual of the Innermost Chamber, a Thai-Shang Scripture; with Commentary.
Ascr. −1st cent.
Attrib. Chou Chi-Thung 周季通.
TT/130.

Thai-Shang Tung-Hsüan Ling-Pao Mieh Tu (or *San Yuan*) *Wu Lien Shêng Shih Miao Ching* 太上洞玄靈寶滅度(or 三元)五鍊生尸妙經.
Marvellous Manual of the Resurrection (or Preservation) of the Body, giving Salvation from Dispersal, by means of (the Three Primary Vitalities and) the Five Transmutations; a Ling-Pao Thai-Shang Tung-Hsüan Scripture.
Date uncertain.
Writer unknown.
TT/366.

Thai-Shang Tung-Hsüan Ling-Pao Shou Tu I 太上洞玄靈寶授度儀.
Formulae for the Reception of Salvation; a Thai-Shang Tung-Hsüan Ling-Pao Scripture [liturgical].
L/Sung, *c.* +450.
Lu Hsiu-Ching 陸修靜.
TT/524.

Thai-Shang Wei Ling Shen Hua Chiu Chuan Tan Sha Fa 太上衛靈神化九轉丹砂法.
Methods of the Guardian of the Mysteries for the Marvellous Thaumaturgical Transmutation of Ninefold Cyclically Transformed Cinnabar; a Thai-Shang Scripture.
Sung, if not earlier.
Writer unknown.
TT/885.
Tr. Spooner & Wang (1); Sivin (3).

Thai-Shang Yang Shêng Thai Hsi Chhi Ching 太上養生胎息氣經.
See *Yang Shêng Thai Hsi Chhi Ching*.

Thai Tsang Lun 胎藏論.
Discourse on the Foetalisation of the Viscera (the Restoration of the Embryonic Condition of Youth and Health).
Alternative title of *Chung Huang Chen Ching* (q.v.).

Thai-Wei Ling Shu Tzu-Wên Lang-Kan Hua Tan Shen Chen Shang Ching 太微靈書紫文琅玕華丹神眞上經.

Thai-Wei Ling Shu Tzu-Wên Lang-Kan Hua Tan Shon Chen Shang Ching (*cont.*)
Divinely Written Exalted Spiritual Realisation Manual in Purple Script on the Lang-Kan (Gem) Radiant Elixir; a Thai-Wei Scripture.
Chin, late +4th century, possibly altered later.
Dictated to Yang Hsi 楊羲.
TT/252.

Thai-Wu hsien-sêng Fu Chhi Fa 太无先生服氣法.
See *Sung Shan Thai-Wu hsien-sêng Chhi Ching*.

Than hsien-sêng Shui Yün Chi 譚先生水雲集.
Mr Than's Records of Life among the Mountain Clouds and Waterfalls.
Sung, mid +12th cent.
Than Chhu-Tuan 譚處端.
TT/1146.

Thang Hui Yao 唐會要.
History of the Administrative Statutes of the Thang Dynasty.
Sung, +961.
Wang Phu 王溥.
Cf. des Rotours (2), p. 92.

Thang Liu Tien 唐六典.
Institutes of the Thang Dynasty (lit. Administrative Regulations of the Six Ministries of the Thang).
Thang, +738 or +739.
Ed. Li Lin-Fu 李林甫.
Cf. des Rotours (2), p. 99.

Thang Pên Tshao 唐本草.
Pharmacopoeia of the Thang Dynasty.
= *Hsin Hsiu Pên Tshao*, (q.v.).

Thang Yü Lin 唐語林.
Miscellanea of the Thang Dynasty.
Sung, collected *c.* +1107.
Wang Tang 王讜.
Cf. des Rotours (2), p. 109.

Thao Chen Jen Nei Tan Fu 陶眞人內丹賦.
See *Nei Tan Fu*.

Thi Kho Ko 體窳歌.
Song of the Bodily Husk (and the Deliverance from its Ageing).
Wu Tai or Sung, in any case before +1040
Yen Lo Tzu (ps.) 煙蘿子.
In *Hsiu Chen Shih Shu* (*TT*/260), ch. 18.

Thiao Chhi Ching 調氣經.
See *Thai-Chhing Thiao Chhi Ching*.

Thieh Wei Shan Tshung Than 鐵圍山叢談.
Collected Conversations at Iron-Fence Mountain.
Sung, *c.* +1115.
Tshai Thao 蔡絛.

Thien-Hsia Chün Kuo Li Ping Shu 天下郡國利病書.
Merits and Drawbacks of all the Countries in the World [geography].
Chhing, +1662.
Ku Yen-Wu 顧炎武.

Thien Hsien Chêng Li Tu 'Fa Tien Ching' 天仙正理圖法點請.
The Right Pattern of the Celestial Immortals; Thoughts on Reading the *Consecration of the Law*.
See Fu Chin-Chhüan (2).

Thien Hsien Chih Lun Chhang Shêng Tu Shih Nei Lien Chin Tan (*Chüeh Hsin*) *Fa* 天仙直論長生度世內煉金丹(訣心)法.
(Confidential) Methods for Processing the Metallous Encyhmoma; a Plain Discourse on Longevity and Immortality (according to the Principles of the) Celestial Immortals for the Salvation of the World.
Alternative title for *Nei Chin Tan* (q.v.).

Thien Kung Khai Wu 天工開物.
The Exploitation of the Works of Nature.
Ming, +1637.
Sung Ying-Hsing 宋應星.
Tr. Sun Jen I-Tu & Sun Hsüeh-Chuan (1).

Thien-thai Shan Fang Wai Chih 天臺山方外志.
Supplementary Historical Topography of Thien-thai Shan.
Ming.
Chhuan-Têng (monk) 傳燈.

Thien Ti Yin-Yang Ta Lo Fu 天地陰陽大樂賦.
Poetical Essay on the Supreme Joy.
Thang, *c.* +800.
Pai Hsing-Chien 白行簡.

Thien Yuan Ju Yao Ching 天元入藥鏡.
Mirror of the All-Penetrating Medicine (the Enchymoma; restoring the Endowment) of the Primary Vitalities.
Wu Tai, +940.
Tshui Hsi-Fan 崔希範.
In *Hsiu Chen Shih Shu* (*TT*/260), ch. 21, pp. 6*b* to 9*b*; a prose text without commentary, not the same as the *Ju Yao Ching* (q.v.) and ending with a diagram absent from the latter.
Cf. van Gulik (8), pp. 224 ff.

Tho Yo Tzu 橐籥子.
Book of the Bellows-and-Tuyère Master [physiological alchemy in mutationist terms].
Sung or Yuan.
Writer unknown.
TT/1174, and *TTCY* (*hsin mao chi*, 5).

Thou Huang Tsa Lu 投荒雜錄.
Miscellaneous Jottings far from Home.
Thang, *c.* +835.
Fang Chhien-Li 房千里.

Thu Ching (*Pên Tshao*) 圖經(本草).
Illustrated Treatise (of Pharmaceutical Natural History). See *Pên Tshao Thu Ching*.
The term *Thu Ching* applied originally to one of the two illustrated parts (the other being a *Yao Thu*) of the *Hsin Hsiu Pên*

Thu Ching (*Pên Tshao*) (*cont.*)
Tshao of +659 (q.v.); cf. *Hsin Thang Shu*, ch. 59, p. 21*a* or *TSCCIW*, p. 273. By the middle of the +11th century these had become lost, so Su Sung's *Pên Tshao Thu Ching* was prepared as a replacement. The name *Thu Ching Pên Tshao* was often afterwards applied to Su Sung's work, but (according to the evidence of the *Sung Shih* bibliographies, *SSIW*, pp. 179, 529) wrongly.

Thu Ching Chi-Chu Yen I Pên Tshao 圖經集注衍義本草.
Illustrations and Collected Commentaries for the *Dilations upon Pharmaceutical Natural History*.
TT/761 (Ong index, no. 767).
See also *Thu Ching Yen I Pên Tshao*.
The *Tao Tsang* contains two separately catalogued books, but the *Thu Ching Chi-Chu Yen I Pên Tshao* is in fact the introductory 5 chapters, and the *Thu Ching Yen I Pên Tshao* the remaining 42 chapters of a single work.

Thu Ching Yen I Pên Tshao 圖經衍義本草.
Illustrations (and Commentary) for the *Dilations upon Pharmaceutical Natural History*. (An abridged conflation of the *Chêng-Ho...Chêng Lei...Pên Tshao* with the *Pên Tshao Yen I*.)
Sung, *c.* +1223.
Thang Shen-Wei 唐慎微, Khou Tsung-Shih 寇宗奭, ed. Hsü Hung 許洪.
TT/761 (Ong index, no. 768).
See also *Thu Ching Chi-Chu Yen I Pên Tshao*.
Cf. Chang Tsan-Chhen (*2*); Lung Po-Chien (*1*), nos. 38, 39.

Thu Hsiu Chen Chün Tsao-Hua Chih Nan 土宿眞君造化指南.
Guide to the Creation, by the Earth's Mansions Immortal.
See *Tsao-Hua Chih Nan*.

Thu Hsiu Pên Tshao 土宿本草.
The Earth's Mansions Pharmacopoeia.
See *Tsao-Hua Chih Nan*.

Thung Hsüan Pi Shu 通玄秘術.
The Secret Art of Penetrating the Mystery [alchemy].
Thang, soon after +864.
Shen Chih-Yen 沈知言.
TT/935.

Thung Su Pien 通俗編.
Thesaurus of Popular Terms, Ideas and Customs.
Chhing, +1751.
Tsê Hao 翟灝.

Thung Ya 通雅.
Helps to the Understanding of the *Literary Expositor* [general encyclopaedia with much of scientific and technological interest].
Ming and Chhing, finished +1636, pr. +1666.
Fang I-Chih 方以智.

Thung Yu Chüeh 通幽訣.
Lectures on the Understanding of the Obscurity (of Nature) [alchemy, protochemical and physiological].
Not earlier than Thang.
Writer unknown.
TT/906.
Cf. Chhen Kuo-Fu (*1*), vol. 2, p. 390.

Tien Hai Yü Hêng Chih 滇海虞衡志.
A Guide to the Region of the Kunming Lake (Yunnan).
Chhing, *c.* +1770, pr. +1799.
Than Tshui 檀萃.

Tien Shu 典術.
Book of Arts.
L/Sung.
Wang Chien-Phing 王建平.

Ting Chhi Ko 鼎器歌.
Song (or, Mnemonic Rhymes) on the (Alchemical) Reaction-Vessel.
Han, if indeed originally, as it is now, a chapter of the *Chou I Tshan Thung Chhi* (q.v.).
It has sometimes circulated separately.
In *Chou I Tshan Thung Chhi Fên Chang Chu Chieh*, ch. 33 (ch. 3, pp. 7*a* ff.).
Cf. *Chou I Tshan Thung Chhi Ting Chhi Ko Ming Ching Thu* (*TT*/994).

Ton Isho 頓醫抄.
Medical Excerpts Urgently Copied.
Japan, +1304.
Kajiwara Shozen 梶原性全.

Tongüi Pogam 東醫寶鑑.
See *Tung I Pao Chien*.

Tou hsien-sêng Hsiu Chen Chih Nan 竇先生修眞指南.
See *Hsi Yo Tou hsien-sêng Hsiu Chen Chih Nan*.

Tsao Hua Chhien Chhui 造化鉗鎚.
The Hammer and Tongs of Creation (i.e. Nature).
Ming, *c.* +1430.
Chu Chhüan 朱權.
(Ning Hsien Wang 寧獻王, prince of the Ming.)

Tsao-Hua Chih Nan 造化指南.
[= *Thu Hsiu Pên Tshao*.]
Guide to the Creation (i.e. Nature).
Thang, Sung or possibly Ming. A date about +1040 may be the best guess, as there are similarities with the *Wai Tan Pên Tshao* (q.v.).
Thu Hsiu Chen Chün 土宿眞君 (the Earth's Mansions Immortal).
Preserved only in quotation, as in *PTKM*.

Tsê Ko Lu 則克錄.
Methods of Victory.
Title, in certain editions, of the *Huo Kung Chieh Yao* (q.v.).

Tsêng Kuang Chih Nang Pu 增廣智囊補.
Additions to the *Enlarged Bag of Wisdom* Supplemented.
Ming, *c.* +1620.
Fêng Mêng-Lung 馮夢龍.

Tshai Chen Chi Yao 採眞機要.
Important (Information on the) Means (by which one can) Attain (the Regeneration of the) Primary (Vitalities) [physiological alchemy, poems and commentary].
Part of *San-Fêng Tan Chüeh* (q.v.).

Tshan Thung Chhi 參同契.
The Kinship of the Three; or, The Accordance (of the *Book of Changes*) with the Phenomena of Composite Things [alchemy].
H/Han, +142.
Wei Po-Yang 魏伯陽.

Tshan Thung Chhi.
See also titles under *Chou I Tshan Thung Chhi.*

Tshan Thung Chhi Chang Chü 參同契章句
The *Kinship of the Three* (arranged in) Chapters and Sections.
Chhing, +1717.
Ed. Li Kuang-Ti 李光地.

Tshan Thung Chhi Khao I 參同契考異.
[=*Chou I Tshan Thung Chhi Chu.*]
A Study of the *Kinship of the Three.*
Sung, +1197.
Chu Hsi 朱熹 (originally using pseudonym Tsou Hsin 鄒訢).
TT/992.

Tshan Thung Chhi Shan Yu 參同契闡幽.
Explanation of the Obscurities in the *Kinship of the Three.*
Chhing, +1669, pref. +1729, pr. +1735.
Ed and comm. Chu Yuan-Yü 朱元育.
TTCY.

Tshan Thung Chhi Wu Hsiang Lei Pi Yao 參同契五相類祕要.
Arcane Essentials of the Similarities and Categories of the Five (Substances) in the *Kinship of the Three* (sulphur, realgar, orpiment, mercury and lead).
Liu Chhao, possibly Thang; prob. between +3rd and +7th cents., must be before the beginning of the +9th cent., though ascr. +2nd.
Writer unknown (attrib. Wei Po-Yang).
Comm. by Lu Thien-Chi 盧天騭, wr. Sung, +1111 to +1117, probably +1114.
TT/898.
Tr. Ho Ping-Yü & Needham (2).

Tshao Mu Tzu 草木子.
The Book of the Fading-like-Grass Master.
Ming, +1378.
Yeh Tzu-Chhi 葉子奇.

Tshê Fu Yuan Kuei 册府元龜.
Collection of Material on the Lives of Emperors and Ministers, (lit. (Lessons of) the Archives, (the True) Scapulimancy); [a governmental ethical and political encyclopaedia.]
Sung, commissioned +1005, pr. +1013.
Ed. Wang Chhin-Jo 王欽若 & Yang I 楊億.
Cf. des Rotours (2), p. 91.

Tshui Hsü Phien 翠虛篇.
Book of the Emerald Heaven.
Sung, *c.* +1200.
Chhen Nan 陳楠.
TT/1076.

Tshui Kung Ju Yao Ching Chu (or *Ho*) *Chieh* 崔公入藥鏡註(合)解.
See *Ju Yao Ching* and *Thien Yuan Ju Yao Ching.*

Tshun Chen Huan Chung Thu 存眞環中圖.
Illustrations of the True Form (of the Body) and of the (Tracts of) Circulation (of the Chhi).
Sung, +1113.
Yang Chieh 楊介.
Now partially preserved only in the *Ton-Isho* and the *Man-Anpō* (q.v.). Some of the drawings are in Chu Hung's *Nei Wai Erh Ching Thu*, also in *Hua Tho Nei Chao Thu* and *Kuang Wei Ta Fa* (q.v.).

Tshun Fu Chai Wên Chi 存復齋文集.
Literary Collection of the Preservation-and-Return Studio.
Yuan, +1349.
Chu Tê-Jun 朱德潤.

Tso Chuan 左傳.
Master Tso chhiu's Tradition (or Enlargement) of the *Chhun Chhiu* (*Spring and Autumn Annals*), [dealing with the period −722 to −453].
Late Chou, compiled from ancient written and oral traditions of several States between −430 and −250, but with additions and changes by Confucian scholars of the Chhin and Han, especially Liu Hsin. Greatest of the three commentaries on the *Chhun Chhiu*, the others being the *Kungyang Chuan* and the *Kuliang Chuan*, but unlike them, probably originally itself an independent book of history.
Attrib. Tsochhiu Ming 左邱明.
See Karlgren (8); Maspero (1); Chhi Ssu-Ho (1); Wu Khang (1); Wu Shih-Chhang (1); van der Loon (1), Eberhard, Müller & Henseling (1).
Tr. Couvreur (1); Legge (11); Pfizmaier (1–12).
Index by Fraser & Lockhart (1).

Tso Wang Lun 坐忘論.
Discourse on (Taoist) Meditation.
Thang, *c.* +715.
Ssuma Chhêng-Chên 司馬承貞.
TT/1024, and in *TTCY* (*shang mao chi*, 5).

Tsui Shang I Chhêng Hui Ming Ching 最上一乘慧命經.
Exalted Single-Vehicle Manual of the Sagacious (Lengthening of the) Life-Span.
See *Hui Ming Ching.*

Tsun Shêng Pa Chien 遵生八牋.
Eight Disquisitions on Putting Oneself in Accord with the Life-Force [a collection of works].
Ming, +1591.
Kao Lien 高濂.
For the separate parts see:
1. *Chhing Hsiu Miao Lun Chien* (chs. 1, 2).
2. *Ssu Shih Thiao Shê Chien* (chs. 3–6).
3. *Chhi Chü An Lo Chien* (chs. 7, 8).
4. *Yen Nien Chhio Ping Chien* (chs. 9, 10).
5. *Yin Chuan Fu Shih Chien* (chs. 11–13).
6. *Yen Hsien Chhing Shang Chien* (chs. 14, 15).
7. *Ling Pi Tan Yao Chien* (chs. 16–18).
8. *Lu Wai Hsia Chü Chien* (ch. 19).

Tsurezuregusa 徒然草.
Gleanings of Leisure Moments [miscellanea, with much on Confucianism, Buddhism and Taoist philosophy].
Japan, *c.* +1330.
Kenkō hōshi 兼好法師 (Yoshida no Kaneyoshi 吉田兼好).
Cf. Anon. (103), pp. 197 ff.

Tu Hsing Tsa Chih 獨醒雜志.
Miscellaneous Records of the Lone Watcher.
Sung, +1176.
Tsêng Min-Hsing 曾敏行.

Tu I Chih 獨異志.
Things Uniquely Strange.
Thang.
Li Jung 李冗 (*or* 冗).

Tu Jen Ching 度人經.
See *Ling-Pao Wu Liang Tu Jen Shang Phin Miao Ching.*

Tu Shih Fang Yü Chi Yao 讀史方輿紀要.
Essentials of Historical Geography.
Chhing, first pr. +1667, greatly enlarged before the author's death in +1692, and pr. *c.* +1799.
Ku Tsu-Yü 顧祖禹.

Tung-Chen Ling Shu Tzu-Wên Lang-Kan Hua Tan Shang Ching 洞眞靈書紫文琅玕華丹上經.
Divinely Written Exalted Manual in Purple Script on the Lang-Kan (Gem) Radiant Elixir; a Tung-Chen Scripture.
Alternative name of *Thai-Wei Ling Shu Tzu-Wên Lang-Kan Hua Tan Shen Chen Shang Ching* (q.v.).

Tung-Chen Thai-Shang Su-Ling Tung-Yuan Ta Yu Miao Ching 洞眞太上素靈洞元大有妙經.
See *Ta Yu Miao Ching.*

Tung-Chen Thai-Wei Ling Shu Tzu-Wên Shang Ching 洞眞太微靈書紫文上經.
Divinely Written Exalted Canon in Purple Script; a Tung-Chen Thai-Wei Scripture.
See *Thai-Wei Ling Shu Tzu-Wên Lang-Kan Hua Tan Shen Chen Shang Ching,* which it formerly contained.

Tung Hsien Pi Lu 東軒筆錄.
Jottings from the Eastern Side-Hall.
Sung, end +11th.
Wei Thai 魏泰.

Tung-Hsüan Chin Yü Chi 洞玄金玉集.
Collections of Gold and Jade; a Tung-Hsüan Scripture.
Sung, mid +12th cent.
Ma Yü 馬鈺.
TT/1135.

Tung-Hsüan Ling-Pao Chen Ling Wei Yeh Thu 洞玄靈寶眞靈位業圖.
Charts of the Ranks, Positions and Attributes of the Perfected (Immortals); a Tung-Hsüan Ling-Pao Scripture.
Ascr. Liang, early +6th.
Attrib. Thao Hung-Ching 陶弘景.
TT/164.

Tung Hsüan Tzu 洞玄子.
Book of the Mystery-Penetrating Master.
Pre-Thang, perhaps +5th century.
Writer unknown.
In *Shuang Mei Ching An Tshung Shu.*
Tr van Gulik (3).

Tung I Pao Chien 東醫寶鑑.
Precious Mirror of Eastern Medicine [system of medicine].
Korea, commissioned in +1596, presented +1610, printed +1613.
Hŏ Chun 許浚.

Tung-Pho Shih Chi Chu 東坡詩集注.
[= *Mei-Chhi Shih Chu.*]
Collected Commentaries on the Poems of (Su) Tung-Pho.
Sung, *c.* +1140.
Wang Shih-Phêng 王十朋 (i.e. Wang Mei-Chhi 王梅溪).

Tung Shen Ching 洞神經.
See *Tung Shen Pa Ti Miao Ching Ching* and *Tung Shen Pa Ti Yuan Pien Ching.*

Tung Shen Pa Ti Miao Ching Ching 洞神八帝妙精經.
Mysterious Canon of Revelation of the Eight (Celestial) Emperors; a Tung-Shen Scripture.
Date uncertain, perhaps Thang but more probably earlier.
Writer unknown.
TT/635.

Tung Shen Pa Ti Yuan (Hsüan) Pien Ching 洞神八帝元(玄)變經.
Manual of the Mysterious Transformations of the Eight (Celestial) Emperors; a Tung-Shen Scripture [nomenclature of

Tung Shen Pa Ti Yuan (Hsüan) Pien Ching (*cont.*)
spiritual beings, invocations, exorcisms, techniques of rapport].
Date uncertain, perhaps Thang but more probably earlier.
Writer unknown.
TT/1187.

Tzu Chin Kuang Yao Ta Hsien Hsiu Chen Yen I 紫金光耀大仙修眞演義.
See *Hsiu Chen Yen I.*

Tzu-Jan Chi 自然集.
Collected (Poems) on the Spontaneity of Nature.
Sung, mid +12th cent.
Ma Yü 馬鈺.
TT/1130.

Tzu-Yang Chen Jen Nei Chuan 紫陽眞人內傳.
Biography of the Adept of the Purple Yang.
H/Han, San Kuo or Chin, before +399.
Writer unknown.
This Tzu-Yang Chen Jen was Chou I-Shan 周義山 (not to be confused with Chang Po-Tuan).
Cf. Maspero (7), p. 201; (13), pp. 78, 103.
TT/300.

Tzu-Yang Chen Jen Wu Chen Phien 紫陽眞人悟眞篇.
See *Wu Chen Phien.*

Tzu Yang Tan Fang Pao Chien Chih Thu 紫陽丹房寶鑑之圖.
See *Tan Fang Pao Chien Chih Thu.*

Wai Chin Tan 外金丹.
Disclosures (of the Nature of) the Metallous Enchymoma [a collection of some thirty tractates on *nei tan* physiological alchemy, ranging in date from Sung to Chhing and of varying authenticity].
Sung to Chhing.
Ed. Fu Chin-Chhüan 傅金銓, *c.* 1830.
In *CTPS*, *pên* 6–10 incl.

Wai Kho Chêng Tsung 外科正宗.
An Orthodox Manual of External Medicine.
Ming, +1617.
Chhen Shih-Kung 陳實功.

Wai Kuo Chuan 外國傳.
See *Wu Shih Wai Kuo Chuan.*

Wai Tan Pên Tshao 外丹本草.
Iatrochemical Natural History.
Early Sung, *c.* +1045.
Tshui Fang 崔昉.
Now extant only in quotations.
Cf. *Chin Tan Ta Yao Pao Chüeh* and *Ta Tan Yao Chüeh Pên Tshao.*

Wai Thai Pi Yao (Fang) 外臺秘要(方).
Important (Medical) Formulae and Prescriptions now revealed by the Governor of a Distant Province.
Thang, +752.
Wang Thao 王燾.
On the title see des Rotours (1), pp. 294, 721. Wang Thao had had access to the books in the Imperial Library as an Academician before his posting as a high official to the provinces.

Wakan Sanzai Zue 和漢三才圖會.
The Chinese and Japanese Universal Encyclopaedia (based on the *San Tshai Thu Hui*).
Japan, +1712.
Terashima Ryōan 寺島良安.

Wamyō-Honzō. See *Honzō-Wamyō.*

Wamyō Ruijūshō 和(or 倭)名類聚抄.
General Encyclopaedic Dictionary.
Japan (Heian), +934.
Minamoto no Shitagau 源順.

Wamyōshō 和名抄.
See Wamyō Ruijushō.

Wan Hsing Thung Phu 萬姓統譜.
General Dictionary of Biography.
Ming, +1579.
Ling Ti-Chih 凌迪知.

Wan Ping Hui Chhun 萬病回春.
The Restoration of Well-Being from a Myriad Diseases.
Ming, +1587, pr. +1615.
Kung Thing-Hsien 龔廷賢.

Wan Shou Hsien Shu 萬壽仙書.
A Book on the Longevity of the Immortals [longevity techniques, especially gymnastics and respiratory exercises].
Chhing, +18th.
Tshao Wu-Chi 曹無極.
Included in Pa Tzu-Yuan (*1*).

Wang Hsien Fu 望仙賦.
Contemplating the Immortals; a Hymn of Praise [ode on Wangtzu Chhiao and Chhih Sung Tzu].
C/Han, −14 or −13.
Huan Than 桓譚.
In *CSHK* (Hou Han sect.), ch. 12, p. 7*b*; and several encyclopaedias.

Wang Lao Fu Chhi Khou Chüeh 王老服氣口訣.
See *Thai-Chhing Wang Lao Fu Chhi Khou Chüeh.*

Wang-Wu Chen-Jen Khou Shou Yin Tan Pi Chüeh Ling Phien 王屋眞人口授陰丹秘訣靈篇.
Numinous Record of the Confidential Oral Instructions on the Yin Enchymoma handed down by the Adept of Wang-Wu (Shan).
Thang, perhaps *c.* +765; certainly between +8th and late +10th.
Probably Liu Shou 劉守.
In *YCCC*, ch. 64, pp. 13*a* ff.

Wang-Wu Chen-Jen Liu Shou I Chen-Jen Khou Chüeh Chin Shang 王屋眞人劉守依眞人口訣進上.
Confidential Oral Instructions of the Adept of Wang-Wu (Shan) presented to the Court by Liu Shou.

Wang-Wu Chen-Jen Liu Shou I Chen-Jen Khou Chüeh Chin Shang (cont.)
Thang, *c.* +785 (after +780); certainly between +8th and late +10th.
Liu Shou 劉守.
In *YCCC*, ch. 64, pp. 14*a* ff.

Wei Lüeh 緯畧.
Compendium of Non-Classical Matters.
Sung, +12th century (end), *c.* +1190.
Kao Ssu-Sun 高似孫.

Wei Po-Yang Chhi Fan Tan Sha Chüeh.
See *Chhi Fan Tan Sha Chüeh.*

Wei Shêng I Chin Ching 衛生易筋經.
See *I Chin Ching.*

Wei Shu 魏書.
History of the (Northern) Wei Dynasty [+386 to +550, including the Eastern Wei successor State].
N/Chhi, +554, revised +572.
Wei Shou 魏收.
See Ware (3).
One ch. tr. Ware (1, 4).
For translations of passages, see the index of Frankel (1).

Wên Shih Chen Ching 文始眞經.
True Classic of the Original Word (of Lao Chün, third person of the Taoist Trinity).
Alternative title of *Kuan Yin Tzu* (q.v.).

Wên Yuan Ying Hua 文苑英華.
The Brightest Flowers in the Garden of Literature [imperially commissioned collection, intended as a continuation of the *Wên Hsüan* (q.v.) and containing therefore compositions written between +500 and +960].
Sung, +987; first pr. +1567.
Ed. Li Fang 李昉, Sung Pai 宋白 *et al.*
Cf des Rotours (2), p. 93.

Wu Chen Phien 悟眞篇.
[= *Tzu-Yang Chen Jen Wu Chen Phien.*]
Poetical Essay on Realising (the Necessity of Regenerating the) Primary (Vitalities) [Taoist physiological alchemy].
Sung, +1075.
Chang Po-Tuan 張伯端.
In, e.g., *Hsiu Chen Shih Shu* (*TT*/260), chs. 26–30 incl.
TT/138. Cf. *TT*/139–43.
Tr. Davis & Chao Yün-Tshung (7).

Wu Chen Phien Chih Chih Hsiang Shuo San Chhêng Pi Yao 悟眞篇直指詳說三乘祕要.
Precise Explanation of the Difficult Essentials of the *Essay on Realising the Necessity of Regenerating the Primary Vitalities*, in accordance with the Three Classes of (Taoist) Scriptures.
Sung, *c.* +1170.
Ong Pao-Kuang 翁葆光.
TT/140.

Wu Chen Phien San Chu 悟眞篇三註.
Three Commentaries on the *Essay on Realising the Necessity of Regenerating the Primary Vitalities* [Taoist physiological alchemy].
Sung and Yuan, completed *c.* +1331.
Hsüeh Tao-Kuang 薛道光 (or Ong Pao-Kuang 翁葆先), Lu Shu 陸墅 & Tai Chhi-Tsung 戴起宗 (or Chhen Chih-Hsü 陳致虛).
TT/139.
Cf. Davis & Chao Yün-Tshung (7).

Wu Chhêng Tzu 務成子.
See *Huang Thing Wai Ching Yü Ching Chu.*

Wu Chhu Ching 五廚經.
See *Lao Tzu Shuo Wu Chhu Ching.*

Wu Hsiang Lei Pi Yao 五相類祕要.
See *Tshan Thung Chhi Wu Hsiang Lei Pi Yao.*

Wu Hsing Ta I 五行大義.
Main Principles of the Five Elements.
Sui, *c.* +600.
Hsiao Chi 蕭吉.

Wu Hsüan Phien 悟玄篇.
Essay on Understanding the Mystery (of the Enchymoma), [Taoist physiological alchemy].
Sung, +1109 or +1169.
Yü Tung-Chen 余洞眞.
TT/1034, and in *TTCY* (*shang mao chi*, 5).

Wu I Chi 武夷集.
The Wu-I Mountains Literary Collection [prose and poems on physiological alchemy].
Sung, *c.* +1220.
Ko Chhang-Kêng 葛長庚 (Pai Yü-Chhan 白玉蟾).
In *Hsiu Chen Shih Shu* (*TT*/260), chs. 45–52.

Wu Kên Shu 無根樹.
The Rootless Tree [poems on physiological alchemy].
Ming, *c.* +1410 (if genuine).
Attrib. Chang San-Fêng 張三峯.
In *San-Fêng Tan Chüeh* (q.v.).

Wu Lei Hsiang Kan Chih 物類相感志.
On the Mutual Responses of Things according to their Categories.
Sung, *c.* +980.
Attrib. wrongly to Su Tung-Pho 蘇東坡.
Actual writer (Lu) Tsan-Ning (monk) 錄贊寧.
See Su Ying-Hui (*1*, *2*).

Wu Li Hsiao Shih 物理小識.
Small Encyclopaedia of the Principles of Things.
Ming and Chhing, finished by +1643, pr. +1664.
Fang I-Chih 方以智.
Cf. Hou Wai-Lu (*3*, *4*).

Wu Lu 吳錄.
Record of the Kingdom of Wu.
San Kuo, +3rd century.
Chang Pho 張勃.

Wu Shang Pi Yao 無上秘要.
Essentials of the Matchless Books (of Taoism), [a florilegium].
N/Chou, between +561 and +578.
Compiler unknown.
TT/1124.
Cf. Maspero (13), p. 77; Schipper (1), p. 11.

Wu shih Pên Tshao 吳氏本草.
Mr Wu's Pharmaceutical Natural History.
San Kuo (Wei), *c.* +235.
Wu Phu 吳普.
Extant only in quotations in later literature.

Wu Shih Wai Kuo Chuan 吳時外國傳.
Records of the Foreign Countries in the Time of the State of Wu.
San Kuo, *c.* +260.
Khang Thai 康泰.
Only in fragments in *TPYL* and other sources.

Wu Tai Shih Chi.
See *Hsin Wu Tai Shih.*

Wu Yuan 物原.
The Origins of Things.
Ming, +15th.
Lo Chhi 羅頎.

Yang Hsing Yen Ming Lu 養性延命錄.
On Delaying Destiny by Nourishing the Natural Forces (or, Achieving Longevity and Immortality by Regaining the Vitality of Youth), [Taoist sexual and respiratory techniques].
Sung, betw. +1013 and +1161 (acc. to Maspero), but as it appears in *YCCC* it must be earlier than +1020, very probably pre-Sung.
Attrib. Thao Hung-Ching or Sun Ssu-Mo.
Actual writer unknown.
TT/831, abridged version in *YCCC*, ch. 32, pp. 1*a* ff.
Cf. Maspero (7), p. 232.

Yang Hui Suan Fa 楊輝算法.
Yang Hui's Methods of Computation.
Sung, +1275.
Yang Hui 楊輝.

Yang Shêng Shih Chi 養生食忌.
Nutritional Recommendations and Prohibitions for Health [appended to *Pao Shêng Hsin Chien*, q.v.].
Ming, *c.* +1506.
Thieh Fêng Chü-Shih 鐵峰居士.
(The Recluse of Iron Mountain, ps.).
Ed. Hu Wên-Huan (*c.* +1596) 胡文煥.

Yang Shêng Tao Yin Fa 養生導引法.
Methods of Nourishing the Vitality by Gymnastics (and Massage), [appended to *Pao Shêng Hsin Chien*, q.v.].
Ming, *c.* +1506.
Thieh Fêng Chü-Shih 鐵峰居士.
(The Recluse of Iron Mountain, ps.)
Ed. Hu Wên-Huan (*c.* +1596) 胡文煥.

Yang Shêng Thai Hsi Chhi Ching 養生胎息氣經.
[= *Thai-Shang Yang Shêng Thai Hsi Chhi Ching*.]
Manual of Nourishing the Life-Force (or, Attaining Longevity and Immortality) by Embryonic Respiration.
Late Thang or Sung.
Writer unknown.
TT/812.
Cf. Maspero (7), pp. 358, 365.

Yang Shêng Yen Ming Lu 養生延命錄.
On Delaying Destiny by Nourishing the Natural Forces.
Alternative title for *Yang Hsing Yen Ming Lu* (q.v.).

Yao Chung Chhao 藥種抄.
Memoir on Several Varieties of Drug Plants.
Japan, *c.* +1163.
Kuan-Yu (Kanyu) 觀祐. MS. preserved at the 滋賀石山寺 Temple. Facsim. reprod. in Suppl. to the Japanese Tripiṭaka, vol. 11.

Yao Hsing Lun 藥性論.
Discourse on the Natures and Properties of Drugs.
Liang (or Thang, if identical with *Pên Tshao Yao Hsing*, q.v.).
Attrib. Thao Hung-Ching 陶弘景.
Only extant in quotations in books on pharmaceutical natural history.
ICK, p. 169.

Yao Hsing Pên Tshao 藥性本草.
See *Pên Tshao Yao Hsing.*

Yao Ming Yin Chüeh 藥名隱訣.
Secret Instructions on the Names of Drugs and Chemicals.
Perhaps an alternative title for the *Thai-Chhing Shih Pi Chi* (q.v.).

Yeh Chung Chi 鄴中記.
Record of Affairs at the Capital of the Later Chao Dynasty.
Chin.
Lu Hui 陸翽.
Cf. Hirth (17).

Yen Fan Lu 演繁露.
Extension of the *String of Pearls* (*on the Spring and Autumn Annals*), [on the meaning of many Thang and Sung expressions].
Sung, +1180.
Chhêng Ta-Chhang 程大昌.
See des Rotours (1), p. cix.

Yen Hsien Chhing Shang Chien 燕閒清賞箋.
The Use of Leisure and Innocent Enjoyments in a Retired Life [the sixth part (chs. 14, 15) of *Tsun Shêng Pa Chien*, q.v.].
Ming, +1591.
Kao Lien 高濂.

Yen I I Mou Lu 燕翼詒謀錄.
Handing Down Good Plans for Posterity from the Wings of Yen.
Sung, +1227.
Wang Yung 王栐.

Yen-Ling hsien-sêng Chi Hsin Chiu Fu Chhi Ching 延陵先生集新舊服氣經.
New and Old Manuals of Absorbing the Chhi, Collected by the Teacher of Yen-Ling.
Thang, early +8th, *c.* +745.
Writer unidentified.
Comm. by Sang Yü Tzu (+9th or +10th) 桑榆子.
TT/818, and (partially) in *YCCC*, ch. 58, p. 2*a et passim*, ch. 59, pp. 1*a* ff., 18*b* ff., ch. 61, pp. 19*a* ff.
Cf. Maspero (7), pp. 220, 222.

Yen Mên Kung Miao Chieh Lu 鴈門公妙解錄.
The Venerable Yen Mên's Record of Marvellous Antidotes [alchemy and elixir poisoning].
Thang, probably in the neighbourhood of +847 since the text is substantially identical with the *Hsüan Chieh Lu* (q.v.) of this date.
Yen Mên 鴈門 (perhaps a ps. taken from the pass and fortress on the Great Wall, cf. Vol. 4, pt. 3, pp. 11, 48 and Fig. 711).
TT/937.

Yen Nien Chhio Ping Chien 延年却病牋.
How to Lengthen one's Years and Ward off all Diseases [the fourth part (chs. 9, 10) of *Tsun Shêng Pa Chien*, q.v.].
Ming, +1591.
Kao Lien 高濂.
Partial tr. of the gymnastic material, Dudgeon (1).

Yen Shou Chhih Shu 延壽赤書.
Red Book on the Promotion of Longevity.
Thang, perhaps Sui.
Phei Yü (or Hsüan) 裴煜 (玄).
Extant only in excerpts preserved in the *I Hsin Fang* (+982), SIC, p. 465.

Yen Thieh Lun 鹽鐵論.
Discourses on Salt and Iron [record of the debate of −81 on State control of commerce and industry].
C/Han, *c.* −80 to −60.
Huan Khuan 桓寬.
Partial tr. Gale (1); Gale, Boodberg & Lin.

Yin Chen Chün Chin Shih Wu Hsiang Lei 陰眞君金石五相類.
Alternative title of *Chin Shih Wu Hsiang Lei* (q.v.).

Yin Chen Jen Liao Yang Tien Wên Ta Pien 尹眞人寥陽殿問答編.
See *Liao Yang Tien Wên Ta Pien*.

Yin Chen Jen Tung-Hua Chêng Mo Huang Chi Ho Pi Chêng Tao Hsien Ching 尹眞人東華正脈皇極闔闢證道仙經.
See *Huang Chi Ho Pi Hsien Ching*.

Yin Chuan Fu Shih Chien 飲饌服食牋.
Explanations on Diet, Nutrition and Clothing [the fifth part (chs. 11–13) of *Tsun Shêng Pa Chien*, q.v.].
Ming, +1591.
Kao Lien 高濂.

Yin Fu Ching 陰符經.
The Harmony of the Seen and the Unseen.
Thang, *c.* +735 (unless in essence a preserved late Warring States document).
Li Chhüan 李筌.
TT/30.
Cf. *TT*/105–124. Also in *TTCY* (*tou chi*, 6).
Tr. Legge (5).
Cf. Maspero (7), p. 222.

Yin Shan Chêng Yao 飲膳正要.
Principles of Correct Diet [on deficiency diseases, with the aphorism 'many diseases can be cured by diet alone'].
Yuan, +1330, re-issued by imperial order in +1456.
Hu Ssu-Hui 忽思慧.
See Lu & Needham (1).

Yin Tan Nei Phien 陰丹內篇.
Esoteric Essay on the Yin Enchymoma.
Appendix to the *Tho Yo Tzu* (q.v.).

Yin-Yang Chiu Chuan Chhêng Tzu-Chin Tien-Hua Huan Tan Chüeh 陰陽九轉成紫金點化還丹訣.
Secret of the Cyclically Transformed Elixir, Treated through Nine Yin-Yang Cycles to Form Purple Gold and Projected to Bring about Transformation.
Date unknown.
Writer unknown, but someone with Mao Shan affiliations.
TT/888.

Ying Chhan Tzu Yü Lu 瑩蟾子語錄.
Collected Discourses of the Luminous-Toad Master.
Yuan, *c.* +1320.
Li Tao-Shun 李道純 (Ying Chhan Tzu 瑩蟾子).
TT/1047.

Ying Yai Shêng Lan 瀛涯勝覽.
Triumphant Visions of the Ocean Shores [relative to the voyages of Chêng Ho].
Ming, +1451. (Begun +1416 and completed about +1435.)
Ma Huan 馬歡.
Tr. Mills (11); Groeneveldt (1); Phillips (1); Duyvendak (10).

Ying Yai Shêng Lan Chi 瀛涯勝覽集.
Abstract of the *Triumphant Visions of the Ocean Shores* [a refacimento of Ma Huan's book].
Ming, +1522.
Chang Shêng (*b*) 張昇.
Passages cit. in *TSCC*, *Pien i tien*, chs. 58, 73, 78, 85, 86, 96, 97, 98, 99, 101, 103, 106.
Tr. Rockhill (1).

Yōjōkun 養生訓.
Instructions on Hygiene and the Prolongation of Life.
Japan (Tokugawa), *c.* +1700.
Kaibara Ekiken 貝原益軒 (ed. Sugiyasu Saburō 杉靖三郎).

Yü-Chhing Chin-Ssu Chhing-Hua Pi-Wên Chin-Pao Nei-Lien Tan Chüeh 玉清金笥青華祕文金寶內鍊丹訣.
The Green-and-Elegant Secret Papers in the Jade-Purity Golden Box on the Essentials of the Internal Refining of the Golden Treasure, the Enchymoma.
Sung, late +11th century.
Chang Po-Tuan 張伯端.
TT/237.
Cf. Davis & Chao Yün-Tshung (5).

Yü-Chhing Nei Shu 玉清內書.
Inner Writings of the Jade-Purity (Heaven).
Probably Sung, but present version incomplete, and some of the material may be, or may have been, older.
Compiler unknown.
TT/940.

Yü Fang Chih Yao 玉房指要.
Important Matters of the Jade Chamber.
Pre-Sui, perhaps +4th century.
Writer unknown.
In *I Hsin Fang* (*Ishinhō*) and *Shuang Mei Ching An Tshung Shu*.
Partial trs. van Gulik (3, 8).

Yü Fang Pi Chüeh 玉房祕訣.
Secret Instructions concerning the Jade Chamber.
Pre-Sui, perhaps +4th century.
Writer unknown.
Partial tr. van Gulik (3).
Only as fragment in *Shuang Mei Ching An Tshung Shu* (q.v.).

Yu Huan Chi Wên 游宦紀聞.
Things Seen and Heard on my official Travels.
Sung, +1233.
Chang Shih-Nan 張世南.

Yü Phien 玉篇.
Jade Page Dictionary.
Liang, +543.
Ku Yeh-Wang 顧野王.
Extended and edited in the Thang (+674) by Sun Chhiang 孫强.

Yü Shih Ming Yen 喻世明言.
Stories to Enlighten Men.
Ming, *c.* +1640.
Fêng Mêng-Lung 馮夢龍.

Yü Tung Ta Shen Tan Sha Chen Yao Chüeh 玉洞大神丹砂眞要訣.
True and Essential Teachings about the Great Magical Cinnabar of the Jade Heaven [paraphrase of +8th-century materials].
Thang, not before +8th.
Attrib. Chang Kuo 張果.
TT/889.

Yu-Yang Tsa Tsu 酉陽雜俎.
Miscellany of the Yu-yang Mountain (Cave) [in S.E. Szechuan].
Thang, +863.
Tuan Chhêng-Shih 段成式.
See des Rotours (1), p. civ.

Yuan Chhi Lun 元氣論.
Discourse on the Primary Vitality (and the Cosmogonic Chhi).
Thang, late +8th or perhaps +9th.
Writer unknown.
In *YCCC*, ch. 56.
Cf. Maspero (7), p. 207.

Yuan-Shih Shang Chen Chung Hsien Chi 元始上眞衆仙記.
Record of the Assemblies of the Perfected Immortals; a Yuan-Shih Scripture.
Ascr. Chin, *c.* +320, more probably +5th or +6th.
Attrib. Ko Hung 葛洪.
TT/163.

Yuan Yang Ching 元陽經.
Manual of the Primary Yang (Vitality).
Chin, L/Sung, Chhi or Liang, before +550.
Writer unknown.
Extant only in quotations, in *Yang Hsing Yen Ming Lu*, etc.
Cf. Maspero (7), p. 232.

Yuan Yu 遠遊.
Roaming the Universe; or, The Journey into Remoteness [ode].
C/Han, *c.* −110.
Writer's name unknown, but a Taoist.
Tr. Hawkes (1).

Yüeh Wei Tshao Thang Pi Chi 閱微草堂筆記.
Jottings from the Yüeh-wei Cottage.
Chhing, 1800.
Chi Yün 紀昀.

Yün Chai Kuang Lu 雲齋廣錄.
Extended Records of the Cloudy Studio.
Sung.
Li Hsien-Min 李獻民.

Yün Chhi Yu I 雲溪友議.
Discussions with Friends at Cloudy Pool
Thang, *c.* +870.
Fan Shu 范攄.

Yün Chi Chhi Chhien 雲笈七籤.
The Seven Bamboo Tablets of the Cloudy Satchel [an important collection of Taoist material made by the editor of the first definitive form of the *Tao Tsang* (+1019), and including much material which is not in the Patrology as we now have it].
Sung, *c.* +1022.
Chang Chün-Fang 張君房.
TT/1020.

Yün Hsien Tsa Chi 雲仙雜記.
Miscellaneous Records of the Cloudy Immortals.
Thang or Wu Tai, *c.* +904.
Fêng Chih 馮贄.

Yün Hsien San Lu 雲仙散錄.
Scattered Remains on the Cloudy Immortals.
Ascr. Thang or Wu Tai, *c.* +904, actually probably Sung.
Attrib. Fêng Chih 馮贄, but probably by Wang Chih 王銍.

Yün Kuang Chi 雲光集.
Collected (Poems) of Light (through the) Clouds.
Sung, *c.* +1170.
Wang Chhu-I 王處一.
TT/1138.

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Hai Kho Lun 海客論
Guests from Overseas [descriptions of alchemical exotica] Sung.
Li Kuang-Hsüan 李光玄.
TT/1033.

Ju Lin Wai Shih 儒林外史.
Unofficial History of the World of Learning [satirical novel on the life of the literati in the Ming period].
Chhing, begun before +1736, completed +1749.
Wu Ching-Tzu 吳敬梓.
Tr. Yang & Yang (1); Tomkinson (2).
Cf. Chang Hsin-Tshang (2).

Shih Shuo Hsin Yu 世說新語.
New Discourse on the Talk of the Times [notes of minor incidents from Han to Chin].
Cf. *Hsü Shih Shuo*.
L/Sung, +5th.
Liu I-Chhing 劉義慶.
Commentary by Liu Hsün 劉峻 (Liang).

CONCORDANCE FOR *TAO TSANG* BOOKS AND TRACTATES

Wieger nos.		Ong nos.
1	(*Ling-Pao Wu Liang*) *Tu Jen* (*Shang Phin Miao*) *Ching*	1
8	*Thai-Shang San-shih-liu Pu Tsun Ching* (contains *Shang Chhing Ching*)	8
30	(*Huang Ti*) *Yin Fu Ching*	31
119	*Huang Ti Yin Fu Ching Chu*	122
127	*Thai Hsi Ching Chu*	130
130	*Thai-Shang Tung Fang Nei Ching Chu*	133
132	(*Tshui Kung*) *Ju Yao Ching Chu Chieh*	135
133	*Lü Shun-Yang Chen Jen Chhin Yuan Chhun Tan Tzhu Chu Chieh*	136
134	(*Chhiu Chhang-Chhun*) *Chhing Thien Ko Chu Shih*	137
137	*Shang-Chhing Wo Chung Chüeh*	140
138	(*Tzu-Yang Chen Jen*) *Wu Chen Phien Chu Su*	141
139	*Wu Chen Phien San Chu*	142
140	(*Tzu-Yang Chen Jen*) *Wu Chen Phien Chih Chih Hsiang Shuo San Chhêng Pi Yao*	143
146	*Hsiu-Chen Thai Chi Hun Yuan Thu*	149
147	*Hsiu-Chen Thai Chi Hun Yuan Chih Hsüan Thu*	150
148	*Chin I Huan Tan Yin Chêng Thu*	151
149	*Hsiu-Chen Li Yen Chhao Thu*	152
153	*Shang-Chhing Tung-Chen Chiu Kung Tzu Fang Thu*	156
163	*Yuan-Shih Shang Chen Chung Hsien Chi*	166
164	*Tung-Hsüan Ling-Pao Chen Ling Wei Yeh Thu*	167
173	*Hsüan Fêng Chhing Hui Lu*	176
228	*Chen I Chin Tan Chüeh*	231
229	*Huan Tan Pi Chüeh Yang Chhih-Tzu Shen Fang*	232
230	*Huan Tan Chung Hsien Lun*	233
231	*Hsiu Tan Miao Yung Chih Li Lun*	234
237	*Yü-Chhing Chin-Ssu Chhing-Hua Pi-Wên Chin-Pao Nei-Lien Tan Chüeh*	240
239	*Chih-Chou hsien-sêng Chin Tan Chih Chih*	242
240	(*Chhen Hsü-Pai hsien-sêng*) *Kuei Chung Chih Nan*	243
241	*Ta Tan Chih Chih*	244
243	*Hsi Shan Chhun Hsien Hui Chen Chi*	246
248	*Chhüan-Chen Chi Hsüan Pi Yao*	251
252	*Thai-Wei Ling Shu Tzu-Wên Lang-Kan Hua Tan Shen Chen Shang Ching*	255
256	(*Thao Chen Jen*) *Nei Tan Fu*	259
257	*Chhin Hsüan Fu*	260
258	*Chin Tan Fu*	261
260	*Hsiu-Chen Shih Shu*	263
261	*Chen Chhi Huan Yuan Ming*	264
263	*Chin I Huan Tan Pai Wên Chüeh*	266
266	*Chih Chen Tzu Lung Hu Ta Tan Shih*	269
275	*Chhing Wei Tan Chüeh* (or *Fa*)	278
289	*Han Wu* (*Ti*) *Nei Chuan*	292
290	*Han Wu* (*Ti*) *Wai Chuan*	293
293	*Li-Shih Chen Hsien Thi Tao Thung Chien*	296
297	*Hua-Yang Thao Yin-Chü Chuan*	300
300	*Tzu-Yang Chen Jen* (*Chou I-Shan*) *Nei Chuan*	303
301	(*San*) *Mao Shan Chih*	304
304	*Hsi Yo Hua-Shan Chih*	307
328	(*Thai-Shang*) *Huang Thing Nei Ching Yü Ching*	331
329	(*Thai-Shang*) *Huang Thing Wai Ching Yü Ching*	332
366	(*Thai-Shang Tung-Hsüan Ling-Pao Mieh Tu* (or *San Yuan*) *Wu Lien*) *Shêng Shih Miao Ching*	369
385	*Thai-Shang Ling-Pao Wu Fu* (*Ching*)	388
398	*Huang Thing Nei Ching Yü Ching Chu* by Liu Chhang-Shêng	401
399	*Huang Thing Nei Ching* (*Yü*) *Ching Chu* by Liang Chhiu Tzu	402
400	*Huang Thing Nei Wai Ching Yü Ching Chieh*	403
416	*Ling-Pao Chung Chen Tan Chüeh*	419
417	*Shen Hsien Fu Erh Tan Shih Hsing Yao Fa*	420
418	*Têng Chen Yin Chüeh*	421
419	(*Shang-Chhing*) *San Chen Chih Yao Yü Chüeh*	422
421	(*Shang-Chhing*) *Ming Thang Yuan Chen Ching Chüeh*	424
423	*Shang-Chhing Thai-Shang Pa Su Chen Ching*	426
428	*Shang-Chhing Han Hsiang Chien Chien Thu*	431
429	*Huang Thing Nei Ching Wu Tsang Liu Fu Pu Hsieh Thu*	432
439	*Shang-Chhing Hou Shêng Tao Chün Lieh Chi*	442
445	(*Hsi Shan*) *Hsü Chen-Chün* (*Hsü Hsün*) *Pa-shih-wu Hua Lu*	448
447	*Thai-Chi Ko Hsien-Ong* (or *Kung*) (Ko Hsüan) *Chuan*	450
524	*Thai-Shang Tung-Hsüan Ling-Pao Shou Tu I*	528
605	*Ling-Pao Chiu Yu Chhang Yeh Chhi Shih Tu Wang Hsüan Chang*	610
611	*Kuang Chhêng Chi*	616

Wieger nos.		Ong nos.
634	*Huang-Thien Shang-Chhing Chin Chhüeh Ti Chün Ling Shu Tzu-Wên Shang Ching*	639
635	*Tung Shen Pa Ti Miao Ching Ching*	640
761	*Thu Ching (Chi Chu) Yen I Pên Tshao*	767 768
773	*Hsüan Phin Lu*	780
810	*(Thai-Chhing) Chung Huang Chen Ching*	816
811	*(Thai-Chhing) Tao Yin Yang-Shêng Ching*	817
812	*(Thai-Shang) Yang-Shêng Thai-Hsi Chhi Ching*	818
813	*Thai-Chhing Thiao Chhi Ching*	819
814	*Thai-Shang Lao Chün Yang-Shêng Chüeh*	820
815	*Thai-Chhing (Wang Lao) Fu Chhi Khou Chüeh* (or *Chhuan Fa*)	821
817	*Sung Shan Thai-Wu hsien-sêng Chhi Ching*	823
818	*(Yen-Ling hsien-sêng Chi) Hsin Chiu Fu Chhi Ching*	824
821	*(Huan-Chen hsien-sêng) Fu Nei Yuan Chhi Chüeh*	827
830	*Chen Chung Chi*	836
(830)	*(Shê Yang) Chen Chung Chi* (or *Fang*)	(836)
831	*Yang Hsing Yen Ming Lu*	837
835	*(Pao Phu Tzu) Yang Shêng Lun*	841
838	*Shang-Chhing Ching Chen Tan Pi Chüeh*	844
856	*Shen Hsien Lien Tan Tien Chu San Yuan Pao Chao Fa*	862
873	*Thai-Chhing* (or *Shang-Chhing*) *Chin I Shen Tan Ching*	879
874	*Thai-Chhing Shih Pi Chi*	880
875	*Thai-Chhing Chin I Shen Chhi Ching*	881
876	*(Thai-Chhing Ching) Thien-Shih Khou Chüeh*	882
878	*(Huang Ti) Chiu Ting Shen Tan Ching Chüeh*	884
879	*Chiu Chuan Ling Sha Ta Tan Tzu Shêng Hsüan Ching*	885
880	*(Chang Chen Jen) Chin Shih Ling Sha Lun*	886
881	*(Wei Po-Yang) Chhi Fan Tan Sha Chüeh*	887
882	*(Thai-Chi Chen Jen) Chiu Chuan Huan Tan Ching Yao Chüeh*	888
883	*(Ta-Tung Lien Chen Pao Ching) Hsiu Fu Ling Sha Miao Chüeh*	889
884	*(Ta-Tung Lien Chen Pao Ching) Chiu Huan Chin Tan Miao Chüeh*	890
885	*(Thai-Shang Wei Ling Shen Hua) Chiu Chuan Tan Sha Fa*	891
886	*Chiu Chuan Ling Sha Ta Tan*	892
887	*Chiu Chuan Chhing Chin Ling Sha Tan*	893
888	*Yin-Yang Chiu Chuan Chhêng Tzu Chin Tien Hua Huan Tan Chüeh*	894
889	*Yü-Tung Ta Shen Tan Sha Chen Yao Chüeh*	895
890	*Ling Sha Ta Tan Pi Chüeh*	896
891	*Pi Yü Chu Sha Han Lin Yü Shu Kuei*	897
892	*Ta Tan Chi*	898
893	*Tan Fang Hsü Chih*	899
894	*Shih Yao Erh Ya*	900
895	*(Chih-Chhuan Chen Jen) Chiao Chêng Shu*	901
896	*Shun-Yang Lü Chen Jen Yao Shih Chih*	902
897	*Chin Pi Wu Hsiang Lei Tshan Thung Chhi*	903
898	*Tshan Thung Chhi Wu Hsiang Lei Pi Yao*	904
899	*(Yin Chen Chün) Chin Shih Wu Hsiang Lei*	905
900	*Chin Shih Pu Wu Chiu Shu Chüeh*	906
901	*Shang-Chhing Chiu Chen Chung Ching Nei Chüeh*	907
902	*Lung Hu Huan Tan Chüeh*	908
903	*Chin Hua Yü I Ta Tan*	909
904	*Kan Chhi Shih-liu Chuan Chin Tan*	910
905	*Hsiu Lien Ta Tan Yao Chih* (or *Chüeh*)	911
906	*Thung Yu Chüeh*	912
907	*Chin Hua Chhung Pi Tan Ching Pi Chih*	913
908	*Huan Tan Chou Hou Chüeh*	914
909	*Phêng-Lai Shan Hsi Tsao Huan Tan Ko*	915
910	*(Pao Phu Tzu) Shen Hsien Chin Shuo Ching*	916
911	*Chu Chia Shen Phin Tan Fa*	917
912	*Chhien Hung Chia Kêng Chih Pao Chi Chhêng*	918
913	*Tan Fang Ao Lun*	919
914	*Chih Kuei Chi*	920
915	*Huan Chin Shu*	921
916	*Ta Tan Chhien Hung Lun*	922
917	*Chen Yuan Miao Tao Yao Lüeh*	923
918	*Tan Fang Chien Yuan*	924
919	*Ta Huan Tan Chao Chien*	925
920	*Thai-Chhing Yü Pei Tzu*	926
921	*Hsüan Chieh Lu*	927
922	*(Hsien-Yuan Huang Ti) Shui Ching Yao Fa*	928
923	*San-shih-liu Shui Fa*	929
927	*Thai Pai Ching*	933
928	*Tan Lun Chüeh Chih Hsin Chien*	934
932	*Ta Tan Wên Ta*	938
933	*Chin Mu Wan Ling Lun*	939
934	*Hung Chhien Ju Hei Chhien Chüeh*	940
935	*Thung Hsüan Pi Shu*	941
937	*Yen Mên Kung Miao Chieh Lu* (=921)	943
938	*Hsüan Shuang Chang Shang Lu*	944
939	*Thai-Chi Chen Jen Tsa Tan Yao Fang*	945
940	*Yü Chhing Nei Shu*	946
942	*Thai-Ku Thu Tui Ching*	948
943	*Shang-Tung Hsin Tan Ching Chüeh*	949
944	*(Hsü Chen-Chün) Shih Han Chi*	950

Wieger nos.		Ong nos.
945	*Chiu Chuan Liu* (or *Ling*). *Chu Shen Hsien Chiu Tan Ching*	951
946	*Kêng Tao Chi*	952
988	(*Ku Wên*) *Lung Hu Ching Chu Su*	994
989	(*Ku Wên*) *Lung Hu Shang Ching Chu*	995
990	*Chou I Tshan Thung Chhi* (*Chu*) comm. by Yin Chhang-Shêng	996
991	*Chou I Tshan Thung Chhi Chu* comm. anon.	997
992	*Tshan Thung Chhi Khao I* (or *Chou I Tshan Thung Chhi Chu*) comm. by Chu Hsi	998
993	*Chou I Tshan Thung Chhi Fên Chang Thung Chen I* comm. by Phêng Hsiao	999
994	*Chou I Tshan Thung Chhi Ting Chhi Ko Ming Ching Thu* comm. by Phêng Hsiao	1000
995	*Chou I Tshan Thung Chhi Chu* comm. anon.	1001
996	*Chou I Tshan Thung Chhi Fa Hui* comm. by Yü Yen	1002
997	*Chou I Tshan Thung Chhi Shih I* comm. by Yü Yen	1003
998	*Chou I Tshan Thung Chhi Chieh* comm. by Chhen Hsien-Wei	1004
999	*Chou I Tshan Thung Chhi Chu* comm. by Chhu Hua-Ku	1005
1004	*Chen Kao*	1010
1005	*Tao Shu*	1011
1020	*Yün Chi Chhi Chhien*	1026
1022	*Thai Hsüan Pao Tien*	1028
1024	*Tso Wang Lun*	1030
1028	*Huang Chi Ching Shih* (*Shu*)	1034
1034	*Wu Hsüan Phien*	1040
1044	*Tan-Yang Chen Jen Yü Lu*	1050
1047	*Ying Chhan Tzu Yü Lu*	1053
1053	(*Shang Yang Tzu*) *Chin Tan Ta Yao*	1059
1054	(*Shang Yang Tzu*) *Chin Tan Ta Yao Thu*	1060
1055	(*Shang Yang Tzu*) *Chin Tan Ta Yao Lieh Hsien Chih*	1061
1056	(*Sheng Yang Tzu*) *Chin Tan Ta Yao Hsien Phai* (*Yuan Liu*)	1062
1058	*Chin Tan Chih Chih*	1064
1067	*Chin Tan Ssu Pai Tzu* (*Chu*)	1073
1068	*Lung Hu Huan Tan Chüeh Sung*	1074
1074	*Huan Tan Fu Ming Phien*	1080
1076	*Tshui Hsü Phien*	1082

Wieger nos.		Ong nos.
1077	*Huan Yuan Phien*	1083
1087	*Thai Phing Ching*	1093
1124	*Wu Shang Pi Yao*	1130
1125	*San Tung Chu Nang*	1131
1127	*Hsien Lo Chi*	1133
1128	*Chien Wu Chi*	1134
1130	*Tzu-Jan Chi*	1136
1135	*Tung-Hsüan Chin Yü Chi*	1141
1136	*Tan-Yang Shen Kuang Tshan*	1142
1138	*Yün Kuang Chi*	1144
1139	(*Wang*) *Chhung-Yang Chhüan Chen Chi*	1145
1140	(*Wang*) *Chhung-Yang Chiao Hua Chi*	1146
1141	(*Wang*) *Chhung-Yang Fên-Li Shih-Hua Chi*	1147
1142	(*Wang*) *Chhung-Yang* (*Chen Jen*) *Chin-Kuan* (or *Chhüeh*) *Yü-So Chüeh*	1148
1145	*Chhang-Chhun Tzu Phan-Chhi Chi*	1151
1146	*Than hsien-sêng Shui Yün Chi*	1152
1147	*Thai-Ku Chi*	1153
1162	*Mo Tzu*	1168
1170	*Huai Nan* (*Tzu*) *Hung Lieh Chieh*	1176
1171	*Pao Phu Tzu, Nei Phien*	1177
1172	*Pao Phu Tzu, Pieh Chih*	1178
1173	*Pao Phu Tzu, Wai Phien*	1179
1174	*Tho Yo Tzu*	1180
1187	*Tung Shen Pa Ti Yuan* (*Hsüan*) *Pien Ching*	1193
1204 1205 1206	*Shang-Chhing Ling-Pao Ta Fa*	1211 1212 1213
1212	*Chhüan-Chen Tso Po Chieh Fa*	1219
1216	(*Wang*) *Chhung-Yang Li-Chiao Shih-Wu Lun*	1223
1225	*Chêng I Fa Wên* (*Thai-Shang*) *Wai Lu I*	1233
1235	*Tao Fa Hsin Chhuan*	1243
1273	*Shang-Chhing Ching Pi Chüeh*	1281
1276	*Shang-Chhing Huang Shu Kuo Tu I*	1284
1287	*Ko Hsien-Ong* (Ko Hung) *Chou Hou Pei Chi Fang*	1295
1295	(*Tung-Chen Thai-Shang Su-Ling Tung-Yuan*) *Ta Yu Miao Ching*	1303
1357	*Shang-Chhing Thai-Shang Ti Chün Chiu Chen Chung Ching*	1365
1382	*Huang Thing Chung Ching Ching*	1390
1405	*Thai-Shang Lao Chün Thai Su Ching* (see index s.v. *Thai Su Chuan*)	1413
1442	*Han Thien Shih Shih Chia*	1451

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GENERAL INDEX

by MURIEL MOYLE

NOTES

(1) Articles (such as 'the', 'al-', etc.) occurring at the beginning of an entry, and prefixes (such as 'de', 'van', etc.) are ignored in the alphabetical sequence. Saints appear among all letters of the alphabet according to their proper names. Styles such as Mr, Dr, if occurring in book titles or phrases, are ignored; if with proper names, printed following them.

(2) The various parts of hyphenated words are treated as separate words in the alphabetical sequence. It should be remembered that, in accordance with the conventions adopted, some Chinese proper names are written as separate syllables while others are written as one word.

(3) In the arrangement of Chinese words, Chh- and Hs- follow normal alphabetical sequence, and *ü* is treated as equivalent to *u*.

(4) References to footnotes are not given except for certain special subjects with which the text does not deal. They are indicated by brackets containing the superscript letter of the footnote.

(5) Explanatory words in brackets indicating fields of work are added for Chinese scientific and technological persons (and occasionally for some of other cultures), but not for political or military figures (except kings and princes).

TABLE OF CHINESE DYNASTIES

夏	Hsia kingdom (legendary?)		*c.* −2000 to *c.* −1520
商	Shang (Yin) kingdom		*c.* −1520 to *c.* −1030
周	Chou dynasty (Feudal Age)	Early Chou period	*c.* −1030 to −722
		Chhun Chhiu period 春秋	−722 to −480
		Warring States (Chan Kuo) period 戰國	−480 to −221
First Unification	秦 Chhin dynasty		−221 to −207
	漢 Han dynasty: Chhien Han (Earlier or Western)		−202 to +9
	Hsin interregnum		+9 to +23
	Hou Han (Later or Eastern)		+25 to +220
	三國 San Kuo (Three Kingdoms period)		+221 to +265
First Partition	蜀 Shu (Han)	+221 to +264	
	魏 Wei	+220 to +265	
	吳 Wu	+222 to +280	
Second Unification	晉 Chin dynasty: Western		+265 to +317
	Eastern		+317 to +420
	劉宋 (Liu) Sung dynasty		+420 to +479
Second Partition	Northern and Southern Dynasties (Nan Pei chhao)		
	齊 Chhi dynasty		+479 to +502
	梁 Liang dynasty		+502 to +557
	陳 Chhen dynasty		+557 to +589
	魏: Northern (Thopa) Wei dynasty		+386 to +535
	Western (Thopa) Wei dynasty		+535 to +556
	Eastern (Thopa) Wei dynasty		+534 to +550
	北齊 Northern Chhi dynasty		+550 to +577
	北周 Northern Chou (Hsienpi) dynasty		+557 to +581
Third Unification	隋 Sui dynasty		+581 to +618
	唐 Thang dynasty		+618 to +906
Third Partition	五代 Wu Tai (Five Dynasty period) (Later Liang, Later Thang (Turkic), Later Chin (Turkic), Later Han (Turkic) and Later Chou)		+907 to +960
	遼 Liao (Chhitan Tartar) dynasty		+907 to +1124
	West Liao dynasty (Qarā-Khiṭāi)		+1124 to +1211
	西夏 Hsi Hsia (Tangut Tibetan) state		+986 to +1227
Fourth Unification	宋 Northern Sung dynasty		+960 to +1126
	宋 Southern Sung dynasty		+1127 to +1279
	金 Chin (Jurchen Tartar) dynasty		+1115 to +1234
	元 Yuan (Mongol) dynasty		+1260 to +1368
	明 Ming dynasty		+1368 to +1644
	清 Chhing (Manchu) dynasty		+1644 to +1911
	民國 Republic		+1912

N.B. When no modifying term in brackets is given, the dynasty was purely Chinese. Where the overlapping of dynasties and independent states becomes particularly confused, the tables of Wieger (1) will be found useful. For such periods, especially the Second and Third Partitions, the best guide is Eberhard (9). During the Eastern Chin period there were no less than eighteen independent States (Hunnish, Tibetan, Hsienpi, Turkic, etc.) in the north. The term 'Liu chhao' (Six Dynasties) is often used by historians of literature. It refers to the south and covers the period from the beginning of the +3rd to the end of the +6th centuries, including (San Kuo) Wu, Chin, (Liu) Sung, Chhi, Liang and Chhen. For all details of reigns and rulers see Moule & Yetts (1).

SUMMARY OF THE CONTENTS OF VOLUME 5

CHEMISTRY AND CHEMICAL TECHNOLOGY

Part 2, Spagyrical Discovery and Invention: Magisteries of Gold and Immortality

Part 3, Spagyrical Discovery and Invention: Historical Survey, from Cinnabar Elixirs to Synthetic Insulin

Part 4, Spagyrical Discovery and Invention: Apparatus and Theory

Laboratory apparatus and equipment

The laboratory bench
The stoves *lu* and *tsao*
The reaction-vessels *ting* (tripod, container, cauldron) and *kuei* (box, casing, container, aludel)
The sealed reaction-vessels *shen shih* (aludel, lit. magical reaction-chamber) and *yao fu* (chemical pyx)
Steaming apparatus, water-baths, cooling jackets, condenser tubes and temperature stabilisers
Sublimation apparatus
Distillation and extraction apparatus
  Destillatio per descensum
  The distillation of sea-water
  East Asian types of still
  The stills of the Chinese alchemists
  The evolution of the still
  The geographical distribution of still types
The coming of Ardent Water
  The Salernitan quintessence
  Ming naturalists and Thang 'burnt-wine'
  Liang 'frozen-out wine'
  From icy mountain to torrid still
  Oils in stills; the rose and the flame-thrower
Laboratory instruments and accessory equipment

Reactions in aqueous medium

The formation and use of a mineral acid
'Nitre' and *hsiao*; the recognition and separation of soluble salts
Saltpetre and copperas as limiting factors in East and West
The precipitation of metallic copper from its salts by iron
The role of bacterial enzyme actions
Geodes and fertility potions
Stabilised lacquer latex and perpetual youth

The theoretical background of elixir alchemy [with Nathan Sivin]

Introduction
  Areas of uncertainty
  Alchemical ideas and Taoist revelations
The spectrum of alchemy
The role of time
  The organic development of minerals and metals
  Planetary correspondences, the First Law of Chinese physics, and inductive causation
  Time as the essential parameter of mineral growth
  The subterranean evolution of the natural elixir
The alchemist as accelerator of cosmic process
  Emphasis on process in theoretical alchemy
  Prototypal two-element processes
  Correspondences in duration
  Fire phasing
Cosmic correspondences embodied in apparatus
  Arrangements for microcosmic circulation
  Spatially oriented systems
  Chaos and the egg
Proto-chemical anticipations
  Numerology and gravimetry
  Theories of categories

Comparative survey

China and the Hellenistic world
  Parallelisms of dating
  The first occurrence of the term 'chemistry'
  The origins of the root 'chem-'
  Parallelisms of content
  Parallelisms of symbol
China and the Arabic world
  Arabic alchemy in rise and decline
  The meeting of the streams
  Material influences
  Theoretical influences
  The name and concept of 'elixir'
Macrobiotics in the Western world

Part 5, Spagyrical Discovery and Invention: Physiological Alchemy

The outer and the inner macrobiogens; the elixir and the enchymoma

Esoteric traditions in European alchemy
Chinese physiological alchemy; the theory of the enchymoma (*nei tan*) and the three primary vitalities
  The quest for material immortality
  Rejuvenation by the union of opposites; an *in vivo* reaction
  The *Hsiu Chen* books and the *Huang Thing* canons
The historical development of physiological alchemy
The techniques of macrobiogenesis
  Respiration control, aerophagy, salivary deglutition and the circulation of the *chhi*
  Gymnastics, massage and physiotherapeutic exercise
  Meditation and mental concentration
  Phototherapeutic procedures
  Sexuality and the role of theories of generation
The borderline between proto-chemical (*wai tan*) and physiological (*nei tan*) alchemy
Late enchymoma literature of Ming and Chhing
  The 'Secret of the Golden Flower' unveil'd
Chinese physiological alchemy (*nei tan*) and the Indian Yoga, Tantric and Hathayoga systems
  Originalities and influences; similarities and differences
Conclusions; *nei tan* as proto-biochemistry

The enchymoma in the test-tube; medieval preparations of urinary steroid and protein hormones

Introduction
The sexual organs in Chinese medicine
Proto-endocrinology in Chinese medical theory
The empirical background
The main iatro-chemical preparations
Comments and variant processes
The history of the technique

ROMANISATION CONVERSION TABLES

BY ROBIN BRILLIANT

PINYIN/MODIFIED WADE–GILES

Pinyin	Modified Wade–Giles	Pinyin	Modified Wade–Giles
a	a	chou	chhou
ai	ai	chu	chhu
an	an	chuai	chhuai
ang	ang	chuan	chhuan
ao	ao	chuang	chhuang
ba	pa	chui	chhui
bai	pai	chun	chhun
ban	pan	chuo	chho
bang	pang	ci	tzhu
bao	pao	cong	tshung
bei	pei	cou	tshou
ben	pên	cu	tshu
beng	pêng	cuan	tshuan
bi	pi	cui	tshui
bian	pien	cun	tshun
biao	piao	cuo	tsho
bie	pieh	da	ta
bin	pin	dai	tai
bing	ping	dan	tan
bo	po	dang	tang
bu	pu	dao	tao
ca	tsha	de	tê
cai	tshai	dei	tei
can	tshan	den	tên
cang	tshang	deng	têng
cao	tshao	di	ti
ce	tshê	dian	tien
cen	tshên	diao	tiao
ceng	tshêng	die	dieh
cha	chha	ding	ting
chai	chhai	diu	tiu
chan	chhan	dong	tung
chang	chhang	dou	tou
chao	chhao	du	tu
che	chhê	duan	tuan
chen	chhên	dui	tui
cheng	chhêng	dun	tun
chi	chhih	duo	to
chong	chhung	e	ê, o

Pinyin	Modified Wade–Giles	Pinyin	Modified Wade–Giles
en	ên	jia	chia
eng	êng	jian	chien
er	êrh	jiang	chiang
fa	fa	jiao	chiao
fan	fan	jie	chieh
fang	fang	jin	chin
fei	fei	jing	ching
fen	fên	jiong	chiung
feng	fêng	jiu	chiu
fo	fo	ju	chü
fou	fou	juan	chüan
fu	fu	jue	chüeh, chio
ga	ka	jun	chün
gai	kai	ka	kha
gan	kan	kai	khai
gang	kang	kan	khan
gao	kao	kang	khang
ge	ko	kao	khao
gei	kei	ke	kho
gen	kên	kei	khei
geng	kêng	ken	khên
gong	kung	keng	khêng
gou	kou	kong	khung
gu	ku	kou	khou
gua	kua	ku	khu
guai	kuai	kua	khua
guan	kuan	kuai	khuai
guang	kuang	kuan	khuan
gui	kuei	kuang	khuang
gun	kun	kui	khuei
guo	kuo	kun	khun
ha	ha	kuo	khuo
hai	hai	la	la
han	han	lai	lai
hang	hang	lan	lan
hao	hao	lang	lang
he	ho	lao	lao
hei	hei	le	lê
hen	hên	lei	lei
heng	hêng	leng	lêng
hong	hung	li	li
hou	hou	lia	lia
hu	hu	lian	lien
hua	hua	liang	liang
huai	huai	liao	liao
huan	huan	lie	lieh
huang	huang	lin	lin
hui	hui	ling	ling
hun	hun	liu	liu
huo	huo	lo	lo
ji	chi	long	lung

Pinyin	Modified Wade–Giles	Pinyin	Modified Wade–Giles
lou	lou	pa	pha
lu	lu	pai	phai
lü	lü	pan	phan
luan	luan	pang	phang
lüe	lüeh	pao	phao
lun	lun	pei	phei
luo	lo	pen	phên
ma	ma	peng	phêng
mai	mai	pi	phi
man	man	pian	phien
mang	mang	piao	phiao
mao	mao	pie	phieh
mei	mei	pin	phin
men	mên	ping	phing
meng	mêng	po	pho
mi	mi	pou	phou
mian	mien	pu	phu
miao	miao	qi	chhi
mie	mieh	qia	chhia
min	min	qian	chhien
ming	ming	qiang	chhiang
miu	miu	qiao	chhiao
mo	mo	qie	chhieh
mou	mou	qin	chhin
mu	mu	qing	chhing
na	na	qiong	chhiung
nai	nai	qiu	chhiu
nan	nan	qu	chhü
nang	nang	quan	chhüan
nao	nao	que	chhüeh, chhio
nei	nei	qun	chhün
nen	nên	ran	jan
neng	nêng	rang	jang
ng	ng	rao	jao
ni	ni	re	jê
nian	nien	ren	jên
niang	niang	reng	jêng
niao	niao	ri	jih
nie	nieh	rong	jung
nin	nin	rou	jou
ning	ning	ru	ju
niu	niu	rua	jua
nong	nung	ruan	juan
nou	nou	rui	jui
nu	nu	run	jun
nü	nü	ruo	jo
nuan	nuan	sa	sa
nüe	nio	sai	sai
nuo	no	san	san
o	o, ê	sang	sang
ou	ou	sao	sao

Pinyin	Modified Wade–Giles	Pinyin	Modified Wade–Giles
se	sê	wan	wan
sen	sên	wang	wang
seng	sêng	wei	wei
sha	sha	wen	wên
shai	shai	weng	ong
shan	shan	wo	wo
shang	shang	wu	wu
shao	shao	xi	hsi
she	shê	xia	hsia
shei	shei	xian	hsien
shen	shen	xiang	hsiang
sheng	shêng, sêng	xiao	hsiao
shi	shih	xie	hsieh
shou	shou	xin	hsin
shu	shu	xing	hsing
shua	shua	xiong	hsiung
shuai	shuai	xiu	hsiu
shuan	shuan	xu	hsü
shuang	shuang	xuan	hsüan
shui	shui	xue	hsüeh, hsio
shun	shun	xun	hsün
shuo	shuo	ya	ya
si	ssu	yan	yen
song	sung	yang	yang
sou	sou	yao	yao
su	su	ye	yeh
suan	suan	yi	i
sui	sui	yin	yin
sun	sun	ying	ying
suo	so	yo	yo
ta	tha	yong	yung
tai	thai	you	yu
tan	than	yu	yü
tang	thang	yuan	yüan
tao	thao	yue	yüeh, yo
te	thê	yun	yün
teng	thêng	za	tsa
ti	thi	zai	tsai
tian	thien	zan	tsan
tiao	thiao	zang	tsang
tie	thieh	zao	tsao
ting	thing	ze	tsê
tong	thung	zei	tsei
tou	thou	zen	tsên
tu	thu	zeng	tsêng
tuan	thuan	zha	cha
tui	thui	zhai	chai
tun	thun	zhan	chan
tuo	tho	zhang	chang
wa	wa	zhao	chao
wai	wai	zhe	chê

Pinyin	Modified Wade–Giles	Pinyin	Modified Wade–Giles
zhei	chei	zhui	chui
zhen	chên	zhun	chun
zheng	chêng	zhuo	cho
zhi	chih	zi	tzu
zhong	chung	zong	tsung
zhou	chou	zou	tsou
zhu	chu	zu	tsu
zhua	chua	zuan	tsuan
zhuai	chuai	zui	tsui
zhuan	chuan	zun	tsun
zhuang	chuang	zuo	tso

MODIFIED WADE–GILES/PINYIN

Modified Wade–Giles	Pinyin	Modified Wade–Giles	Pinyin
a	a	chhio	que
ai	ai	chhiu	qiu
an	an	chhiung	qiong
ang	ang	chho	chuo
ao	ao	chhou	chou
cha	zha	chhu	chu
chai	chai	chhuai	chuai
chan	zhan	chhuan	chuan
chang	zhang	chhuang	chuang
chao	zhao	chhui	chui
chê	zhe	chhun	chun
chei	zhei	chhung	chong
chên	zhen	chhü	qu
chêng	zheng	chhüan	quan
chha	cha	chhüeh	que
chhai	chai	chhün	qun
chhan	chan	chi	ji
chhang	chang	chia	jia
chhao	chao	chiang	jiang
chhê	che	chiao	jiao
chhên	chen	chieh	jie
chhêng	cheng	chien	jian
chhi	qi	chih	zhi
chhia	qia	chin	jin
chhiang	qiang	ching	jing
chhiao	qiao	chio	jue
chhieh	qie	chiu	jiu
chhien	qian	chiung	jiong
chhih	chi	cho	zhuo
chhin	qin	chou	zhou
chhing	qing	chu	zhu

Modified Wade–Giles	Pinyin	Modified Wade–Giles	Pinyin
chua	zhua	huan	huan
chuai	zhuai	huang	huang
chuan	zhuan	hui	hui
chuang	zhuang	hun	hun
chui	zhui	hung	hong
chun	zhun	huo	huo
chung	zhong	i	yi
chü	ju	jan	ran
chüan	juan	jang	rang
chüeh	jue	jao	rao
chün	jun	jê	re
ê	e, o	jên	ren
ên	en	jêng	reng
êng	eng	jih	ri
êrh	er	jo	ruo
fa	fa	jou	rou
fan	fan	ju	ru
fang	fang	jua	rua
fei	fei	juan	ruan
fên	fen	jui	rui
fêng	feng	jun	run
fo	fo	jung	rong
fou	fou	ka	ga
fu	fu	kai	gai
ha	ha	kan	gan
hai	hai	kang	gang
han	han	kao	gao
hang	hang	kei	gei
hao	hao	kên	gen
hên	hen	kêng	geng
hêng	heng	kha	ka
ho	he	khai	kai
hou	hou	khan	kan
hsi	xi	khang	kang
hsia	xia	khao	kao
hsiang	xiang	khei	kei
hsiao	xiao	khên	ken
hsieh	xie	khêng	keng
hsien	xian	kho	ke
hsin	xin	khou	kou
hsing	xing	khu	ku
hsio	xue	khua	kua
hsiu	xiu	khuai	kuai
hsiung	xiong	khuan	kuan
hsü	xu	khuang	kuang
hsüan	xuan	khuei	kui
hsüeh	xue	khun	kun
hsün	xun	khung	kong
hu	hu	khuo	kuo
hua	hua	ko	ge
huai	huai	kou	gou

Modified Wade–Giles	Pinyin	Modified Wade–Giles	Pinyin
ku	gu	mu	mu
kua	gua	na	na
kuai	guai	nai	nai
kuan	guan	nan	nan
kuang	guang	nang	nang
kuei	gui	nao	nao
kun	gun	nei	nei
kung	gong	nên	nen
kuo	guo	nêng	neng
la	la	ni	ni
lai	lai	niang	niang
lan	lan	niao	niao
lang	lang	nieh	nie
lao	lao	nien	nian
lê	le	nin	nin
lei	lei	ning	ning
lêng	leng	niu	nüe
li	li	niu	niu
lia	lia	no	nuo
liang	liang	nou	nou
liao	liao	nu	nu
lieh	lie	nuan	nuan
lien	lian	nung	nong
lin	lin	nü	nü
ling	ling	o	e, o
liu	liu	ong	weng
lo	luo, lo	ou	ou
lou	lou	pa	ba
lu	lu	pai	bai
luan	luan	pan	ban
lun	lun	pang	bang
lung	long	pao	bao
lü	lü	pei	bei
lüeh	lüe	pên	ben
ma	ma	pêng	beng
mai	mai	pha	pa
man	man	phai	pai
mang	mang	phan	pan
mao	mao	phang	pang
mei	mei	phao	pao
mên	men	phei	pei
mêng	meng	phên	pen
mi	mi	phêng	peng
miao	miao	phi	pi
mieh	mie	phiao	piao
mien	mian	phieh	pie
min	min	phien	pian
ming	ming	phin	pin
miu	miu	phing	ping
mo	mo	pho	po
mou	mou	phou	pou

Modified Wade–Giles	Pinyin	Modified Wade–Giles	Pinyin
phu	pu	tên	den
pi	bi	têng	deng
piao	biao	tha	ta
pieh	bie	thai	tai
pien	bian	than	tan
pin	bin	thang	tang
ping	bing	thao	tao
po	bo	thê	te
pu	bu	thêng	teng
sa	sa	thi	ti
sai	sai	thiao	tiao
san	san	thieh	tie
sang	sang	thien	tian
sao	sao	thing	ting
sê	se	tho	tuo
sên	sen	thou	tou
sêng	seng, sheng	thu	tu
sha	sha	thuan	tuan
shai	shai	thui	tui
shan	shan	thun	tun
shang	shang	thung	tong
shao	shao	ti	di
shê	she	tiao	diao
shei	shei	tieh	die
shên	shen	tien	dian
shêng	sheng	ting	ding
shih	shi	tiu	diu
shou	shou	to	duo
shu	shu	tou	dou
shua	shua	tsa	za
shuai	shuai	tsai	zai
shuan	shuan	tsan	zan
shuang	shuang	tsang	zang
shui	shui	tsao	zao
shun	shun	tsê	ze
shuo	shuo	tsei	zei
so	suo	tsên	zen
sou	sou	tsêng	zeng
ssu	si	tsha	ca
su	su	tshai	cai
suan	suan	tshan	can
sui	sui	tshang	cang
sun	sun	tshao	cao
sung	song	tshê	ce
ta	da	tshên	cen
tai	dai	tshêng	ceng
tan	dan	tsho	cuo
tang	dang	tshou	cou
tao	dao	tshu	cu
tê	de	tshuan	cuan
tei	dei	tshui	cui

Modified Wade–Giles	Pinyin	Modified Wade–Giles	Pinyin
tshun	cun	wang	wang
tshung	cong	wei	wei
tso	zuo	wên	wen
tsou	zou	wo	wo
tsu	zu	wu	wu
tsuan	zuan	ya	ya
tsui	zui	yang	yang
tsun	zun	yao	yao
tsung	zong	yeh	ye
tu	du	yen	yan
tuan	duan	yin	yin
tui	dui	ying	ying
tun	dun	yo	yue, yo
tung	dong	yu	you
tzhu	ci	yung	yong
tzu	zi	yü	yu
wa	wa	yüan	yuan
wai	wai	yüeh	yue
wan	wan	yün	yun