

PARASITICAL PLANTS.—THE *BALANOPHORACEÆ*.

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(With a Tinted Plate.)

THE structure and habits of parasitical plants are so peculiar and anomalous to those of other branches of the vegetable kingdom, that they have not only claimed the particular attention of learned and acute observers, but are also of great interest to all lovers of nature; indeed one of the most popular plants, the mistletoe, belongs to this class, as well as the largest known flower in the vegetable world, namely, that of *Rafflesia Arnoldi*. It is to the class of parasites to which the *Rafflesia* was formerly considered to be allied—the *Balanophoræ*—that we wish to direct the reader's attention; *Balanophoraceæ*, *Cytinaceæ*, and *Rafflesiaceæ* were included by Lindley under the head of *Rhizanthæ*, which constitutes one of his five divisions of the vegetable kingdom. The plants so classed are all destitute of true leaves, but having instead cellular scales they do not partake of any of the appearances of other plants, having no indication whatever of green colouring matter about them, but are either brown, purple, yellow, or a pale, livid pink. They have short amorphous stems; that is, they are without regular or definite form, and are always parasitical on the roots of other plants. They have true flowers, with stamens, pistils, etc., but these flowers vary considerably in their form and structure; so much so, indeed, as to induce some botanists to consider them widely distinct, and to place them widely apart in botanical classification. Dr. Hooker is of opinion that the *Balanophoræ* have no affinities whatever with *Rafflesia*, but are nearly connected with *Haloragaceæ*, to which the *Trapás* belong.

Numerous papers have been read from time to time at the various learned societies both here and on the continent, on the structure and affinities of the various genera and species of the *Balanophoræ*, but no one has devoted so much attention to the whole group as Dr. J. D. Hooker, the present Director of the Royal Gardens, Kew, who by the aid of his extensive correspondence, as well as by his own travels, has secured an unrivalled collection of these peculiar vegetable forms for the Kew Museum.

These plants rise not more than a foot above the ground. They are all natives of hot countries, in the tropical and sub-tropical mountains of Asia and South America, where they

probably occur in nearly equal proportions. The rhizome, or rooting portion of *Balanophorous* plants is usually in the form of a simple or branched tuber, seated flat upon the root of the plant, to which it is attached. In very young plants the appearance is nothing more than a mass of cellular tissue, united with the tissue of the root. Dr. Hooker says, "It offers at first no trace of a vascular system, nor any distinction of parts, but before it has reached the cambium layer of the bark, and before its upper extremity has attained any considerable size, an opaque line of white cellular tissue, different from the rest, may be found in the centre of the mass, or beneath each of its lobes, in which vascular tissue makes its appearance. Shortly afterwards the wood of the root upon which the parasite grows appears to become affected, its annual layers are displaced, and at a still later period vascular bundles, enclosed in a cellular sheath, are found in the axis of the rhizome, and are continuous with those already found in it. Some genera do not present the appearance of any vascular bundles communicating with those of the root stock, but their own vascular bundles may be traced descending to the line of union between the root and the parasite, where they become closely applied to the vascular system of the former, without, however, forming any interlacement or organic union."

The roots or rhizomes of these plants are of comparatively slow growth, but vary much in the several species. This may in some measure be referred to the different forms of attachment or union with the roots upon which the parasites grow, for it would appear that there are three distinct modes of attachment in the several distinctive forms or genera, and these have been suggested as lines by which to divide the *Balanophoræ* into three sections; firstly, where the vascular tissue of the parasite and nourishing plant is apparently merged in one, or continuous; secondly, where the attachment is alone effected by means of the cellular system; and thirdly, where the termination of the vessels from the root into the parasite are definite or distinct. The most perfect examples of the first of these divisions are to be found in the genera *Rhopalocnemis* and *Balanophora* itself, where also the most perfect vascular system exists, the woody tissue being present throughout the whole plant. Fig. 1 shows a transverse section of *B. involu-crata*. The formation of the tissue in *Helosis Mexicana* illustrates the second division, Fig. 2; while that of *Langsdorffia* illustrates clearly the third, Fig. 3.

In the cellular tissue of many of the *Balanophoræ*, wax is secreted in large quantities. A view of one of these cells, burst open, and discharging its waxy granules, is shown at Fig. 4. The wax is found mostly in *Balanophora* and *Langs-*

dorffia, while in *Lophophytum*, *Cynomorium*, and *Sarcophyte* in particular, as well as in other genera, starch grains are found in the place of wax.

The plants are either monœcious or diœcious. The flowers in some species are arranged in a capitulum, or head, varying in shape, being either round, oblong, ovoid, etc., and in other species they are in compound spikes or panicles. The individual flowers also vary considerably in the different species; they are most perfectly developed in *Mystroptalon*, and the least so in the female of *Balanophora* and the male of *Lophophytum*. The flowers are either with or without a perianth, but when present it is usually dimorphous. In the genus *Rhopalocnemis* it is tubular, while in *Thonningia* it is composed merely of three very minute scales. The styles, stamens, etc., are very variable in number, as well as in form, but though they are always present, they are in many species so imperfectly developed as almost to warrant a very low position in the arrangement of flowering plants; but, on the other hand, "if we disregard imperfection, and inquire what organs are wanting in the order, we shall find that, with the exception of terrestrial roots, all are present which are necessary to justify their being placed among phænogamic plants."

Of the whole of the genera of the *Balanophoraceæ*, *Mystroptalon* is the most perfect, or highly developed. In the capitulæ, or flower-heads of this genus, the male flowers are always seated at the top, and the female flowers below. This does not occur as a rule through the other genera, the males in many instances being lowest. *Cynomorium coccineum*, Michx. is the *Fungus melitensis* of the old writers. From its old name one might be led to expect that it is alone indigenous to the Island of Malta, but its range extends to the Levant, the Canary Islands, and Northern Africa. The plant grows to about a foot in height, it has a deep pink or reddish tinge, and a very fleshy appearance. The flowers are unisexual, but sometimes hermaphrodite flowers are likewise found on the same head. The parts of the perianth, or floral coverings, are always in sixes. The whole plant is covered with small scales. This plant was formerly much valued in Malta as a medicine for the cure of dysentery, and the places where it grew were carefully guarded to prevent its being stolen. The plants were, even up to a recent date, protected and gathered under the supervision of an officer appointed by the British Government. They formerly had a great reputation for stopping the flow of blood, and it is said that the celebrated styptic used by the Crusaders to stanch their wounds was none other than this plant. Mr. P. B. Webb, who travelled in the Canaries, tells us that it is eaten for food there, and much esteemed. Of the genus

Sarcophyte, *S. sanguinea*, Sparrm. is the only species known. It is found only in South Africa, principally on the roots of species of *Acacia*. The male flowers are paniced, but one of the characters by which this genus is distinguished from *Balanophora* is that the filaments and connectives of the stamens are free, while in *Balanophora* they are united. The male flowers have a three-lobed perianth, and the female flowers are arranged in globose heads, and have no perianth. The arrangement of the tissues in the stem of *Sarcophyte* do not differ essentially from other species of the order, though in the peduncle the vascular bundles are very irregularly deposited. The roots of the plant upon which it grows are connected by stout, woody branches with the rhizome of the parasite, and there seems to be a complete fusion of the vascular tissues of both. The stems of *Sarcophyte* contain innumerable starch granules.

Two species are enumerated of *Langsdorffia*, *L. hypogæa*, Mart., and *L. rubiginosa*, Wedd., but Dr. Hooker, who is undoubtedly the best authority on *Balanophoræ*, doubts whether there are sufficient characters to distinguish the latter from *L. hypogæa*. They are both natives of South America, the first being distributed through Mexico and Brazil. The remarkable parasitism of *Langsdorffia*, Dr. Hooker describes in the following terms :—"The dichotomously branching rhizomes appear most frequently to corrode, as it were, the back of the roots they encounter, which they even sever, and then enclose the end that remains attached to the parent plant. The root swells considerably at the junction, and appears to send prolongations of wood into the rhizome of the parasite, which run along its axis for several inches, and though there is an intimate union between the wood of the root and the cellular tissue of the parasite, there seems to be no blending of their vascular systems." The fruit-bearing receptacle after flowering dilates very much, which causes the scales to spread open, and when fully expanded the whole has a similar appearance to the involucre of a thistle (Fig. 5). The rhizome of this species is highly charged with wax, and it will burn freely with a clear flame. The secretion is contained entirely in the cellular tissue where it appears as a large opaque mass in every utricle. This wax is collected to a large extent by the people of New Grenada, who make candles of it, while in Bogota the stems themselves are collected and sold in all the markets without any preparation, for use as candles on Saints'-days. On the Tolima range of mountains around Bogota the plant is known by the names of "Belacha" and Melonsita, and the soft receptacle, when ripe, is eaten and considered stimulating and refreshing.

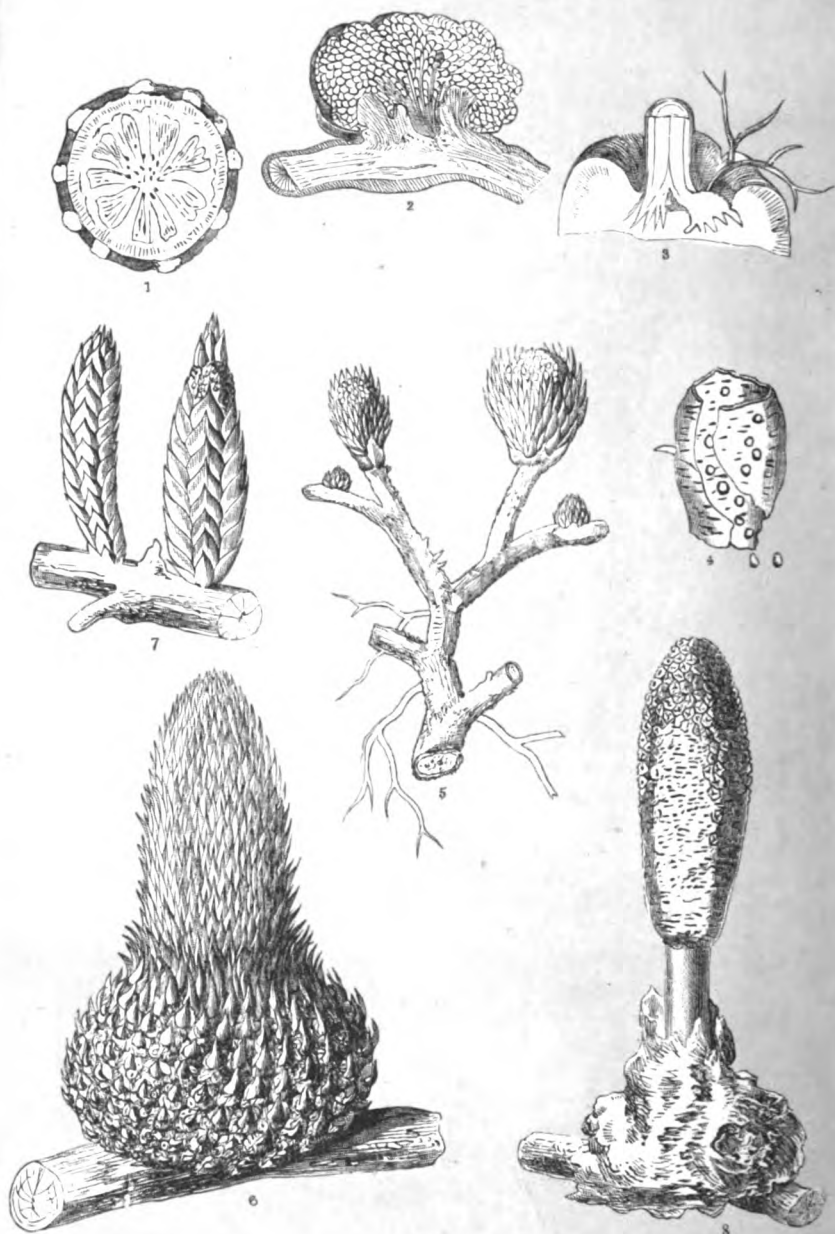
Thonningia sanguinea, Vahl., is found in Western Tropical Africa, on the roots of trees. Its root-stock is of a dingy

brown colour, and the flower-stalks are covered with closely-imbricated scales of a bright red colour. The only difference between the female flower of this plant and that of *Langsdorffia* is that in *Thonningia* it has a more complete tubular 3—5 toothed perianth, the stamens are united into one column, at the base of which are a few scales. Specimens of these plants were first brought to Europe by Thonning in 1804, Vahl examined them, and described the genus, naming it after its discoverer. So far as is known they have no economic uses.

Of the genus *Balanophora*, eight or nine species are enumerated, but in bringing them down to this number, some varied forms or varieties are included as one species. Quoting Dr. Hooker upon this point, it appears these varieties are so numerous that neither colour, form, nor the sexuality of the capitula are constant characters. In the same woods wherein the Doctor gathered *B. involucrata* var. *gracilis*, growing upon the roots of oak, he also gathered var. *flava*, growing on those of an Araliaceous shrub, and differing from the var. *gracilis* only in its more robust habit. *B. involucrata*, Hook. fil., grows in the Himalayas at an elevation of from 7000 to 9000 feet. It is, however, common in Sikkim up to 8000 or 10,000 feet. The capitula of this species, as well as the stalks, are of a very bright colour, either red, a rich deep crimson, a brightish yellow, or of a purplish tinge.

Balanophora dioica, Br., *B. indica*, Wall., and *B. polyandra* are all East Indian species. The first is very common in Eastern Himalaya and Khasia, and is also very variable in form, according to the localities in which it is found. "Specimens of all sizes may be found, from an inch to a foot high, of all degrees of robustness, and of all colours between blood red, yellow and white, or brown." *B. polyandra* is very abundant on the Khasian and Himalayan mountains, at an elevation of from 4000 to 6000 feet. It varies from two inches to six inches in height, and differs from some of the other species in having the capitula always short and sub-cylindric or conical, but like *B. dioica* it varies much in colour and robustness. It flowers during the months of August, September, October, and November.

B. elongata, Bl., is an inhabitant of the mountains of Java, where it is found at an altitude of from 5000 to 9000 feet. It is also found in Ceylon, and on the mountains of the East Indian islands. It has been found in flower in the months of March, May, and August. *B. globosa*, Jung., is found in Burmah, and *B. alutacea*, Jung., in the Philippine islands. They both flower in April. The first of these two species in general habit much resembles *B. indica*. The rhizome has a peculiar, crumpled appearance, covered with small tubercles, or



BALANOPHORA

1. Transverse section of rhizome of *Balanophora* (H. B. K.).

2. Vertical section of *Helios Mexicana* showing its attachment to the root.

3. Vertical section of *Helios Mexicana* showing its attachment to the root.

4. Single cell of cellular tissue from *Helios Mexicana*.

5. A plant of *Langelandia rubra*.

6. Vertical section of *Langelandia rubra* showing its attachment to the root.

7. Vertical section of *Langelandia rubra* showing its attachment to the root.

8. A plant of *Langelandia rubra*.

warts. The whole mass appears highly charged with wax. Wallich says that it is sold in the Burmese bazaars for medicinal purposes.

B. fungosa, Forst., is peculiar, as being the only Australian species. The following description of the arrangement of the tissues in this species is so clear that we cannot do better than quote it entire:—"The most curious point in this species is the tendency of the tissues forming each vascular bundle in the rhizome to arrange themselves rudely into the form of an exogenous stem, the wood forming a zone of wedges round a central pith, enclosed by a cellular zone that communicates with the pith by broad medullary rays. The total absence of pith in the root, with whose wood these bundles communicate, would thus seem to indicate that the wood of the rhizome belongs to itself, though it has all the appearance of being solely produced by the root; the root, in short, supplies the nutriment from its own vascular tissue, but the parasite organizes it."

The several species of *Balanophoræ* are found on the roots of such trees as oaks, maples, vines, etc., but *B. involucrata* has also been found growing on the exposed ærial rootlets of oaks in damp or humid forests. This species, when growing upon subterranean roots, appears to affect them much more than any other, as it produces large knots from two to four inches in diameter. These are much prized by the natives, who make from them very neat wooden cups, which are in general use throughout the Himalaya and Thibet. Some of them are esteemed antidotes for poison, and for this purpose fetch a high price. This and the Java species, *B. elongata*, which furnishes a wax from which candles are made, are the only species of any importance in an economic point of view. In *Lophophyllum Weddellii*, Hf., the root-stock is a somewhat spherical fleshy mass, covered on the upper part with long overlapping scales. From the top of this mass springs the flower-stalk, very much in the form of a pine cone, and covered likewise with imbricated scales. On the upper portion of this stalk small regular branches are given off, upon which the flowers are closely packed. A better idea of this singular plant will be obtained from Fig. 6 of the plate. It is a native of New Grenada, in moist woods. It is said to be used by the natives as an article of food. Two other species have been described, viz.:—*L. mirabile*, Schott and Endl., and *L. Bolivianum*, Wedd. Both of these are South American, the first being known in Brazil, the other in Bolivia.

Ombrophytum Peruvianum, Poeppig and Endl., is another of those peculiar plants which Poeppig has described as being eaten by the Peruvians, who boil it, and treat it similar

to fungi. The generic name is derived from the Greek, *ombros*, a shower, and *phyton*, a plant; in reference to the sudden way in which they are said to spring up after a shower of rain. The genera *Scybalium* and *Sphærorhizon* follow here in the order of classification. *Scybalium fungiforme*, Sch. et Endl., a native of the forests of Brazil, being the only described species of the first genus, and *Sphærorhizon curvatum*, H. f., the only species of the second. This plant, from the fact of its roots penetrating only the last year's wood of its prey, and producing no effects in the layers below, would seem to be only of annual duration.

Phyllorcorhiza Jamaicensis, H. f., is found in the savannahs of Jamaica, as its specific name indicates. It is the only West Indian species, and is commonly known in Jamaica as John Crow's nose, but whence the derivation of such a singular vernacular we are unable to tell. The plant is found in flower from January to July. The rhizome or root-stock is branched or lobed, a transverse section of which shows "a thick brown cellular cortical layer, formed of hexagonal cells full of starch granules and chlorophyll, with occasional masses of hard, woody, or sclerogen cells." From this root-stock numerous flower-stalks arise, covered all the way up with closely imbricating scales. These flower-stalks bear large cylindrical or oblong flower-heads. (Fig. 7).

Rhopalocnemis phalloides, Jung., is undoubtedly the most noble, if we may so speak, of all the *Balanophoræ*. It is found at the roots of trees in the mountains of Java, at an elevation of 7000 feet, as well as in the Khasian and Himalayan mountains, Nepal and Sikkim, at 6000 to 8000 feet. It grows in shady woods in large masses, and has a very pretty appearance, with its pale yellow brown heads only showing above the ground. The rhizomes are of various sizes, from that of an egg to masses as large as the human head. The flower-buds, which spring from the rhizome in their earliest state, appear like swellings, which presently burst forth and reveal the most magnificent flower-heads. "Both males and females expand at the same time, throwing off their cohering bracteal scales in large masses, and exposing a velvety pile of style, and a dense mass of subjacent articulate threads. There are several crops of male flowers which expand successively, and in the dense humid woods in which this genus grows, insect agency is probably necessary to impregnation." A representation of this plant will be found at Fig. 8.

Three species of *Corynæa* are enumerated, namely, *C. crassa*, Hook. fil., *C. sphaerica*, H. f., and *C. Purdiei*, Hook. fil. The first of these is the most imposing plant of the three, frequently weighing many pounds. It attacks the roots of its prey in all

directions, swelling over stems, and completely encircling them. It has a thick, fleshy flower-stalk and dense flower heads; the male flowers much resemble those of *Rhopalocnemis*, it is a native of New Granada, at an altitude of 8000 feet. *C. sphaerica* is also a New Granada species, and is found at a similar elevation. Like the former, the rhizome completely encircles the root of its prey; though the plant itself has a very different appearance to *C. crassa*, the flower heads are more globular and regularly formed. *C. Purdiei* is a native also of the same country, growing chiefly on the roots of *Cinchona*. The capitula and the flowers themselves are very similar to those of *C. sphaerica*.

Helosis Guyanensis, Rich., is a very remarkable plant, and has been described and written about by several illustrious botanists. It is found in Guiana, as its specific name indicates. Its range, however, appears to be in "damp woods on the East coast of South America, from Trinidad to south of the equator." The rhizome, or root, runs underground for a great distance, adhering to any roots which come in its way. Dr. Hooker has shown that the arrangement of the tissues in a transverse section of this rhizome closely resembles that of many menispermaceous plants, and that the vascular system of the peduncle consists of scattered bundles that run free, and unbranched from the rhizome to the capitulum, where they partially anastomose, forming a plexus within the circumference, from which bundles are given off with great regularity towards the base of each scale. The plants vary much in size from an inch to about a foot high. The flower-stalks are numerous, with globose or ovoid heads of flowers, the males and females being on separate heads. From close observation it would appear that the female flowers are seldom, if ever, fertilized except through insect agency. The native country of *H. Mexicana*, Lieb., is also indicated by its specific name. It is found on the Mexican mountains, at an altitude of 3000 to 5000 feet. It does not differ considerably in form or structure to *H. Guyanensis*, but it is not so variable. Plants of this genus are of little or no economic value, though they are sometimes used as styptics in their native countries.

Though the *Balanophoræ* are of no value or importance in a commercial or economic point of view, they are most interesting in a scientific point. Popularly little is known about them, or even of the existence of such plants. This is easily to be attributed to the fact that no living plants have been seen in this country, and they are certainly less attractive to a general observer in a dried state than when arrayed in their bright colours. But even with a slight acquaintance of their habits and modes of growth, they cannot fail to excite some interest.

PHASES IN THE DEVELOPMENTAL HISTORY OF
INFUSORIAL, ANIMAL LIFE.*

BY JABEZ HOGG, F.L.S., F.R.M.S., ETC.

THE elucidation of the mystery which surrounds the beginnings of organic life, and the discovery of the living principle which exerts so powerful an influence on all animated creation, has often and long been sought for by philosophers as well as physiologists, from the earliest ages down to the present time; but all their efforts have been in vain, and we stand in precisely the same position in regard to this subject as that occupied by the first philosopher who entered upon its investigations. Although we have not been able to throw much light on the nature of life, we find that the degree of vitality possessed by an animal is to a great extent in proportion to the degree of its organization, and we may conclude from this that there is an intimate connection between life and organization. Not that organization can create life; of this we have no instance at all, but that the principle of life, which exists in and has been given to any organic germ is only brought to maturity in accordance with the original law of its organization; and by means of this *principle of life* it is enabled to pass into a state of greater perfection, constituting what has been called, and is now recognized as the *law of progressive development*. First, let me say that I do not purpose to enter upon any inquiry into the precise nature of life, such as I have just hinted at, but rather let me on this occasion direct attention to some points of interest in the developmental history of infusorial life.

On the threshold of this inquiry a remarkable theory, and one which cannot be passed over without discussion, stares us in the face, "Whether among the smallest, and apparently the most elementary forms of organic life, the phenomenon of spontaneous generation obtains?" This question has quite recently formed the subject of careful experiment and animated discussion on the continent; the *general opinion*, however, seems to be that the lowest forms, in common with the highest, are generated by reproduction from preceding forms.

Aristotle found no difficulty in believing that worms and insects were generated by dead bodies; and to the mind imperfectly acquainted with the results of modern investigations, spontaneous generation is as easy of belief as it was to Aristotle.

* Being the substance of a lecture delivered to the Old Change Microscopical Society, September 27th, 1866.

Do we not constantly see vegetable mould covering our cheese, our jam, our bread? Even our air-tight vessels cannot be kept free from plants and animals, where neither plant nor animal could be seen before, and where it appears impossible that their seeds could have penetrated. Where do those parasitic animals come from which are to be found in the blood, the brain, the liver, and the eye? How got they there? These questions are more easily answered on the supposition that generation can take place spontaneously; nevertheless, the weight of scientific evidence has been year after year accumulating against such a supposition, and the majority of physiologists have come to the positive conclusion that no generation whatever can occur except by direct parentage.*

And yet how difficult at times to divest the mind altogether of some such theory, when asked to account for the apparently sudden appearance in a most unlikely place, of some such extraordinary creature as that of Mr. Crosse's *acarus*. This, as you are aware, was found in a solution of silicate of potash, through which an electric current was passing, and after every care had apparently been taken to free the apparatus from every particle of dust and foreign matter; or that noticed by Dr. Maddox on the surface of a nitrate of silver bath, which had been set by for some time. The several bright spots in motion proved to be well-developed, highly-organized acari, looking like "miniature fat sheep."†

These, and other like remarkable instances were at one time regarded as good evidences of spontaneous generation, and afforded a simple and easy mode of getting rid of a difficulty.

The first formidable assailant of the doctrine of spontaneous generation was the celebrated Italian naturalist, Redi. In his work *On the Generation of Insects*, he proved that the worms and insects which appear in decaying substances, are really developed from eggs designedly deposited there by the mature animal. But it was thought preposterous to suppose that putrefaction could produce an insect, and this explanation was for a time rejected. But driven from the insect world, where such an hypothesis could have no chance of success, the upholders of it sought refuge in the world of infusorial and parasitic life.

Any one acquainted with the writings of Leuwenhoek will see how steadily this father of microscopy set his face against spontaneous generation, because even his imperfect instrument showed him that many of the most minute animals produced eggs, and were generated like the larger ones. Since his time

* Lewes.

† *Quarterly Journal of Microscopical Science*, vol. ii. p. 96.

hundreds of observers have brought their contributions to the general stock, and the modes of development of plants and animals have been more and more clearly traced; and each extension of knowledge in this direction has had the effect of narrowing the ground on which the spontaneous hypothesis could possibly find a footing; and the question now comes to this: "Is it more probable that a law of generation which is well nigh universal in the organic world, should have an exception; or that our researches have as yet been so faulty that we have not as yet been able to bring this seeming exception under the law? One after another, cases which seemed exceptions have turned out to be none at all. One after another, the various obscurities have been cleared away, and it is therefore the dictate of philosophic caution which suggests that so long as we remain in positive ignorance of the actual process, we must assume that a general law prevails."*

Positive evidence would at once settle the dispute, and I take this opportunity of directing ardent and aspiring microscopists to the question, as one well worthy any amount of time and trouble; but I must tell them beforehand that every one who has hitherto made any experiments, or attentively followed those of others, has found it exceedingly difficult to devise any experiment which shall be conclusive. This arises, first, because the facts elicited admit of very different interpretations; and secondly, from numerous sources of error. "For it is quite true that there are organic beings of which we can as yet only say that there is the strongest presumptive evidence against their being exceptions to the otherwise universal law to which I have alluded. As an instance, we do not know how the *Amæba* arises, no one has even seen its eggs, or ever been a witness of its mode of reproduction; and yet we find the *Amæba* in almost every drop of rain-water, and most vegetable infusions, so that we may be perfectly certain that its ova are carried about by every breath of air." Schultze, of Berlin, devised an experiment which might have been thought to settle the question. This experiment proved that an infusion of organic substance, supplied with air driven through a strong acid, could be suffered to remain for three months without either any animal or vegetable life becoming apparent. At the end of that time atmospheric air was allowed to enter freely, and in three days the infusion was found to be swarming with animalcules.

It will be at once observed that the essential condition in such an investigation is to be quite certain that no organic germs are introduced into the liquid from without, and that there should be secured a free supply of air, carrying no

* *Lewes.*

organic germs ; on the hypothesis that animalcules, like other animals and plants, are produced from germs or eggs, which might be in the water and yet so excessively minute as to be easily overlooked, and only awaiting the proper *conditions* for their speedy development ; or, on the other hand, supposing them to be floating about in the air, they would fall into or enter any vessel containing organic matter in a state of decomposition and there develop. Schultze's experiment, then, looked very like a conclusive one, for no sooner were measures taken to destroy the germs, supposed to be suspended in the air, than the infusion was kept free from animalcules ; and no sooner was the air allowed to enter in the ordinary manner than both animal and vegetable life abounded. It was thought, however, by M. Morren, that air in its passage through sulphuric acid underwent some alteration which affected its power of supporting life ; and upon putting this to the test, he found that air passed through sulphuric acid was incapable of sustaining life. We have then, M. Pouchet's experiments, which are of a most imposing character. He announced that there was nothing in either Schultze's test or Morren's correction, for he declared that in following the former's experiment in every particular, and also in repeating it with fresh precautions, he could constantly find both plants and animals in an infusion in which every organic germ had been previously destroyed, and to which the air only had access after passing through concentrated sulphuric acid, or through a series of porcelain chambers kept at a red heat. M. Pouchet even goes farther than this. He determined to substitute for atmospheric air, *artificial air* ; this he introduced into a flask containing an infusion of hay, the *hay* having previously been subjected for twenty minutes to a heat of 212° F. He thus guarded against the presence of any germs in the infusion or in the air. The whole was then hermetically sealed ; but in spite of all these precautions, both plants and animals appeared in the infusion. He repeated the experiment with pure oxygen gas instead of common air and with similar results.

Professor Wyman instituted a series of thirty-three experiments, prepared in different ways, in which solutions of organic matter, some of them previously filtered, having been boiled at the ordinary pressure of the atmosphere for a length of time varying from fifteen minutes to two hours, were exposed to air purified by heat. In only four were the contents of the flasks unchanged when opened ; in all the rest *Bacteriums*, *Vibrios*, *Ferment-cells*, *Monads*, or *Kolpoda-like* bodies were seen, some of them having ciliary movements. In nearly every instance their presence was indicated by the formation of a film, which appeared in some ; on the second, and in others not until the

nineteenth day. The result of these experiments is, that the boiled solutions of organic matter made use of, exposed only to air which has passed through tubes heated to redness, or enclosed with air in hermetically sealed vessels, and exposed to the heat of boiling water, became the seat of infusorial life; but such experiments throw no light on the immediate source from whence the organisms in question were derived. I have shown repeatedly, as well as numerous other observers, that the air contains many kinds of organic matter, spores of cryptogams, starch granules, and other vegetable fragments, and probably also the eggs of many animalcules, all of which are floating freely about.

Milne-Edwards objected to the conclusions of Pouchet, saying, there is no proof that the hay itself had been subjected to the temperature of boiling water, it being very probable that although the furnace was at that heat, the hay, which was in a glass vessel and surrounded with air at rest, was not at anything like that temperature. On the other hand, granting that the temperature may have been reached, that would not suffice for the destruction of all the germs if they were perfectly dry; the power of resistance possessed by vegetable silicated cylindrical tubes, as hay and straw, is well known. The observations of M. Doyere prove that the *Tardigrada*, "water-bears," when thoroughly desiccated, preserve the power of reviving even after having been subjected to a temperature of 316° F. The *Vibrio tritici* will maintain its vitality for many years through all the vicissitudes of heat and cold. I have kept wheat for ten years, and still find these animals easily resuscitated; and Mr. Deane mentions a remarkable fact, "that on a particular piece of land whenever wheat is grown it is always infested with *Vibrio*, no matter what the length of time since the previous wheat crops, nor what crops have been sown in the meantime." If, therefore, animals of so complex a structure as these *Tardigrada* and *Vibrios* can resist the action of time and temperature, there is no reason for supposing that the germs of the simpler animalcules would be destroyed by them.

The Rev. Lord Sidney Godolphin Osborne, in a letter filled with interesting remarks on "Cholera and its germs," which appeared a few weeks ago in the columns of the *Times*, writes—"I know from experiment that there are 'germs' containing a principle of life, that will stand very strange usage, and yet not have that principle destroyed. Many years since I applied a certain matter to a piece of glass about four inches square. This has another very thin piece cemented close over it on three sides, leaving a space just sufficient for a thin stratum of water between the two. It has been exposed for days to

the action of the direct rays of the sun, it has been kept in the dark, and sometimes has been for a year or two in a very dry place without a particle of water touching its surface. To amuse friends I have again and again allowed a little water, sometimes filtered, generally of the coldest *spring* nature, to fill up the space between the two glasses—water I had previously tested for any living organisms. I have never failed to produce, in a few hours, a most beautiful exhibition of one of the most interesting species of Infusoria, having beforehand sketched the exact creature I would produce. With the same water, in another glass tank of the same nature but not so prepared, I fail to produce anything at all until it has been left for some days, and then the creatures seen are not my old friends. I have read, not seen, that these organisms retain their vitality even when the glass has been made red hot. I don't say I believe, but from what I have seen I think it quite possible."

I have myself found, upon subjecting the spores of *Penicillium* to the action of boiling water, twice over, that they remain uninjured, their vitality is so little impaired that on placing some of them in saccharine solutions and other substances, carefully excluded from the air, a very short time sufficed to show the presence of the characteristic mould growing up from the spots where the spores rested, and microscopic examination confirmed the character of the growth.

M. Quatrefages says, that he examined the dust remaining on the filter after ignition from some observations on rain-water, and found that the organic elements presented a confused assemblage of particles, and this continued to be the case for a few minutes after their immersion in water; but in a few hours he detected a great number of vegetable spores, infusoria, and those minute spherical and ovoid bodies familiar to microscopists, which inevitably suggest the idea of eggs of extremely small size. He also declares that he has frequently seen monads revive and move about after a few hours immersion.*

M. Pouchet's reply is, that if the air is filled with animalcules and their eggs, they will, of course, fall into any vessel of water, and as water is their natural element, will there exhibit their vitality. But if half-a-dozen vessels of distilled water, perfectly free from animalcules, be left exposed to the air beside one vessel of distilled water containing organic matter in decay, the half-dozen will be free from animalcules and eggs, but the one will abound with them. Now it is perfectly intelligible that inasmuch as organic matter is said to

* Mr. Samuelson examined the dust shaken from rags brought from Alexandria, Trieste, Tunis, Peru, and Melbourne, and found in all germs of *Monads*, *Bacteria*, and *Kolpoda*.

form the indispensable condition for the development of the eggs, it is only in the vessel containing such matter that the eggs will develop; but why are they not also visible *as eggs* in the other vessels? Why are not the animalcules themselves visible there as they were in the water examined by M. Quatrefages?

My reply to Pouchet's question is, that in all the vessels ova had probably been deposited, but for lack of nourishment, in five, they had quickly died. It is well known that in all organized structures, disorganization rapidly sets in, unless either some vegetable matter or a well-oxygenated medium be ready at hand to carry the ova on to maturity. And as to their not appearing in all the six vessels, I can only say that this does not accord with my experience; for upon exposing any number of bottles to the same atmospheric influences, all have given positive results, and I can only suppose that M. Pouchet either made a very imperfect and cursory examination, or his microscopic manipulation must have been greatly at fault.

A few years ago an observation made by Cienkowski, the botanist, seemed finally to settle the question of spontaneous generation, and to place the matter beyond doubt, because it caught nature in the act, so to speak, of spontaneously generating. Cienkowski's statement is as follows:—If a slice of raw potatoe be allowed to decompose in a little water, it will be found, after some days, that the starch cells have a peculiar *border*, bearing a strong resemblance to a cell-membrane. This shortly turns out to be a real cell-membrane, and is gradually raised above the starch grain, which then occupies the position of a cell-nucleus. Thus, *out of a grain of starch a cell has been formed under the observer's eye*. Inside this cell little granular masses are developed, which begin to contract. Finally, minute eel-like animalcules (a species of *Anguillulidae*) are developed there, which bore their way through the cell-wall into the water.

Franke, in his report of this observation, which he says he has verified, asks, "how is it possible to deny spontaneous generation here? Before our eyes a grain of starch becomes a cell, in that cell are developed living forms, which bore their way out." Again, Professor *Nægeli* stated that he had been baffled at first in the attempt to verify this observation, but that after nearly a hundred trials he had succeeded; he appears to have confirmed all the statements made by Cienkowski; but if the phenomenon was of such rare occurrence, surely there must have been some other explanation than that of spontaneous generation.

It seemed probable that error had crept in somewhere. Cienkowski himself at length discovered the source of his own

error: the membrane which seemed to form itself round the starch granule had quite another origin. He observed the little *Monads* swimming about, and noticed one of them adhere to a starch grain, spread its elastic body round it, and finally envelope it, just as the *Amœba* does its food. Thus was explained how the starch grain came to be inside a cell; and as this process was never suspected, and as the starch-grain was within a cell-wall, the idea of natural formation was inevitable, the more so as the wall seemed to grow larger and larger.

M. Pasteur, who has been the leading and most determined opponent of the spontaneous generation theory, contrived a series of experiments which met many of the arguments brought forward by Pouchet, and he thought it was possible to obtain, in some place, atmospheric air so pure that it would not produce any change whatever in a putrescible liquid. M. Pouchet, Joly, and others, in their desire to meet this idea, ascended the glacier of La Maladetta, in the Pyrenees, taking with them a number of flasks, each one third filled with an infusion of hay, which had been previously filtered and boiled for more than an hour. The air was then exhausted, and the flasks hermetically sealed. Four were then afterwards filled with air on the surface of the glacier, and four in a crevasse. The examination of four of the flasks, three days afterwards, gave specimens of *Bacteria*, *Monads*, *Vibrio*, *Mucidinea*, and *Amœba*. The conclusion drawn from this was that even the air of high mountains did not fulfil the conditions which M. Pasteur predicated of it. Nevertheless M. Joly said that he believed that M. Pasteur was quite right in his statement that all that was required for the production of animalcules was "air and a liquid susceptible of putrescence," and that in his opinion there is no such thing as "spontaneous generation."

M. Pasteur goes on to state that the doctrine of spontaneous generation may be expected to be constantly turning up, since it maintains a hold over us, unknown to ourselves, from its relation to the impenetrable mystery of the origin of life upon the surface of the globe. Gay Lussac's report of his examination of the method of preserving provisions for the army, was not without its influence on the minds of men on the subject now under consideration. He proved that when the air in the bottles in which substances have been well preserved is analyzed, it no longer contains oxygen, and consequently that the absence of that gas is a necessary condition for the conservation of animal and vegetable substances. He also found that grapes crushed under mercury do not undergo fermentation unless brought into contact with pure oxygen, or with common air, even in a scarcely perceptible quantity. Such experiments, made with so much exactness and care by so great a master of

chemistry, have never been disputed, and other observers, following in his footsteps, have extended their researches to the organisms which arise in vegetable infusions; and all, whether partisans or opponents of the theory of spontaneous generation, admit that the smallest possible quantity of atmospheric air is sufficient, when brought into contact with a suitable infusion, to produce in a short time such changes, that there appears an incredible number of minute forms of animal life. The character of the infusion most decidedly exerts an influence over the ultimate results; as for instance when any kind of albuminous material is added to the saccharine fluid, the spores of a fungus, *Penicillium glaucum*, cover the surface in a few days; the infusions are also affected by the atmospheric conditions, whether summer or winter, by locality, whether placed inside or outside the house, in town or in country.

To sum up, and in a few words, after having carefully considered the arguments used by disputants on *both* sides of this question, I believe I am perfectly right in saying that the balance of experiment is certainly very much against the spontaneous generation theorists; but so much has been said and written on this subject, that we might if space permitted, greatly extend our remarks. There is, however, another point deserving of notice, which appears naturally to follow an inquiry into the source of living organisms, namely, the order of their successive appearance in vegetable infusions. This point in the life history of the infusoria has already occupied the attention of many investigators: and one in particular I wish to direct attention to,—Mr. Samuelson, whose researches were carried on in conjunction with Dr. Balbiani of Paris, and confirmed by him. As might have been expected of this gentleman, he starts by asserting his utter disbelief in spontaneous generation, and then goes on to tell us that when a carefully prepared infusion of vegetable matter in distilled water is exposed to the air, the *Protozoa* which first appear in it are *Amæba*: these in a few days disappear, and are succeeded by ciliated infusoria, such as *Kolpoda*, *Cyclidium glaucoma*, and sometimes *Vorticella*, and these in their turn by what we have looked upon as higher forms, as *Oxytrichum*, *Euplotes*, *Kerona*, etc., consequently Mr. Samuelson thinks that *Monads* are but the larval condition of the ciliated infusoria. He also noticed the constant occurrence of *Monads* belonging to the species *Circomonas fusiformis*, or *acuminata* of Dujardin, etc., in pure distilled water after a certain exposure to the air, and this without the previous admixture of vegetable matter of any kind in the water. The same results were obtained upon shaking rags, in various and distant parts of the world, over the distilled water; other experiments were also tried, and in all cases in

about three weeks he invariably obtained forms of ciliated infusoria. "The fusiform body of the *circo-monas* bears a long whip-like cilium at its anterior end, and a short seta at its caudal extremity: this finally drops off, and when exposed to undue heat and light, the animal is transformed into an *Amæba*."

Mr. Samuelson's results do not very materially differ from my own, save in one or two particulars. I have not seen the succession of generations take quite the same course, and the animal and vegetable bodies generally appear simultaneously, or so soon after each other, that it is at times difficult to decide the priority of appearance; but as my experiments have been chiefly confined to collections of rain and distilled water, *without* the addition of vegetable matter of any kind, this will materially affect the results. We are, however, quite agreed as to the wide and general distribution and great tenacity of life presented by these infusorial germs. With regard to the supposed purity of rain-water, at no time can it be taken without the numerous matters floating in the air being brought down with it, and, consequently, within a few hours after it is caught, *Protococcus pluvialis*, *Amæbæ*, and *Circomonas*, may always be found in great numbers. It is somewhat remarkable that the purest snow water, caught in a clear glass vessel, and allowed to remain well corked, will, in the course of two or three weeks, be found to contain *Amæbæ* and *Circomonas*, but it rarely presents other forms of animal life; the vegetable matter completes its growth very slowly, gradually passes to *confervæ*, and for a time no other change is seen to take place; so that it is painfully apparent that the atmosphere in which we live and move and have our being is something more than a mixture of gases, as apparently determined by chemical analysis.

Mr. Glashier's "*blue mist*," which he believes to be in some way associated with our cholera visitations, certainly does not depend upon the presence of any unusually large number of spores floating about in the air. Although spores, etc., exist, as I have shown, in the atmosphere, in greater abundance about the period of such visitations, they also exist when the public health is good. And therefore it should be regarded as a mere coincidence, if certain bodies prove to be more abundant during the prevalence of epidemic disease. But this "fungus-spore" theory is no new thing, for it is upon record that rusts and mildews have sprung up so rapidly upon articles of food and clothing, as to have appeared to herald approaching plagues. A so called "blood-rain" is said to have been the forerunner of the plague of Rome. It has been noticed, however, that the present year (1866) has been especially characterized by the prevalence of all kinds of moulds and mildews upon vegetation generally; we consequently

find the air thoroughly charged with the germs of *Uredo* (smut) and *Penicillium*; and we may readily believe that the same depressing influences that render the human family subject to epidemic disease also affect vegetable life, and the weakly and sickly plant equally with the higher human creature, goes to the wall, and may ultimately furnish the nidus for a colony of parasites.

In all my collections of rain, snow, and distilled water, animal and vegetable life proceeds to one definite point, and then recedes. I have never found any go beyond *Euglena*; and unless some vegetable matter be added to the solution, no higher form of life appears; on the contrary, a retrograde condition takes place. If some kind of vegetable matter, as hay or lettuce-leaf, be added, then I find, with Mr. Samuelson, rotifers make their appearance—not otherwise. But here, again, we get no further, and the infusion requires a something more to give it a start in life. As might be predicted, these changes are all modified, accelerated, or retarded by the action of light, heat, season, and so forth, and by the presence of any albuminoid material. If fresh-caught rain water be filtered and excluded from atmospheric influences, the appearance of both vegetable and animal life is very much delayed; but when fresh and clean rain water is exposed to the air, *Protococcus* quickly makes its appearance, and with it *Amæba*; the cells of the *Protococcus* soon throw off zoospores, and the *Amæba* take possession of the cells and feed upon the zoospores. I mention this latter circumstance, because some observers, both before and since Cienkowski, having doubtless seen the same occurrences, have stated their belief in the conversion of the contents of the cells of the *Protococcus* or *Ohlamydococcus* into a free moving mass of amœboid bodies.

Mr. Carter, well known for his valuable contributions to microscopical science, was one of the first to notice and promulgate this apparently impossible transitory condition of the volvox-zoospores; but he afterwards saw fit to change his opinion, and in place of looking upon it as the conversion of the vegetable protoplasm into that of an animal, he now believes that the germ of the *Amæba* must have been included in the vegetable cell, or as a parasite made its way into its interior; and remarking upon his first statement, that *Acitenæ* are thrown off by *Vorticellæ*, he writes thus: "Seeing, then, the great analogy, if not real identity, that exists between the nature of these organisms, I would suggest that the germ of *Acitenæ*, like the egg of the *Ichneumonidæ*, becomes hatched in the *Vorticellæ*, and lives upon its host." *

Carter. *Notes on Organization of Infusoria*. Ann. Mag. Nat. Hist. B. Vol. viii., p. 207.

To my mind this view scarcely admits of a doubt, and it is clear that the young of the *Amœba* in some manner find their way into the cell, just as it is on the point of breaking up, and so become developed in a situation where they are at once provided with a due amount of nourishment for the support of their earliest state of existence. I must not, however, omit to say that no less an authority than Dr. Hicks still holds to the former opinion, and fully believes, after many careful observations, that these bodies, which move freely about in the cell, ever changing their position, protruding and retracting portions of their membranous walls, exactly as the *Amœba* do, are really and positively what they appear to be, animals belonging to the class of *Rhizopoda*. He further observes, that after the amœboid bodies have begun to shift about in the cell, for every such moving body there was a corresponding empty space; and he cannot suppose it possible that any parasite could enter the cell from without, but that every examination tends to confirm his opinion that the amœboid organism is really the product of the metamorphosis of a mass of vegetable protoplasm.

Another careful observer, Mr. Archer, of Dublin, has also recorded the development of amœboid bodies in the cells of *Stephanosphaera pluvialis*; he looks upon the phenomenon as analogous to that which is known as occurring in one of the stages of development of the *Gregarinida*, the encysting stage; the central nucleus and vesicle disappear, and after a certain time "the mass breaks up into a series of rounded portions, which become elongated and slightly pointed at each end, constituting a little body which has been called a 'pseudo-navicella,' from its striking resemblance to the Diatomaceous navicula; the capsule next bursts, and the pseudo-navicellæ are scattered, and pass out of the body of the creature which they inhabited." *

Dr. Hicks believes that he has seen the young volvox pass into an amœboid state; in other words, the conversion of the protoplasm of a vegetable cell into an animal. He says, "Towards the end of the autumn the endochrome mass of the volvox increases to nearly double its ordinary size, but instead of undergoing the usual subdivision, so as to produce a *macrogonidium*, it loses its colour and regularity of form, and becomes an irregular mass of colourless protoplasm, containing a number of brownish granules."†

* Huxley.

† I have continuously had the volvox under the microscope during the past summer and autumn, and made more than a hundred examinations without having once seen anything approaching to the form of an *Amœba* in the interior of the cell.

The final change and ultimate destination of these curious amœboid bodies have not yet been made out; but from Dr. Hicks's previous observations, made on similar bodies developed from the protoplasmic contents of the cells of the roots of mosses, "which in the course of two hours become changed into ciliated bodies," he thinks it very probable that this is designedly the way in which these fragile structures are enabled to retain life, and to resist all the varied external conditions, such as damp, dryness, and rapid alternations of heat and cold. "The philosophic mind," observes Mr. Carter, "takes up this line of argument." No one can at first sight witness the changes which take place, almost like a dissolving view, in the protoplasm and chlorophyll of *Chlamydococcus*, *Eudorina*, and in that of the cells of the *Algæ* generally, and during which they pass from their original form into that of a rhizopod, without inferring that the form produced is merely another one of that which preceded it, and not an absolute change. Hence my description of the fancied passage of the vegetable protoplasm into *Actinophrys*.*

Passing on to the consideration of another stage of this inquiry, we must be struck with "the remarkable powers of multiplication by fission and gemmation which many of the group exhibit; within the last few years the investigations of Müller, Balbiani, Stein, and others have shown that these minute creatures possess a true process of sexual reproduction, and that the sexual organs are those which have been hitherto denominated the 'nucleus' and 'nucleolus.'"[†] And ultimately it will be found that the infusoria have a life history as important as that of the higher classes of animals. Dr. Grant in 1851 recorded the presence of ova in one of the marine sponges (*Tethya*), thus showing that the Protozoa formed no exception to the other sub-kingdoms of animals in the possession of these essential elements. Five years later his observations were corroborated by Lieberkuhn, in the case of one of the fresh-water sponges. Even then the existence of the generative elements still remained to be demonstrated in the Infusoria. Ehrenberg, it is true, had drawn particular attention to the "nucleus," and some others took note of certain minute filaments, but there these observations rested. Now, however, the whole aspect of this subject is changed, and for the vagueness which, four or five years ago, charac-

* The circumstances under which the moss-roots should be placed to show these phenomena, are to float any common moss on a glass of water in the shade; and when the radicles thrown out are of a considerable length, they may be removed to the slide and examined. Care must be taken not to expose them to too much light and heat.—Dr. Hicks's *Quarterly Journal of Microscopical Science*, 1862, p. 103.

† Huxley.

terized all attempts to explain anything like a generative function in the Infusoria, we have substituted, by Balbiani, a clear and complete survey of their leading phenomena. The Infusoria have long been known to multiply by spontaneous fissure, gemmation, and the production internally of various formed bodies, which many observers have described under the name of "embryos." The phenomena of "encysting," "conjugation," etc., which these minute bodies frequently exhibit, and the relation, real or supposed, between such processes, and their various modes of propagation, have from time to time afforded matter for no little controversy. M. Balbiani's investigations, however, derive additional interest from the very complete manner in which they have been carried out. As an instance of this, he states that in his examination of *Paramœcium aureliæ* he could not look upon them as conclusive until he had succeeded in extracting uninjured some of the eggs from the parent body, and had subjected them to the action of the surrounding water; when he saw each egg resolve itself into two portions, the smaller being enclosed within the larger, then by employing reagents, acetic acid and iodine, he produced the changes more rapidly; and in this way again and again obtained abundant proofs of the truth of each observation. So much then for Dr. Balbiani's researches on the phenomena of reproduction among the Infusoria, which have added most valuable information to our former meagre knowledge of these interesting forms of organic life.

The case of the Infusoria is, in some respects, comparable to the fertilization of Orchids, which Darwin has investigated with so much care, and rendered doubly interesting by showing how highly complicated are the contrivances by which among this beautiful and extensive group of hermaphrodite plants, fertilization is accomplished, and that, save in a few exceptional instances, self-fertilization is almost impossible. Comparing the Infusoria with Orchids, we may see that their fecundation is effected by constant dissimilar elements produced in different individuals; and in both cases the details of the process are curiously varied in their several tribes.

In 1819 Chamisso detected the mode of reproduction of the *Biphoræ*, and coined the term, "Alternation of Generations."* He found that the isolated *Salpæ* only produced chained-salpæ, and then only by gemmation; whilst the chained-salpæ produced isolated ones, and only by ova. The discovery of the now well-known life history of the *Medusæ* was next made by Saars and Siebold; it was shown that the *Medusa aurita* deposits an egg, which gives rise to a polyp,

* This term is more generally associated with the name of Steenstrup, the well-known author of a learned and valuable treatise on the subject.

which grows by gemmation and fissuration, and produces from a single individual several small medusæ, which again in their turn produce ova. Other phenomena were soon collated with these, as the fissiparous generation of Annelidæ, the various processes exhibited by certain Spongidæ and Infusoria. In 1845, T. Müller described the remarkable larvæ of the *Echinodermata*, from whose viscera the future perfect being is thrown off by a process of gemmation; and the researches of Kuchenmeister and Van Beneden afterwards fully illustrated the remarkable migrations and metamorphoses of the Helminthoid worms. "In the *Distoma* the embryos have at first the form of ciliated monads, these are metamorphosed into Gregarina-form worms, and in the interior of each of the latter, numbers of *Cercariform*, or tailed animalcules, are developed, which ultimately become true *Distomata*."

Quatrefages and Professor Goodsir, however, look upon all this as simply a part of the process of growth, comparable to the growth of a lost or mutilated limb in the Crustaceæ. The gemmation of the *Hydra*, the medusification of the Polyp, the peculiar virgin-propagation of the Aphis, the segmentation of the Nais, the gradual development of the Echinoderm within its Phitean larva, and all similar instances, are regarded as mere phenomena of *growth*, and not as illustrations of the *Parthenogenesis* of Owen. And this view is now held by nearly all biologists. We might even go a step further and point out that recent investigations have established the wide spread existence of *polymorphism*. One of the fungi has been known to possess six different kinds of fructification; the *Uredo* exhibits four, and others might be named, which were formerly looked on as distinct species.

In some of the gemmiparous animals new creatures are at times multiplied to an almost incredible extent by simple mechanical division. I have seen, after breaking away an Actinia from the side of my aquarium, a number of small pieces of the foot-stalk left adherent to the sides of the vessel; all of which fragments became in a few days perfectly-formed young Actiniæ. The *Hydra viridis* may, as we know, be divided longitudinally, or transversely, into several parts, and each part will become a perfect polyp; or if a wound be made in the body of the animal, a new one sprouts from the site of the injury.

"The gemmiparous form of generation is met with in a large variety of animals. It exists in the Infusoria, Entozoa, Polypi, Medusæ, Annulata and Tunicata. In the *Nereis* a constriction first appears in the tail of the animal, immediately behind which the head of a new *Nereis* is developed, and the posterior division becomes separated from the anterior, or parent, as a

perfect animal. In this form of reproduction animals are formed, not from ova, or from the fission of primary reproductive cells, but from secondary or derivative germ-cells, placed in reserve in the tissues of these animals. The same process occurs in the *Triton* or the lobster, when a broken-off claw or tail is replaced, the new formation springs from derivative germ-cells placed in the claw or tail—that is, a reserve of derivative germ-cells, not wanted for use in the general development, is deposited in these different parts of the body.”*

Professor Goodsir believes that “the regenerative faculty does not reside at any part of the claw of the lobster indifferently, but in a special locality at the basal end of the first joint. This joint is almost filled by a mass of nucleated cells surrounded by a fibrous and muscular band.”

With respect to the *Hydra*, its reproduction is indifferently by gemmation or by true ova. The young hydra from the egg is identical in structure and character with that produced by budding. Nearly all writers now regard gemmation and generation by ova as two essentially distinct processes; nevertheless, the identity of the results is clearly seen in Mr. R. Crouch’s observations on the Sertularian Polyps. “At certain seasons of the year,” he says, “they produce cells much larger than those of a more permanent character. These are at first composed of the granular pulp of the stem, afterwards the pulp becomes furrowed, and finally formed into cells. After a short period they separate from the parent, and undergo the process of development. If these cells attain a certain size they are developed into eggs: if, on the other hand, they are stunted by cold, or otherwise interfered with, they are formed into polyps, while, if from further unfavourable circumstances they are rendered still smaller, they grow into branches, and thus we see that, according to circumstances, different organs are capable of being eliminated from the same structure.”

It appears, then, that there are three forms of reproduction, fission, gemmation, and generation by ova; in other words, “*Fissiparous*, when a cell spontaneously divides into two or more: *Gemmiparous*, when a plant or animal sends forth young branches from its stem; *Oviparous*, when the young are produced from seeds or eggs.” If we endeavour to arrange the known facts of reproduction, proceeding from the simple to the more complex, we must begin with a very simple process; namely, that of a single cell spontaneously multiplying itself by subdivision. In all the albuminous, starchy, or gelatinous matter called *protoplasm*,* a single cell appears, it assimilates

* Huxley’s *Lectures on Comparative Anatomy*.

† *Protos* (πρῶτος) first, *plasma* (πλάσμα) formative substance.

more and more of the fluid portions of the protoplasm, and then divides into two parts, perfectly symmetrical; these two quickly divide into four, eight, or sixteen, and so go on multiplying until a number of cells is produced, each cell being attached to its fellow by its wall, but capable of a separate existence. By this process of subdivision, a single cell of *Protococcus nivalis* (Red snow plant) has been known to redden in a single night vast tracts of snow, and the *Bovista giganteum* is estimated to produce in one hour no less than four thousand millions of cells. Ehrenberg computed the increase of the infusorial animalcule, *Paramœcium*, at two hundred and sixty-eight millions in a month. This simple mode of reproduction is certainly identical with that of growth of both plants and animals of a higher type.

If we ascend a step we reach the second form of reproduction, namely, the union of two *similar* cells, termed by botanists "*conjugation*." This consists in the coalescence of two similar cells to form a new starting point from which multiplication may proceed. Instead of two cells in the same filament we may have two cells in contiguous filaments coalescing, but in each case it is the union of two similar cells. From the fission of one cell into two, and the conjugation of two similar cells, we pass to the third mode of reproduction, namely, *generation by ova*, or the union of two dissimilar cells, and for the production of the more complex organisms, the union of germ with sperm-cells is indispensable.

By these several separate modes of reproduction we must admit that there is nothing more marvellous in an animalcule producing several millions of its kind, than in a plant constructed by as many cells, each produced by a process identical in every way. In the development of the tissues of the animal body, the newly-formed cells increase by division: and become determined in their growth by the character of the secretion elaborated within the walls of those previously existing. The formation of the more complex animal tissues takes place in the same way as that already noticed in plants, with this difference, that the mother cell contains a nucleus, within which is seen a very minute body called a nucleolus. The nucleus has the power of appropriating, or drawing in, a certain portion of the surrounding material—protoplasm—enlarges, and ultimately divides into two perfect cells. From the aggregation of such cells we have the animal body built up in all its complexity.

We have thus far traced the development of organic life through some very curious and highly interesting stages, and we have seen that life, in all cases, whether in the highest or lowest forms, depends upon perfection of organization for

development and maintenance ; but it must not therefore, as we said before, be supposed that it is altogether the result of organization, for death may occur without any trace of organic lesion to account for it. Nevertheless, the extent of organization necessary to the enjoyment of life is apparently very small indeed. A simple cell constitutes the entire organism of such plants as the *Chlamydococcus* or the *Palmella cruenta*, or even an animal, as the *Amœba*, and in these and such like simple structures resides a vital principle on which its integrity depends. But whatever the *extent* of organization may be, its perfection is essential and necessary to the maintenance of life ; for, as we now know, the seed which has been dormant a thousand years will, if its organization be perfect, spring into activity when planted ; but if crushed, its living principle is destroyed, and it will no longer germinate. Thus it is exemplified that to those minds familiarized with the phenomena of life, as manifested by the simpler organisms, the microscope "is not the mere extension of a faculty, it is a new sense."

THE NOVEMBER METEORS.

BY HENRY J. SLACK, F.G.S.,

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On the night of the 12—13th November the anticipated meteors were magnificently seen from my house in Camden Square, N.W. Occasionally mist and cloud drifted across the clear sky, but no large portion was obscured at any time between 11 p.m. and 3½ a.m., and when the interrupting vapours came, they were generally thin enough to allow the stars to peer through. At just about 11h. 8m. p.m. a magnificent fire-ball as bright as Jupiter passed over Betelgeuse and under Bellatrix in a nearly horizontal path. It had a beautiful greenish train, with undulating smoke-like edges. At (about) 11.37 a reddish meteor shot upwards under Mars, with a train lasting half a second. At (about) 11.41 another meteor shooting upwards, vanished near Castor ; and at (about) 11.48 a very fine one appeared under Rigel, slightly sloping to the south, and displaying a yellow and green train ; the train of this meteor was of a character frequently seen later in the night. The margins were like fine gold dust, and the centre a singularly beautiful pale emerald green. The golden yellow might be called between three and four of Admiral Smyth's scale, and the green though more emerald in hue, between the same numbers of his greens.

At (about) 11.51 two meteors shot from under Pollux and vanished beyond Orion; these had yellowish red trains. At (about) 11.54 the train of one west of Capella lasted from two to three seconds, and three minutes later the train of another exhibited the aspect of a narrow shower of closely packed sparks. At (about) 12.8 a meteor with a similar train, but red, appeared below Capella. At (about) 12.13 one shot up from below Mars towards Betelgeuse: the ball was orange and the train bluish green. At 12.13 I looked at a meteor moving towards Castor, through a Herschel-Browning spectroscope, and it exhibited all the colours; its train lasted about three seconds. About 12 p.m. my wife joined me, and while I looked from Leo to Orion, she watched a sky space from Orion to the S. W. Towards one o'clock the meteors came thicker and thicker, and from 1 to 1.30 it is scarcely an exaggeration to say that all the heavens were a blaze with fiery balls and long streaming tails of coloured light. The long trains stretched from 40, 50, to 60, 90°, and possibly greater lengths. In these cases a large proportion of the whole length of the trains was in a highly lustrous condition at the same moment of view. The effect was that of a continuous stream of burning particles left behind by the meteors in their course, and quite different from any luminous appearance that might arise from mere compression of the air in the fire-ball's flight.

Looking towards Leo it seemed as if a celestial rocket battery had been established in that constellation. A few meteors went downwards from γ Leonis, and many more upwards from the same star; but the majority had a more central radiant point. Upwards they shot by dozens, scores, and hundreds; now pelting past Procyon and through Orion, now bombarding Castor, then up to the zenith and down again: then through the Great Bear, under and over the pointers. Occasionally a little to the south of γ Leonis, meteors burst, and disappeared immediately, showing no trains. Probably their tails were behind them, and invisible from the foreshortening of perspective. At the same time the meteoric shower went on in descending curves west of the zenith point, and by 2.15 we had counted 1,400, excluding at least a hundred more seen before they came thick and strong, and our attempts to number them began.

At 1.22 my wife saw one perform a zigzag below Orion. The ups and downs of the ∇ it made, were shorter than is usual with forked lightning.

In addition to the long tailed meteors, we saw many with short fan tails. None of these reached any great height above the horizon, perhaps not more than 45°, and their tails exhibited glowing rainbow tints. These came from Leo. My wife saw some with light blue trains, and some with purple.

Catching meteors in a spectroscope is not an easy task. It is a sort of celestial snap-shooting in which there are more misses than hits. From the luminous glow which filled the whole atmosphere, and which was heightened by the London gas-lights, it was hopeless to spectroscopize trains, except at their brightest. Out of a dozen or two I saw through the instrument, the best defined spectra were yellow and green from the trains, and with all the colours when the nucleus or ball was in the field. My wife compared one she saw of a ball, to the spectrum of Sirius, but brighter.

I tried, ineffectually, to catch some of these shooting stars in my six and a half inch telescope, but they evaded me. I put on a large, low, eye-piece—an aplanatic of Horne and Thornthwaite,—which, with my instrument, gives a field of 4m. 15s, and pointed it at stars near which meteors were flashing, but although fresh supplies came in the expected direction, they provokingly went a little too high or too low.

The great majority of the meteors were as bright as first magnitude stars, such as Vega and Sirius; some as bright as Jupiter; others rivalled Venus, but few, if any, exceeded her. One of the largest I saw shot horizontally in the N. E. and burst with a irregular flame at (about) 2.38. A shower of sparks came from one near γ Leonis.

At the height of the shower the meteors came in batches and volleys. Sometimes two or more travelled close together, and at others, sets of four or five flashed in diverging courses from various parts of the heavens.

Near two o'clock I marked the paths of a good many on one of Herschel's British Association maps. Most of them seemed to converge to a point between α and ι Leonis, but the courses of several that passed through Gemini and Canis minor would, if continued straight backwards through their points of first visibility, have converged in Leo minor. The radiant point of the great majority was undoubtedly in Leo, and we must wait for Mr. Herschel to compare the various observations, and give us an accurate estimation.

The duration of the trains is probably underrated from their tendency to be lost prematurely in the general luminosity of the sky. Mr. J. Symons saw some for two minutes through a two and a half inch telescope. We saw several flashes like lightning, but whether they were really electrical discharges, or the light of meteors bursting out of sight, I cannot tell.

From the impossibility of two persons seeing and counting all the meteors, the total number must be set down as considerably in excess of our enumeration. We counted 1500 by about 3 a.m., and adding 100 or so seen earlier, this makes 1600—a portion only of the entire display. If these bodies are

regarded as microscopic planetoids, one night has consumed—burnt up—many thousand little worlds, and their remains are diffused in our atmosphere, or scattered unnoticeably on our earth. To meet and burn up a shower of these little bodies and convert them into most glorious fireworks is a pleasant incident in the journey of our earth-ball through celestial space, and perhaps the most enthusiastic advocate of the habitability of the planetary worlds does not consider that we have brought to a fiery ending the lives of microscopic populations on these tiny globes.

These shooting-stars, periodically met with in swarms, appear to be circling round the sun like larger planets, and it happens at recurring intervals that their orbit crosses ours when we are near enough to attract them into our atmosphere, which they enter with velocities of thirty or forty miles a second, and get burnt up through the heat which the friction engenders. A cannon-ball moves at about 1600 feet per second at its greatest velocity, and when we consider how insignificant this motion is when compared with thirty miles a second, we may imagine the intensity of the heat developed by friction even against the particles of highly attenuated air.

From the small size of the bodies of the shooting-stars their bombardment of our earth is unable to do any harm or produce any visible effect on its surface, but if there be swarms of bodies as big as the great meteoric stones, and likely to get in our way, future astronomers may not find watching a meteor shower so agreeable an affair as those of this generation found their labours on the famous November night in 1866.

We may add an interesting observation of the Rev. E. L. Berthon of Romsey, who says—"One most brilliant, rose coloured globe, which passed through Gemini below Pollux, left a long train of blue light, which continued like a comet 16° long for three minutes, and then gathering itself gradually into a wisp, remained in sight for six minutes and twenty seconds." Between one and two o'clock Mr. B. Scott, F.R.A.S., saw from Weybridge two meteors in the west, which he describes in the *Morning Star* as "revolving, like partners hand in hand in a country dance, round each other, describing spirals of light."

Papers already published in the *INTELLECTUAL OBSERVER* will supply much information for which we have been asked, and we shall resume the subject in our next number, supplying full answers to inquiries for popular expositions. A general account of *Falling Stars and Meteorites*, by Professor Ansted, will be found in vol. iv., p. 157. In vol. i., p. 217, is a paper by Mr. A. S. Herschel, on the *Observed Heights of Meteors*, illustrated by a diagram. In vol. iii., p. 31, is a translation from M. Quetelet's *Physique du Globe*, containing much valuable information on shooting stars, with a diagram, showing the

frequency of these meteors in different months. The meteor of Nov. 22, 1862 (with a sketch) is described by Mr. E. J. Lowe, vol. ii., p. 422. *Remarkable Detonating Meteors* of Feb. and Nov., 1865, are described by Mr. Herschel, vol. ix., p. 99. The "Herschel-Browning Spectroscope," is figured in the article called *The Coming Meteoric Shower—Spectra of Meteors*, Aug. number (1866), p. 38. In the last paragraph but one of this article, read *gaseous* matter instead of "porous." This paper contains important extracts from Mr. Herschel's lecture at the Royal Institution. The October number (1866) commences with a most important paper by Mr. Herschel on the *Prismatic Spectra of the August Meteors*, illustrated by a coloured plate.

FATIO ON THE FORMS AND COLOURS OF PLUMAGE.

M. VICTOR FATIO has kindly sent us a copy of his important paper on "*the Different Modifications in the Form and Colouration of Plumage*,"* of which we shall proceed to give an account, with extracts from the more important passages.

Speaking of the down first developed in birds, M. Fatio says, "In the thickness of the skin, on a growing bulb, and in the place of the future feather, the down grows and develops itself in a manner analogous to that which we shall presently study in the feather. It moves on little by little as it grows through the cutaneous layers, and at last pierces the surface in the form of a hairy looking material, ordinarily composed of eight to twelve, and sometimes of as many as twenty-four distinct filaments. This down does not always possess a stem and central axis like the barbs of a feather, and resembles those barbs which are held together by the extremity of a small special sheath. Down not only belongs to a young age, for we find it as a protecting covering of adult birds, whether garnishing the base of the stems of nearly all feathers, as a material without axis, at the base, and in the middle of the principal stem, or lastly when arranged on a separate stem, isolated and developed in the single tube of the principal feather, and lining to a greater or less extent its internal surface. This arrangement constitutes the double feathers of our Gallinaceous birds, and of our birds of prey, and is seen in the triple feather of the cassowary of the Indian Archipelago."

M. Fatio enumerates three sorts of down—cutaneous down, basilar, and feather down. The first is directly attached to the skin, the second confined to the basal portion of the feathers, and the third to the principal stem at the sides of downy feathers. The barbs in these downs vary a little in form, but

* *Des Diverses Modifications dans les Formes et la Colouration des Plumes*, par Victor Fatio. (Tiré du *Memoires de la Société de Physique et d'Histoire Naturelle de Genève*, tome xviii, 2me. partie.)

still more so the barbules in different groups of birds, or in different positions of growth. Down is often coloured: sometimes by the irregular diffusion of an internal pigment, in its barbs and barbules, and sometimes by pigment deposits in regular order and definite positions, and in parts swollen out, like the antennæ of certain insects.

"After a greater or less lapse of time the feather, which has followed the path prepared for it by the cutaneous down, drives before it the latter and its sheath, and at last thrusts out its downy termination. The great quill feathers, whether wing or tail, generally appear first, and a feather generally consists of a *stem*, or central axis; *barbs*, or secondary axes, lateral or branching from the former; *barbules*, tertiary axes implanted in the barbs, or between them on the stem; *hooklets* (*crochets*), appendages of the barbules, or quaternary axes." These parts exhibit an *epidermis*, formed of flat, irregular cells, and below this a larger *cortical substance*, formed of elongated cells, or their fibres; and in the centre a *medullary axis*, continuous or segmented, formed of regular pigment cells, polygonal or rounded. Besides down and feathers, most birds have, on the nostrils or feet, piliform feathers, which, as their name intimates, resemble the hair of animals. They are stems without barbs. Some birds, like the wax-wing (*Bombycilla garrula*), have horny and coloured developments at the end of some of their feathers, which, as we shall show, are probably barbs conglomerated together. Other species have defensive spines composed by the union of several feathers, united by extravasated pigmentary matter, and strongly reminding us of the formation of rhinoceros horn, by the coalescence of hair.

In studying feathers, M. Fatio says we must distinguish in the hooklets between those which have true quaternary axes and those which are merely outlying portions of the cortical matter. The first feather of a young bird is not always constructed exactly like that which succeeds it. Its barbs are lower and more distant, and its barbules have fewer hooklets.

In a young bird still in its shell, Engel has shown the existence of definite spots and rows of mother cells from which the feathers arise. "The primary cell divides into smaller cells, some of which accumulate in a basilar bulb, and then range themselves round the circumference, and others occupy the centre. The sheath which envelopes these primary materials, has at its base an orifice, commonly called the *inferior umbilicus*, and through it pass blood vessels, which convey to all parts the elements necessary for their progressive development. The plastic pigment-bearing matter forms gradually, and the cells which it produces, and as they take up their places they elongate

the rudimentary feather, which, furnished with its envelope, advances obliquely under the epidermis. The constituent pigmented cellules, polygonal, round, and nucleated, arrange themselves in series, composing the barbs, barbules, and axis of the feather."

"As the cellules which constitute the cortical portion develop and group themselves, their nuclei disappear in part, and they elongate themselves and assume a fibrillose form."

When the end of the growing feather has become firm enough to pierce its sheath, it puts forth the terminal barbules of the perfect feather, at first rolled round their axis, but soon developing into a tuft by the elasticity they acquire in drying. "They are coloured as the extremity of the adult feather should be, and have received already all the pigment which they will obtain." As the growth proceeds, each part receives on emerging from the sheath all the elements of colour which it will afterwards exhibit. At a later period the blood vessels are obliterated, the inferior umbilicus closed, and the sheath thrown off, and the pulp which constitutes the life of the feather dries up.

In a chapter on "true moults," M. Fatio explains that each bird, whatever its species, receives in its first feathers a certain dose of pigment, and after its first moult the new feathers are supplied with a fresh dose of new pigment, which, being differently elaborated, causes the bird to assume a different livery. M. Fatio regards the autumn moult as the true and most complete one, while the spring moult is more or less complete as the existing feathers are capable or incapable of modification. The special decorations which appear on the head and neck at the love season arise from local irritation. When a feather has gone through its course of growth and modification, it gradually dies, and is usually thrust out by a new feather growing at its base. M. Fatio cites on the authority of M. Lunel, the case of a goldfinch which had two complete sets of wing feathers, resembling a double set of teeth; the new ones having emerged a little out of their true direction, and not having thrust the others out.

"We have seen," says M. Fatio, "that when a feather has reached its natural size, and has thrown off its external sheath, the internal marrow dries up, and an operculum closes the inferior umbilicus. This drying up and closing are most complete in the longest feathers, but in no case is there any further supply of blood. The researches which I have been able to make on this subject, in many birds, as well as the observations of many authors, like those of M. Martin at the *Anas nigra*, demonstrate that the skin at the base of a dried feather does not exhibit the local inflammation or sanguine turgescence

noticeable at the base of a growing feather. A feather once dried, receives no more blood or pigment, because it no longer grows from its base."

Besides variations of colour produced by moults, other colour changes occur in most birds, taking place gradually from the end of the autumn, and in some cases going on rapidly at the approach of spring. Two principal phenomena are exhibited in these colour changes: "the interior pigment dissolves and spreads, while the extreme parts of each feather fall and allow the new colouration to appear, which has been formed below them, and thus showing suddenly a new livery which had been concealed."

M. Fatio describes the latent colour as residing in pigmentary granules, not dissolved, isolated, or grouped, and usually confined to the centres of the different parts of the feather to which they are to impart a new colouration. The colour which is seen is spread through the cortical substance of the same parts, and arises from an anterior colouration of other pigment granules, or of a subsequent solution of latent pigment deposits. Light, atmospheric moisture, and temperature are agents influencing these changes, operating in conjunction with food and the sanitary conditions of the bird.

"Here," exclaims M. Fatio, "are two feathers from the same part of the same bird—one an autumn feather, uniform, or variegated, with clear tints, dark, but comparatively feeble and not lustrous; the other, a spring feather with more definite and brilliant colouring. I place the autumn feather under the microscope, and, studying it with magnifications of from 80 to 300, I notice in its tissues the two conditions just spoken of; the colouration more or less strong, transparent, and diffused: and also its internal deposits somewhat diminished, or disappeared, from the extreme parts, such as those of the barbs and barbules. The pigment in the axis has been dissolved in, and spread abundantly through, the surrounding cortical substance; some parts being largely developed in their proportions."

After citing the opinions of other observers, M. Fatio describes his own experiments, and states that by exposing the feathers of the starling and linnet to the influence of moisture by immersing some in water, and floating others on the surface, they soon exhibited a sensible development of their cortical substance in the barbules of the starling, and in the barbs of the linnet. At the end of twenty days the pigment was not dissolved, or only so imperceptibly.

In another experiment M. Fatio moistened feathers with water, and gradually heated them on a plate of glass. He noticed at first a slight extension of colour in the tissues, and

when the moisture was evaporated, a perfect sketch of the barbs and barbules was traced upon the glass by a deposit of greasy matter.

In another case he wetted the feather with alcohol, but still obtained the sketch in greasy matter, which he considered to demonstrate that besides the coloured pigment, most of the tissues contained a little colourless grease.

Having satisfied himself that this diffused and colourless grease did not act as a solvent of the pigment granules, to which he ascribed a greasy nature, he made further observations thus described:—"I set to work to study and compare under the microscope the basilar tubes (quills) of different feathers in process of colouration, and I noticed always many greasy colourless cellules in the tissue of the tube, in its inside, and in the cortical substance of the parts nearest the stem, close to the spot where many of the feathers exhibited a marked strangulation. I could not, however, make out the channels this grease must follow, and I endeavoured to dissolve it on the field of the microscope. Having introduced a drop of ether between the two glasses that enclosed the feather, I saw like a circular canal, opening at the base of the stem, and probably able to conduct the grease between the remains of the subcutaneous sheath and the external wall of the tube; and I noticed within, a possible direct communication, between the hollow of the tube and the broad layer of cortical substance which looked like a channel of porosity. I speak now of small feathers, in which a less complete internal desiccation may more easily allow this internal circulation of greasy matter than the large feathers, in which the cortical substance becomes more opaque and horny with lapse of time."

To test these suppositions, M. Fatio dipped the quill ends of two small feathers in solution of carmine, having left one intact, and stripped the barbs off half the stem of the latter. At the end of twenty-four hours he found the carmine had ascended either externally between the sheath and the quill, or internally through the diaphragms formed by the cortical substance. In the first feather the fluid had ascended comparatively little, because it was carried off laterally by the barbs; but in the second it rose up to the point at which the barbs were left.

M. Fatio in further pursuit of his analysis, "procured a linnet whose breast feathers already showed a little of their spring colours, and having delicately applied to them the grease contained in the bird's oil-glands, soon perceived a more intense colouration, which was increased by heat. This colouration was not fugitive like that which grease or water will

produce on any feather, but remained intense and brilliant after many washings with alcohol and complete drying." The same experiment succeeded with the feathers of a finch (*Fringilla caelebs*) and similar results were obtained in a few minutes by the use of olive oil.

With reference to the large feathers, M. Fatio remarks that birds in preening their feathers pass their beaks all along each wing and tail feather, regularly taking a supply of grease from the oil-gland. He adds, "if a change of colour does not begin regularly at the extremity of a wing feather, as is usual with the smaller feathers, it is because it is much more exposed to the action of the air than the latter. And if sometimes the colouration does not proceed regularly in a small feather from the periphery towards the centre, it is for the accidental reason that some parts have been more exposed to moisture and light, or more readily penetrated by the grease." He further observes that the oil-gland becomes larger at the approach of the love season, and that fat birds usually exhibit the most intense colours.

"The external grease is absorbed by the barbs and barbules, and penetrating by endosmose or capillarity the more or less porous tissues fills the empty spaces, and finding its passage facilitated by dilatations occasioned by moisture, it gradually dissolves the fatty pigments they contain."

"Thus under the influence of moisture, alternately absorbed and evaporated, as a preparatory developing agent, afterwards of the grease of the body as a solvent, then of temperature and light facilitating chemical action, the feather colours itself, and changes and augments its tints."

Referring to the labours of other observers, M. Fatio employs the divisions of Bogdanow, but adds to his "ordinary feathers" others which he calls mixed, and to his "optical feathers" others which he calls enamelled (*emailées*). "Ordinary feathers," although often brilliant, do not exhibit metallic reflexions, and they show by their transparency an internal pigment resembling the colour they exhibit by incident light. The "optical feathers" exhibit reflexions, and show by their transparency an internal pigment of a different shade to the colour they assume in incident light. The linnet furnishes "ordinary," and the starling "optical feathers." "From their first appearance out of their sheaths, I see," says M. Fatio, "essential differences between the ordinary and the optical feathers which grow after the autumn moult on the breast of these two birds. I perceive, it is true, on all those parts which are about to fall, that they are grey or brownish in the linnet, or white or yellowish in the starling, but I notice in the former, barbules slender and slightly coloured, while in the latter the

extreme barbules are already large, well coloured, and even showing metallic reflexions. As these feathers finish their growth, as well as after their complete moult, they show the same difference—an inferiority of development and colour in the barbule of the ordinary feather as compared with an optical one. If I look at the feathers of the same birds in spring, I am struck by a series of differences which multiply more and more between the ordinary and the optical feathers, as I enter more minutely into their details of development, structure, and colouration. In the first place to the naked eye merely, the linnet's feather is shortened through the loss of its brown extremities, and has become red by a more complete solution of its internal pigment, whilst the starling's feather which has lost its white tip, and the ends of its upper lateral barbs has taken a more thread-like aspect (*effilée*) whilst its reflexions are much more brilliant and extensive. Under the microscope, in the ordinary feather, the barbule, instead of developing, is seen in many places to have fallen off, whilst the barb or secondary axis is enlarged and coloured, especially at its extreme portions. In the optical feather of the starling the barb has slightly changed, while the barbules, or tertiary axis are much developed both in size and colour."

"The barbs, or branches of the single stem, are in general formed of superimposed segments, more or less persistent, and the barbules constructed on a similar plan, are implanted in the barbs by their basilar segments. This base of the barbule is larger and stronger according to the period, and the nature of the feathers; but internal communications appear always to exist, which may render possible a mingling of pigments between the two axes of optical feathers, and between the same parts of ordinary mixed feathers. All the barbules are, like the barbs, composed of larger or smaller segments, arranged end to end and enveloped in a common epidermis; but as their segmentation has much more importance than that of the barbs, let us see the chief differences which exist between them in spite of their unity of structure."

"1. The lines of demarcation between the segments of optical barbules are much more decided than in ordinary barbules; or, to speak explicitly, separating diaphragms of these different parts are stronger in the former than in the latter. 2. The granular pigment deposits ordinarily diffused in the central nucleus of the segments, are always more abundant and more regularly distributed in the first than in the second. 3. We distinguish around these dark nuclei a layer of parallel or longitudinal fibres, much thicker in the optical barbule than in the ordinary one. 4. The lateral hooklets of the optical barbules are in general more developed in autumn than in spring, and their function

is, as we shall see, different from those of the ordinary barbules."

"Moisture developes each part in proportion to its supply of cortical substance. In the optical feathers the barbules, only augment in diameter, and as each segment swells into a little cylinder, more or less regular, we sometimes see the lateral hooklets swallowed up (*noyés*) in the distended mass, and disappear more or less completely. In the ordinary feather, the barb possesses the most cortical substance and becomes most developed. Possessing all the qualities of the optical barbule, it becomes swollen and coloured, sometimes immersed in its own matter, but usually expelling its useless barbules."

"The ordinary barb becomes much dilated like the optical barbule; but instead of increasing like it, the proportions of its segmentation and separating diaphragms, it loses in its development the character which is associated with the persistence of the barbules in mixed feathers."

"The ordinary barb is simply a fibrous mass. It is at the moment of extreme dilatation of the cortical substance that the pigmentary matter, often extravasated, proceeds to unite and sometimes solder together adjacent barbs, to form certain masses which have a horny appearance, and which we have spoken of in the wax-wing. I have seen several of these accidental solderings in the red frontal feathers of the goldfinch. This enormous dilatation of the barb is only exhibited in those ordinary feathers which are destined to acquire a certain splendour or lustre, and there are many others which exhibit a mean development, and these we call *mixed*."

"*Mixed feathers* comprise all the feathers which undergo little change of form; they constitute a great part of the plumage of ordinary birds: they never exhibit metallic reflexions, are often dull, and though sometimes of a certain lustre, rarely show that brilliance which belongs to the ordinary feathers."

"The barbules of mixed feathers are persistent and in direct communication with the barb that bears them. These barbules dilate and colour themselves at the expense of the barbs, without exhibiting the regular form or the pronounced segmentation of the latter."

"In certain mixed feathers the colouring matter accumulates at the ends of the barbules, which often break at these points, and assume the truncated appearance of optical cylinders. I call these feathers mixed, because they resemble the optical feathers in their mode of development, and the ordinary feather by their mode of colouration."

"Those feathers which owe their colour entirely to the light, whether optical or enamelled, do not change their internal pigmentation, and only acquire their colours by changes

of form ; but it is not so with the ordinary or the mixed feathers. They modify their colours either by augmenting the intensity of their original tint, or by replacing an old colour with a new one. In the first case there is a more complete solution of the internal pigments, and in the second an extravasation of the old colouring matter which disappears as an external dust, while a new solution is made of another pigment latent in the barbs. In this case it is rather difficult to obtain a complete solution by operating from without ; and I think that since those birds which entirely change the colours of their great wing and tail feathers, modify their little feathers much less, it is probable that a particular grease developed in the body, and reaching the feather internally, may be necessary to a solution of the new pigment, which, as we have seen, is already deposited in the interior of the feather."

"The feathers I have called *enamelled*, comprise all the blue feathers without metallic reflexions, and some of the most brilliant green feathers which are without these reflexions. . . . These enamelled feathers always exhibit in the interior of their barbs at their birth as well as after a complete moult, large polygonal cells with coloured nuclei. Below the colourless epidermis and on the dorsal or upper face of new feathers, the microscope always shows a layer of elongated vertical cells, and their thickness gradually diminishes in advancing towards the lower surface. These cells constitute what I call the *enamel*.

"This transparent enamel is differently coloured and variable in thickness. Its tint gives the appearance of green or blue, and its thickness gives a greater or less fixity to the colours which often change from the finest blue to the finest green, and sometimes to a tint of delicate yellow. A very thick layer gives the appearance of an opaque colour. In spring the colouration increases, the barbs develop a little, and many barbules disappear, while in the meantime the dark internal pigment gradually dissolves, passing through transitive tints. The enamel only seems to be slightly soluble in the dissolving material in the axis."

M. Fatio gives the following summary of these various actions :—

"1. Of two successive axes the first develops always at the expense of the latter.

"2. In ordinary feathers, properly so called, the secondary axis predominates over the tertiary, and the chief changes take place in the barbs.

"3. In optical feathers, properly so called, the tertiary axis predominates, and the chief modifications are effected in the barbules.

"A. In mixed feathers the barbs undergo some changes, and the persistent barbules are much less modified than in optical feathers.

"B. In enamelled feathers the barbs though optical in pigmentation, swell and colour themselves; the barbules fall."

We must, on a future occasion, return to M. Fatio's important paper.

NEBULAR AND STELLAR SPECTRA.—SOLAR OBSERVATION.—RED STAR.—PLANETS.—OCCULTATION.

BY THE REV. T. W. WEBB, A.M., F.R.A.S.

THE return of the glorious Orion Nebula to our evening skies will always be a source of pleasurable anticipation to the astronomical student: and now that its gaseous composition is fully recognized, the possibility of change will be a fresh inducement to its attentive examination. It must still remain a matter of strange and perplexing mystery, by what agency such changes of figure or intensity can be produced in free space; but it will be admitted that there is less difficulty in conceiving their existence in such a filmy mass, than among an innumerable host of stars, where the presence of mutual gravitation renders derangement of figure almost inconsistent with permanency of existence: and hence the alterations of figure and brightness already recorded or imagined, do not now appear so incredible as they might in earlier days, nor so probably if not certainly due to differences of instruments or climates. We have already on several occasions* referred to the opinions of eminent observers on this head, and we have now to add that renewed investigations have been in active progress on the other side of the Atlantic. A considerable time has elapsed since the late W. C. Bond published, in the *Memoirs of the American Academy*, a finely executed figure of this nebula, with a catalogue of the involved and adjacent stars, which has been thought open to some exception. Otto Struve, in particular, gave it as his opinion in 1857, that the latter was "crowded with errors, and worked without any system," and that the author had "expended more care on the graphical representation of the nebula," without, as it should seem, intending to rate even the diagram very highly. In consequence of these remarks, a careful review was undertaken with the noble instrument previously employed, an achromatic, by Merz,

* See INTELLECTUAL OBSERVER, iv. 258; v. 58; vii. 139; ix. 177.

of 14.95 inches aperture, and 22.5 feet focus, under the direction of G. P. Bond, the worthy successor of his father; and at his death, Feb. 17, 1865, we are informed that he left a MS. containing a thorough and systematic examination of the nebula; a work which continued to occupy his thoughts until a few days previous to his decease.

The Report of Harvard University, dated in the following month, states that "during the winter and early spring of 1864-5, minute observations were made on 59 nights, resulting in the discovery of many new features." The astronomers engaged assert that "it will require a long series of observations to determine whether there are variations of the form of the nebula, or of its light. It will also require many observations to get more precise results about the variability of the stars in the nebula." They think it a question whether the three apparently well-defined groups of stars represented to the naked eye as ι , β , and γ *Orionis*, may not be associated with the nebula itself, rather than barely superposed, a point deserving of notice being that many of the stars have nebulous envelopes. It seemed to them highly probable that these three clusters are coincident with three centres of aggregation of nebulosity; and they therefore extended their fresh survey $1\frac{1}{2}^{\circ}$ N, and as far S of θ , preserving nearly the same limits of R.A., $16^{\circ} 52'$ * each way. Within this area they have determined the places of 1143 stars; the number in H's and Σ 's catalogues having been 155, a difference arising in part from the enlarged extent. "It has been found hardly possible to confirm Σ 's supposed discovery of variable stars, except in one or two instances. The special difficulty arises from the fact that a bad state of the atmosphere, and the consequent blending of the nebula with small stars in its immediate neighbourhood, renders the latter invisible." They have found 6, not identical with Σ 's, which show marked signs of change. They mention among their other results, the tracing of the connection of γ , and ι , *Orionis*, with θ , especially the great loop uniting ι with θ , one of the finest features of the whole nebula: the association of the nebulosity with stars by general aggregation round the three clusters—by wisps of nebula attached to certain stars—and by larger numbers of small stars in bright nebulous areas, contrary to the natural optical effect of a brighter ground: the spiral structure of the parts surrounding θ : and the comparative permanency of the form and aspect of the nebula, in contradistinction to the rapid variations supposed by Otto Struve.

These observations, so far as respects the extent and connection of the whole nebulous mass, are in exact correspondence

* There seems to be some mistake in these figures, which I am unable to rectify.

with those of Secchi (INT. OBS. vii. 139); and the possessors of the large silvered specula which are now coming into use will find it an interesting task to ascertain how far they may be able to confirm them. We have already mentioned the full recognition of the gaseous character of this marvellous phenomenon, which cannot be discredited after the accordant results of Huggins and Secchi; but it is gratifying to add that the resolution which has for twenty years been usually ascribed to the reflector of the E. of Rosse, has been disclaimed by its noble maker; his lordship having authorized Mr. Huggins to state "that the matter of the great nebula in Orion, which the prism shows to be gaseous, has not been resolved by his telescope. In some parts of the nebula he observed a large number of exceedingly minute *red* stars. These red stars, however, though apparently connected with the irresolvable blue material of the nebula, yet seem to be distinct from it." This alone was wanted, to set that most curious inquiry definitively at rest. One singular fact, however, may be noted here. The spiral arrangement ascribed to part of the nebula by the American observers is also a well-known characteristic of many clusters and groups of stars, and should its existence in the Orion nebula be confirmed, it will form a curious bond of connection between objects of a nature apparently most dissimilar.

An examination of former observations with the great reflector, for which we are indebted to Lord Oxmantown, leads to the important conclusion, that no object to which prismatic investigation has ascribed a gaseous nature has shown a stellar composition in the telescope; the widest discrepancy being that 6 nebulae giving a gaseous spectrum, had been considered "resolved, or resolvable?" at Parsonstown. The indications of the two very distinct and dissimilar modes of analysis seem therefore to be rapidly and satisfactorily converging. Our readers will be interested in knowing what results the spectroscope of Huggins has given with respect to the objects already enumerated in our list of clusters and nebulae. The following were all found to exhibit a continuous spectrum: by which is meant, in contradistinction to the insulated bright lines given out by incandescent gases, a spectrum similar to that of such stars as are bright enough for examination, and to that of our own sun.

No. 19 (INT. OBS. vi. 115). 11 M. 4437 Gen. Cat. "The continuous spectra of all the brighter stars were separately visible. When the clockwork of the equatoreal was stopped, an interesting spectacle was presented by the flashing in rapid succession of the linear spectra of the minute stars of the cluster as they passed before the slit. In no part of the

cluster was any trace of bright lines [*i.e.*, the indication of gaseous matter] detected."

No. 20 (INT. OBS. vi. 117). 13 M. 4230 Gen. Cat. "Spectrum ends abruptly in the orange. The light of the brighter part is not uniform; probably it is crossed either by bright lines or by lines of absorption."

No. 25 (INT. OBS. vi. 347). 56 M. 4485 Gen. Cat. "Suspicion of unusual brightness in the middle part of the spectrum."

No. 26 (INT. OBS. vi. 348). 81 M. 1949 Gen. Cat. "The red end of the spectrum wanting or very faint."

No. 27 (INT. OBS. vi. 348). 82 M. 1950 Gen. Cat. "The absence or great faintness of the red portion of the spectrum more marked than in the spectrum of No. 1949."

No. 29 (INT. OBS. viii. 207). 51 M. 3572 Gen. Cat. "A suspicion that some parts of the spectrum [of each of the bright centres] were abnormally bright relatively to the other parts."

Such is the result of prismatic analysis applied to nebulae and clusters with which we have been made familiar. In a very remarkable and suggestive note the author states that the peculiar appearance of the continuous spectra of some of the nebulae and clusters has suggested to him, from his first examination, that possibly the luminous points into which the telescope resolves some of them, may not be of the same nature as the true stars. The spectrum of the great nebula in Andromeda and its small companion was recorded in August 1864 as ending abruptly in the orange: and throughout its length not uniform, but evidently crossed, either by lines of absorption, or by bright lines. The same characters, he adds (as we have already seen), have since been found in several of the brighter nebulae and clusters: it would be possible to explain the absence of the less refrangible rays by absorption through vapour; but the apparently *complete* want of light at that end, and the unequal, mottled appearance of the brighter parts suggest rather a gaseous source; and that the spectrum consists of numerous *bright* lines: they are too faint, however, to admit of a sufficient contraction of the slit to determine this point. But some quite recent observations (June, 1866) not yet complete, appear to support the view that the bright points of some clusters may not be similar in constitution to the sun, or the brighter stars.

Thus it would seem that a new and unsuspected, and most singular field of inquiry is opened to the view of those whose instrumental means admit of its investigation. Such means, indeed, are rare. But if, where they exist, they were pushed to their full capability, much valuable aid might be given to

one whose name must ever stand foremost as the leader of the prismatic analysis of the starry heavens.

Another eminent observer, Secchi, has been diligently prosecuting spectroscopic, or, as he calls them, "spectrometric" inquiries, and has arrived at conclusions differing in some respects from those of Huggins. He has formed a classification of stellar spectra according to distinctly-marked types :—1. That of the bluish-white stars, such as Sirius and Wega, with dark bands in the blue and violet, including nearly one-half of the stars examined :—2. That of the red, or orange stars, with broad zones, such as Betelgeuse and Antares :—3. That of the yellow stars, comprising Capella, Arcturus, etc., marked by fine lines, and resembling the spectrum of our sun. To these are added a type the inverse of the first, found only as yet in γ Cassiopeæ and β Lyræ, and a type peculiar to Orion, distinguished by the intensity of the green. He has also observed in other regions the separate and special predominance of some one type of light. All this is certainly very remarkable, but is only given by himself as the result of a few evenings' work preparatory to a more general and detailed research. Before, however, any fully satisfactory conclusion can be attained, a question will have to be decided as to the nature of many of the bands towards the red end of the solar spectrum, the origin of which, as will be seen in our last number (p. 317), has been largely referred by M. Jansen, of Paris, to the presence of aqueous vapour. As to some of these confessedly delicate and obscure points, further investigation and the labours of many observers are obviously desirable. In such stellar spectra as are crossed by numerous dark bands, a difficulty has been pointed out in ascertaining whether certain intervening luminous spaces may not assume the deceptive aspect of bright and gaseous lines from contrast alone, and here the finest instruments will be required for the decision. As to nebulous material, it is frequently so deficient in luminosity as to elude all known means of analysis. Up to the beginning of the present year Secchi had discovered fourteen very feeble nebulae which had escaped all former observers; and has found occasionally large spaces where the sky has a milky aspect—the "diffused nebulosity," no doubt, of the Herschels. In the latter case there seems no impossibility in the idea of a vicinity to our own system, which, if it could be estimated, might perhaps surprise us. According to the Roman astronomer the nebula of Orion extends through all the space from ζ southwards to 49 and ν , two 5 mag. stars nearly on the parallel, and somewhat less than 2° apart, forming the bottom of the sword.

One of the most curious observations of this nature, for

which we are indebted to Secchi, relates to a singular convolution of nebulous streaks, RA. 17h. 55m. 18s. DS. $24^{\circ} 21' 15''$. This is M 8*, or Gen. Cat. 4361. He says (1865, Aug. 8) that this object "se trouve notablement changée. La portion qui divisait ses ovals a disparu, et les ovals ne sont qu'un canal presque continu." The ovals are three included spaces, one entirely, two others comparatively dark, which were, when figured by H. at the Cape (1837, June 27), divided by two streaks of irresolvable haze. There is, indeed, some difficulty in reconciling H.'s description and drawing (semi-inverted, it must be remembered, owing to his front view) with the expressions of Secchi. If I interpret the former aright, his three ovals thrown into one would not form a continuous canal, but an opening bent back at an acute angle, and Secchi seems to be referring to another opening described by H. as a larger and more ill-defined basin distinct from the ovals, and lying in the same straight line with two of them. But whether this conjecture may or may not be right, there seems strong evidence of change. H. observes that the nucleus (which is in the *p* streak) is not stellar, and greatly resembles that of the nebula in Andromeda. Secchi finds that under the spectroscope it exhibits "la raie ordinaire," the usual bright band of gaseous matter. To a suspicion that the great aperture of H.'s reflector (18½ inches, front view) might reveal interruptions of continuity which Secchi might not perceive, it might be replied that the former was on the other hand unsuccessful in tracing any connection between the principal mass of the Orion nebula and that surrounding the star *c.* 8 M is not included in the *Bedford Catalogue*; it has now left our evening sky, but may form an interesting object of search in another year, when Sagittarius is in a suitable position.†

SOLAR OBSERVATION.

The "Solar Caps" or dark glasses which have hitherto been adapted to the eye-pieces of telescopes to intercept the heat, and as much as is unnecessary of the light of the sun, are all more or less objectionable as giving a tint to the solar image which might interfere with the real colour, and in some cases perhaps affect the visibility of the more delicate details. A very ingenious contrivance has lately been introduced by G. and S. Merz of Munich to obviate this defect. It is well

* M 1 in the *Astronomische Nachrichten*, from a misreading of the Cape Observations.

† It should have been noticed before that subsequent investigation has shown the relative fixity of the nebulous star 45 μ iv. and its companion: so that the suspicion of proper motion advanced in INT. OBS. vii. 188, and derived from earlier measures, must be abandoned.

known that the rays of light, when reflected at a certain angle from a surface of glass, become polarized, and consequently will be either transmitted through, or reflected from, a second similar surface, according to the angle under which the latter receives them. In Merz's new solar eye-piece, 2 pairs of plane glass mirrors (of course, un-silvered), are so arranged as by the rotation of one pair relatively to the other, to intercept at pleasure the whole, or any required part, of the light transmitted through the telescope. Secchi's opinion of this contrivance is decidedly favourable. He says, "your helioscopic polarizing ocular is preferable, because it shows the sun of its true colour; thus films which appeared blue in the ordinary oculars with blue glass, are seen with yours of a rosy hue, the same tint as the protuberances which are seen during eclipses. This is an important fact." It is to be hoped that Mr. Browning or some other skilful optician will turn his attention to this construction in our own country, where the solar phenomena are at present attracting so much notice.

RED STAR.

In an extract from the Memoirs of the Astronomical Society, Vol. iii. p. 187, I find the following statement on the authority of H. "No. 895 (Σ) R.A. 6h. 12m. P.D. $84^{\circ} 12'$ [=D. N. $5^{\circ} 48'$] L full ruby red, or almost blood colour. S fine green, which it loses when the large star is concealed." This object from its double character may possibly have been intentionally omitted from the catalogue of Dr. Schjellerup, of which an abridgment was given in our Sept. number; but it seems likely to repay the search. It will be found near the nose of Monoceros.

PLANETS OF THE MONTH.

MARS is now rapidly approaching the earth, and becoming a telescopic object of much interest. As the opposition, which occurs on Jan. 10, will be somewhat more favourable than the last, as well as those for some years to come, we trust that all available telescopes will be employed in the scrutiny and delineation of his features.

The following remarks, by one so pre-eminent in the art of design as De la Rue, are too valuable not to find a place in relation to this subject. Speaking of the disagreement too frequently observable in astronomical drawings, he says, "These discrepancies no doubt arise in some measure from differences in the aperture and defining power of the telescopes employed; in other instances, much is attributable to the state of the atmosphere at the places of observation. The discordances

arising from the foregoing causes, would, however, not present so many difficulties, were astronomers, as a rule, able to delineate what they see with anything like an approach to accuracy of detail. Much confusion is created by the exaggeration of certain details which happen to strike forcibly the mind of particular observers, who give undue prominence to those features both as regards size and intensity. But astronomers are not responsible for the whole of the difficulties placed in the way of those who undertake the task of reducing observations; the steel-engraver, the lithographer, and the wood-engraver, are answerable for a great share of the confusion engendered by their very free translations of the drawings placed in their hands to be copied."

Mr. Banks, to whom we owe a beautiful series of drawings of this planet in 1864, published in the *Astronomical Register*, remarks that a considerable change will be found in the position of the poles, the N., which was then beyond the limb, coming more and more into sight, while the spots near the equator will be projected further from the centre of the disc, and follow a course much more curved upwards (as seen inverted) so as to render their identification more difficult.

URANUS will be very well situated for observation this month; at the commencement of it lying very near the *sf* edge of the fine cluster near *Propus* (INT. OBS. v. 54) and reaching at its opposition on the 27th, a station between 2° and 3° *sp e* *Geminorum*, a 3 mag. star standing about $\frac{1}{2}$ of the way from Pollux to Aldebaran.

OCCULTATION.

20th. B.A.C. 1526, 6 mag. 5h. 11m. to 5h. 59m.

ON SILK PRODUCED BY DIURNAL LEPIDOPTERA.

BY PHILIP HENRY GOSSE, F.R.S.

THE Rev. D. C. Timins, in his interesting paper *On the Habits of some Lepidopterous Larvæ* (INTELLECTUAL OBSERVER, Nov., 1866) says at p. 255, after describing a silken couch spun across a leaf by the caterpillar of *Charaxes Jasius*—"This is, so far as I know, the only instance of silk being produced by a member of the *diurnal Lepidoptera*."

The expression is too strong; for I need not remind Mr. Timins, I am sure, that the pupæ of the *Vanessadæ* and similar dangling forms hang from a dense conical button of silk spun by the mature caterpillars, while those of the

Papilionidæ and *Pieridæ* have, besides, a thoracic girdle of silk.

But my object in writing is not to correct this little oversight of phrase, but to mention a case very curiously parallel to that recorded by Mr. Timins, of a reposing couch of silk spun by the caterpillar of another showy butterfly, the Tiger Swallow-tail of North America (*Papilio Turnus*). Nearly twenty-seven years ago I thus announced the fact in question in my *Canadian Naturalist* :—

“September 1st. I have lately taken several of the fine green velvety caterpillars of the Tiger Swallow-tail, with violet spots on the body, and two eye-spots. It spins a bed of silk so tightly stretched from one edge of a leaf to the other as to bend it up, so that a section of it would represent a bow, the silk being the string. On this elastic bed the larva reposes, the fore parts of the body drawn in so as to swell out that part, on which the eye-spots are very conspicuous. I have taken it from willow, poplar, and basswood, but chiefly from brown ash. Before it spins its button and suspending girth, it gradually changes colour to a dingy purple.”—(*Op. cit.* p. 293.)

ARCHÆOLOGIA.

DISCOVERIES of considerable importance to English history were made in the latter part of the last month in the CATHEDRAL OF ROUEN, under the care of the well-known Norman antiquary, the Abbé Cochet. It is well known that, as far back as 1838, some well-directed excavations brought to light the original effigy, or statue, of Richard Cœur-de-Lion; the Abbé Cochet has discovered that of Richard's elder brother, HENRY COURT-MANTEL, the turbulent son of Henry II., who, as it is well known, was crowned during his father's life. Contrary to the statement of Montfaucon, who said that Henry's effigy was sculptured in white marble, the material was found to be the hard lias of Créteil, as was the case of that of Richard I. It is unfortunately much mutilated, and the body cracked through the middle. Still it presents many points of great interest. It represents a king of England and Duke of Normandy, and offers a faithful representation of the royal costume of the time. The young prince wears a tunic, or long robe, fastened under the throat by a handsome circular fibula. A girdle, buckled on the loins, is ornamented in its own length with St. Andrew's crosses, and other devices, in a very graceful pattern. The body of the Prince is enveloped in the royal mantle, which is fastened at the shoulders by means of two clasps in the form of quatrefoils. The effigy is without a sword, as was the case in that of his brother

Richard; a broken sceptre is supported on the left arm, and an extremely elegant armônière is suspended to the girdle. After this discovery the explorations were continued, and other objects of interest were brought to light, by far the most important of which was a leaden coffin, which there can be no doubt was that of John of Lancaster, Duke of Beaufort, the brother of our Henry V., and Regent of France under Henry VI. This had evidently been originally enclosed in a strong coffin of oak. The bones of the great duke were found inside undisturbed; the body had been embalmed with some aromatic substances, the nature of which could not be satisfactorily ascertained, except that mercury had entered largely into them. Drops of mercury which fell from it almost formed a stream. The hair of the head was found perfectly preserved. The hands were crossed over the abdomen. On the breast lay a cross formed by a fillet of a stuff which resembled silk, or fine linen. It was the only object of art found with the body. The Abbé Cochet deserves the greatest praise for the skill and energy he has displayed in carrying out these interesting explorations.

The city of HEREFORD ought to feel flattered in its character for antiquarian interest, for it appears that the three great archæological institutions, the British Archæological Association, the Archæological Institute, and the Cambrian Archæological Association, had each, unknown to the other, chosen Hereford for its place of meeting next year. The Cambrian Association, having been the first to publish its choice, remains in possession, and will hold its meeting in Hereford in the month of August, 1867. The Archæological Institute is understood to have changed its place of meeting to Hull. The British Archæological Association has resolved upon holding its meeting next year at Ludlow, and has elected for its president Sir Charles H. Rouse Boughton, of Downton Hall, near that town. Its week of meeting is to be that beginning on Monday, July 29, and ending on Saturday, August 3. No town in England could, by the beauty of its scenery, and by the multitude of objects of antiquarian interest scattered in and round it, offer so many attractions to the archæologist as Ludlow.

A correspondent at NORHAM has sent us a drawing of an ANCIENT SWORD which was found protruding from alluvial deposit, on the Tweed banks, near that place, after a severe flood, some feet below the surface of the land. The blade, he informs us, is thirty-two inches long; it tapers gradually to a point, and the handle is formed by two lunette cross-bars, the convex sides turned towards each other. It is a very rare type, but Mr. Roach Smith, in his well-known Museum of London antiquities, had one closely resembling it, which was found in the bed of the Thames. He considered it as belonging to a date not older than the thirteenth century, but perhaps even a little later, and this opinion is probably correct.

The excavations at SILCHESTER, on the site of the Roman town (*Calleva*), have been carried on with vigour during the summer and autumn, at the expense of the Duke of Wellington, and under the direction of the Rev. J. G. Joyce, and are becoming every day more interesting. Lines of streets have been already traced, and houses

have been opened, presenting somewhat varied examples of hypocausts, and remains of tessellated pavements, all throwing new light on the condition and manners of the inhabitants of this island during the Roman period. One of the hypocausts recently uncovered is unusual in character: the ground has been first cut into channels radiating from a centre, and afterwards perforated, and faced with tiles, instead of the ordinary arrangement of supporting columns of tiles. The part on which Mr. Joyce is now at work, is supposed, from the appearance of the buildings and from the various objects found in it, to have been the forum of the Roman city. Some of the houses present the appearance of having been altered more than once from their original plan, as though through restorations and adaptations after they had been destroyed. This is not uncommon in the remains of Roman buildings in this island.

An ancient PYRAMID has been recently discovered in the vast plains between New Mexico and California, through which the Rio Colorado flows. It has been originally about 130 feet high, with a platform of a few feet square at the top. It presents the appearance of having at some period suffered from an earthquake. The resemblance of these curious monuments of a primitive Mexican civilization to those of Egypt is very remarkable.

A ROMAN INSCRIPTION has been found on the shore near the now small town of Skinburness, on the coast of Cumberland. Formerly a town of some importance stood at Skinburness, but it was destroyed by a great irruption of the sea so long ago as 1301. It is a fragment of an altar dedicated to the deities addressed on it as MATRIBVS PARCIS. The worship of the *deæ matres*, usually represented as three females seated, and holding fruit, was extensively spread over the north-western provinces of the Roman empire. Here they are identified with the three Parcæ, or Fates. The discovery of this stone would seem to show that the old town of Skinburness had occupied a Roman site.

T. W.

PROCEEDINGS OF LEARNED SOCIETIES.

GEOLOGICAL SOCIETY—November 7.

The following communications were read:—

ON SOME REMAINS OF LARGE DINOSAURIAN REPTILES FROM THE STORMBERG MOUNTAINS, SOUTH AFRICA. By Professor T. H. Huxley, F.R.S., V.P.G.S.—The specimen more particularly described in this paper is a portion of a right femur, twenty-five and a half inches long, so that the entire femur may be safely assumed to have exceeded thirty inches in length. The peculiar form of the bone, and the characters and position of the trochanters, leave no doubt of the Dinosaurian affinities of the reptile to which it belonged, which must have been comparable in point of size to its near allies, the *Megalosaurus* and the *Iguanodon*. To the former of these it possesses the closest affinity, but differs in the proportional size and

form of its trochanters, and in its much heavier proportions; and the author proposes for it the name *Euskelosaurus Browni*. A portion of the distal end of a femur indicating another genus of large-sized Dinosaurian reptiles was also described, the characters yielded being sufficient to prove that it belongs to another genus than *Euskelosaurus*. The discovery of these remains in the Stormberg rocks was stated to be by no means decisive of their geological relations, as Dinosaurian reptiles lived throughout the Mesozoic period, and may have existed during the Permian; but it is interesting to observe that the Stormberg rocks conformably overlie the Karoo beds, which have yielded the Dicynodonts, and so many other remarkable reptiles and Labyrinthodonts.

ADDITIONAL NOTES ON THE GROUPING OF THE ROCKS OF NORTH DEVON AND WEST SOMERSET. By J. Beete Jukes, Esq., M.A., F.R.S., F.G.S.—Commencing with the country around Wiveliscomb, near which place Sir H. De la Beche had indicated an east and west fault of small extension on the maps of the Geological Survey, Mr. Jukes described the rocks of the district reaching from that place north-west to the Brendon Hills, and westwards to Dulverton, including the valley of the Tone, more to the south. From Dulverton he examined the country towards Simonsbath, and then, proceeding to Barnstaple, made traverses from that place to Challacombe and to Bittadon. Similarly, after examining the neighbourhood of Combe Martin, he proceeded along the north coast in an easterly direction, through Countisbury, Porlock, and Dunster, and across the Williton valley to the Quantock Hills. The observations made during these several journeys were given in detail by the author; and the principal conclusions at which he had arrived in consequence were stated to be the following:—(1) There are three areas of old red sandstone in this region, namely, *a*, the Quantock Hills; *b*, the Porlock, Minehead, and Dunster area; and *c*, the Morte Bay and Wiveliscombe ridge. (2) Each of these masses of old red sandstone dips under a great mass of carboniferous slate. (3) The coal-measures, the carboniferous slate, and the old red sandstone of Devon are contemporaneous with the coal-measures, the carboniferous limestone, and the old red sandstone to the north of the Bristol Channel. (4) That if the great fault which the author believes to exist be proved to be absent, his other conclusions will not be altogether vitiated, for the red rocks of Porlock and Dunster may then be taken as the top of the true old red sandstone lying underneath a great thickness of carboniferous slate.

ROYAL MICROSCOPICAL SOCIETY—Nov. 14.

A letter was read containing Her Majesty's command that this society, which recently obtained a charter of incorporation, shall be a "Royal Society." Fellows will use the letters F.R.M.S. The bye-laws of the society were revised, and one of them referring to the term of office of the president was suspended with a view to the re-election of Mr. Glaisher, whose term of office would normally expire in February.

Mr. Wenham described a modification of his plan of combining two prisms for binocular vision with high powers, designed by Mr. Ahren; and Mr. Jabez Hogg exhibited the spring clip described in our *Notes and Memoranda*. Mr. How showed his new student's microscope, which is described in our *Notes and Memoranda*.

NOTES AND MEMORANDA.

MEASURING SMALL INTERVALS AND COUNTING METEORS.—The Rev. N. J. Heineken has sent us two letters on the above subjects. He says that an ordinary spring tape measure—one yard—drawn out and suddenly released, springs back in a quarter of a second, and it may be arrested so as to mark smaller divisions. He says that although the velocity is not strictly uniform, it is near enough for ordinary purposes. By attaching a weight to the tape, and allowing it to spring vertically, he thinks the motion might be regulated. In counting the meteors in the late splendid display, he used "one of Perkins's old pedometers." Each step is registered in this instrument by pulling a string, and Mr. Heineken holds it in one hand, and pulls the string with the other, each time a meteor appeared.

How's NEW STUDENT'S MICROSCOPE.—When a number of respectable firms compete in the construction of cheap microscopes, it naturally happens that they distribute the inevitable expenditure in different directions, and it would be impossible to do justice to Messrs. Beck, Pillischer, Baker, Collins, etc., without instituting an elaborate comparison of their several patterns. Mr. How now comes forward with a new pattern, which deserves a high place amongst cheap instruments. The brass-work is very good, the stage has a new arrangement for facilitating its motions, which is one of the best we have seen. The upper part is held to the lower one with springs, offering a convenient resistance, and it can be moved backwards, forwards, up and down, or in slanting directions. Its action resembles that of the magnetic stage in smoothness, etc., but it is far more reliable. A dividing object-glass is supplied with this instrument, giving with ten inches of tube and a Ross A eye-piece, powers of about 45, 100, and 130. The eye-piece employed by Mr. How is of higher power, bringing the magnification to about 200 with the whole combination. Still deeper eye-pieces can be used satisfactorily. The powers are very well finished and corrected. They are of English make, and differ from higher-priced ones in having much smaller angles of aperture. This is a legitimate mode of lessening cost, and small-angled powers being much more easy to manage, and having great penetration, are the best fitted for beginners. All the ordinary objects (excluding lined tests, for which the apertures are not sufficient) are beautifully shown with Mr. How's cheap objectives, and as his student's microscope is made with the universal screw, other objectives may be added when required.

THE WIRE SPRING CLIP FOR MICROSCOPIC OBJECTS.—Mr. Curtis (of Mr. Baker's establishment), has improved upon a clip for holding down the covering glass when preparing microscopic objects, which was originally devised by Dr. Maddox. It is made by bending an elastic brass wire, so that it will open and shut like the common letter clip. The cover is pressed down by a small cork, and held in its place while cement is applied and allowed to dry, or Canada balsam allowed to insinuate itself by capillary attraction. Mr. Jabez Hogg informs us that he has found it "extremely useful in mounting algæ, tongues of mollusca, etc., in glycerine jelly, or similar preparations." We can also speak well of it from personal use, and its price per dozen is very small.

THE PORTABLE HORIZONTAL SLIDE CABINET AND COVERED OPAQUE SLIDE.—These two excellent inventions of Mr. J. Piper, a member of the Old Change Microscopical Society, will, we believe, be sold by the principal makers and dealers in microscopes. The "Cabinet" is a neat box, containing six strong

cardboard trays, lined with white glazed paper. Each tray is divided into six compartments, to hold six slides in a horizontal position. When the box is closed, and the lid held down by an elastic band, each slide is retained safely in its own place, and the whole can travel without injury. As these very excellent cabinets can be sold at a very moderate price, they will, no doubt, come into general use. Mr. Piper's covered slide is exactly what is wanted for opaque objects, which it is desirable to view without the intervention of covering-glass. It consists of a mahogany slide with the usual central cavity, over which a cover is fastened by a small brass pin. When the object is to be viewed, the cover turns on the pin on one side, and can be rotated back again as often as required.

PSEUDOSCOPIC APPEARANCE OF THE MOON.—Most observers are annoyed more or less frequently with the tendency of hollows in the moon to appear in the telescope like elevations, and elevations to look like depressions. Mr. R. Hodgson, in a communication to the *Monthly Notices*, ascribes these effects to the "position of the shadows being the reverse of what we usually see," and he states that by using a reflecting diagonal eye-piece he can change the appearances from reliefs to intaglios or *vice versa* by revolving the whole eye-piece 180°. We do not feel satisfied with the explanation, as we are accustomed to see shadows in all directions; but we recommend our telescope-using readers to try the experiments Mr. Hodgson suggests.

PECULIAR DISENGAGEMENTS OF GAS.—M. Babinet states in *Comptes Rendus* that when cold water is poured on the powder of roasted coffee, a considerable quantity of gas is disengaged. This gas, he adds, is probably common air, and equals in volume the mass of coffee employed. If a bottle is half-filled with coffee-powder, and cold water poured in up to the place of the cork, which must be inserted, an explosion takes place, by which the cork is driven out, or the bottle broken. The roasted coffee-powder acts like charcoal in absorbing air, and the water drives it out again.

SECOND ON DOUBLE STARS.—In *Astronomische Nachrichten*, Father Secchi gives the following positions, measurements, and dates:—For 36 Andromedæ, 1866, 052 P 349° 51 D 1° 314. ζ Cancri AB, 1865, 213 P 245° 30 D 0° 641. Do. 1866, 285 P 234° 62. D 0° 40. ϵ Bootis 1865, 482 P 324° 70 D 3° 292. η Coronæ 1863, 592 P 23° 26 D 0° 827. Do. 1865, 504 P 28° 26. D 0° 792. Do. 1866, 538 P 33° 13 D 1° 122. μ Bootis 1866, 578 P 180° 30 D 0° 3. ζ Herculis 1865, 55 P 86° $\pm$ single "Position of a little prominence (?)." ρ Libræ (ξ Scorpii) A B he could not well separate in 1864, he now gives them 1866, 519 P 161° 00. D 0° 4 + "well separated."

HUMAN REMAINS IN THE RHINE VALLEY.—Mr. Faudel describes in *Comptes Rendus* the discovery of portions of a human skull at Engisheim, near Colmar, in the formation termed *lehm Alpin*, and in conjunction with bones of the *Elephas primigenius* and *Bos priscus*. He considers these remains to show that man lived in Alsace and in the Upper Valley of the Rhine at the period when the loam (*lehm*) was deposited, and before the country had reached its existing form.

PAPER SUBSTITUTE FOR LINT.—The Italian *Medical Gazette* states that the Viennese surgeons employ a white blotting-paper, locally known as *papier de soie*, as a cheap and efficient substitute for lint.

A MONSTER AEROLITE.—Marshal Vaillant informs the French Academy that Marshal Bazaine has found a Mexican aerolite, weighing not less than 860 kilogrammes. It is on its way to France, and will figure in the exhibition of 1867.

NINETY-FIRST PLANET.—M. Le Verrier informs the French Academy that another planet, the ninety-first, has been discovered at the observatory, Marseilles.

A LIGHT FOR PHOTOGRAPHERS.—*Cosmos* states that M. Sayers recommends twenty-four grammes nitrate of potash dried and powdered, seven flowers of sulphur, and seven red sulphurate of arsenic as giving a light with great photographic power.

THE GLASS ROPE OF THE HYALONEMA.—In our last number we mentioned some remarks of Dr. Gray on this subject to which Dr. Bowerbank replies in

Annals of Natural History, and promises shortly a paper to show the "organic unity" of the basal mass of sponge tissue, the spicular axis or rope, and its coriaceous envelope.

DEEP SEA LIFE.—*Annals of Natural History* contains a report by Mr. George Jeffreys on *Dredging among the Hebrides*, in which he states that Professor Sars is of opinion that Dr. Wallich's deep sea star fish is an *Ophiocantha spinulosa*, a well-known Greenland species, found usually from 20 to 190 fathoms depth. He states that Professor Sars has enumerated fifty-two species and distinct varieties of animals found by himself at a depth of 300 fathoms—sponges, rhizopods, actinozoa (anemonies), polyzoa, true mollusks, and worms. The Swedish deep sea dredgings, in the expedition to Spitzbergen (1861), sounded depths of from 6000 to 8400 feet (1000 to 1400 fathoms), and the sea bottom at these depths was covered with a fine greasy-feeling material of a yellowish-brownish or grey colour, rich in diatomacea; and polythalamia, annelids, crustacea, and mollusca were found at these depths.

MR. PEARSON'S PHOTOMICROGRAPHS.—Mr. Pearson has published, through Mr. Frederick J. Cox, a series of photographs of microscopic objects taken with the lime light. Most of those we have seen are exceedingly good; salicine and cinchonidine under polarized light, sections of sarsaparilla, pepper, cherry-tree wood, coal, lime-stone from the Himalayas, and oolite are very beautiful specimens of this ingenious art, excellently displaying the peculiarities of the several objects. A slide of foraminifera seems to be less successful, and the *trichine spirales* have not come out with sufficient distinctness. Others, which we have specified, occupy a high place among works of this kind, and show how valuable the photographic process is to give accurate delineations of objects extremely troublesome to draw anything like as well.

NEW EDITION OF "THE HEAVENS."—A subscriber calls our attention to Mr. Bentley's advertisement of a new edition of *The Heavens*, with "sixty illustrations," and asks what number the last French edition contains. On referring to our French copy we find 40 plates, and 192 engravings incorporated in the text. We can give no information as to what Mr. Bentley includes in the "sixty" he announces, but we observe that he wants as much money for his edition as the complete French one costs.





NAKED-THROATED COTINGA.

Chasmorhynchus nubicollis.

THE INTELLECTUAL OBSERVER.

JANUARY, 1867.

THE BELL-BIRDS OF AMERICA.

BY P. L. SCLATER, M.A., PH.D., F.R.S.,

Secretary to the Zoological Society of London.

(With a Coloured Plate.)



It is only within the last few months that the Zoological Society of London have succeeded in adding to their large collection of living birds examples of the species belonging to the great fruit-eating family of Cotingas (*Cotingidæ*), which plays so conspicuous a part in the ornithology of Tropical America. Birds that in a state of nature subsist almost entirely on ripe fruit are, as might have been naturally expected, difficult creatures to provide for in a state of captivity, especially during the voyage home, and consequently rarely reach our shores alive. Recently, however, several forms belonging to the different frugivorous families of the tropics of both hemispheres have been successfully imported, and amongst them examples of the Cock-of-the-rock of Guiana (*Rapicola crocea*), and the Bell-bird of Brazil (*Chasmorhynchus nudicollis*), two of the most striking members of the above-mentioned family. It is to the latter of these birds and its allied species, which are

alike remarkable for very curious peculiarities in structure and habits, that I now propose to call attention.

The genus *Chasmorhynchus* of naturalists embraces four species of birds, each inhabiting a distinct region of tropical America, of about the same size as the missel-thrush of Europe, but essentially different in structure. Their general form is much the same as that of the typical Cotingas, but they have a more depressed bill and wider gape, and their nostrils placed further forward. The wings are long and pointed, indicating extensive powers of flight. The feet and legs are moderately strong. The tarsi are covered in front with a series of six or seven horny shields; behind with numerous much smaller reticulated scales. The outer and middle toes are united together at their bases to the end of their first phalanx. These two last characters, together with the possession of ten well-developed primaries in the wings, are marked features of the family *Cotingidæ*, to which this genus belongs. But the most special external character which distinguishes the Bell-birds from other genera of the same family is the development in the adult male of naked skin and fleshy wattles in various parts of the head and neck. In all of the known species the adult male is either wholly or partly of a pure snowy white, with more or less of these cutaneous developments, and the female of a dull green above and yellowish below, without any of the peculiar excrescences of the head and neck which distinguish the male sex. Having said thus much about the general features of the genus, I will now say a few words about each of the four known species of this curious group, commencing with the Brazilian *Chasmorhynchus nudicollis*, of which a coloured illustration is given, drawn from the adult male in the Gardens of the Zoological Society.

In the naked-throated or Brazilian Bell-bird, the adult male is wholly of a pure snowy white. The space round the eyes and throat are covered with a naked fleshy skin, which is very sparingly clothed with minute black feathers, only distinguishable on close examination. In the breeding season this naked skin becomes of a fine green colour, which disappears during the rest of the year. The female, as has been already stated, is a very different-looking bird—being of a dull green above, with a blackish head, and yellowish, flammulated with green, below. Nor has she any trace of the naked throat and face which are the characteristics of the male sex.

This Bell-bird was first made known to science by the French naturalist Vieillot,* in 1815, from specimens in the collection of the Jardin des Plantes at Paris. But the best, and, in fact, only good description of it in a state of nature is

* *Nouv. Dict. d'Hist. Nat.*, viii., p. 164.

that given by that excellent and observing naturalist Prince Maximilian of Neuwied, in his *Contributions to the Natural History of Brazil*.* Prince Maximilian tells us that this remarkable bird is one of the most singular features in the fauna of the wooded coast-region of Brazil, and attracts the stranger's notice as well by its brilliant white plumage as by its clear ringing voice. It seems to be very generally distributed through the woods, resorting especially to the thickest and most secluded parts of them. Hence it resulted that the Prince and his party, during their expeditions in the neighbourhood of Rio de Janeiro, became well acquainted with its singular notes some time before they obtained specimens of the producer of them. Prince Maximilian describes these notes as resembling the sound of a clear-ringing bell, sometimes repeated at intervals, sometimes following each other in quick succession. In the latter case they are more like the sound produced by a blacksmith when he strikes a piece of steel upon an anvil, whence the bird has obtained its Portuguese name *Ferreiro* (*smith*†). The song is heard at all hours of the day, and when, as often happens, several of these birds are in the same neighbourhood, and begin singing against and answering each other, a most wonderful vocal concert is the result. The *Araponga*, as this bird is also called in Eastern Brazil, often takes up its station at the highest withered summit of a colossal forest-tree, and pours forth its loud metallic notes out of the reach of gun-shot, at the same time presenting with its lovely white plumage a fine contrast to the clear blue sky. It is, however, easily disturbed by anything unwonted making its appearance. Its food, as ascertained by dissections, appears to be exclusively fruit. Nothing was ascertained by Prince Maximilian respecting its nidification, nor have subsequent observers added to our knowledge on this point.

Of this extraordinary bird a living specimen was first acquired for the aviaries of the Zoological Society of London in May last. It was an adult male, and was purchased from a well-known London dealer in living animals for the sum of £10. Shortly after this bird had arrived in the Society's gardens it commenced its song, and continued to pour forth its peculiar notes at intervals of more or less frequency for several weeks. These notes have been described by an accurate observer in the following manner:—

“The first note is a loud, harsh, and somewhat grating noise; this is followed by six or eight fine, clear, metallic, ringing notes, with an interval of about a second between each of

* *Beiträge zur Naturgeschichte von Brasilien*, 3 vols., Weimar, 1830.

† Professor Burmeister (*Syst. Ueb. d. Thiere Brasiliens*, ii., p. 426) says the Portuguese name is *Ferrador*, not *Ferreiro*, but the meaning is the same.

them. The resemblance of these to the sound of an anvil is most extraordinary. The clear metallic ring, repeated at about the same rate that a blacksmith strikes upon the anvil, is so perfect that many persons upon hearing it are unwilling to believe the sound could be produced by the delicate organs forming the vocal apparatus of so small a bird."

I may add that the bird also makes the most extraordinary gesticulations when producing these sounds. When commencing its song it usually stands upright with its bill aloft, as represented in the coloured plate herewith given. Subsequently it lowers its bill and throws itself violently forward and downward, seeming to assist itself in this manner to pour forth its final notes.

The *Araponga* lost the brilliant green colour of its face and throat at the conclusion of the love-season, and those parts became of a dull grey or lead-colour, as they now remain. Later in the summer a second example of the same species was purchased for the Society. It was a young male, which, as is usually the case with young birds, was clad in the plumage of the female, but is now gradually assuming its adult dress. We are in great hopes, therefore, of having both these birds in full song during the ensuing summer.

In the forests of Cayenne, British Guiana, and Surinam, the *Araponga* is replaced by a second bird of the same genus, the "*Campanero*," or *Chasmorhynchus nivicus* of naturalists. In this species the adult male is pure white, as in its Brazilian representative, but there is no deficiency of feathers on the throat, and a long straight caruncle issues from the base of the bill, which at once distinguishes it from the preceding. This curious caruncle in a specimen of a young male in my collection is about three and a half inches long, but is often longer in adults. It is scantily clothed with small feathers throughout. In the breeding-season it is probably carried erect, as figured by Buffon in his *Planches Enluminées*, No. 793, at any rate when the bird is in song. The female has no caruncle, and much resembles the same sex in the preceding species. The Bell-bird of Cayenne was well-known to the older authors, but our best account of its habits is derived from the *Wanderings* of the late Mr. Waterton, who, speaking of the Cotingas, of Demerara, says:—

"The fifth species is the celebrated 'Campanero' of the Spaniards, called 'Dara' by the Indians, and 'Bell-bird' by the English. He is about the size of the jay. His plumage is white as snow. On his forehead rises a spiral tube, nearly three inches long. It is jet black, dotted all over with small white feathers. It has a communication with the palate, and when filled with air looks like a spire; when empty it becomes

pendulous. His note is loud and clear, like the sound of a bell, and may be heard at the distance of three miles. In the midst of these extensive wilds, generally on the dried top of an aged mora, almost out of gun-reach, you will see the *Campanero*. No sound or song from any of the winged inhabitants of the forest, not even the clearly-pronounced 'Whip-poor-Will,' from the goat-sucker, causes such astonishment as the toll of the *Campanero*."

"With many of the feathered race he pays the common tribute of a morning and an evening song; and even when the meridian sun has shut in silence the mouths of almost the whole of animated nature, the *Campanero* still cheers the forest. You hear his toll, and then a pause for a minute, then another toll, and then a pause again, and then a toll, and again a pause. Then he is silent for six or eight minutes and then another toll, and so on. Acteon would stop in the mid chase, Maria would defer her evening song, and Orpheus himself would drop his lute to listen to him; so sweet, so novel, and romantic is the toll of the pretty snow-white *Campanero*. He is never seen to feed with the other *Contingas*, nor is it known in what part of Guiana he makes his nest."

Proceeding a little further northwards in the forests bordering the northern coast of Venezuela, we meet with a third Bell-bird, the *Chasmorhynchus variegatus*. In this species the adult male has again a white body-plumage; but his wings are black and his head is brown, so that he cannot easily be confounded with either of the former species. His bare throat is sparingly clothed with small black feathers, as in the *Araponga* of Brazil, but besides this there are numerous small fleshy caruncles dependent from the lower part of the throat, which in adult birds attain a considerable length. The female, however, is very like the female of the Brazilian species. This Bell-bird extends along the coast of Venezuela into the forests of Trinidad, where its existence is well known to the colonists.

To find a fourth, and in some respects still more wonderful, species of Bell-bird, we must go further northwards across the isthmus of Panama into Chiriqui and Costa Rica. Here is the abode of the Three-wattled Bell-bird, *Chasmorhynchus tri-carunculatus*, the male of which exhibits several very marked differences from those of its three southern congeners. In the first place the head, neck, and breast of this species are alone of the glossy white which is so characteristic of the genus, the whole hinder portion of the body, including the wings and the tail, being of a deep chesnut red. Besides, not content with a single caruncle springing from the base of the bill which distinguishes his brother of Cayenne, the male of this Bell-bird throws out two additional elongated wattles from the

angles of its mouth. These are thinner and narrower than the *Araponga's* single horn, and attain a greater length—the medial caruncle in a young male bird in my collection measuring nearly $4\frac{1}{2}$ inches in length, and extending, when recumbent, down beyond the middle of its back. The female of the Costa-Rican Bell-bird again hardly differs materially from the females of the other species.” *

It appears, therefore, that there are four rather widely separated districts in tropical America, each of which is tenanted by a distinct species of this group of birds. The intelligent mind naturally proceeds to inquire why this is so. Why should the Bell-bird of Brazil be different from the Bell-bird of Cayenne, and the Bell-bird of Venezuela from that of Costa Rica? What is the meaning of these four birds, each having a special abode into which the others never intrude? Why are the males of each of them all so different, and the females all four so much alike? Not many years ago it would have been thought rather irreverent to ask such questions as these. We should have been informed in reply, that it was for the same reason that “dogs delight to bark and bite”—because Divine Providence “hath made them so;” and it would be, therefore, no use inquiring into the matter. And this is the theory (if theory it can be called) of the supporters of “special creation” to the present day. They say that each species of organic beings was created to perform certain functions over a definite area, and there is an end of the matter. But it is not easy to satisfy the inquiring spirit of the present age in so summary a manner. Let us try, therefore, if by adopting Mr. Darwin's views of the derivative origin of species and “natural selection,” we can invent a theory of any sort which would account for the present state of things as regards the case of these four Bell-birds, and numerous other cases of the same description.

Let us suppose then, that these four Bell-birds, now so distinct, are all descended from a common progenitor—a certain “*Chasmorhynchus priscus*” we will call him. This would at once account for the females of the four species being all alike. Let us suppose that in bygone ages *Chasmorhynchus priscus* lived in a small area (*a, b, c, d*, Fig. 1) occupying the centre of the extended area *A, B, C, D*. Let *A, B, C, D* represent the “generic area” of *Chasmorhynchus* at the present period, that is the whole of the areas now occupied by the four known species of the genus, together with the intervals between them which are not now tenanted by any species of *Chasmorhynchus*.

* Both sexes of this very singular bird are figured in the *Ibis* for 1865, Pl. iii., where Mr. Salvin has likewise given many interesting remarks on this and the allied forms.

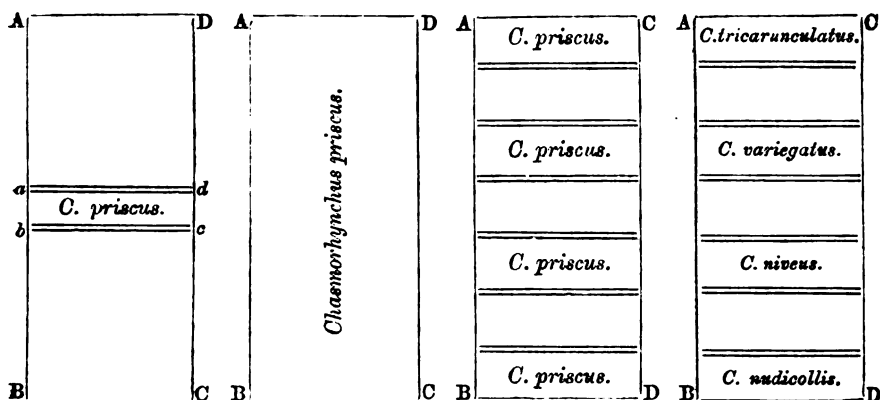
It may be easily imagined that *C. priscus* finding a country suitable to its habits and mode of life, gradually extended its range northwards and southwards, until, instead of its original "specific area" (*a, b, c, d*, Fig. 1), it became occupant of the larger area (*A, B, C, D*, Fig. 2), i. e., the whole of the present "generic area" of *Chasmorhynchus*. Now, so long as the area *A, B, C, D*, remained united and homogeneous it is probable

FIG. 1.

FIG. 2.

FIG. 3.

FIG. 4.



that, in spite of the innate tendency to perpetual variation, there would be but slight modifications in the structure of our *C. priscus*, as the different varieties would to a certain extent neutralise each other by interbreeding. At all events the changes introduced by progressive variation would be similar or nearly similar over the whole area, and would be such as would, perhaps, enable us to distinguish the extreme northern and southern forms from one another, as is usually the case with species spread over a very extended area, but not of sufficient importance to necessitate the recognition of more than one species.

But now let us suppose that the slow course of secular variation which is constantly altering every part of the surface of our globe, operates upon the area *A, B, C, D*, where the vacant intervals are placed in Fig. 3, and renders these portions unfit for the habitation of *C. priscus*. This might take place either by the submergence of the vacant tracts, and division of the extended area into four islands, or by their elevation, or simply by the failure of certain trees on the fruit of which *Chasmorhynchus* subsists within the vacant areas. *Chasmorhynchus priscus* would, after this event took place, occupy four different areas, completely cut off from one another, as shown in Fig. 3. The tendency to variation would now act

upon the individuals located in each of these four separate areas in a different manner, according to the different natural influences (such as food, weather, climate, etc.) affecting them. Communication being cut off between them, there would be no neutralization of the variation occurring in one area by a contrary variation occurring in the adjoining area. The four isolated colonies of our *C. priscus* would therefore, in process of time, become a series of four distinct species, as represented in Fig. 4.

It will be remarked in the present case that the variation which has taken place has mainly affected the male birds. The females of the four species of *Chasmorhynchus* are still nearly identical. There has been manifestly a much greater "struggle for existence," as Mr. Darwin calls it, amongst the males than amongst the females of these birds. And it is not difficult to see how this has occurred. The very object of the structures that have altered in the present instance is to render the male agreeable to its mate, so that we have here an influence that would work forcibly upon the male sex, and cause it to vary, while it would leave the female untouched.

It appears, therefore, that if we adopt Mr. Darwin's theory, a few simple hypotheses will enable us to give a reasonable explanation of the mode in which the present distribution of the four species of the Bell-bird may have been brought about. Similar hypotheses will explain hundreds and thousands of other cases in which groups of animals and plants offer corresponding phenomena as to their geographical distribution. What the exact influences were that divided up the area formerly occupied by the common progenitor of the four *Chasmorhynchi*, it would be impossible at present to say; but it will be seen at once that when the geological structure of the earth is more perfectly known, great light will necessarily be thrown on problems of this nature. Such problems, in our present state of ignorance of the formation of the greater part of the earth's surface, it would be vain to attempt to answer in a decisive way. But it seems better, even under present circumstances, to attempt some sort of explanation of these and similar phenomena, than to remain content with the *deus-ex-machina* theory of "special creation," which is in fact no theory at all, but only a periphrastic way of confessing our ignorance of the subject.

PARASITIC BEETLES.

BY E. C. RYE.

OUR *Coleoptera*, or beetles, exhibit none of those pre-eminently social or constructive instincts which have attracted the earliest exercise of human observation to certain of the *Hymenoptera* (bees, ants, etc.). It is true that in some cases their habits are gregarious; but their associations are for the most part apparently devoid of purpose, beyond the procuring of food, and are usually to be accounted for on the most easily intelligible grounds, such as (in the case of the *Phytophaga*) the occurrence of their food-plant in isolated spots, or the incapability of much motion attendant upon the structure of the larvæ of many species, which usually causes the produce of one batch of eggs not to get dispersed until they arrive at the perfect state. Their labours, also, which seem never (except in the case of certain *Necrophori*, commonly known as "burying-beetles") to be undertaken in concert, are limited in their earlier stages to the construction of the most rudimentary hybernacula, cells, galleries, or pits, or to the erection of protective cases (*Clythra*, *Cryptocephalus*)—in all of which operations they exhibit less ability than the caterpillars of the more lowly organized order *Lepidoptera*, and, in their perfect state, to the exercise of the most ordinary instincts for the protection of their future offspring; such protection being in the majority of instances confined to depositing the eggs in convenient and proper situations, though some species, such as the above-mentioned burying-beetles, certain of the *Rhynchophora* (*Rhynchites*, *Pisodes*, *Balaninus*, etc.), and some of the indigenous Coprophagous representatives of the sacred-beetle of the Egyptians, exhibit considerable ingenuity, and are compelled to use much physical force, in their preparations for the welfare of their descendants.

There remain, however, certain (as it were, morganatic) alliances constantly contracted by beetles with other insects, for which as yet no satisfactory explanation has been given; and it is to these that the present paper refers. There are even some associations of *Coleoptera* with animals out of their own class, such as that of *Haploglossa nidicola* (one of the *Aleocharidæ*, a large family of small *Brachelytra*, of which section the common "Devil's coach-horse," *Ocypus olens*, is the most gigantic and the best known exponent) with the sand-martin, and *Drilus flavescens* with certain species of *Helix*; but these and their like are readily capable of interpretation. The former insect, which has received its specific name from its nest-hunting propensities, is a parasite upon the bird for

the sake of its droppings, and possibly for such crumbs as fall from its table. I am not aware whether the sand-martin employs much (if any) dried twigs, grass, or leaves as a pad at the bottom of its burrow; if such be the case, however, it would be of use in assisting to solve the question of the alliance between bird and beetle, as another of the latter's genus, *Haploglossa prætexta*, sometimes swarms in twigs, etc., at the bottom of neglected hay-stacks. Another of its intimate allies, *Haploglossa gentilis* (hereafter mentioned), is a parasite upon ants; so that sycophancy seems to run in the family. *H. ridicola*, being very small, is doubtless in some of its stages unwittingly transported by the birds from one nest to another; I have never heard, however, of its being found in the nests of any bird but the sand-martin, under banks perforated by which it may be found in profusion. The nests of birds, on account of their warmth, damp, etc., often serve as a home for beetles, which in many cases may be originally introduced with the substances of which they are built. A curious instance of this, and somewhat entomologically akin to the accounts so often to be read in provincial journals of birds building in unusual or much frequented situations, is to be found in the capture by Mr. E. Waterhouse of several specimens of the rare *Dendrophilus punctatus* in sparrow's-nest rubbish stuck in a water-pipe of the British Museum. Another species of *Dendrophilus* (*D. pygmæus*) is a true ant-parasite, and *D. punctatus* has itself been taken in nests of *Formica rufa*; so that the parallel between it and *Haploglossa* is, oddly enough, somewhat close.

Drilus flavescens is constantly found in the vicinity of snails (*Helix nemoralis*, etc.), for the simple reason that its larva feeds upon those molluscs. It is, however, noteworthy on account of the males only being known in this country (in certain chalky parts of which, near Dover, Dartford, etc., it is not uncommon); but the non-appearance of the other sex is not due to the same cause (whatever it may be) as that which baffles us in the endeavour to discover the males of certain abundant species of *Cynips* (gall-insects). In the latter case persistent but unsuccessful endeavours have been made (by breeding, etc.) to solve the enigma; but, as to the *Drilus*, failure is owing simply to a want of sufficient experiment: for if any one assiduously collected snails in the localities where the male occurs, the female would assuredly be detected, as I have found the full-grown female larva at the base of Shakespeare's Cliff, running very quickly among empty snail-shells in the hot sunshine. The two sexes—as in the glow-worm (*Lampyris noctiluca*), to which it is closely allied, and which is equally rapacious and mollusc-devouring, *malgré* its poetical reputation—are very dissimilar in appearance; the male having wings and brown

elytra, with conspicuous and strongly pectinated black antennæ, and the female being apterous and slug-shaped, having, indeed, been described as belonging to a separate genus, *Cochleoctonus*, founded upon it, and named in allusion to its habits. As also in the glow-worm, the resemblance between the perfect female and full-grown female larva is considerable.

The ordinary associations of beetles with other insects are purely for the purposes of preying upon them or their leavings; but some few are sufficiently interesting to be noticed. The most frequent and unvarying alliances of this class are, perhaps, those of certain of the *Nitidulidæ* (e.g., *Epuræa* 10-guttata, *Soronia* grisea and *S. punctatissima*, *Cryptarcha* strigata and *C. imperialis*, and, I suspect, the very rare *Thalycra* sericea) and *Aleocharidæ* (*Homalota* cinnamomea and *H. hospita*) with the goat-moth (*Cossus ligniperda*); in and about the burrows made in the solid wood by the large naked red fleshy larva of which insect most of them may be readily found, and sometimes in profusion—no matter in what tree, be it oak, elm, willow, or poplar, the Lepidopterous devastator may be ploughing its deep tracks. The exudation of sap and quantities of wet woody excrement, caused and left behind by this caterpillar, strongly impregnated, moreover, with its peculiarly rancid odour, seem to act as a never-failing attraction to the above-mentioned beetles (as the collector well knows), and to many others; amongst them being the very rare *Quedius dilatatus*, a large black *Brachelytron*, formerly only known to occur in the nests of the common hornet (*Vespa crabro*), under the protection of whose sting (by what means diverted from itself we cannot tell) it may readily be believed that it was safe from capture. M. Chevrolat, a distinguished French entomologist, has, however, recently detected it haunting the burrows of the goat-moth larva, coursing rapidly in and out of the galleries by night; and it has since his discovery been taken under similar circumstances in this country. There can be little doubt, from the habits of certain other *Quedii* (*Q. lævigatus*, *cruentus*, *xanthopus*, *scitus*, *longicornis*, and *truncicula*) frequenting trees, that this beetle merely exhibits a preference for such localities in consequence of the number of other insects also attracted to them, upon which it preys.

Many other beetles also found under or about bark are pre-daceously parasitic upon insects either of their own or another order. Of these, *Ips* and *Rhizophagus*, attendant upon the genuine wood-feeders, *Hylesinus*, *Hylastes*, and *Hylurgus* (as mentioned in No. LVI., p. 133), are notable examples; and with them may be classed two very rare species, *Nemosoma elongata*, one of the *Trogositidæ*, and *Colydiem elongatum*, the type of the *Colydiadæ*, both of which are of an elongate tere-

brant form, and have hitherto been considered as true wood-feeders; but the former is a parasite upon some of the genuine *Xylophaga*, and the latter preys upon *Platypus cylindrus*, to whose attenuate shape it bears some resemblance. *Opilus* and *Clerus*, predaceous Malacoderms, follow *Anobium* and other dry-wood eaters, upon the larvæ of which their larvæ feed: *Anthribus* and its allies, sedate and massive, and, on account of their belonging to the peaceful section of *Rhynchophora*, long unsuspected of such appetites, are now known to prey in their larval condition upon *Coccus*; a habit for which fruit-growers would doubtless thank them; the beetles are, however, so exceedingly rare here that no practical good can result from their operations. Of a similar class to these relations is the companionship of *Dyschirius* with *Bledius*, members of which two genera are constantly found together—often in profusion—burrowing in sandy places on our coasts and elsewhere. Both are of elongate and cylindrical shape, eminently adapted for their sphere of existence; *Dyschirius* (the wolf) being clothed with more continuous and solid armour, and possessing two very strongly arched, thickened and spined front legs, eminently fitted for fossorial purposes, and representing the structure of the fore paws of the mole; and *Bledius* (the lamb) having a flexible and somewhat loosely articulated body, and often (in the male) acute, stout, projecting horns on the head and thorax, doubtless also of service in digging.

Another—and the largest reputed British—member of the *Geodephaga* (to which section *Dyschirius* also belongs), *Calosoma sycophanta*, has received its specific name from its parasitic connection with the gregarious larva of the processionary moth (*Cnethocampa processionea*), upon which it gorges its fill, both in its own larval condition and as a perfect beetle. It is an exceedingly handsome and large insect, being of a violet-black colour with golden, green, and coppery reflexions, and has for a long time stood its ground in our lists of indigenous species (of which, from mere beauty's sake, it forms one of the chief glories) on the strength of its periodical occurrence, chiefly on or near the coast-line. There seems little doubt, nevertheless, that it is merely an accidental visitor from some of the continental districts where it abounds; as its especial pabulum, the processionary caterpillar, is not found at all in England, and the beetle is not only possessed of stout wings, and, from its strong build, evidently capable of considerable exertion, but has even been taken actually floating on the sea near our shores, suggesting the idea of its dropping nearly exhausted after a long flight.

The numerous recorded instances of butterflies and other equally delicately organized insects being seen at greater

distances from land than the *Calosoma* would have to travel, quite warrants this supposition. We have, however, another undoubtedly British species, *Calosoma inquisitor*, of smaller size and less beauty, which constantly frequents oaks for the purpose of promiscuous feeding on the many Lepidopterous larvæ frequenting those trees. This habit of tree-haunting is very rare among the large and predaceous *Carabidæ*, which usually prowl about on the ground, except occasionally at night, when they have been observed investigating tree trunks for their victims. Another of the *Geodephaga*, *Zabrus gibbus*, a large, heavy, clumsy, black species, departs from the habits of the members of that group so far as to be often seen climbing up the shoots of young wheat and other plants. This has been so frequently observed that it has been strenuously urged that the beetle, unlike all its sectional allies, is a vegetable feeder; but the more reasonable view appears to be that it frequents the plants for the purpose of preying upon the numerous small insects of all orders found upon them. A similar explanation accounts for the constant occurrence of one of the burying-beetles, *Silpha quadripunctata*, upon young oak-trees, where it finds a ready meal on plant-feeding larvæ. I have never found this insect in any other place than upon an oak-tree; though the other *Silphæ* (except, perhaps, *S. atrata*) constantly occur in carrion.

All the above cases of companionship, therefore, readily admit of explanation, as also do certain of those hereafter mentioned, of some of which the entire life-history has, indeed, been accurately chronicled.

It will be observed that, in all the following instances, the insects with which the beetles are associated belong to the order *Hymenoptera*; and it is in connection with the social members of this order that the most constant and perfect—though hitherto unexplained—cases of beetle-parasitism occur.

The bees, to begin with, are affected by species of at least three different genera, viz., *Trichodes*, *Melœ*, and *Sitaris*.

The first of these, one of the *Oleridæ*, has two reputed British exponents, *T. apiarius* and *T. alvearius*, whose names sufficiently indicate their propensities. Both of them are, however, of exceedingly doubtful British origin, though abundant on the continent; they are of moderate size, elongate, bright blue with red bands, and very pubescent. *T. apiarius* lives in its larval condition in the combs of the honey-bee (*Apis mellifica*); whilst *T. alvearius* at a similar stage of its existence inhabits the nests of mason-bees (*Megachile muraria*, and others), though it has also been found under pine bark. Both of them feed upon the larvæ of the legitimate owners of their temporary residences, and, in their perfect

state, are found in flowers, where it is possible that they may deposit their eggs, which would be readily (inadvertently) carried to their nests by the visiting bees.

Melœ comprises the well-known "Oil-beetles"—huge, clumsy, wingless, fat, blue-black insects, with short overlapping sytra, and of feeble development—frequently seen crawling heavily in early spring on commons and waste lands, especially among butter-cups, and conspicuous for their nasty peculiarity of exuding a clear yellow oil from their joints when handled, which has in bygone times (with many more nauseous remedies) been in favour for the purposes of medicine. The female deposits separate batches of small yellow ova, thousands at a time, but on a diminishing scale after the first laying. These ova are agglutinated, and dropped into small holes in the ground previously dug by her; and from them, after a period of from three to six weeks, as the heat of the weather varies, the young larvæ are hatched, being then long, flat, yellow, with longish legs and four hairs at their hinder apex, resembling, in short, small bird-lice. For a time they keep torpid; but, on being sufficiently roused by increased warmth, course about certain low plants (chiefly *Ranunculicæ*) with wonderful rapidity of motion. From these plants they fasten, sometimes in great quantities, on the hairy bees that are busy about the flowers: at times, also, getting attached in error to some equally hairy species of *Volucella* (Dipterous insects superficially much resembling bees), that also settle on their temporary lodgings. Of course, in the latter case, the attachment is not a lucky one for the parasite: as the fly makes no nest to which it can be transported, and it must perforce starve. It is probably the chance of this, added to the numerous lucky combinations that *must* take place before the *Melœ* larvæ can reach its destined haven, that causes the parent beetle to deposit so large a number of ova; and there can be no doubt that the produce of one female would, if it all came to maturity, outnumber vastly all the perfect insects that would be seen by any one observer in his lifetime.

Supposing that the larva has been carried by the unconscious bee to its nest, it devours the egg of the latter therein contained, and changes into a second form (not unlike the larva of a small Lamellicorn beetle, being cylindrical, arched, and possessing stout legs and toothed mandibles), subsisting on the food laid up by the bee for its own young. After some time the second condition of the larva changes its outer skin, which is not, however, entirely shed, but remains wrinkled up at the hinder extremity of the body; it is then arched, composed of thirteen segments, contracted at each end, and motionless. This is called the *false pupa*, and from it (pro-

bably after a winter's interval) a third form of the larva appears, similar to the second. Here, however, ceases all direct record of the extraordinary metamorphoses of this insect; the most unaccountable part, viz., the passage of the heavy, full-grown, bloated beetles from the bees' nest to the commons where they are usually found, not having been hitherto observed.

The transformations, however, of *Sitaris muralis*, the third above-mentioned bee-parasite, throw some light upon the final changes of its ally *Melœ*. This insect, which, unlike the latter, has ample wings, though its elytra are of imperfect development, is, during all its existence, parasitic upon mason-bees of the genus *Anthophora*, which are common in old brick-walls. Here the larvæ undergo fewer vicissitudes than those of *Melœ*, as the eggs are deposited by the parent at the entrance of the bees' burrow, near which it stays; and the young larvæ, after passing through the above-mentioned stages, and taking no food in their third condition, change to the ordinary Coleopterous pupa, from which the imago is produced after about a month's interval; the whole metamorphoses covering a space of about two years.

Mr. Newport has given particulars of his discoveries as to this species in the *Linneæan Transactions*, vol. xx., p. 297, and vol. xxi., p. 167. M. Fabre, also, in his "Mémoire sur l'Hypermétamorphose et les mœurs des Méloïdes," in the *Annales des Sciences Naturelles*, sér. 4, vol. vii., 1857, p. 299, goes into considerable detail with reference to the abnormal nature of the above-mentioned changes.

In connection with these beetles, mention must be made of certain interesting insects variously considered as a separate order, under the name of *Strepsiptera*, or simply as a family of the *Coleoptera*, under the name *Stylopides*. As there exist strong reasons to suppose that the latter view is incorrect, and as the details of their structure and habits are too voluminous and interesting to be hurried over in a paper of this kind, it may be sufficient to remark that they are parasites chiefly upon the females of certain *Andrenidæ*, a family of wild bees; the female *Stylops* remaining enclosed between the abdominal rings of the *Andrena* during all her stages, and the male until his perfect condition; when he acquires wings, exhibits great activity in his search for the other sex (which is, of course, carried about in its living prison), and dies within a day of arriving at maturity. Our countryman, Kirby, was the discoverer of these marvellous insects.

Of other—and undoubtedly Coleopterous—bee-parasites, *Leptinus testaceus*, a species of considerable rarity in this country. (I once found it in a nest of the large black wood-ant, *Formica*

fuliginosa, at Mickleham), has recently been detected on the continent, living in the nests of one of the larger white-tailed humble-bees (probably *Bombus terrestris*). Herr Eichhoff, who records this occurrence, states that there were but two or three nests in which he did not find the beetle, out of thirty that he examined, and that some contained twenty or thirty specimens each; there can, therefore, be little doubt that the true residence of this interesting Acaroid little creature has been now discovered. Other beetles, also occurring (though comparatively rarely) in this country, have been observed on the continent to be parasites upon humble-bees, such as *Cryptophagus setulosus* (in great plenty) and *C. pubescens*, *Anthrophagus nigricornis*, *silaceus*, and *pallens*.

Nor are the dwellings of the allied genus *Vespa* without their illegitimate tenants. The hornet (*V. Crabro*) fosters (or is compelled to tolerate, whichever be the true interpretation) *Quedius dilatatus*, as above-mentioned; and the common wasp (*V. vulgaris*), apart from *Cryptophagus pubescens* (which has been observed on the continent to be more abundant with it than with the humble-bees) and, occasionally, *Onthophilus* (one of the true Coprophagous *Histeridæ*), lodges in its structures a most curious beetle, *Rhipiphorus paradoxus*, one of the *Mordellidæ*, in which the body is broadest and convex on the upper side, but shelves down to a mere ridge beneath, and a certain degradation in the development of the parts of the mouth commences. This insect undergoes its transformations in the cells of the nests, the larger larvæ (from which the females are produced) being found with, and feeding on, the female wasp grubs. The perfect insect, which is also sometimes found in the nests, varies considerably in the two sexes, the female being the largest and usually having blue-black elytra, which are of imperfect development, being attenuated and gaping, so as to allow the wings to be seen. In the male the elytra are reddish testaceous, and the antennæ have the third and following joints divided into double fan-like rays. It will be remarked that the parasitic habits of this insect, as in *Meloe* and *Sitaris* above-mentioned, are accompanied by a lessening of the usual development of certain parts of the body. Our countryman Mr. S. Stone has accurately observed the economy of these parasites on the *Hymenoptera*.

Lastly remain to be noticed the most interesting of all the alliances of the *Coloptera*, viz., those with the ants. So numerous and constant are these alliances that the epithet "*Myrmecophila*" has been coined to express the beetles that contract them; and they have formed objects of study to eminent entomologists in all European countries, Aubé, Chevrolat, Grimm, Janson, Kiesenwetter, Mørkel, Mannerheim,

Motschulsky, and Schiödt being conspicuous among them. In spite, however, of the numerous observations that have been made, and of the extension among British Coleopterists of acquaintance with these beetle-ant connections through collecting operations, no satisfactory explanation has been given for them. It has, indeed, been suggested that the *Coleoptera*, and especially those of the section *Brachelytra*, resorting to the nests may be in some way conducive to the welfare of the communities, in all probability yielding secretions which serve as food to the young brood. But this view appears to me to reverse the case. It is surely more likely that the beetles find in the secretions of the ants or in the materials of which they form their nests, or in the food which they procure for their young brood, a sufficient attraction to induce them, as free agents, to take up their abode with the latter. On the other hand, in two instances, at least, viz., *Claviger testaceus* and *Atemeles*, there can be no doubt that their landlords are as careful over them as their own young, bearing them rapidly, but with an excess of care, away from the approach of danger, and exhibiting as much anxiety on their account as some of their species do for the *Aphides*, to whose secretions, so agreeable to the ants, it is possible that those of the beetles may be similar. It is certain that the larger *Brachelytra* frequenting ants' nests acquire a most peculiar and pungent odour, and that they often distil an iodine-coloured fluid on the cards on which they are mounted, and retain a like smell for a considerable period. This, evidently (from its similarity of smell) derived from constantly dwelling in a vapour of exhalations of formic acid, may, on the principle of "similia similibus," be acceptable to the ants, whose ingenuity may succeed in "tapping" the internal supply, though there is no visible outlet as in the *Aphides*. Apart from this interpretation, there remains no solution for the enigma but that of sentimental attachment, which is rather too absurd for such work-a-day folk as the *Formicidæ*. No verbal expression could, nevertheless, sufficiently depict the evident trouble and anxiety with which a *Formica fusca* carries away *Atemeles emarginatus* in its jaws, tenderly bearing it; and there is something ludicrous in the complacency of the beetle, a great, angular *Brachelytron*, as it submits to be thus dandled; the absurdity of the thing being more apparent when one compels the ant to drop its nurseling, which straightway opens out its long legs and antennæ, and, considerably larger than its late porter, scuttles away with straggling gait.

The British ants which have hitherto been observed to harbour beetles in their nests are *Formica rufa*, *F. congerens*, *F. fusca*, *F. fuliginosa*, *F. flava*, *F. sanguinea*, and *Myrmica rubra*.

The first of these, *F. rufa*, commonly known as the wood-, hill-, or horse-ant, is of large size and red colour, with darker abdomen; it builds heaped up nests of a conical shape, composed of twigs or any light rubbish not too bulky for transportation. Sometimes these nests, when undisturbed, are quite two feet high; and they are often constructed inside the trunks of hollow trees or piled up against the outsides. The cells appear to be formed in the ground, and the heap acts merely as a shelter.

Associated with this ant—which is a most pertinacious, pungent, and pugnacious creature, holding on by its mandibles, and allowing its body to be torn away, leaving the head and jaws attached, rather than relinquish its bite; and which, moreover, has a pleasing habit of bringing its abdomen forward between its hind-legs, and therefrom projecting an acrid juice to some distance—are found some twenty species of beetles in this country, the majority belonging to the *Brachelytra*. Of these, perhaps, the most typical is *Myrmedonia humeralis*, belonging to the genus of myrmecophilous beetles *par excellence*, as all its members are either positively or by reputation ant-parasites, one of them, indeed, *M. canaliculata*, being found with nearly all ants, though also in other situations. The two exceptions are *M. Haworthi* and *M. collaris*, both considered myrmecophilous, but I think erroneously; the former is so rare both here and abroad that there is no sufficient evidence of its true habitat, all that have been found having occurred in sandpits or among dead leaves; and the latter is certainly a wet-moss insect, occurring in the Norfolk Fens and on Wimbleton Common in *Sphagnum*. Our countryman, J. F. Stephens, who first described the former of them, separated them both from *Myrmedonia*, and formed two separate genera (not now recognized) on their behalf. It is somewhat amusing to notice the revolutions that take place in a few years both in nomenclature and collections. At the time of publication of that author's manual, the secret of ant's nest hunting was either not known or not appreciated in England; the result being that the claim of divers species (now in every novice's cabinet) to a place in our lists depended upon single specimens, found "under a stone," or "flying," or under similar accidental circumstances.

In the nests of *F. rufa* are also found the following *Brachelytra*:—*Thiasophila angulata* (and sometimes *T. inquilina*), *Dinarda Mærkelii* (a small form of which occurs also with *F. sanguinea*), the exceedingly rare *Lomechusa strumosa*, *Oxyopoda formiceticola* and *O. hæmorrhœa*, *Homalota anceps* and *H. flavipes*, *Quedius brevis* (some of whose congeners are above-mentioned as either direct or indirect parasites on other insects), *Lepta-*

cinus formicetorum and *Xantholinus ochraceus* (which, though found in the nests, is probably not truly attached to the ants). Of the *Histeridæ*, *Saprinus piceus* and *Dendrophilus pygmæus* (and perhaps *D. punctatus*); and, of the *Colydiadæ*, *Monotoma conicicollis* and *M. angusticollis* frequent these nests, where also the larvæ of the common rose-chaffer, *Cetonia aurata*, occasionally live, and those of *Clythra 4-punctata* seem to have their natural habitat, though the perfect insects of both these species would never be suspected of such an origin. Another unsuspected visitor is the rare and delicate *Prionocyphon serri-cornis*, which has, on more than one occasion, been taken in these nests.

In the nests of *Formica congerens*, a species closely allied to *F. rufa*, and occurring in Perthshire, the larva of *Cetonia ænea* has its dwelling; the perfect beetle having been observed to fly down and disappear, burrowing in the huge mounds of nests until it reaches a place judged fit for the deposit of its eggs. Here also is found the little *Homalota parallela*.

With *Formica fusca* cohabit *Atemeles paradoxus* and *A. emarginatus*, *Dinarda dentata*, and the quaint pigmy *Heterius sesquicornis*, with uni-articulate club to its antennæ. The nests of this ant are very unlike those of the preceding, being merely cells connected by intricate passages and galleries, excavated beneath the surface of light warm banks, and usually having their entrance under a stone. The *Heterius* seems to be an object of great care to the ants. Near the nests of this species (and also with *F. rufa*) the large and handsome *Aleochara ruficornis* has been captured. *Homæusa acuminata* was, also, first introduced as British on the authority of a specimen taken in a nest of *F. fusca*; but subsequent investigation has shown, that its true haunts are the runs or beaten paths worn by the thin lines of scouts ever on the tramp near nests of *F. fuliginosa*, a large jet-black ant usually building in decaying trees, from and to holes near the roots of which hundreds of its shining workers may be seen constantly hurrying.

With the latter *Myrmedonia humeralis* and *Quedius brevis*, at times so abundantly associated with *Formica rufa*, are very rarely found; but other *Myrmedoniæ* in plenty supply their place, no less than five species of that genus (*funesta*, *laticollis*, *lugens*, *cognata*, and *limbata*) evincing a partiality for the chewed woody fibres ejected from their galleries by the ants, and deposited near the mouths of the burrows in moist fermenting heaps. The first of these beetles, *M. funesta*, is often exceedingly abundant, running about rapidly amongst the troops of its friends, from which, on account of its similar stature, equally shining mail, and deep black colour, it is not readily to be distinguished. All these *Myrmedoniæ* have a

curious habit of packing themselves up when not in motion; the head being deflected, the abdomen rolled up over the thorax and elytra, and the antennæ and legs cramped together; so that, when they suddenly stretch their body and limbs to their fullest extent, the difference in size is very conspicuous. They also readily counterfeit death; and scamper off with marvellous celerity on the approach of danger. Many other *Brachelytra* are found in *fuliginosa* nests; *Haploglossa gentilis*, *Oxypoda vittata*, *Homalota confusa*, *Thiasophila inquilina*, *Omalium pygmaeum*, and *Falagria thoracica* (the latter, however, being often seen in other situations) constantly occurring in them, with beetles of other sections, such as *Amphotis marginata*, *Batriscus venustus*, *Abræus globosus*, *Atomaria ferruginea*, etc. I have taken the rare *Leptinus* (above mentioned as a *Bombus*-parasite) with this ant; and the very rare *Oxylæmus variolosus* has been recorded on the continent as also dwelling in its nests. This is not unlikely to be the case, as I have found *Cicones variegatus*, one of its close allies, in the sodden wood-dust at the mouth of the burrow; but in both these instances it is probable that the visits are only accidental, for *Cryptophagus scanicus*, and other certainly non-myrmecophilous species, may be often found in these places. In the runs near the nests above alluded to, and which are from time to time changed by the ants, a new and conspicuous species of *Oxypoda* (*O. glabriventris*, mihi) has recently been discovered at Mickleham.

The little yellow ant, *Formica flava*, abundant all over the country, appears, in the construction of its nests, to adapt itself to circumstances; for in woods or green meadows it raises little mounds to keep the rain away from its cells, having, indeed, been remarked to utilize mole-heaps for this purpose; but in hilly or chalky districts it simply constructs passages and cells under large stones. These latter are the residences of that most curious little yellow beetle, *Claviger testaceus*, which, on account of its want of eyes, and otherwise general debasement of structure, is usually placed at the end of the *Coleoptera*, being the opposite extreme to the highly organized *Cicindelidæ*, or tiger-beetles. There can be no doubt, from the number of times that *Formica flava* has been observed to evince the greatest care over this beetle, hurrying it away to the inmost recesses of the burrows, on the surface stone being lifted, that it is an object of importance to the community; for to suppose that the somewhat similar appearance of beetle and ant in size and colour deludes the latter into taking these precautions, under the supposition of the *Claviger* being one of the family, is not only an insult to its intelligence, but is not warranted by usual practice, for the ants only carry away their

larva or pupæ, which are of a different shape and hue to themselves. With this ant *Myrmedonia limbata* and the rare *Trichonyx Mærkelii* also occur sometimes.

From the above account it will be seen that the bond of persistent connection between certain *Coleoptera* (chiefly of the section *Brachelytra*) with some of the Heterogynous *Hymenoptera* remains yet to be fully explained ; and rural observers of insect economy, who desire a change from the study of the habits of the honey-bee, will find a new field in the endeavour to supply this explanation.

BUDDHISM AND ITS LEGENDS.*

A religion which at the present day represents the feelings and guides the thoughts of at least three hundred millions of the human race, which had its origin some centuries before the Christian era, and which is more or less associated with the highest existing forms of Oriental civilization, is, of necessity, a very remarkable object of contemplation ; and there are peculiarities about Buddhism which make the extent of its diffusion an almost unique phenomenon. From the stationary tendencies of Eastern life, we can imagine that any set of opinions once adopted would be tenaciously preserved ; and, had it not been for occasional extensive conquests, the Oriental mind could have had few tendencies to change impressed upon it for a long series of generations. The causes why the civilization of Oriental nations ceased to be progressive are no doubt complicated ; but, if we look to the way in which society progresses in Europe, we may arrive at the conclusion that no people continue to advance except they are stimulated by contact and competition with other people equal with, or superior to, themselves in some important particulars of knowledge, aptitude, or skill.

In former ages there was more vitality in the East, and, about six hundred years before our era, in the days of the Prophet Daniel, Mr. Spence Hardy invites us to imagine ourselves "in an appanage of Rajagaha, the capital of Mágadha, where the lord paramount of the Aryan race holds his court." He pictures the intellectual culture as resembling that of Athens in the days of its earlier philosophers ; the commercial activity well developed, and "a freedom of manners and constancy of intercourse between the different grades of society

* *The Legends and Theories of the Buddhists compared with History and Science.* With introductory notices of the Life and System of Gotama Buddha. By R. Spence Hardy, Hon. M.B.A.S. Williams and Norgate.

like that seen now among the nations of Europe." "A general opinion seems to prevail that some great personage is about to appear, who will make all one, from being gifted with unerring intelligence and unbounded power . . . and men are waiting for some event to decide whether future ages are to be ruled by a Chakrawartti, a universal monarch, or guided by a Buddha, or all-wise sage."

On Sunday, the day of the full moon in the month of May, and in the year B.C. 623,* a prince of the house of Sákya was born in Kapilawastu, a city supposed to have been on the borders of Nepaul, and on the following day his mother died. As he grew up, his preceptors foretold that he would become a recluse, and his father endeavoured to entice him into a more regal mode of living by the pleasures of the chase and the glories of war. At the age of sixteen he was married to the princess Yasodhora, "peerless in excellence and in grace"; but his character seems to have had few capacities for domestic enjoyment. The sight of a leper, and afterwards of a decomposing corpse, encouraged his brooding and introspective propensities. He came to the conclusion that all existence was vanity, and he determined to exchange his princely rank, with all its luxuries, for the position of a wandering mendicant, carrying an alms-bowl to receive the gifts of the charitable. He put this intention into practice on the very day on which his wife presented to him his first-born child. He looked at the infant and its sleeping mother, felt no compunction at leaving them, and rushed off into the forest with an attendant, whom he soon dismissed.

When he carried his beggars' alms-bowl through the town, the beauty of his person and the grace of his manner caused many to take him for a celestial personage. He accepted the morsels of food that were given to him, and eat them under a tree; their uncleanness reminding him of the vileness of man's body. His austerities nearly cost him his life, but he recovered, and spent six years in mental anguish and ineffectual search for absolute truth, and the means of extinguishing all human desire. Again he carried the alms-bowl, and, being deserted by his companions, continued his struggle alone. "Taking with him," says Mr. Spence Hardy, in his graphic narrative, "as much food as would support him during forty days of additional trial, he retired to the spot that was afterwards to become of world-wide renown. There, under a bo-tree, he was assaulted by innumerable demons, and the contest was fiercely

* The dates of Gotama's birth and death are variously given; the latter being, according to some authorities, 2422 years B.C., others place it at 544 B.C., and Westergaard as late as 370 to 368 B.C. Spence Hardy is a high authority on all questions of Buddhism, and we give his in the text.

prolonged; but he resisted with like success the menaces of frightful fiends and the allurements of beauty, under all the forms that licentiousness could devise, until, before the setting of the sun, he was the acknowledged victor; and, before the light had again dawned, the great end of his toil was accomplished, and he stood forth before all worlds a supreme Buddha, 'wiser than the wisest, and higher than the highest.' "

His first intention was to keep his newly-acquired wisdom to himself, but, on second thoughts, he resolved to commence preaching the Dhamma, unfolding the principles of his religion. Five Brahmins, who had been the associate of his first ascetic wanderings, were chosen as his first hearers and disciples. He taught them that sorrow is connected with every mode of existence, and that its cause is desire or attachment to sensuous objects, from which, by right conduct and mental tranquility, man may be relieved. Perfect freedom from desire would constitute the nirwana, or state of final perfection.

The King of Mágadha became a convert "on hearing the stanza so often found in monuments" now existing in India, "All things proceed from some cause: this cause has been declared by the Tathágato: all things will cease to exist: this is that which is declared by the great Sramana (Buddha)." It is, perhaps, impossible for any member of the modern Western world to understand how such maxims or dogmas could be accepted as the results of a supernatural exaltation to the highest medium, or how the metaphysical system of the ascetic sage could so readily obtain its marvellous sway. Mr. Spence Hardy considers that, at the period when the new religion was introduced, the popular theology was in a transition state between the Vedantic and the Brahminical systems, but with a tendency towards the latter, which developed its cumbrous mythology at a later date. In times when wealth and power are concentrated in few hands, an ascetic religion is sure to exercise a fascination over those who are hopelessly shut out from luxurious enjoyments, and it also comes as a relief and contrast, needed by those who repent of licentiousness when they are satiated and nauseated with its evanescent delights. The power of self-renunciation for a good object must likewise, in all stages of society, exercise a charm over the human mind, and Sákya-Muni, the "Penitent," must have appeared, in the eyes of his followers, elevated far above the earthly dignities which he abandoned in his resolute and arduous, though misguided pursuit of truth.

Were any one now to profess to be "wiser than the wisest," his pretensions would be tested according to the positive methods of physical science; but pre-scientific times were of necessity times of credulity, in which there were no means

of disproving the most preposterous assertions, and when the world was prepared to accept teachers more from the vigour of their egotistical assertions, than from the evidence they might adduce. We may suppose Sákya-Muni to have come as a religious reformer, opposing certain growing and mischievous errors of Brahminism, and their hateful doctrines of *caste*; supplying a void in the popular faith, manifesting his integrity by his self-denial, and propounding a philosophy plausible enough for the vulgar, and subtle enough to exercise the deepest minds. Miracles were, of course, not wanting, in the belief of his disciples, to the attestation of his powers; but after several wonderful and supernatural escapes from danger, he finished his career, at the age of eighty, by a most unromantic attack of diarrhoea, brought on by eating pork.

To despise forms, to avoid evil, to think kindly of enemies by dwelling on their good qualities, and to put aside revenge by reflecting that its object is only a lot of bones, a skin covered with hair, and a mass of blood-vessels, and to meditate on the perfection attainable by subduing desires, seem to have been the chief teachings of Buddhism, as apprehended by the mass of its early followers; but for the more speculative due provision was made. Gotama Buddha affirmed that a sentient being depended upon, or was composed of, five essentials, called Khandas: "1. Rupa, the organized body; 2. Vedana, sensation; 3. Sannya, perception; 4. Sankhara, discrimination; 5. Winyána, consciousness." Mr. Spence Hardy remarks, "This system tells man that he is a heap, a collection, an accumulation, an aggregation, a congeries, an increment, and nothing more. To develope light, there is the lamp, the wick, the oil, and the flame; and to develope the man, there must be an organized body, and the five Khandas. When the flame is extinguished, the light ceases to be; when the Khandas are broken up, the man ceases to be;" but this negative result is not accepted by all the followers of Sákya-Muni, and is repudiated by the Llamas in Thibet.

Through the operation of Upádána, or cleaving to existence, a new being is produced at the dissolution of the old one, and to this, the Kamma, or aggregate of all the actions and responsibilities of the original being, is transferred. Mr. Hardy gives the following very curious passage on the Buddhist doctrine of continued existence: "On account of awijja, ignorance, sankháro, merit and demerit, are accumulated; on account of these accumulations, winnyánán, the conscious faculty is produced; in consequence of the faculty of consciousness, námarúpa, the sensitive powers, the perceptive powers, the reasoning powers, and the body, are produced; on account of the námarúpa, the body and sensitive faculties, the sadáya-

tanán, the six organs of sense (the eye, the ear, the tongue, the nose, the body, and the mind) are produced; on account of the six bodily organs, phassa, contact (the action of the organs), is produced; on account of contact, wédaná, sensation, is produced; on account of sensation, tanhá, desire, is produced; in consequence of desire, upádána, attachment, is produced; in consequence of attachment, bhawa, existence, is produced; in consequence of a state of existence, játi, birth, is produced; in consequence of birth, decay, death, sorrow, weeping, grief, discontent, and vexation are produced. Even this is the origin of the complete catenation of sorrow."

The Buddhists recognize three phases of being—1. Kama, in the worlds belonging to which (places of punishment included) pleasures and pains result from the exercise of the senses; 2. Rupa, worlds in which are organization and intellect, but no senses; 3. Arupa, worlds in which there are no bodily forms, but sensation, perception, discrimination, and consciousness. There are four of these worlds, the last being a sort of dreamland, in which consciousness is imperfect, there being neither consciousness nor unconsciousness. "Were a sentient being to pass through all these states of existence, in all these worlds, the period would extend to 231,628 maha kalpas, and 12,285,000,000 years."

The nirwána is the state of freedom, from wána, attachment, or desire. "The great rishis (prophets) who are free from wána, desire, call that nirwána which is achutan, that from which there is no going (no transmigration); achchantán, that which has no boundary (neither birth nor death); asankhatán, that which is not affected by cause or effect; anuttara, that to which there is not anything superior; and padán, that to which there is nothing to excel it in advantage."

In Ceylon the nirwána seems to be synonymous with annihilation, and Buddhism is described as atheistic, from its not recognizing any one paramount and supreme self-existing being. It must be a weary soul that can long for the eternal cessation of all sensation and activity, as its hoped for rest; and a religion which inculcates the destruction, instead of the regulation and right direction, of desire, must oppose a tremendous obstacle to social progress; but Buddhism has more theistic aspects in Cochin China, Siam, and Thibet, at least among the more cultivated classes; and as they become gradually acquainted with European science, their implicit credence in numberless absurdities must pass away.

From Mr. Spence Hardy's book, which was originally published in Ceylon, we find he is engaged in a most important controversy with the Buddhists. He assails their religion with all the weapons of rationalistic criticism, and the native priests,

assisted pecuniarily by the King of Siam and a local chief, use the printing press in their defence. Thus we have a very remarkable collision of the western and eastern minds, from which beneficial effects of the highest moment may happily arise.

The Buddhist views of the universe indicate their origin in a pre-scientific period, when mystical imaginations took the place of accurate observation. Boundless systems of worlds, Sakwalas, scattered through space in groups of twos and threes, can all be seen by Buddha, who can tell what is transacting in any one if he wills to know it. "In the centre of each system is a mountain called Sinérn, or Maha Meru. It is 1,680,000 miles from its base to its summit, half of which mass is below and half above the surface of the ocean. On each side it is of a different colour, being like silver towards the east, and like a sapphire towards the south. . . . It is supported on the three-peaked Trikuta rock, like a vessel upon a tripod." It is also said to be firmly clasped by them as by a pair of pincers. The three rocks rest upon a world of stone. On the summit of Maha Meru is the heaven of Sekra; in the body of the earth are eight places of suffering. Between Meru and the Sakwala ridge are seven circles of rocks, with seven seas between them, and the waters of the seas do not evaporate, and no rain falls in them. The first world is 2,400,000 miles thick. At its base is a stone world, impervious to water, 1,200,000 miles thick, and above it is the world of the earth, which has the same thickness, and below it is the world of water, 4,800,000 miles thick, and below that the world of wind, 9,600,000.

Each Sakwala has a sun and moon. The sun is 500 miles in height, length, and breadth, and its circumference is 1,500,000 miles. The moon is 490 miles in height, length, and breadth, and its circumference 1470 miles, etc., etc.

Buddhist astronomy, physical geography, and natural history proceed in this absurd style, offering an easy victory to real science wherever members of the Buddhist faith can be induced to study it, and to apply its teachings fairly and honestly to the correction of this preposterous legend.

Eclipses are occasioned by a monster nearly 50,000 miles high, who sometimes hides the sun and moon in his mouth, and sometimes covers them with his hand.

It is supposed that Buddha has passed, and will pass through endless forms of existence, for the benevolent purpose of teaching sentient beings the way to permanent peace—the nirwana which we have described; but, as might be expected, the recorded sayings of Buddha are not consistent with the pretensions of such enormous and varied experiences.

The Buddhist method of arriving at truth is one which necessarily passes out of public favour, as scientific and industrial civilization ensue. Solitary meditation in lonely places, carried to a certain point, is expected to bring comfort to the devotee; but he still retains reasoning and investigation, which a continuance of the ascetic process takes away and replaces by a condition of pleasurable intuition. A third process of solitary meditation, if successful, removes joy, gladness, and sorrow, and diffuses through the whole system a perfect tranquillity; and after a fourth process of the same kind, all reasoning, and all attachment to sensuous objects being removed, purity and enlightenment of mind engross the Buddhist saint, like a garment that covers him from head to foot. That those who can sustain the physical discomforts of this route to "perfection," arrive at the most complete and egotistic self-satisfaction, is evidenced not only by Buddhist devotees, but by the ascetic mystics of all ages and of all creeds; but whatever may be the precise dogmas of the superstition that sanctions such practices, they usually lead to the same result, the degradation of the individual, and his withdrawal from the performance of all the duties and obligations imposed upon man as a social being. The ideal of perfection held up before a community that accepts any of the varieties of such a faith is of the most mischievous kind. It renounces duty as well as enjoyment, and looks to annihilation or inactivity as its ultimate reward!

Mr. Spence Hardy attacks the Buddhists by scientific criticism. He tells them that the personal existence of Gotama himself is open to doubt; that all the notions ascribed to him concerning the physical condition of the universe are provably incorrect; that the books in which the legends and opinions of Buddhism are set forth cannot be historical, because they state things which are impossible, and were not written till long after the events they pretend to describe. So far as they are able, the Buddhists reply, and thus the controversy goes on.

Railways, irrigation works, better pay for labour, and the opening prospects of personal advancement to those who are intelligent and industrious—these are the circumstances which seem likely to raise the Oriental mind when they can be brought to bear upon it. The superstitions of Buddhism and Brahminism belong to particular conditions of society, and experience seems to show that extensive changes in speculative thought can only be effected when other changes have prepared the way. The difference between the Oriental and European point of view is enormous, and hitherto no European race has succeeded well in governing and improving Orientals, though

occasionally some gifted individual, like the late Sir C. Napier, in Scinde, has been of wonderful use. Perhaps the industrial development of India may lead the natives to do their part towards reforming themselves. No amount of European benevolence can be a substitute for self-action, and the conservatism of Eastern nations can only be overthrown by movements that develop new interests and create new wants.

KAFFIR PROMISE AND CAPABILITY.

BY DE. MANN, F.R.A.S., F.R.G.S., F.R.S.L., SUPERINTENDENT
OF EDUCATION IN NATAL.

(With a Tinted Plate.)

IN a recent number of the *INTELLECTUAL OBSERVER* an allusion was made to the curious fact that there is a kind of education going on even among the wild Kaffirs, in consequence of the lives of gossip and of incessant talk that the men lead; and that this becomes at once apparent when the features of the young men are compared with the features of the old men, the countenances of the young men being commonly wild, furtive, and unintelligent, and the countenances of the old men being as commonly gentle, astute, and sagacious. This fact is illustrated in the plate of *Types of Zulu Kaffirs* that accompanies the present number. Figure 3 is the portrait of a young man of Ngoza's people, taken by photography at the chief's kraal, near the base of Table mountain, within sixteen miles of the city of Maritzburg; and Figure 4 is the portrait of Umshiyane, an old man of the same clan, taken by photography at Maritzburg. Figure 3 may be deemed a fair type of the young wild Kaffir of Natal, and Umshiyane is a fair specimen of what the young wild Kaffirs of Natal become after they have gossipped together for half a century.

Figures 1 and 2 of this same plate illustrate another scarcely less interesting fact in connection with Kaffir features, namely, that there are two very opposite types occasionally developed with great distinctness even in the same families—the one having the flat nose, projecting jaw, thick lips, and low cerebral development of the pure negro race; and the other having the small jaw, sharp features, prominent nose, and full capacious foreheads, that must be referred to some higher form of organization. It is not possible to have any extended acquaintance with the Kaffirs of Natal, without feeling that they have much in them that is common to themselves and to the negro. But it is equally apparent that they have

also much that the true negroes want, and that at times comes out in sufficient force to entirely mask the negro organization and blood. There can scarcely be a doubt that the Kaffirs of Natal and its neighbourhood are a composite people, formed by the engrafting of some nobler organization upon the negro stock, and that there is continually a developing out of the leading characteristics of both the lower and the higher element in different individuals. Figure 1 may be taken as a pictorial representation of the lower type, although without the full development of jaw that is often encountered. It is the portrait of a man of the Amabaca tribe, a people who originally dwelt between the site on which Maritzburg now stands and the Umgeni river, and who were driven from that position, at the time of the Zulu invasion, to the river Umzimkulu, at the south-western frontier of the colony, where they now dwell, partly within and partly beyond the British territory, Figure 2 illustrates the higher type of Kaffir organization. It is the portrait of Umkalipa, a subordinate chieftain, who is often seen at the seat of the Colonial Government, and who not infrequently proves a useful man to the authorities. Both these portraits are from photographs taken in Maritzburg by the author of this paper, and both have been very admirably and exactly copied by the engraver.

It is matter of familiar observation that the leading characteristics of the negro organization are very much more softened on the eastern side of the great African continent than they are on its western side. This seems to indicate that the modifying influence is in some way connected with geographical position—that it lies in the east, or more exactly in the north-east. Professor Huxley believes that the Kaffirs are a composite race, mingling distinct elements in their blood, and is of opinion that there has been a migration from the north-east. It looks very much indeed as if some people of higher organization than the true negro, but not disinclined to amalgamate with them, had come from the north, possibly somewhere among the highlands of Abyssinia, and passing through the equinoctial region of this side of the continent, the natural seat of the negro, had mingled with them there, and sent a mixed offset towards the south, where the Kaffir tribes are now found. It is not unworthy of note that Mr. W. C. Palgrave, the great modern authority on Arabian matters, found a people in the province of Oman who present many points of resemblance to the Kaffirs of the highest type. Mr. Palgrave considers that the inhabitants of the central and northern provinces of Arabia are Ismaelitic, and of true Asiatic origin; but that the inhabitants of the southern province and Oman are of different extraction, and come primarily from the high-

lands of Abyssinia. The southern and eastern Arabs, or Kahtanic variety, manifest a remarkable sympathy towards Africans, and readily admit the negro races to social fellowship, not unfrequently intermarrying with them. The emancipated negro in Oman commonly gives his sons and daughters to the middle or lower class of Arab families, and the mixed race springing from these unions are called the "Benoo-khodeyr," or "Sons of the Green one." Mr. Palgrave states that it has been his fate to be honoured by the intimacy of more than one handsome "Green-man," with a silver-hilted sword at his side, and a rich dress upon his dusky skin, but denominated sheykh, or emir, and who was humbly sued to by Arabs of the purest Ismaelitic or Kahtanic pedigree. In reading his description one is almost induced to think that Othello must have been a "Benoo-khodeyr." The Arab town of Riad is full of "Green-men" shopkeepers, merchants, and officers of government. The Ismaelitic Arabs are reserved, self-contained, and of gloomy temper, and narrow and concentrated intellect and will. The Kahtanic Arabs are frank, impulsive, light-hearted, and of social instincts and habits, like the Kaffirs. It must also be added, that so far as the brown, olive, or yellow hue of the skin is concerned, there are unquestionably "Green-men" among the Kaffirs.

In considering the capabilities and possible future of the Kaffir races of Natal, there very naturally arises, first and foremost, the question of hard work. What are they worth, or likely to become worth, as beasts of burthen, and as "sons of toil." They do not take to bodily labour naturally; there can be no doubt about that. But when impelled by circumstances to waive their personal inclinations and predilections in this particular, they can do hard work, and do it well. In the agricultural districts of the colony, Kaffirs are now hired, as field labourers, in considerable numbers. They go to work under monthly engagements, and receive from six to ten shillings per month, and rations, for their service; their food being principally Indian corn, which costs about ten shillings per month for each man. They need to be looked after carefully, and also require, in most instances, to be shown exactly what they are to do. They work very well in gangs, headed by white men. Most of the public works in the colony are carried out by Kaffirs in this way. The roads are made by them. Considerable numbers of them have been employed in the harbour works at Durban for some time; and perhaps in this particular labour their powers of endurance and performance have been more fairly and fully tested than in any other instance. Mr. Arnold Taylor, the agent of the contractor for the construction of these works, had between three hundred

and five hundred Kaffirs in his employment during a term of four years. The men were the rudest and wildest specimens of the race, and were sent to him under the orders of the magistrate for six months' term of service. Most of them, when they arrived, were entirely without a conception of a shovel, a pickaxe, or a lever. Mr. Taylor found that, for rough labour, one of these Kaffirs was equal to two of the very best Indian coolies; and he estimated that one Kaffir was worth about a fourth part of a good English labourer, who would receive four shillings a day in England for his work. These Kaffir labourers required one English leader to look after a gang comprising from twenty to thirty individuals. They took kindly to earth-work with shovel, pick, and barrow. Some made excellent sawyers, in pits with white men at the top, and some became very handy as assistants to English smiths. They were always free to leave after six months' service, and were then replaced by new recruits. One remark made by Mr. Taylor is well worth record and attention. He invariably found that the men who came to him wild, raw barbarians, went away at the end of their service altered beings. Their countenances had become perceptibly brighter and more intelligent. Regular discipline and steady industry seemed to exert the most beneficial influence over their characters. There can be no doubt that well-ordered and well-arranged work, carrying with it the proper remuneration, and bringing in its train new cravings to be satisfied by new efforts of industry, would prove among these people the most certain and most potent civilizer that could be employed in their behalf.

Work on the sugar plantations is, in the main, popular among the Kaffirs for two reasons. The climate is warm and genial on the coast, where the sugar is grown, and treacle is a thoroughly appreciated addition to the daily fare. The chief drawback to the employment of Kaffirs in industrial enterprise up to the present time has been the uncertainty of their labour. It has been found hitherto impossible to induce them to take any long term of engagement. They will work while the humour is on them, but they will reserve to themselves the right to start off to their kraals whenever the humour changes. They are as fitful and capricious as children, and look with ready jealousy and suspicion upon all attempts to impose obligations and constraints upon them. On this account a considerable number of Indian coolies have been introduced into the colony to work upon the plantations, with fixed terms of service. The mail which has just reached England from the Cape brings the most welcome intelligence, that one of the enterprising coast planters in Natal has recently succeeded in inducing the Kaffirs to undertake to clear ground intended for

the cultivation of coffee upon contract by piece-work, the contract for clearance being at the rate of thirty shillings per acre. This is unquestionably a step onwards towards civilization.

With the sole exception that refugee natives who come into the colony from beyond the border are registered and apprenticed out to white masters for three years' service, and that men are supplied to the Government works under requisition from the magistrates, no pressure of any kind is put upon the Kaffir population to induce them to work for European settlers. The affair is entirely one of free inclination under the temptation of wages. Kaffirs living in native villages, either in their own reserved locations, or upon the property of the Crown, or of private holders, come of their own accord to the employers of labour, and make their own terms for remuneration and period of service. The average number of Kaffirs engaged in the service of white men in the colony last year was nearly seven thousand. The terms of service are generally short. This number, therefore, did not by any means represent the sum-total of native men that came under the civilizing influence of labour and personal communication with white masters during the year. The exact number of the black people from whom these supplies of service are drawn is not certainly known. The estimate is made from the number of huts that pay taxes to the Government, and it is assumed that each hut accommodates a certain number of inhabitants. The return made to the Government upon this estimate in recent consecutive years varies between 136,000 and 175,000. It is probable that the latter number is not very far from being correct as the tally of the native subjects of Queen Victoria, residing at the present time under British protection and rule in the colony of Natal. Assuming that one in eight of the Kaffir population is of man's estate within the years suitable for service, the number actually engaged in work is not a very contemptible proportion under all the circumstances of the case. It has yet to be seen that there are many more than those actually engaged in service to white masters, who are steadily within the pale of civilizing influences. It will be inferred from what has been said in a preceding article on the subject of polygamy that, as a rule, Kaffir women do not engage in service to white mistresses or masters. Their service is jealously and exclusively reserved for their own black lords.

Kaffir children manifest a very remarkable facility for the acquisition of book-learning. Children of tender age learn to read with great readiness, and soon become expert with all the simple rules of arithmetic. They are quick with mental arithmetic when well taught. The boys make excellent composers



and printers. There is a little monthly Kaffir periodical called the *Ikweze*, issued at the American Missionary station, at Esidumbine, which is principally printed by a Kaffir boy. A native lad, named Magema, is the Bishop of Natal's principal printer, and during the bishop's recent absence in England, used to correct the proofs of his work as well as to print them. This lad is very clever indeed, in his vocation, and it is no inapt illustration of the change which the light of civilization can work in these people, that the birth-name of the skilful Magema was "skellum," which, in the Dutch patois, means "rascal."

The missionaries of various denominations in Natal have all been for some time engaged in creating a "literary Kaffir Language," which is printed in books, and in some measure taught in schools by the aid of dictionary and grammar. The chief argument which the missionaries employ in advocating this proceeding is their urgent desire that every Kaffir shall be able to read the Bible. This argument would have considerable weight in it, if it were the fact that the general Kaffir population of the land can read the Bible when it is printed in the Kaffir language. This, however, is not the case. When the Bible is printed in Kaffir, the Kaffirs still cannot read, unless the further labour has been performed of specially teaching them to do so. But in practice it is found that it is really quite as easy to teach Kaffirs to read English, as it is to teach them to read a new written language manufactured out of their own rude tongue. There therefore remains the very important consideration, whether when they are taught to read, it would not be better at once to teach them to read in the English language, which would immediately bring them so much more within the pale of white influences. There are many who think that if one-fourth part the labour which has been given to create a new definite and formal language out of the Kaffir elements, and which the wild Kaffirs do not all understand when it is so created, until they are painfully and gradually taught to do so, had been devoted to teaching them to speak, read, and write English, a tenfold larger result in the way of education would have been gained than is now being realized. Kaffir children who are well taught learn to read and understand the English language much more quickly than to speak it. The faculty of speaking it comes slowly, and with a little difficulty at first; but when mastered, it is spoken well. No doubt the English language seems to them at first a very barbarous one to have to articulate, being so free as it is from clicks and from guttural explosives. The author once asked a young, clever Kaffir girl, who had acquired a fair understanding of English in a school, but manifested a

pertinacious determination not to speak it, for an explanation of her reason. The young lady informed him that she did not like to speak it because she was sure it would make her tongue crooked! The difficulty was entirely removed by the author pledging himself that if such a result ensued, he would set the crooked organ straight by a surgical operation, and by his showing the instruments with which he proposed to effect the rectification. It is, of course, very important that missionaries and teachers should themselves so far understand the Kaffir language as to be able to speak it with facility. The facility is needed, indeed, to enable them to teach English to Kaffirs. Their object should, however, be colloquial rather than literary. It is one thing to speak a rude language familiarly, according to the custom of, and in the idiom of, the people, and another thing to convert that rude language into a written and printed one, to be perpetuated in a fixed and definite form for special teaching.

The Kaffir men manifest a very great eagerness to learn to read and write. They look upon the art as a sort of magic which the white man employs in carrying on the wonderful operations of his strange life, and they think it a very desirable thing to qualify themselves for similar performance. This is strikingly, although somewhat ludicrously, illustrated by the way in which young Kaffir men may be seen striving to effect their purpose in the principal large towns of the colony. Evening after evening gatherings may be seen of young Kaffirs who have been at work all day, and who then assemble round some wall tablet, and repeat simultaneously, with stentorian energy, B-a, ba; B-e, be; B-i, Bi, as one of their number points to the printed characters with a wand. It is almost painful to note the patient and resolute way in which these young fellows pursue the exercise hour after hour and night after night, in the faith that they are rapidly becoming adepts in wielding the white man's instruments. If the public income were sufficient for the work, the Government would experience scarcely any difficulty in establishing native schools for English instruction, even among the wildest and most retired natives. It once occurred to the writer to receive a visit, in a wild part of the country, from a powerful young barbarian chief, who came with a company of his old councillors to offer to build a school hut at his kraal, if the Government would send him a teacher to instruct the children of his people there. He explained that the principal ground of his request was his desire to be able, in case of need, to communicate with the head of the state by means of a messenger carrying his words in a written document. In consequence of the extreme youth of the colonial community, and the great demand that there is

for the employment of the public revenue in works of general utility, the Government is not yet able to devote any large sum to the furtherance of the work of native education. The expedient course has therefore been taken of giving small grants in aid from the public funds to the various missionary establishments already having a footing in the land, upon the condition that the English language and industrial pursuits are taught to the native children of the neighbourhood. It would unquestionably have been better for the immediate prospect of success if the Government could have taken the work of secular native instruction entirely into its own hands, because among the wild native people the influence of prestige is in favour of the Government and against the missionaries. The wild natives are generally suspicious of the missionaries, because they are so very zealous in their work, and because they preach energetically against polygamy. The natives think it is quite impossible for men to be so personally eager about making converts, unless for their own purposes and for their own gain. The alternative plan, which has been adopted on economical grounds, of using the agency already established on the field by missionary spirit and enterprise will, in the meantime, produce very decided results in the right direction, until more energetic and costly measures can be added. The system alluded to has only been in force three years, and there are, at the present time, as a first instalment, 1700 Kaffir children learning English at the various schools, of which one is a central training school, where the most promising native pupils from other schools are received to complete their education as pupil teachers. The cost to the Government of the common native schools is a trifle in excess of £900 per annum, and, in the last year, contributions were made in ten of these schools by the Kaffirs themselves in aid of their support, amounting in the whole to £205 12s. 9d. The Colonial Government also furnishes £1000 a year to these schools, for industrial training of natives. The amount is expended in the payment of salaries to skilled labour masters or mistresses. Last year about 120 boys and girls were benefiting by these industrial grants, of whom several were under regular indenture for fixed terms. The lads in these industrial schools are trained as carpenters, cabinetmakers, waggonmakers, brickmakers, stonemasons, builders, thatchers, tailors, and shoemakers. They readily attain fair proficiency in all these arts. Most of the extension of the buildings on the principal stations is now performed entirely by the boys; and, in some of the most advanced schools, the boys are beginning to go out as hired workmen to settlers living in the neighbourhood.

There is no more interesting subject of observation and

thought than the proceedings of Christian missionaries in wild lands. In the small and young colony of Natal, there are thirty-six stations occupied by resident missionaries, of which nearly one-third belong to the American Board of Missions. There are several Norwegian missionaries residing in Zulu Land, far beyond the British territory. As a rule, these missionaries settle down in remote wild districts, and build themselves houses there, where other objects and influences do not yet bring civilized men to dwell. Some few of the wild natives gather round their dwellings, fix their huts upon the missionary grounds, attend the missionary religious services, and send their children to the missionary schools. There are altogether about 3000 native people attending the services of the thirty-six missionary stations in Natal. Some of these go for curiosity and amusement; some for what they can get; and some are serious converts to the Christian practice and creed. Whatever may be thought of the actual economy of missionary work, on comparing results with outlay; or of the question whether from Christianity to civilization, or from civilization to Christianity, is the natural and appointed progress for barbarous man, there can be no doubt of the fact that these missionary stations, scattered through the wilderness, do serve as most valuable outposts in the attack of civilization upon barbarism. The most careless and casual comparison of a wild native kraal, with a missionary native village in Natal, serves to establish at once this fact. In the wild kraal the Kaffir is a naked savage, squatting in the sunshine, or skulking in his straw bee-hive, amidst equally naked women, whenever *they* find intervals from the bodily drudgery of drawing his water, bearing his burthens, or delving his ground. In the missionary village the Kaffir is a clothed man, living in a square house with a wife and a family of children, who derive their daily bread from the sweat of his brow, and beginning to understand the dignity of labour, the responsibilities of rational existence, and the value of temporal possessions. In many instances he is a curious creature in his new-fledged state, and bears his unaccustomed graces with a very manifest expression of self-complacency. Deference to the white man is a striking and constant feature in the character of the wild Kaffir. He is even slow to follow the example which civilized life sets before him in social things, because he looks upon the white man as a being of an altogether higher order than himself, and as the proper inheritor of special gifts and arrangements in which he can have no part. One of the answers occasionally made to missionary appeal by wild Kaffirs is, "Oh, yes; that is all very true. There is no doubt a great Spirit who looks after,

and cares for the white man. But He has nothing to do with the black men. The black man has no protector of that kind." When the missionary has just succeeded in getting so far with him as to lodge skin deep the idea that he has been mistaken in this, and that the Great Spirit of the white man does care for him, and that he is a "man and brother," it can hardly be matter of surprise if he begins to think rather better of himself than he did before, and if his natural deference and modesty gives place to self-assurance and personal conceit. There is no doubt that the phase is but a transitional one, and that a prolonged experience of the conditions and working of civilized and Christian life will assuredly bring its own remedy for the evil. Still the tendency is well worthy of note, because it points to one obvious precaution which missionaries may easily make a part of their programme when they prepare themselves to deal with the raw material of barbarism.

It is also deserving of remark that the missionary stations in Natal, which are so placed as to afford an industrial career for the natives resident at them, are those which are manifesting the surest signs of vitality and success. Wherever townships, or fairly prosperous settlements of white people have grown up in the close neighbourhood, so that there is transport work to be performed by waggons and oxen, and a ready market for such articles as the Kaffir can make, or such produce as the Kaffir can rear, or where there is a sugar-mill at hand to manufacture such cane as he may be able to grow, there the native Christian communities thrive and enlarge quickly. Upon the whole the most successful missionary station in Natal is that of the Umvoti. This station was established by Mr. Aldin Grout, one of the fathers of the American Mission, in the year 1844. A few years since the Colonial Government erected steam machinery for the manufacture of sugar at this station, with a view to encourage the growth of the cane among the natives. One half the sugar manufactured is taken by the Government to cover the cost of manufacture, and the other half belongs to the native planters. At this station there are now sixty-seven square European houses inhabited by native sugar-planters, who for the most part employ their own native waggon-drivers as hired servants. Many of these men are estimated to have property belonging to them at the present time of the value of not less than £800 a-piece. Mr. Grant believes that two of them are worth £2000 each. These planters have built a large brick church, capable of accommodating a congregation of 500 individuals, at their own cost, and they contribute £75 yearly for the maintenance of a school for the education of their children.

The most remarkable instance of the industrial capability of the Kaffir that has come within the writer's own personal experience yet remains, however, to be given. At the missionary station of the Amanzimtote, on the southern coast, and sixty miles away from the Umvoti station, there lives a Kaffir named Nembulo. This man, having heard of the wonders which the sugar-mill at the Umvoti was working, one day took his staff, and walked off to look into the matter with his own eyes. He returned home from the Umvoti, pondering upon what he had seen. When he had completed his deliberations, he went to a native intimate, named Uncajiana, living close by, and proposed to him that they two should buy a sugar-mill for themselves, and grow and manufacture sugar at the Amanzimtote! His overtures being well received by his companion, he next visited a white planter, Mr. Sidney Platt, residing near Durban, and bargained with him for the purchase of a small steam-mill, that Mr. Platt was wishing to replace by a larger one, the exact terms of the bargain being that Nembulo was to begin to pay for the mill one year after he had commenced operations, that all the sugar made was to be devoted to the payment until the debt was cleared, and that the price was to be £500. In the year 1864, the writer chancing to hear of this spirited proceeding when he was in the neighbourhood, sent for Nembulo, and questioned him about his plans. The only doubt about them seemed to be whether the Kaffir would be able really to get his mill fairly started, to make the money which was to pay the debt. After due consideration of all the features of the case, the writer brought the affair under the notice of the Lieutenant-governor, and procured a loan of £100 from the Government, to be expended in removing the mill to Nembulo's place, and in setting it to work there. In the month of June, 1865, the writer again visited Nembulo, to see how he had succeeded in his enterprise. He found the Kaffir stripped to the waist, driving the steam-machinery of a pretty little mill, the rollers of which were being fed with cane by the women of his family. There was no white man near him. He was "monarch of all he surveyed," and master of the position. When questioned, he gave the writer a very lucid explanation of the safety-valve, and some other parts of the machinery. He had just manufactured five tons of very excellent sugar. His Kaffir neighbours had already planted a considerable stretch of cane, and he stated that he expected to be able to pay off his entire debt, which then, including the advance from the Government, amounted to £700, within two or three years. He found that he was able to manufacture twelve hundred-weight of sugar (worth from £12 to £15) per day. His first year's crop was estimated at about seven tons. The history of

his proceedings since the previous year was, that he had procured an engineer from Durham to remove and erect the mill for him. He had then retained the man three days to give him a lesson in managing the machinery, and at the end of the three days dismissed him with a payment of £15 for his services, and immediately afterwards carried the £5 which remained of the Government loan to Mr. Platt, as the first instalment of the purchase-money. Having settled this piece of business, he filled up his time until the crushing season arrived, by going about from mill to mill to perfect his knowledge of the machinery; and when the proper time did come, he started his own machinery single-handed, without a single mishap, and worked it with entire success.

One other fact is all that can now be added to the arguments and illustrations of this paper. It is a trifle in itself, but it is a trifle that is full of meaning and promise, and therefore well worthy of record. Not very long since the writer was riding on horseback in Natal, quite alone, and in a wild part of the country, when greatly to his surprise he came suddenly upon a large surface of the open ground, unmistakably traced by the familiar furrow of the plough-share. There was a wide horizon round, and no sign of human life in sight, and no other token of the neighbourhood of civilized appliances. He was quite aware that there was no white man's house within many miles. At the end of the day's ride he found the solution of the enigma by learning that the wild Kaffirs of that district were in the habit of sending twenty miles to a settlement of their more advanced brethren which possessed draft oxen and ploughs, to get one of the fraternity to bring up the magic implements and break up the ground for their grain-crops.

It will be seen from the several statements contained in the preceding pages of this paper that an interesting social problem is in process of practical solution in Natal. Certain important questions, that relate to the future destinies of a large race of mankind are being there put to the test of actual experiment under eminently favourable circumstances. The contingency is the work of what is ordinarily termed accident, rather than of design. A black race, under the immediate influence of a reign of tyranny and terror, is flocking in to the midst of an industrious English community settled in an exceptionally fine and congenial climate. In order merely to put some check to the rapidity of this black exodus from beyond the Tugela, the colonial authorities have found it essential to enact an ordinance providing that all cattle brought into British territory by refugees shall be given back to the Zulu chiefs on formal demand, and that the refugees themselves

shall be registered, and apprenticed to English masters for a term of three years. The English rule is already more popular with the great majority of the wild Zulu people beyond the border than their own government. The smile of Queen Victoria has more power on the banks of the white and black Umfolusi in Zulu land than the frown of the shade of Chaka. Mr. Shepstone, the Secretary for Native Affairs in Natal, is of opinion that the instant the two restrictions alluded to above are relaxed, or withdrawn, the remaining fragments of the Empire of Chaka and barbarous Zuludom will crumble into pieces. Within the last few months, since the writer of these pages has left the land that he is speaking of, the Basuto chief Moshesh, beyond the north-western frontier, has sent a special messenger to the British High Commissioner to say how ardently he desires that his people, another division of the great Kaffir family, should be enrolled among the black children of the British Queen. The race that is concerned in these movements of contemporaneous history combines in itself the docility of the negro, with certain mental qualities that are of a higher order than those of the negro. Therefore, no theory that can be shown to affect the true negro, and no experience that has been reaped from the true negro, can be relied upon in reasoning upon its future destinies. The final issue of the Natal experiment is yet in the obscurity of time. But this much at least is known—so far as the British territory is concerned this interesting aboriginal people must either be converted into an industrious and civilized community, serving the interests and co-operating in the objects of their white and more highly gifted brethren, or their places on colonial ground must become vacant. Civilization and barbarism cannot long stand side by side, or face to face. In such a state of affairs the few notes that have been placed on record in these pages cannot be held to be without deep interest, both as indications and as suggestions—as indications of what may fairly be hoped for, and as suggestions of what may possibly be done.

region. Yet a view of the vicinity, which I subsequently obtained on April 21, enabled me to add a few features, some of which, at least, it is strange that they should have overlooked. It is now to be regretted that the sketch in the February number did not include a wider area, so as to give room for a more interesting comparison; our purpose, however, will be sufficiently answered by the accompanying diagram, in which the lettered objects only are to be found in the map of B. and M.

With a power of 212, and very good definition in my $5\frac{1}{2}$ -inch achromatic, I distinctly perceived that the upper part of the ridge running down into the interior of *Aristoteles*, from the peak close to the breach in the S.W. wall, was really a chain of small craters, probably four or five in number. This, however, was of course an object of such delicacy, as to form no ground of inference. One of the lava-currents (?) issuing N.E. appeared as a very minute furrow, beginning at about $\frac{1}{3}$ of the diameter of the great ring from its summit as a little crater, probably broken down outwards, and running in a slightly curved direction for about an equal distance, with an aspect of irregular depth, as though it might possibly prove, under more favourable circumstances, to be a confluent chain of craters. Between B. and M.'s A (at the bottom of the diagram) and their two hills Γ is a curious group, consisting of a conspicuous pair of little contiguous craters, the larger N, with a smaller companion E, two unequal hills N. and another W. The ring B, of B. and M. has some irregularity within it, unnoticed by them. S.W. of it, about $\frac{1}{3}$ of the distance to the ring of a, but W. of the line, is a minute but conspicuous crater: between this and the wall of *Aristoteles* are several others still smaller, of which a mere idea is given in the sketch, as well as of a number of others to the S.W., the grouping of which seems to point to a, as their focus of action. N. of *Eudoxus* A (the most southern crater in the sketch) were several others; and on the whole the neighbourhood of *Aristoteles* was more like that of *Copernicus* than would have been imagined from B. and M.'s map. The W. of their two hills marked Γ either is a regular crater, or has a cavity on its summit.—April 23, 24, 25, the furrow could still be seen, though with decreasing visibility: the group of three craters between A and Γ remained conspicuous. April 23, I could still see the pit on the summit of the western Γ . All these objects therefore are confirmed, and the group of little craters in particular is shown to be an object of persistent visibility under varied illumination.

This assemblage of three craters and three hills had been previously discovered, together with several other very minute

craters near *Aristoteles* and *Egede*, Jan. 23, and reviewed Feb. 22, by Mr. Leigh, then of Birkenhead, with a very fine 9¼-inch silvered speculum by With, but I had not at that time before me the sketch with which that gentleman had favoured me, nor any other than a very general recollection of its nature. I have no doubt the larger crater might be perceived with much less powerful instruments.

Now, are we to suppose that these objects did, or did not, exist at the time of B. and M.? In the face of their own drawing and description, it cannot be pleaded that this is an out-of-the-way region, which a selenographer might perhaps be pardoned for scrutinizing with less care. Nor can the admitted inferiority, as to light, of their optical means be alleged, when a portion of the objects, at least, are so very readily and persistently seen. A reference to Lohrmann's map shows us one of the twin craters, and so far tells against his contemporaries. But the question, it would appear, admits as yet of no completely satisfactory answer; and the same inquiry might be made, with the same ambiguous result, in examining many other parts of the lunar hemisphere. There must evidently be greater precision in detail before we can form safe conclusions as to the present condition of the moon.

OCCULTATIONS.

Jan. 8th, 18 Aquarii, 6 mag. 4h. 4m. to 5h. 2m.—9th. B.A.C. 7774, 6 mag. 6h. 2m. to 7h. 10m.—16th. θ Tauri, 4½ mag. 4h. 1m. to 4h. 39m. 75 Tauri, 6 mag. 4h. 4m. to 4h. 50m. θ^2 Tauri, 4½ mag. a near approach. B.A.C. 1391, 5 mag. 4h. 47m. to 5h. 48m. ALDEBARAN, 7h. 26m. to 8h. 37m.—17th. 130 Tauri, 6 mag. 11h. 59m. to 13h. 6m.—18th. 26 Geminorum, 5½ mag. 7h. 44m. to 8h. 48m. (The night of 16th will be marked by especial interest, though too near the Full Moon to admit of the visibility of the dark limb; or give any chance of the optical phenomenon of "projection.")

OBSCURATION OF A LUNAR CRATER.

BY W. R. BIRT, F.R.A.S.

ALTHOUGH the disappearance of a crater on the moon's surface may not possess such an amount of interest as the sudden outbreak of a star, or a shower of meteors, as the earth plunges into a congeries of minute bodies, circulating around the sun—the two leading astronomical facts of the year 1866—yet, as giving us, inhabitants of the earth, intelligence that some change is taking place on the surface of our nearest celestial neighbour, every circumstance indicating that a portion of that surface is not in *precisely* the same condition as it was a few months since, must be regarded as extremely interesting; especially when we consider that “change” is the principal means by which we become acquainted, in a more intimate manner, with the physical constitution of bodies.

On the extensive lunar plain known as the *Mare Serenitatis* (INTELLECTUAL OBSERVER, vol. viii., p. 292) stands a crater named “Linné,” in W. longitude, $11^{\circ} 32' 28''$ and N. latitude, $27^{\circ} 47' 13''$. The crater, which is 5·6 English miles in diameter, is situated upon one of those low ridges, described by Mr. Webb, and is perfectly isolated, according to our maps; neither Lohrmann, nor B. and M. give any other in its locality, nor does Schröter; but it is not a little remarkable, that when observing the *Mare Serenitatis*, on the 5th of November, 1788, he saw in the place of “Linné” a dark diffused, but not sharply bordered spot, of not more than $\frac{1}{2}^{\circ}$ of light. Lohrmann saw the crater very distinctly, and measured its position. B. and M. also saw it distinctly, and made seven measurements for position. The indefatigable astronomer Herr Julius Schmidt, the Director of the Observatory at Athens, who has devoted much of his attention to the study of the lunar surface, for more than a quarter of a century, has known the crater since the year 1841, and never found it difficult until October, 1866, when instead of seeing the well known object, he could perceive nothing but a glimmer, a small whitish cloud in its place, and this was repeated in November, so that for upwards of one month, this somewhat conspicuous object must have been under a cloud.

It is hardly likely that this phenomenon can be any other than a *concealment*, and it would be interesting to know, if such were the case, when Schröter recorded the dark spot in its place. This is very probable, as the crater is distinctly shown *on the ridge* in Riccoli's map, published 1653. The most recent observations, December, 1866, show that the

extent of the whitish spot in the place of "Linné," is *greater* than the diameter given above. Upon comparing "Linné" with the standard spot, "Dionysius"—the diameter of which as given by Lohrmann, is 13·8 English miles, and also as measured on Rutherford's photograph—the magnitude—that is, the ratio in size, which "Linné" bears to "Dionysius," reckoned as unity—is 0·40; while on Dec. 15, 1866, its magnitude was 0·79, this will give 10·9 English miles for the extent of the whitish spot *over the crater*, which is exceeded by 5·3 miles. Lunar observers will doubtless watch the locality with great interest, especially as at the time when the terminator was near the spot, it was quite invisible. Whatever the cause of the obscuration may be, it is to be hoped that the first indication of the returning visibility of "Linné" may be made public, so that the period of its concealment may be well determined.

Closely allied to the observations of Herr Schmidt, is a series by the writer of this paper. Between the years 1858 and 1863 when the Sun had attained a considerable altitude above the *Mare Crisium*, a white ill-defined cloudy patch was regularly observed a little W. of the well known crater "Picard," but it was not seen about the time of sunrise or sunset at Picard. Nothing appeared to throw any light upon this appearance until the year 1863, when in the neighbourhood of the cloudy patch, a little before sunset, a small pit-like marking was noticed. In the year 1864 the attention of Mr. Ingall was arrested by a spot 6° or 7° of brightness in this locality, and towards the end of the year, the cloud-like patch had nearly faded out. On December 12, 1864, Mr. Knott, at his observatory, Woodcroft, Cuckfield, Sussex, examined the locality with his 7½-inch Alvan Clark, and discovered two minute craters, I C^{ma 2} and I C^{ma 3} of the new nomenclature. It was some time before this discovery was confirmed, as the smaller crater I C^{ma 3} was very difficult to catch; at length, towards the end of 1865, Mr. F. Bird of Birmingham, saw the pair with his silvered glass mirror, the writer having previously seen them at Cuckfield, in October, 1865.

It is extremely difficult to say if these craters were really new, still the facts are sufficiently interesting to induce a very careful scrutiny in the neighbourhood of "Linné," especially as from the observation of Schröter there is reason to believe that the crater has suffered two obscurations within a period of 80 years.

Upon receipt of Herr Schmidt's letter to the writer, a translation of which we give below, the Moon Committee of the British Association issued a circular, calling the attention of astronomers to the interesting fact recorded in it. It is

probable some valuable observations will result from the adoption of this course.

P.S. Since the preceding was in type, we have received a note from Mr. Birt, with the following additional information:—

“Mr. Buckingham of Walworth, has obtained several photographs of the Moon, in October and November, which I have examined. In almost all I find the place of ‘Linné,’ but the object is very faint. I have one which he took on November 18, 1866, at 6·30 S.M.T. In this ‘Linné’ is visible, but its light I estimate, by comparison with the ground around Copernicus, to be only 2°. I have collected all the recorded brightnesses and compared the photographs which I have in my possession. The results are as follow:—

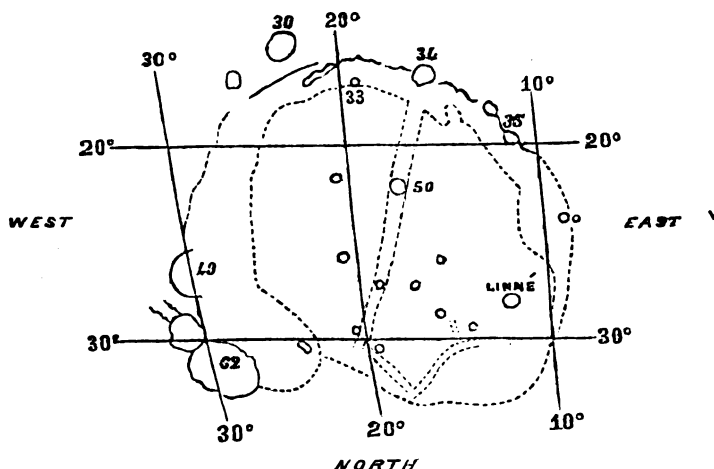
“Variations of brilliancy of the crater ‘Linné,’ since the year 1788.

Observations.		W.R.B.	
1788, Nov. 5.	Schröter.	0·5	0·125
1823, May. 28.	Lohrmann	7·0+	
1831, Dec. 12, 13.	B. and M.	6·	
Photographs.			
1858, Feb. 22.	De la Rue	5·	glass.
1865, Oct. 4.	„ „	5·	print.
	Rutherford	6·	„
1866, Nov. 18.	Buckingham	2·	„

“The above values for the photographs have been estimated, and may be considered as a continuation of the series, W.R.B.; except Rutherford’s, which is brighter than any degree of this scale. There is some uncertainty in the determination of the brightness on the prints, but the difference between 6° and 2° is, I apprehend, too great to be attributed to differences arising in the printing.

“The crater appears to have been brightest in 1823; Lohrmann always saw it brighter than Conon, which he records at 7°·0.

“From these records, it appears that Lohrmann and B. and M. observed ‘Linné’ to be *brighter* than any degree of the scale you have—*i. e.*, brighter than the surface around Kepler. Schröter’s observations give about the eighth of a degree of my scale; but De la Rue’s photographs give a brightness of about that of the surface around Kepler; and Rutherford’s brighter—probably the same as B. and M.’s. Buckingham’s series is so far accordant with Schmidt’s observations as to indicate, very strongly, that the crater has really undergone a change of some kind.”



THE MARE SERENITATIS, FROM MADLER'S SMALL MAP.

References.

No. 30	Plinius.	49	Le Mounier.
„ 33	Taquet.	50	Bessel.
„ 34	Menelaus.	62	Posidonius.
„ 35	Sulpicius Gallus.		

The interior dotted line, shows the boundary of the dark border of the *Mare*. The exterior of the *Mare*, on the N. is not shown, as it is not so well marked as the S.; the white streak, part of a ray from Tycho, across the *Mare*, is indicated by the double dotted line, from Menelaus to the N. border.

RECORDED OBSERVATIONS OF LINNE.

1788, Nov. 5. Schröter.

Dark spot in place of the Crater.

1823, May 28. Lohrmann.

1 Measure. Always saw it brighter than Conon in the Apennines.

1813, Dec. 12, 13. Mädler.

7 Measures. No remarks on its appearance.

1866, Oct., Nov. Schmidt.

Obscured; only a little whitish cloud visible.

SCHMIDT ON THE LUNAR CRATER "LINNÉ," AND
ON THE NOVEMBER METEORS.

THE following is a translation of a letter from Herr Julius Schmidt, the Director of the Observatory at Athens, to Mr. W. R. Birt, from whom we have received a copy of the original :—

"For some time past I find that a lunar crater situated in the plain of the Mare Serenitatis has been invisible. It is the crater which Mädler named Linné, and is in the fourth section of Lohrmann, under the sign A. I have known this crater since 1841, and even at the full it has not been difficult to see. In October and November, 1866, at its epoch of maximum visibility, *i.e.*, about the time of the rising of the sun on its horizon, this deep crater, whose diameter is 5·6 English miles, had completely disappeared, and in its place there was only a little whitish luminous cloud. Be so kind as to make some observations on this locality.

"At Athens, I observed the great meteor shower on the night of the 13-14th November. On the nights of the 12th and 14th, the sky being partially clear, the hourly number of meteors was very small. On the night of 13-14th the sky was perfectly clear, and we found the meteors very scarce between 6 and 12 o'clock; but later the hourly number became enormous, and the spectacle was very brilliant and magnificent by reason of the great number of bolides. From observations made between 6 and 14 hours, and from 16 to 18 hours, and from an approximate calculation, I found the maximum, on November 13th, 14h. 15m., Athens mean time, and the number per hour for one observer = 1055. Almost all the meteors—that is to say, 343 out of 345—came from a radiant point in the vicinity of γ Leonis."

This letter has been communicated to the Lunar and Luminous Meteor Committees of the British Association.

THE NOVEMBER SHOOTING STARS.

BY THE HON. MRS. WARD.

(*With a Woodcut Illustration.*)

TRUE to astronomical prediction, the great November shower of meteors arrived on the night of November 13th, and continued to stream in radiant succession during the early hours of the 14th. Those observers who for years have devoted close attention to luminous meteors, hailed this opportunity for ascertaining fresh facts with regard to their distance, velocity, and physical properties, and for becoming acquainted even with their chemical nature, by the wondrous process of spectrum analysis.*

Some of the results of such observations will probably be laid before the readers of this periodical. My remarks in this paper are intended merely to afford answers to such questions as are likely to be asked by intelligent observers, to whom the whole subject of meteors is new, but who have felt interested by the beautiful display on the morning of the 14th of November; and, secondly, I wish to describe the scene for the benefit of those who, with considerable vexation, are constrained to own that they forgot to look out, and have missed the sight altogether.

For my own part, I narrowly escaped a similar fate. I knew the ordinary November meteors only by hearsay, having watched for them vainly, on the nights of the 12th and 13th in two or three former years; and my attention had not been much attracted by the notices given in the *INTELLECTUAL OBSERVER*, and elsewhere, of the probability that the flight of meteors *this* November was likely to be of imposing appearance.

But now—the morning of the 14th has passed—I have seen the November shooting stars in all their beauty and grandeur, a phenomenon unequalled since 1833, and my thoughts turn to the hundreds of observers who probably saw them also, and who inquire with newly-awakened curiosity, What are they? Whence do they come? What possible reason can be given for their appearance on a fixed day in our calendar? And what grounds were there for supposing that a more splendid display than usual would be seen in 1866?

What are they? And whence do they come?—These are questions difficult to answer; but for the answering of them a vast quantity of evidence has been collected within the last few years, and all observations seem to confirm the theory,

* See *INTELLECTUAL OBSERVER*, August and October, 1866.

that they do not belong to this earth or its atmosphere, but that on the contrary they are *from afar*; and that they circulate round the sun in definite orbits.

On almost any fine night a few shooting stars will be seen; such is the experience of those who have watched for them in various parts of the world. A bright object, looking like a star, is suddenly seen moving a little way through the heavens, and then disappearing. They are common at all times, and, to use Professor Ansted's words, "they are as little exceptional as clouds." These are the ordinary shooting stars, which I have seen hundreds of times, though generally not more than three or four of them during one evening: but we have now to speak of those which are known to be *periodical* in their displays, and by the pre-concerted observation of which, some knowledge has been gained respecting the shooting stars in general.

On several occasions these wanderers have appeared, not few and far between, but in astonishing numbers, conveying the idea of a shower of rockets, or of snow-flakes falling. Observers have noted the dates of such appearances, and the very remarkable fact has been established, that the greatest displays of the kind have uniformly happened on the night between the 12th and 13th, or on that between the 13th and 14th of November. Time out of mind those identical days, or those directly corresponding to them have been occasionally signalized by such exhibitions.

They appear likewise on the 10th of August, and more or less on the 9th and 11th also. The display is less brilliant than in November, but more *certain*. The November show is often interrupted for a number of years, but on those three days in August shooting stars are almost sure to be seen. Other epochs have also been, to a certain extent, established.

And here our third question must be answered—"What possible *reason* can be given for their appearance on a fixed day in our calendar?" A reason *has* been given; and it is so well stated by Sir John Herschel, that I shall give his remarks *verbatim*.* "It is impossible," he says, "to attribute such a recurrence of identical dates of very remarkable phenomena to accident. Annual periodicity, irrespective of geographical position, refers us at once to the place occupied by the earth in its annual orbit, and leads direct to the conclusion that at that place the earth incurs a liability to *frequent* encounters or concurrences with a stream of meteors in their progress of circulation round the sun." Let us test this idea by pursuing it into some of its

* *Outlines of Astronomy*, Art. 901. (1859.)

consequences. In the first place, then, supposing the earth to plunge, in its yearly circuit, into a *uniform ring* of innumerable small meteor-planets, of such breadths as would be traversed by it in one or two days; since during this small time the motions, whether of the earth or of each individual meteor, may be taken as uniform and rectilinear, and those of all the latter (at the place and time) parallel, or very nearly so, it will follow that the relative motion of the meteors referred to the earth as at rest, will be also uniform, rectilinear, and parallel. Viewed, therefore, from the centre of the earth (or from any point in its circumference, if we neglect the diurnal velocity as very small compared with the annual) they will all appear to diverge from a common point, *fixed in relation to the celestial sphere*, as if emanating from a sidereal apex."

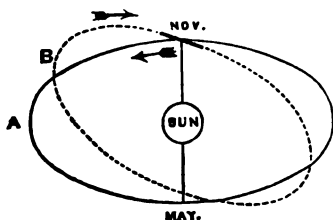
Here Sir John Herschel refers us to his very interesting remarks in an early chapter on the subject of "celestial perspective"—"that branch of the general science of perspective which teaches us to conclude, from a knowledge of the real situation and forms of objects, lines, angles, motions, etc., with respect to the spectator, their apparent aspects as seen by him projected on the imaginary concave of the heavens; and *vice versa*, from the apparent configurations and movements of objects so seen projected, to conclude, so far as they can be thence concluded, their real geometrical relations to each other and to the spectator." He then proves that in celestial perspective "every straight line (supposed to be indefinitely prolonged) is projected into a semicircle of the sphere, *that*, namely, in which a plane passing through the line and the eye, cuts its surface. And every system of parallel straight lines, in whatever direction, is projected into a system of semicircles of the sphere, meeting in two common apexes, or vanishing points, diametrically opposite to each other." This digression is to explain what is meant by a "sidereal apex." And here let me anticipate. On the morning of Nov. 14th, when I saw the meteors emanating from a point at some distance above the horizon, when I observed many of them mounting overhead, and the whole display retaining the form of a canopy, while tending as if to some point far below the opposite horizon, I felt that *perspective* had in some way a great deal to do with their aspect, and that I should not think of them as of sky rockets shot in real curves *over the house*; but it required the luminous words of Sir John Herschel to place the matter in an intelligible form. Let us now take up the thread of his argument.

The shooting stars, he says, ought to appear to diverge from a common point; and he proceeds to tell us, "This is precisely what actually happens. The meteors of the 12—14th

of November, or at least the vast majority of them, describe apparently, arcs of great circles, passing through or near γ Leonis. No matter what the situation of that star with respect to the horizon, or to its east or west points may be at the time of observation, the paths of the meteors all appear to diverge from that star."

The exact position in the heavens from which the meteors appear to radiate, technically known as the "radiant point," is one of the subjects to which the attention of observers has been of late years much directed, and the spot which it occupies in Leo has probably been ascertained with great precision on the present occasion.

And now to sum up the theory, so far. We suppose the earth in its orbit, A, around the sun, to encounter a ring of meteors, B, at the point marked "Nov." There, and there only, we are led to believe, the orbit intersects the ring. At the opposite point, marked "May," the ring falls a little



within the orbit of the earth, instead of cutting through it. A display of the meteors in this ring can therefore occur only in November. Now if the ring were *uniform*, i. e., an unbroken stream of meteors through its whole circle or ellipse,* the earth's encounter with it would take place every revolution—

we should see an exactly similar star-shower every November 13 or 14.

But "if the ring be broken,"—here again I quote Sir John Herschel—"if it be a succession of groups revolving in a period not identical with that of the earth, years may pass without a rencontre; and when such happen, they may differ to any extent in their intensity of character, according as richer or poorer groups have been encountered." A *blank* part of the ring will occasionally occupy the point of intersection just as the earth arrives there—then there will be no November meteors visible that year. Again, a *rich* part of the stream, the *jewel* of the ring, of which we shall presently have much to say, may come to the point of intersection when the earth is there—then we shall have a glorious display, as in the year 1866.

Or, let us suppose we meet a thinner part of the ring, then we have an ordinary November star-shower, such as those which occurred in 1822, 1823, 1832, 1833, etc.; or, to take

* It is believed to be nearly circular.

more recent years, a display of them seen from Malta on Nov. 13th, 1864, when clouds obscured the sky in England, and in 1865, when a considerable number (250 per hour) were observed from Greenwich.

A ring of meteors in space, large almost as this earth's great track round the sun—what a wonderful idea, when one comes to consider it, or to represent it in a diagram! One ring! there are probably *several*, belonging to the various periodic groups of these strange bodies which up to the present time have been detected. The August meteors are as well-marked a group as those of November; they, too, have a sidereal apex always the same at each return, but it is far away from Leo, being close to the small star B Camelopardali. Certain other star-showers, also proved to be periodical, have also their points of radiation; and though in some cases these are not actually to be described as *points* but rather as *regions* of radiation (implying perhaps a want of parallelism in the movements of the meteors), astronomers still hold that it is highly probable that all shooting stars are grouped according to some law, and may form a number of rings, some nearly circular, some of a lengthened elliptical form, like those of comets; and that those which appear to be not periodical may be out-liers of such rings.*

Nor are the positions or dates of appearance the only distinctive features of the various groups of shooting stars, they have their own individuality—"The meteors of particular showers vary in their distinctive characters, some being larger and brighter than others; some swifter, and drawing after them more persistent trains than others."†

Two well-marked groups—probably *rings*—of meteors,—several others more or less known—their nearest approach to the earth estimated at an average of sixty miles, and their ordinary velocity supposed to be somewhere about twenty miles in a second, hastened as they approach the earth's attraction to nearly forty miles—so much being granted, have we yet answered the question "what are they?" Are they solid or gaseous, are they large or small, perpetually luminous or only exceptionally so?

The late observations which have succeeded in subjecting their fleeting light to the process of spectrum analysis will probably clear up some of the difficulties respecting their nature.‡ But even before this clue was given for their investigation, the learned had arrived at the conclusion that all shooting stars are "assemblages of fragments, finer or

* *British Association Report*, 1865, p. 131.

† *Ibid*, 1864, p. 101.

‡ See Mr. Alexander Herschel's paper on the *Prismatic Spectra of the August Meteors*, 1866, *INTELLECTUAL OBSERVER*, October, 1866.

coarser," that they are *not* luminous as they travel through space: but that as they near the earth, the friction of our atmosphere ignites them, and they are entirely consumed in a few moments. This description applies to meteors such as we see in general, and during the periodic displays; but occasionally we encounter bodies of greater density, which cannot be so readily consumed, sometimes entire, and at other times in a fragmentary condition. Samples of such meteors are to be found in various mineralogical collections.

The subject of these metallic stones which have really "fallen from the sky" is most curious, but must not be pursued here; we have made a sufficiently long digression from our fourth question, "What grounds were there for supposing that a more splendid display of meteors than usual would be seen in 1866?" To answer this, I revert to the *INTELLECTUAL OBSERVER* for August, 1866. It contains (p. 39) extracts from a lecture given at the Royal Institution, by Mr. Alexander Herschel, *On the Shooting Stars of the years 1865-66, and on the probability of the Cosmical Theory of their origin.*

The lecturer stated that Professor H. A. Newton, of Yale College, U.S., had calculated that in the current year, 1866, a prodigious flight of meteors, the most imposing of its kind, and visible over a large area of the earth's surface would make its appearance—perhaps for the last time in the present century—on the morning of the 14th of November. Professor Newton had searched in ancient records, and observed that between the 12th of October (O.S.) and the 13th of November (N.S.), during the years from A.D. 902 to 1833, not less than thirteen great star-showers have been recorded. When he had made the requisite corrections for the change of the earth's position, astronomically known as the precession of the equinoxes, he was able to compare the dates with exactness,* and became convinced of the fact that there are periodical re-appearances of the November-shower in extra grandeur, at intervals separated from each other by nearly the third part of a century, or by some multiple of this period. This shower was observed from Cumana in South America by Humboldt and his companion Bonpland, on the morning of November 12th, 1799, and was a spectacle of extraordinary grandeur. Nothing comparable to it appeared till the morning of the 13th of November, 1833, when another magnificent display was seen in the United States of America.

Professor Newton proposed the following theory to account for these returns of the phenomenon, that there is a *condensed*

* See *British Association Report*, 1863, p. 325.

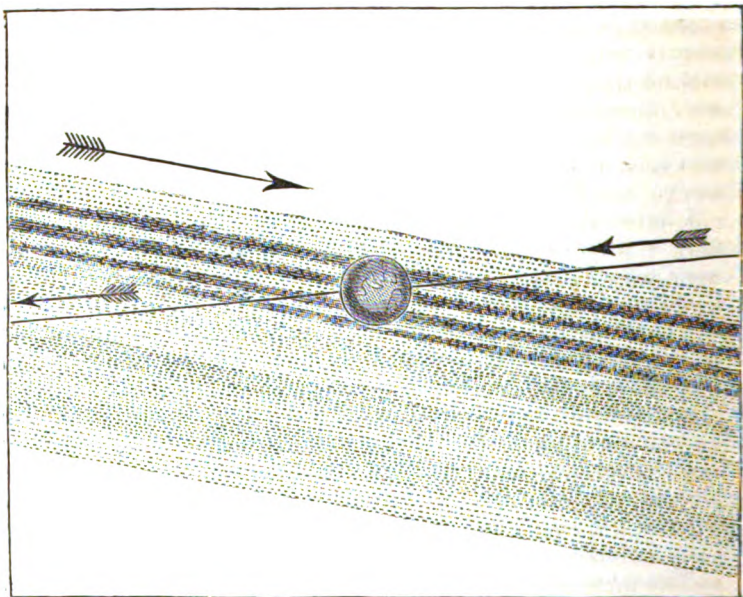
part in the November ring of meteors,—which I have ventured to call the *jewel* of the ring,—and that each meteor in the whole ring, and in this condensed part or *cloud*, moves in a nearly circular orbit round the sun in a period which may be about eleven days less than that of the earth. The earth (for example) encountered the densest portion of this cloud in November, 1833; but the next year this portion passed eleven days before the earth returned to that point of its orbit; the following year the difference amounted to twenty-two days; so that at the end of about thirty-three years it must gain one entire revolution, and return nearly to the position where it must encounter the earth. (See diagram on page 452.) Professor Newton shows that the same result would follow by supposing the period of the ring eleven days *longer* than the earth's, but seems on the whole to incline to the former theory.

I have taken some of these explanatory details from a letter lately written to the *New York Times* by Professor Loomis, of Yale College; also from the *American Journal of Science*, as quoted in the *British Association Report* for 1864, p. 96, containing Professor Newton's data and theories as given by himself. In referring to past recurrences of the phenomenon, he remarks that, "a want of punctuality of one, two, or even three years in the return of the display may be accounted for by the revolution of the earth on its axis, by which observers were deprived of a view of the spectacle during a part of its existence;" but ends his communication by predicting with considerable confidence, a "maximum display on the morning of the 14th November, 1866."

The morning of the 14th of November came—and now let us make an essay in celestial perspective, and see what had happened. Let us divest our minds, if possible, of the idea of a canopy of sky-rockets, and "from the apparent configurations and movements of objects as seen projected on the imaginary concave of the heavens, conclude, so far as they can be thence concluded, their real geometrical relations to each other and to the spectator." What were the real bearings of the earth and the stream of meteors on that memorable morning when this "terrestrial ball" had been for some short time plunged in the current? Somewhat, I think, like this. Never mind, reader, if I have made the earth a little too large in proportion, or the stream too narrow, or too defined in outline. The inclination of the two paths is, or should be, 17° : the course of the meteors is retrograde, as stated by Professor Newton: and the shaded appearance of the stream is meant to indicate the sudden transitions of richness which occurred in the star-shower, causing the meteors to come at the rate some-

times of a hundred per minute, then only fifty, then a hundred, and so on.*

The reflection will probably occur to our readers, were the meteors really like that, a dark, formal stream? How much more beautiful was their actual aspect as seen by us! Truly it was so, as indicated by Mr. Herschel's heartfelt words, describing how they travelled to all parts of the sky "with a swift and stately motion most beautiful to behold, if not almost



IDEAL REPRESENTATION OF THE EARTH'S PASSAGE THROUGH THE STREAM OF METEORS.

too wonderful and too surprising to describe."† I was roused from sleep to look at them. My informant told me that an old railway porter had just said, "God has sent us fire-works to-night;" and I appreciated the remark when I saw them. My thoughts had, on that day, been unavoidably fixed on the concerns of this earthly ball, rather to the neglect of the affairs of space; and I shall long remember how much I was cheered and uplifted by the sight of the November meteors, and how I felt that they were indeed *given* by Him who gives us richly all things to enjoy.

I intended to have introduced a sort of *resumé* of the observations of others, but will leave the task to abler hands,

* The attempt to introduce this circumstance into my drawing was suggested to me by the Rev. F. Howlett, F.R.A.S.

† Letter to the *Times*, November 17, 1866.

and merely tell my own story of what I saw, copied from a narrative which I wrote on that morning before daybreak.* It will be seen how conspicuous was the fact of the meteors radiating from a point in Leo—a circumstance of which I had doubtless read in books, but had little or no recollection of it.

On the evening of the 13th, at eleven o'clock, I looked out from my house at Seapoint, near Dublin, to see whether anything unusual were occurring, and observed that all was still—Mars glowing near Castor and Pollux; Sirius calmly accompanying Orion. "Good night to the stars," thought I; but it was not to be so. At a few minutes after twelve, Dublin time (say 12·30, Greenwich time), I was called up with the information that the shooting stars were chasing each other with wonderful rapidity. I hastened to look at them, and the first idea suggested was indeed that of an exhibition of fireworks, but how much more beautiful they were! Their occurrence was almost incessant. From 12·40 to 1·30, and later,† it would have been difficult to find a moment in which none were visible in some part or other of the sky. Sometimes three or four fine ones could be seen at once.

There was a marked difference in their appearance as seen from a window facing the east, and from a bow window commanding a view of the north, west, and south; and I set myself to find out in what this difference consisted. I first viewed them attentively from the bow window; the shooting stars invariably moved *downwards* there. Each commenced with an outburst of brilliant white light, like *one* of the many stars of a rocket; and this bright star travelled a second or two, and then disappeared, not very rapidly, but remaining visible four or five seconds as a beautiful spindle-shaped track of white light, the general straightness of its form being very remarkable. These spindles tended almost perpendicularly downward in the west, downward from left to right in the south, and downward from right to left in the north. Sometimes a wonderfully bright star appeared, with a long, thread-like track of extraordinary length, nearly from the zenith to the horizon. The stars, or *nuclei*, of these meteors were generally white, but occasionally one appeared blue, or red, or bright yellow. My impression is, that in these cases the train or track of light was sometimes of a different colour from the star.

The shooting-stars in the *east* were in general smaller than those observed in the north, south, and west; but they soon riveted my attention even more than the others had done.

* Mr. Slack's spirited account of the display is already in the hands of my readers. See No. for last month. [The reader is requested to correct the date in Mr. Slack's paper to 13-14th. ED.]

† Greenwich time, which will be henceforth used in this description.

For I presently perceived that *their* course was not invariably downward. I could see some move perpendicularly upward, some darting quite horizontally towards the left, some moving upward in a sloping course, and some also downward like those seen from the bow window. These latter, sloping downward, were those nearest to the north and to the south; and, having ascertained this, I soon observed that there was a point in the heavens from which they actually started in all directions—I do not mean at random, or crossing each other, but in an invariable course, like the railroads from a great city. The meteors *at that spot* (close to the position of the star γ in Leo) were not of very frequent occurrence, but I observed all the different directions described, probably in the course of ten minutes, during one part of the morning; and more than once I saw with great interest two shooting stars at the same moment moving away from this point at right angles to each other. Numerous meteors commenced at points quite distant from γ in Leo; but wherever they commenced they seemed to travel with regularity, as if from about that point.

With respect to the size of the meteors in the east, I am certain I saw none which were long or threadlike, anywhere near γ ; at one time, on the contrary, I saw strangely small and even crooked ones near that spot.* They increased in magnitude as observed towards the north or south. Several fine ones passed above and across Orion, and always downward from left to right. Their *nuclei* were, in my opinion, much brighter than Sirius. Many meteors went *as if* over the house, like sky-rockets; and twice, meteors of extraordinary brightness came, lighting up the whole landscape, but I cannot give a description of their form, as in neither case had I happened to look in the right direction at the moment they appeared. These bright flashes occurred at about 1.45.

I saw one or two exceptions to the straight form in the long meteors. There was one decidedly crooked, or waved. Several of the meteors indeed were curved, as an effect of perspective, from their great length, if seen in the south or north. A few *nuclei* appeared without trains, merely showing a second or two as bright moving stars; but these were exceptions to the general rule.

Towards half-past two o'clock I began to notice that the phenomena were decreasing; at a quarter to three the meteors were rarely visible; and at half-past three they had almost entirely subsided. At 4.25 I remained on the watch for about ten minutes, and no meteors whatever were visible.

* Mr. Slack, it will be remembered, makes the following remark on similar meteors, "Probably their tails were behind them, and invisible from the foreshortening of perspective."

THE NOVEMBER METEOR-SHOWER AT GLASGOW.

BY A. S. HERSCHEL, B.A.

THE cloud-stratum of the second capital of Scotland affords coolness in summer and warmth in winter, and a protection from the unequal radiation of night and day. It would surprise persons unacquainted with the abnormally elevated temperature of climates on western coasts, to be informed that the mean temperature of Glasgow is three degrees warmer than the mean temperature of a place situated, like Birmingham, in the centre of the island; yet such, from the neighbourhood of warm streams of the Atlantic Ocean, is actually the case. The substantial advantage thus derived from the breezes of the sea has, however, its corresponding disadvantage of a more refined, ærial nature; for the watery vapours wafted with the wind do not always reveal at night, in the words of Byron—

“ — in the sky that clear obscure
So deeply dark, and darkly pure,
Which follows the decline of day,
Ere twilight melts beneath the moon away.”

Fine nights, when they occur at this season of the year, are, however, unexceptionally good observing nights; and the morning of the 14th of November, 1866, when the predicted shower of the November meteors was expected to appear, was one of these, which might be reckoned among the most fortunate events of an observer's diary.

The skies were attentively watched to catch the first signs of their appearance, and many, like myself (among the number of four observers, consisting of Professor Grant and his assistants at the Glasgow Observatory), sat up, determined “for once in their lives” to make a night of it.

To witness the successful issue of an altogether novel kind of prediction was a small satisfaction, compared to the advantage which co-operation with Professor Grant afforded me in noting the particulars of the shower. The detailed description which Professor Grant published in the *Glasgow Herald* of the following day, shows his personal interest in the phenomenon, whilst his assistance enabled me to complete a set of observations which, alone, it would not have been possible to carry out.

A violent gale of wind blew from the 4th to the 8th of November; when the wind abated, and a fine double arch of the aurora was visible in the evening, about seven o'clock, spanning the north-west verge of the horizon. It resembled a cap-and-plume, the upper arch being only a fragment, which

joined the lower arch at its extremity close to the west point of the horizon.

Auroral glare in the north, but not so bright, was seen again at about ten o'clock on the evening of the 10th of November. Between three and five o'clock on the mornings of the 9th, 10th, 12th, and 13th, half-hour watches were kept up at intervals when the sky was clear, and the greatest number seen was six meteors in half an hour, on the morning of the 12th of November. These were the preliminaries of the display. From Professor Grant's description we learn that "The early part of the night of the 13th did not promise well—heavy rain and drenching showers alternating with clear views of the sky and the stars." And again, that "between midnight and one o'clock the sky on the whole was not favourable for observation, but occasional views of the heavens showed unmistakably that we were on the track of the meteoric shower, for the meteors were obviously shooting athwart the sky with increasing frequency." During this hour my share of the spectacle began.

At about midnight, an orange-coloured meteor, nearly as bright as Jupiter, shot overhead, with a slightly wavy motion, from Capella to near the head of Aries—a space of 45° or 50° —in about a second and a half of time; leaving a bright streak for a few seconds on its course. This was the first brilliant shot seen, and for the early hour of its appearance, when the phenomenon did not exceed an ordinary display on a fair 10th of August night, it was indeed startlingly bright. At a later stage of the night, when a few of the superlatively large meteors, or "ring-tail roarers" of the shower (to use an Americanism), made their appearance, and multitudes, unnumbered, of its compeers thronged the sky, it would not have arrested attention for a moment. Expectation was gradually raised, when, toward 12h. 30m. A.M., three meteors near together first appeared simultaneously, and drew the eye irresistibly to the locality in *Leo*, from whence they appeared to diverge, and whence a whole fleet of similar craft might shortly be expected to arise above the horizon, like argosies in full sail from foreign parts.

A cloud from the north-west now overspread the sky, and threatened us with showers of a different kind, likely, in fact, to leave us, at the end, but little wiser, and on the whole much wetter for our watch. It passed, however, quickly, and in the clear space which it left behind it, the next meteor was observed. At 12h. 33m. a meteor fully as bright as Venus shot in one second from the right hand of Andromeda to β Pegasi, leaving upon the first part of its course a bright train in separate links, which rapidly faded away. The remaining portion,

6° or 8° in length, continued visible four minutes, at first bowing itself, leech-like, and afterwards contracting itself into a globular nebula, which advanced southwards some 10° or 12° as far as α Andromedæ, where it disappeared. Its width, and ragged edges prevented any conclusion being drawn in the spectroscope regarding the nature of its spectrum.

Ten or fifteen meteors might now be counted by one observer in a minute. Flights of three meteors occasionally appeared together, and a powerful flash, like prolonged lightning at no great distance, drew our attention to every part of the horizon, in the vain attempt to see the residue of some large meteor.

At 12h. 41m. a dazzling object, two or three times as bright as Venus, passed in a second from midway between the "pointers" to the nose of the Lesser Bear, leaving a bright streak, divided like the last into two parts; but the first part in this case remained in sight the longest. The end-half afforded a decided spectrum, appearing as a single bright band in the spectroscope, no broader than if looked at through an ordinary piece of glass. It faded rapidly and disappeared, whilst the first half collected itself into a ball, and grew brighter, exactly as a row of gas-lights, seen one behind the other, look brighter than a single flame. In nine minutes it could no longer be traced, as it gradually vanished between the "pointers" at the place where the meteor first began.

The number of streaks now visible in the sky gave an opportunity for using the spectroscope. "Nov. 14th, 12h. 54m. A.M.; equal to Sirius; from β Canis Minoris to β Eridani. Left a streak for five seconds. The streak appeared as an extremely fine line in the spectroscope."

A more powerful spectroscope was now employed, consisting of the central portion, only, of a Herschel-Browning spectroscope, containing two prisms, and producing, therefore, twice the dispersion of a single prism. My assistant, Mr. Macgregor, looking at the streaks with the unassisted eye, whilst I watched the same streaks in the spectroscope, we each called out "gone," when the streaks appeared to us to vanish.

"12h. 56m. A.M.—Equal to a first magnitude star. Left a greenish blue streak for three to four seconds. We differed in our vanishing moments two-tenths of a second.

"12h. 57m. A.M.—Equal to a first magnitude star. Left a greenish blue streak for three to four seconds. We differed in our vanishing moments one-tenth of a second.

"1h. 0m. A.M.—Equal to Sirius. Left a greenish blue streak for four seconds. We spoke together."

The result shows that some of the streaks were composed of mono-chromatic light, altogether undimmed by its passage through the prisms.

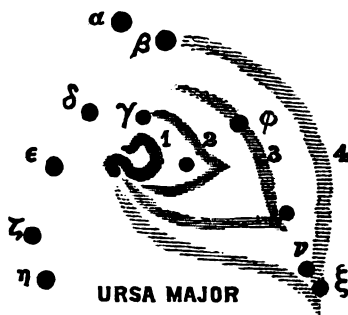
The object of disposing of the radiant point at the early stage of the shower so as to leave the remainder of the night, and the principal part of the shower for the more important observations, put an end for the time to the experiments with the spectroscope, which it was intended to have renewed if the shower had not exhausted itself before a sufficient number of meteor tracks for the purpose of fixing the radiant point had been recorded. The shower increased in intensity until about ten minutes and twenty minutes past one o'clock, at which time fifty-six and fifty-seven meteors were counted by one observer, or almost exactly double the number counted at one o'clock, and at half-past one o'clock; the display then ceased as suddenly as it began; and an interval of three minutes occurred from 1h. 57m. 30s. to 2h. 0m. 31s., in which no meteor as bright as a second magnitude star (so far as my own tolerably open view of the sky extended) made its appearance. At 2h. 30m. the number counted by one observer was also very small, being only one per minute, and long before this time the "Great November shower of 1866" had obviously passed away, and was gone for ever from the field of calculation and prediction into the domain of history!

At 2h. 14m. A.M., a meteor, three times as bright as Jupiter, shot in the southern sky from between α and θ Geminorum to 2° above Aldebaran, leaving a streak, which like previous bright streaks was divided into two parts. The end-half, extending from ι Tauri to Aldebaran, curved itself northwards at the ends, and then collected itself into a knot, which drifted southwards to the three head stars of Orion, where it disappeared. The total period of visibility of this streak was five minutes.

Another meteor, which must have been a large fire-ball, but which the Observatory buildings unfortunately hid from our view, appeared at 2h. 41m. A.M. Shortly afterwards we perceived its streak, bent in the form, and with the appearance of a red hot horse-shoe suspended in the sky, between the stars ϵ , χ of the Great Bear. The open ends of this singular footprint (for so it appeared) of the meteor gradually widened out for fifteen minutes, (during which the streak continued visible) and the apex of the shoe became pointed, and drew off towards the south. Just before disappearance the stars forming the square of Ursa Major appeared clipped by a gigantic calipers of which the point or hinge was at the stars ν ξ upon the Bear's hind-foot.

A number of matters yet remained to be decided regarding the white, yellow, and purple colours of the meteor-streaks, the prevailing yellow or orange colour of the heads, and other important characters of which the use of the spectroscope might

have offered some solution. The want of observations on these points, unavoidably left un-made by the cessation of the shower, a paper by Mr. John Browning, which follows, most opportunely

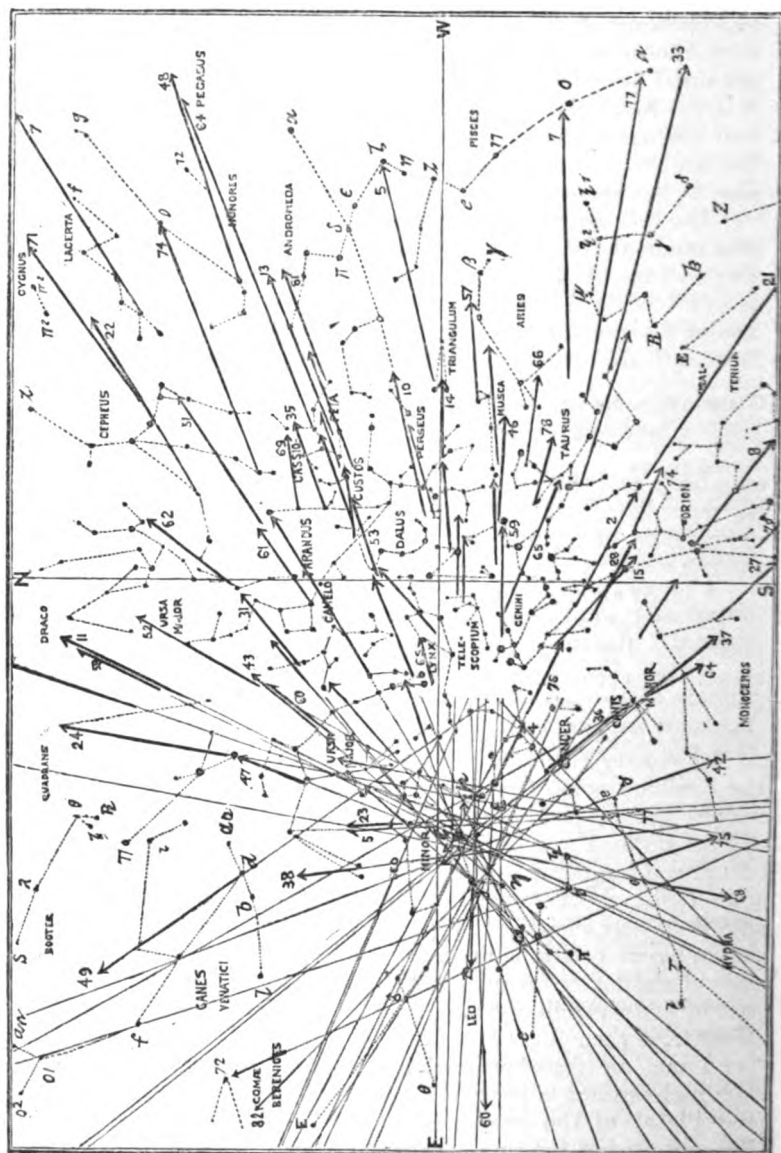


Changes of a Meteor-streak, Nov. 14th, 1866.—1st, 2h. 42m. A.M. 2nd, 2h. 44m. A.M. 3rd, 2h. 48m. A.M. 4th, 2h. 52m. A.M. Disappeared at 2h. 56m. A.M. Duration, 15m.

supplies ; and the present November shower may happily not be regarded, from this circumstance, as a most invaluable opportunity of examining the spectra of the meteors totally thrown away.

A point about midway between γ and μ Leonis is marked by the projection of the meteor tracks upon a map, in a more distinct and positive manner than could possibly be the mere result of accident. The point so prominently shown is evidently the “vanishing point of straight lines seen in perspective” (Olmsted’s expression), either parallel to each other or else converging to a point. If the latter were the case, and the bombardment of meteors proceeded from a local centre, of which the precise place could be determined, observers at distant stations would differ among themselves as to the position of the radiant point,—some placing it north and others south, some east and others west of the average place of its apparent situation,—by the effect of parallax, according to their various geographical positions upon the earth. The frequent appearance of stationary meteors at the very place, or centre in some part of the constellation Leo, from which they appear to diverge, arises from their line of motion, in that direction, been seen “end on,” or foreshortened by perspective, to a point. Of such meteors not a few were recorded in the map projection (see Plate) of the tracks of eighty-three meteors noted at Glasgow during the time—from 1h. 15m. A.M., to 2h. 40m. A.M.—of the greatest intensity of the shower, and one such meteor was observed close to the position of the radiant point obtained from a complete *chevaux-de-frise* of meteor tracks taken from

TRACKS OF 83 SHOOTING STARS OBSERVED AT THE GLASGOW UNIVERSITY OBSERVATORY, 1866, Nov. 14th, 1h. 15m. A.M., to 2h. 40m. A.M., by A. S. Herschel and A. Macgregor, showing the position of the radiant point in R. A. 149° , N. Decl. 24° .



A. S. Herschel, del.—(NOTE.—A stationary meteor, shown thus *, was seen very near the radiant point.) For the sake of greater clearness our engraver has not given the whole of the intersecting lines shown in Mr. Herschel's large map, or in Mr. White's excellent photograph from it.

the surrounding regions, at all distances from the point of radiation of the shower.

For the use of directing a telescope towards its place on the morning of the 14th of November next, a future page will be taken up with a list of twelve places of the radiant-point obtained by observers at Glasgow, and at other places in the "Great November shower" of 1866; together with the heights and distances from the earth of some of the larger meteors so favourably observed at Glasgow in that shower, and, fortunately, also at the same time at other places.

The following is the extract of a letter, to which reference was made above. For this, as it contains valuable notes on the spectra of the meteoric bodies, the reader of the paper is indebted to the successful endeavours, which characterize the use of the spectroscope, in every observation to which it has been applied by Mr. John Browning, F.R.A.S. :—

"ON THE SPECTRA OF SOME OF THE METEORS OF THE NOVEMBER SHOWER IN 1866. BY JOHN BROWNING, F.R.A.S.

"On the night of the 13th of November, I chose for my place of observation the Observatory of Mr. Barnes at Upper Holloway, which is situated on the highest ground in the immediate neighbourhood of the observatory.

I began observing at 9h. 30m. p.m., and continued my observations until 4h. a.m., on the morning of the 14th. The spectra I obtained were of four kinds.

"1st. Continuous spectra; in which the whole of the colours of the spectrum, except violet, were visible. In even the most uniform of these, however, I am inclined to think that the yellow was strongly predominant.

"2nd. Those which gave a bright orange-yellow line of light; or only a faint continuous spectrum in addition to this yellow line. Such spectra have been clearly described in the *INTELLECTUAL OBSERVER*, Number for October, 1866.

"3rd. Those consisting apparently of only a single line of green light of nearly the same colour as that shown by *Thallium*. Of this kind I only obtained the spectra of two meteors. In one of these I thought I detected a trace of a very faint continuous spectrum, nearly obscured by the brilliancy of the green line.

"4th. The spectra of the trains. The light from green trains appeared continuous in the prisms. Those which were of a blue colour appeared as a line of lavender colour, with a still fainter trace of a continuous spectrum. In some few instances, no continuous spectrum could be detected."

The occurrence of bright green light in some of the nuclei, is a very remarkable result of these observations; pointing,

possibly, to the existence of *Thallium* in the meteoric bodies ; as is also the existence of strong lavender light in some of the blue-coloured meteor-streaks occasionally without any continuous spectrum. The morning of the 14th of November next will present an opportunity for verifying the striking variety of colour so unexpectedly revealed by the spectroscope in the light ; and hence also, probably, a corresponding diversity in the chemical composition of the November meteors.

Mr. Browning adds :—

“On account of the great difficulty which attends these observations, I cannot be at all positive of the accuracy of these results, except in the case of those which I have called the first class of meteor-spectra (*i. e.*, uniform continuous spectra of the nuclei).

“At about a quarter to two, a large meteor, of a greenish-yellow colour, shot from near Regulus through the belt of Orion. This meteor left a train of a steel-gray colour, which was visible for nearly three minutes, although the end of its path was partially obscured by fleecy clouds.”

THE PLANET MARS.

BY RICHARD A. PROCTOR, B.A., F.R.A.S.

MY object in the present paper is to exhibit to the readers of the *INTELLECTUAL OBSERVER* the true relations under which the planet Mars will present himself at the opposition which takes place during January, 1867.

There is a marked variation in the circumstances under which Mars is seen at successive oppositions. The other superior planets vary chiefly as respects the altitude at which they cross the meridian (or culminate) while in or near opposition. Mars partakes of these changes*—in fact we shall presently see that they are exhibited in a somewhat exaggerated form in his case ; but there are other and more marked

* A superior planet coming to opposition in midwinter attains an altitude about equal to the sun's midsummer altitude ; near the equinoxes a planet in opposition has a mean altitude about equal to the sun's altitude at either equinox ; and, lastly, a planet coming to opposition in midsummer attains an altitude only equalling the sun's altitude in midwinter. The reason is obvious—for the sun is always on the ecliptic, while the planets all travel near the ecliptic, and the ecliptic must be high by night when it is low by day, and *vice versa*. These changes produce a variation of 47° in the meridian altitude of a planet, a range of change which is yet further increased owing to the inclination of the planetary orbits to the ecliptic. The effect due to the last cause is small, however, except in the case of Mars.

variations presented by Mars, which the other superior planets do not exhibit, or at least not to any noteworthy extent. These peculiarities will be understood when we come to examine the nature of Mars' orbit.

The planetary orbits it is well known, are elliptical. But although several of these orbits differ very appreciably from circles *concentric with the sun*, yet their difference from the circular *form* is always very small indeed. For instance, the orbit of Mars, which is one of the most eccentric, yet differs so little from the circular form that if it were accurately traced down as an ellipse having a greater axis one foot in length, a circle described around this ellipse would nowhere separate from it by a distance exceeding one-eightieth part of an inch; though on the same scale, the distance of the sun from the centre of the ellipse would be represented by a length of more than half an inch (almost exactly $\cdot 56$ of an inch). Again, the inclination of the planetary orbits to the ecliptic, though quite sufficient to make the absolute distances by which the planets may be separated from the plane of the ecliptic very considerable, is yet so small in itself, that a representation of the orbits *in plano* is not unsatisfactory—save only in the case of Mercury, and some of the minor planets. It appears, then, that circles traced on paper may be taken to represent approximately the orbits of planets, if only these circles are properly *centred*.

In Figs. 1 and 2, parts of the orbits of Mars and the earth are traced down as accurately as possible, on the scale of one-eighth of an inch to 4,000,000 miles. S is the position of the sun, C is the centre of the earth's orbit. C' the centre of the orbit of Mars. The position of the earth at the time of winter-solstice is at W. Sol., while in Fig. 2, the position of the earth at the time of vernal equinox is at V. Eq. The two figures must be supposed to be parts of a single delineation of the orbits, the scale of which would be somewhat too large for our pages. The reader is recommended, however, to describe such circles on a larger sheet, taking the centering from Fig. 1. He will then be able to appreciate what is only partially indicated in Figs. 1 and 2, the remarkable variation in the distance separating the two orbits. He will find, indeed, that at the point of nearest approach (nearly in direction C' S) the distance separating the orbits is little more than half the corresponding distance on the opposite side—that is, in direction S C'.

The orbit of the earth is supposed to lie in the plane of the paper, while the plane of Mars' orbit must be supposed to cut the plane of the paper, in the line S Ω the part of the orbit which appears in our figures lying above the plane of the paper.

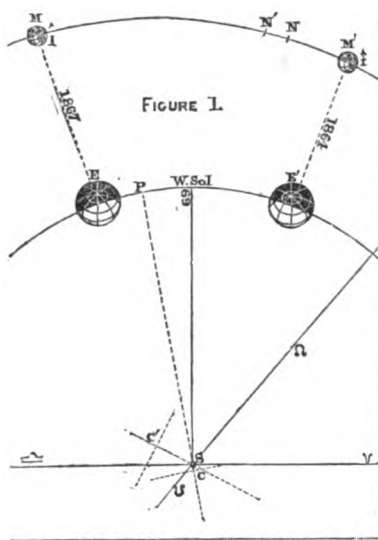


FIGURE 2.

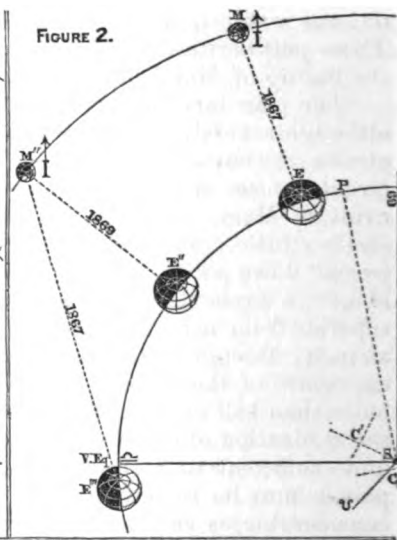


FIGURE 3.

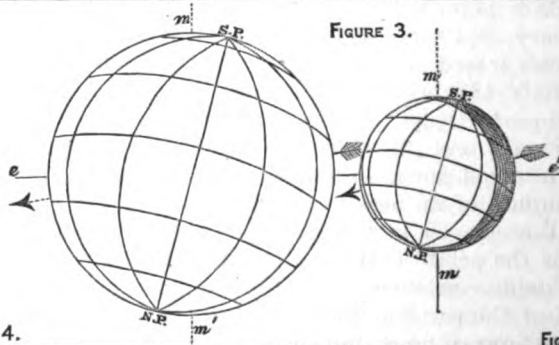
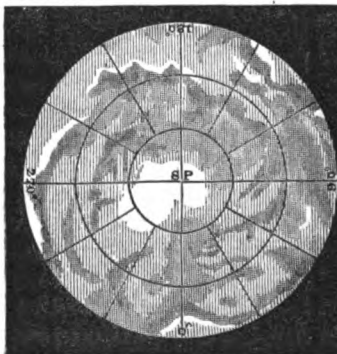


FIGURE 4.



The short lines surmounted by arrow-heads, represent the distance at which different parts of the orbit lie above the plane of the ecliptic.*

The figures representing the earth and Mars, are not drawn to scale, but purposely enlarged. The meridian lines upon them serve to indicate the position of the polar axes of the two planets. They are such that whereas the earth, when at V. Eq., has its polar axis square to the line from the sun, Mars is similarly circumstanced when near N or N'. The axis of the earth must be supposed to be inclined at an angle of $66\frac{1}{2}$ degrees to the plane of the paper; that of Mars, at an angle of about 60 degrees.

The two planets move round their orbits in the same direction (E' E E'' or M' M M'') at different rates; the earth taking one year to complete her circuit, Mars taking 1 year 321 $\frac{1}{2}$ days to complete his. Thus if they start together, the earth will go twice round, while Mars has gone little more than once round; and on an average the earth will make up this small arc by which Mars is in advance, in 49 $\frac{1}{2}$ days. Thus the interval between successive oppositions is on an average 2 years 49 $\frac{1}{2}$ days. But the rate at which Mars travels is so variable, owing to the eccentricity of his orbit, that this interval of 49 $\frac{1}{2}$ days is sometimes largely exceeded, at other times as largely fallen short of. For Mars in perihelion travels nearly half as fast again as he does in aphelion: the earth also moves at a variable rate, though her variation is much less marked than that of Mars; it happens, further, that the earth is moving at a rate less than her mean rate, when opposite that part of Mars' orbit in which he travels fastest, and *vice versa*. Hence it is that the intervals between successive oppositions differ so noticeably, For example: in 1860, Mars came to opposition on the 17th of July; in 1862, he was in opposition on October 5th, 80 days later; in 1864, on December 1st, 56 days later; in 1867, he will come to opposition on January 10th, only 41 days later; in 1869, on February 13th, only 33 days later; and in 1871, a yet smaller number of days will separate the date of opposition from that of 1869.

A word or two as to the absolute dimensions of the two orbits. The mean distance of the earth from the sun, is 91,650,000 miles; her greatest and least distances 93,190,000 miles, and 90,110,000 miles, respectively; thus the eccentricity, or C S, is 1,540,000 miles. The mean distance of Mars from the sun, or the distance C'M, is 139,650,000 miles; his aphelion and perihelion distances being, respectively, 152,670,000, and

* Only the part of such lines between the two cross-lines is to be taken as representing this distance.

126,620,000 miles; his eccentricity, or C'S, is 13,025,000 miles. The rising node of the Martial orbit, is in longitude $48^{\circ} 27'$, measured from S V in the direction of the planet's motion. Mars reaches his greatest distance from the ecliptic plane, near M'' (Fig. 2), when his distance from that plane is no less than 4,850,000 miles.

The point at which the two orbits approach nearest lies nearly in direction C'S, but somewhat *precedes* that direction, owing to the eccentricity of the earth's orbit. Here the orbits are separated only by 34,140,000 miles, whereas, in direction S C', they are separated by no less than 61,860,000 miles. Hence the planet Mars appears much larger when he is in opposition near perihelion, than when he is in opposition near aphelion. He is also more brilliantly illuminated when in the former position. Hence, when in opposition near perihelion, he shines with a brilliancy comparable to that of Jupiter and Venus; and his appearance at such a time has caused alarm to the uneducated. In August, 1719, for instance, when he was only $2\frac{1}{2}^{\circ}$ from perihelion, at the time of opposition, he created the same sort of panic that brilliant comets are apt to produce. His ruddy aspect, which gained for him among the Greeks the epithet *ὁ πυρόεις*, tended to increase this effect.

Since Mars, when he comes to opposition near perihelion, is south of the equinoctial, he attains but a moderate altitude on the meridian, and on this account he is less favourably seen. He is in fact thrown much further south at this time than he would be if he travelled in the plane of the ecliptic. For, although the plane in which he moves is inclined at an angle of only $1^{\circ} 51' 5''$ to the plane of the ecliptic, yet, seen from the earth in opposition, when nearly at his greatest distance south of the ecliptic (which happens if he is in opposition near perihelion), he is thrown nearly $7\frac{1}{3}^{\circ}$ south of the ecliptic. This will be clearly understood if we refer to Fig. 2 to exhibit the corresponding projection of Mars *north* of the ecliptic; for it will be very evident that Mars, being raised above the plane of the paper at M or M'', would appear much more elevated above that plane to an eye placed at or near the centre of E or E'', than he would to an eye placed at S. The greatest possible meridian altitude of Mars in our latitude is about 66° , his least scarcely exceeds 10° . Those who are in the habit of using the telescope will know very well what this means, and will readily understand that perihelion oppositions of Mars lose much of their superiority, through the comparatively low altitude of the planet on the meridian. Hence far better views of Mars were obtained in 1862 and 1864 than in 1860, though he was farther off slightly in 1862, and very considerably in 1864, than he had been in 1860. The approaching opposition is

exceedingly favourable as respects altitude ; but the planet will be yet further removed from us than he was in 1864.

Some misapprehension, by the way, appears to prevail respecting the apparent diameter of Mars in 1867. We find it stated by some of our best authorities that the planet will appear larger than he did in 1864. This is a mistake, though the *Nautical Almanack* appears to countenance the supposition. In 1864, Mars came to opposition when situated as at M' in Fig. 1, the earth being at E' ; this was on December 1st, 1864. In 1867 Mars in opposition will be situated as at M, the earth being at E. If now the distance E M (measured of course from centre to centre) be measured, it will be found to exceed the distance E'M' by more than one-seventh. I would not be understood as placing the accuracy of my figures against the calculations of the *Nautical Almanack* computers ; though I may note in passing that much more may be learned from carefully drawn diagrams than is commonly supposed.* As a matter of fact, however, the increased diameter given in the *Nautical Almanack* results from a change in the assumed value of the planet's actual diameter, and a reference to the columns in which the distance of Mars is noted will at once show that the planet is farther off, and therefore must present a smaller apparent diameter. The actual distance of the planet will be about 58,500,000 miles on January 10, 1867, against less than 50,000,000 miles on December 1st, 1864. At the opposition of February 13, 1869 (see Fig. 2), Mars will be yet further off than in 1867. In fact the next three or four oppositions will be very unfavourable ones as respects the distance of Mars, and will be successively less and less favourable as respects his meridian altitude. At the approaching opposition the planet will attain an altitude of $64\frac{1}{2}^{\circ}$ when in opposition.

But, if we would rightly understand the physical peculi-

* It seems to me that most works on popular astronomy fail in this respect ; it is as easy, or nearly so, to give diagrams correctly representing the relations to be illustrated, as to give incorrect drawings, and it is surely far more instructive. The mind apprehends much more readily, and retains much more certainly, what is presented to the eye, than what is stated verbally. Many of the most marked features of the solar system, or of astronomy generally, admit, too, of being fairly exhibited in diagrams. Occasionally, indeed, it becomes necessary to exaggerate dimensions ; in such a case it is sufficient to call the attention of the reader to the want of proportion in the drawing. But often (almost always, in fact) incorrect drawing is admitted where the just proportions could be easily presented. Take, for instance, the eccentricity of Mars' orbit. In Guillemin's *Heavens* we find a figure representing the orbits of the earth and Mars, in which no attempt whatever is made to exhibit this feature, though it is one of the most remarkable and most easily illustrated in the solar system.

Singularly enough, in the *Bridgewater Treatises*, Whewell remarks that all readers of works on popular astronomy are familiar with the appearance of the solar system, represented as it is in such works by a number of slightly eccentric ellipses. Where are we to find such works ?

arities presented by this interesting planet—the only one whose true surface we are able to examine satisfactorily—we are not to content ourselves with observing him in this or that position among the signs. For then we should only know of his appearance at this or that Martial season. We must examine him at every opposition, and endeavour, if possible, to connect the appearances presented at different oppositions with the seasonal changes which may fairly be assumed to be taking place upon his surface.

The seasons on Mars are due to an axial inclination not differing greatly from that of our own earth. From a series of observations by Sir W. Herschel it would appear to follow that the point of Mars' orbit corresponding to our vernal equinox (northern hemisphere) is at present in longitude 78° ,—N in Fig. 1. He made the inclination of the axis to the plane of Mars' orbit $28^{\circ} 42'$, to the plane of the elliptic $30^{\circ} 35'$. The determination of these elements is not a problem which we can expect to have exactly solved. Accordingly, we find that Dr. Oudemans, applying observations taken in 1830—1837 by Bessel, with the Königsberg heliometer, obtained results differing appreciably from Herschel's. He assigns an inclination $1\frac{1}{2}^{\circ}$ less than that given by Herschel, and he places the Martial vernal equinox as at N', Fig. 1. We learn also that this determination does not correspond quite accurately with some pictures of Mars taken by good observers.*

Fig. 3 indicates the polar presentation of Mars (supposed to be seen in an inverting telescope) at opposition, on Dr. Oudemans' assumption as to the inclination of the axis. The arrow represents the direction in which the planet is actually moving, while $m m'$ represents a declination-circle through his centre, and $e e'$ a declination-parallel, so that the apparent motion of Mars across the field of the telescope will take place in direction $e e'$. The polar presentation will gradually diminish as the planet retrogrades (that is, until the middle of February), and then gradually increase. In the beginning of April, when Mars has nearly reached his maximum phase of gibbosity, he will appear as shown at Fig. 3. At this time he will nearly have reached the summer-solstice of his northern hemisphere, so that the southern polar snows may be expected to be much more extensive than they had been three months before. The planet will, of course, appear much smaller his distance being so much greater—see in Fig. 2 the longer line marked 1867.

* It appears to me that the two pictures by De la Rue, reproduced in Guillemin's *Heavens*, require a somewhat larger inclination than that assigned by Dr. Oudemans.

Figs. 4 and 5 represent the features of land, water, snow-caps, etc., which have been seen by Dawes, De la Rue, Lockyer, Phillips, and others of our best observers on the southern and northern hemispheres of Mars, respectively. It need hardly be said that Mars never presents either pole *directly* towards the earth: nor, if he did, would he appear as in Figs. 4 and 5. These must be looked upon as *maps*, and they are intended to enable the student to fill in tracings or copies of Fig. 3 with suitable details—the upper half (or rather the part above the equator) from Fig. 4, the other part from Fig. 5; the bounding circles in Figs. 4 and 5 representing the Martial equator. When this is carefully done, the student will recognize the well-known features given in works on popular astronomy; and the observer, having made several such maps corresponding to different stages of rotation, will be able to interpret or correct the results of his own telescopic observations of the planet during the first three months of 1867.

PROGRESS OF INVENTION.

ECONOMIC PRODUCTION OF ANILINE.—The importance of aniline and its derivatives, in a commercial point of view, has become so great, that any improvement which tends to facilitate its production is of great value. It is obtained, as our readers are aware, by means of benzine, which hitherto has been procured only by a somewhat complicated process. M. Bobœf has been able greatly to simplify this. He dissolves the heavy oils contained in coal-tar with soda, at ordinary temperatures. They are thus separated from the benzine, which floats on the surface, and may be obtained quite pure by mere decantation and rectification. The residue, after decantation, is a product of some value. It is a combination of coal tar and alkali, which constitutes a kind of soap, and has been termed by M. Bobœf phenate of soda. He considers that it possesses all the useful properties of phenic acid.

DELICATE TEST FOR ACIDS.—Hitherto blue litmus paper has been the most sensitive test possessed by the chemists for the presence of an acid. Unfortunately, however, it has been found that its not being reddened by a given fluid affords no absolute certainty of the absence of acids. It is even inferior in delicacy to the reddened litmus paper used as a test for alkalies. M. Schönbein has, however, furnished us with a test for acids of remarkable sensitiveness. It indicates the presence of the very smallest amount of an acid, being so delicate that it shows the presence of carbonic acid in distilled water that has been merely breathed upon. It is obtained in treating cyanine blue with soda; dissolving one part of the product in one hundred parts alcohol, and adding twice its volume of water to the solution. The cyanine blue is formed by

acting on iodide of amyl with lepidine. Schönbein's test fluid is applicable also to the detection of bases, and is of extraordinary delicacy when used to that purpose, enabling us to ascertain the presence of the exceedingly small amount of oxide of lead, which is dissolved by water, and which is not to be rendered perceptible by sulphuretted hydrogen. That used for acids is adapted to alkalis by merely reddening it with an acid.

PROPULSION OF BOATS ON CANALS.—Great as has been the extension of the railway system, and numerous as are the advantages it possesses over every other mode of conveyance, canals, at least those already constructed, would retain a large portion of their utility, and of their superiority, in point of economy, could steam be employed generally upon them. But such has not been found the case, notwithstanding the many efforts which have been made for the purpose. The great disturbance caused in the water, not only by every form and application of paddle-wheel, but also by every adaptation of the screw propeller, causes a ruinous effect on the banks. A trial is, however, being made in France of a mode of using the paddle-wheel, which is found to be free from objections of this kind, and which will, if not accompanied by others peculiar to itself, most probably give a new impulse to canal navigation. Only one paddle-wheel is used, and it works in the centre of the boat, in a space which is enclosed on all sides, except at the bottom. The lowermost paddles project below the keel, and are so effective as to produce, it is said, a velocity equal to that obtained with any other arrangement that has been tried. /

SIMPLE MODE OF RENDERING RESINS SOLUBLE.—Certain resins, such as Calcutta copal, are not, in ordinary circumstances, soluble in spirits of turpentine, benzine, petroleum, and other hydrocarbons; but they are rendered so by the application of heat. This, however, is objectionable, among other reasons, from the loss of one-fourth of the weight which occurs. It has been found by M. Violette that this loss may be avoided by heating the resins in close and strong vessels to a temperature between 350° and 400° Cent., and after this cooling them. They are then soluble, even at ordinary temperatures, in the above-mentioned fluids, forming excellent varnishes, which may be used for even the most delicate purposes. They undergo no loss of weight, and the effect produced on them is due to the conjoined action of both heat and pressure. There is one circumstance, however, which, at first, may be a source of difficulty, when the manufacture is carried on upon the large scale. The vessel in which the resin is heated must be able to support a pressure of about twenty atmospheres. The resin may be heated, and the varnish made by a single process. For this purpose it is only necessary to heat to the required temperature a mixture consisting of one part by weight boiled linseed oil, four parts spirits of turpentine, and one part Calcutta copal.

PRECIPITATION OF METALS FROM THEIR SOLUTIONS BY MAGNESIUM.—Magnesium, for a long period after its discovery, remained a mere chemical curiosity. It was then applied to the production of a light, suitable not only for ordinary illumination, but, which is of far

more importance, to the purposes of the photographer; and in such a way as that, to him, the day was practically rendered twenty-four hours long, and the darkest cavern became as well adapted to his art as the most brilliantly lighted studio. A new, and scarcely less important use of magnesium has now been discovered. It is found to precipitate metals from their solutions, and in such circumstances as to afford valuable aid to the toxicologist in medico-legal investigations regarding cases of supposed poisoning. Sometimes it gives rise to precipitation in the metallic state. Thus it throws down iron and zinc from slightly acidulated solutions of their proto or sesqui salts; and cobalt from a similar solution of its protoxide. In these, and other cases, a very remarkable circumstance occurs—hydrogen is evolved. The evolution of this gas, however, prevents arsenic, or antimony, from being precipitated in the metallic state; since each of these metals combines with the hydrogen, and passes off with it. The iron, zinc, and cobalt thus precipitated assume a brilliant metallic appearance if they are well-washed, and then compressed—a very slight pressure being sufficient with the zinc. Iron, cobalt, and nickel obtained in this way are highly magnetic. These are not the only metals which are thrown down by magnesium. It precipitates also gold, silver, platinum, bismuth, tin, mercury, copper, lead, cadmium, and thallium. Other important circumstances are the consequence of the great solubility of magnesium. Thus it decomposes water with great rapidity, if a very small quantity of chloride of sodium or sal ammoniac is present; and the hydrogen thus evolved when the magnesium contains no silicium, is quite pure. The great tendency of magnesium to become oxidized also renders it highly effective as a battery element. If a plate of magnesium, only 0.1 gramme in weight, is immersed, with a very small plate of copper, in a glass tube which has a capacity of six cubic centimetres, and is filled with water which has been acidulated, a galvanic current will be produced that will suffice to keep a small electro-magnetic apparatus, or to afford with a Geissler tube an illumination ten centimetres in length for about ten minutes.

NEW APPLICATION OF COLLOID DIAPHRAGMS.—A mode of dialysing gases by means of colloid diaphragms has recently been discovered. It has long been known that even a thin pellicle of caoutchouc is totally impervious to gases, as such. But it has been found that it is capable of liquifying certain gases, which then pass through it, and are again restored to the gaseous form, or reaching the other side of the pellicle. Atmospheric air is one of these gases; but its constituents are not transmitted with a velocity proportioned to their relative amounts; the whole of its oxygen, but only half of its nitrogen is allowed to pass through. We are thus enabled to obtain oxygen sufficiently pure to rekindle incandescent wood. To render the pellicle as effective as possible, the air to be dialysed must have free access to one side of it, and a partial vacuum must be maintained at the other. Colloid membranes are not the only simple means of liquifying gases. Platinum, palladium, and iron condense hydrogen into a liquid which, possibly,

is metallic. Palladium is especially effective in this way. And iron absorbs carbonic acid in still larger quantities than hydrogen—a circumstance which seems to explain certain facts connected with the manufacture of steel. These metals have no effect whatever on either oxygen or nitrogen. The necessity for the liquifaction of gases, previous to their passage through caoutchouc, is due to certain peculiarities of that substance. Though it refuses to transmit gases as such, it is very pervious to fluid. It will absorb water to such an extent, as to become opaque; and its pores are so much opened by this fluid, that the latter will pass through, and be evaporated at the other side. The pores, indeed, are visible under the microscope.

PROJECTILES AFFECTED BY THE EARTH'S ROTATION.—The discovery of the effect of the earth's rotation on the path of a projectile is not new; but the practical consideration of it has only recently engaged attention. The flight of projectiles, from their imperfection, and that of the fire-arms then in use, was formerly so uncertain, that the small deviation produced by the rotation of the earth was considered unworthy of any attention. Such is not the case at present; and hence the subject has been of late carefully studied. The deviation depends on the latitude: being greatest at the poles, and zero at the equator. In our latitude a shell, about twelve inches in diameter, with a range of four thousand yards, would deviate to the extent of eight yards. The direction of deviation is different in the different hemispheres; in ours it is, whatever the azimuth of the vertical plane in which the path of the projectile lies, always to the right. A deviation is caused also by the rifling; and as this depends on the direction of the latter, it may, according to circumstances, either augment, or, to a greater or less extent, diminish that caused by the rotation of the earth. In our latitude, with a Whitworth gun, half the deviation arises from the earth's rotation; a proper system of rifling would therefore prevent any deviation whatever. But it must not be forgotten that a rifle without any deviation in one hemisphere would have a very considerable one in the other: as it would become equal to the sum of the deviations caused by both the rifling and by the earth's rotation.

LITERARY NOTICES.

BENEDICITE; OR, THE SONG OF THE THREE CHILDREN. Being illustrations of the Power, Wisdom, and Goodness of God, as manifested in his Works. By G. CHAPLIN CHILD, M.D. In two Volumes. (Murray.)—The canticle known as the "Benedicite," and commencing "Oh all ye works of the Lord, bless ye the Lord: praise him and magnify him for ever," supplies Dr. Chaplin Child with a series of texts on which he has written elegant little dissertations of a scientific character. The book is beautifully got up,

with good print, pleasant cream-coloured paper, well-designed headings, and tail-pieces to the chapters. The verses of the "Benedicite" carry the doctor through a wide range of subjects, from astronomy to natural history. Dr. Chaplin is strictly orthodox—more so than is common with scientific men—but his pages are free from anything like cant, and they will be welcomed in many families which more elaborate treatises would not reach. The "Benedicite" is a very favourite hymn, both on account of its literary merit, and from its adaptability to music, and it is certainly desirable that those who use it for the expression of their devotional feelings should have some idea of the way in which "all the works of the Lord do praise Him," in the thoughts which they excite in intelligent minds.

THE ORIGIN OF SPECIES BY MEANS OF NATURAL SELECTION; or the Preservation of Favoured Races in the Struggle for Life. By CHARLES DARWIN, M.A., F.R.S., etc. Fourth edition, with additions and corrections. Eighth thousand. (Murray.)—No book of modern times has contributed so much to philosophical thinking on the subject of natural history as the *Origin of Species* of Charles Darwin. A considerable allowance of abuse from those whose minds were ossified with old-established prejudice, did more to call attention to this masterly work than to obstruct the reception of the truths which it conveys, and if its author has to complain of some ill-treatment on the part of those who know no better, he has the satisfaction of being more or less supported by the greatest thinkers of the day. Gross mistakes have been often made in treating the doctrine of "natural selection" as if it were merely a hypothesis capable of being entirely overthrown; whereas the exposition of the doctrine is simply a statement of facts; and the scientific doubt pertaining to it, concerns the extent of its action, and not the question of its existence. That living beings succeed in hereditary series is one fact; that progeny are subject to variations from the parent type is another fact; and it is a third fact that some of these variations are transmissible in long succession. Man, by careful breeding, transmits peculiarities in horses, dogs, cattle, pigeons, etc., according to his wants, or according to his whims. In nature, the permanence, or long duration of a transmissible peculiarity must, as Darwin shows, depend upon its adaptability to the circumstances in which the modified creature finds itself. If it lessens the power of the individual to fight the battle of life, it dies out, while if it assists in that conflict, it remains. The hypothetical part of Darwinism consists in the inferences which he draws, or suggests, as to the *extent* to which these causes have operated in past times. If we suppose their extent of action to be no greater than we can *prove* it to have been, it will not account for the descent of a vast multitude of divergent forms from one, or from a few parent forms; but if the positive evidence in this matter is incomplete, the negative evidence is palpably afflicted with the same defect to an enormous degree. If we had cause to suppose that geology and palæontology displayed to us a fair and unbroken sequence of organic beings from early times to our own, the negative evidence against the hypothesis would be

very strong indeed; but an immense deal has been done of late years, not only to show beyond all doubt that our paleontological record is incomplete; but that it is imperfect to such an extent that it may be likened to a book from which whole chapters of unknown size, and unknown contents, have been cut out. How many of these chapters we may be able to recover no one can guess, as only a small part of the earth has yet been subjected to accurate examination. We are likewise profoundly ignorant of the physiological causes of hereditary transmission, with or without variation. Darwinism, therefore, stands in the position of an array of facts, proving the operation of certain principles, but leaving room for conjecture as to the extent of that operation, and its consequent capacity of evolving new forms. Whether, therefore, it be accepted or rejected, the mind should still have its "philosophic doubt," and avoid bigotry with its antagonism to reason, on either one side or the other. As for the religious questions which have been mixed up with this, as with all former innovations upon received modes of thought, they must be subordinated to the love of truth, and to the conviction that whatever method it may have pleased the Creator to adopt in peopling his world, that method must necessarily be one which, when understood, will excite the love and admiration of his rational subjects. The testimony of all science is conclusive as to the infinitely small proportion of nature which we can either observe or understand; but there is much to lead us to believe that all parts of the vast whole are bound together by a unity of design, as well as by a unity of origin from one ultimate source of intelligence and power. From the vastness of the *Cosmos*, human speculation is necessarily imperfect, from insufficiency of information, or from the complexity of the system baffling men's powers of analysis. The readers of Darwin will find many beautiful and amazing instances of the interdependence of objects that might have been supposed disconnected; and no one in whom the religious spirit is active can rise from a perusal of his pages without higher conceptions of the evidence which Natural Theology offers to the mind.

AN ELEMENTARY TREATISE ON HEAT. By BALFOUR STEWART, LL.D., F.R.S., Superintendent of the Kew Observatory, Examiner at the Universities of Edinburgh and London. (Oxford: At the Clarendon Press, MDCCCLXVI.)—This is by far the most compendious and well-arranged treatise on heat which we have seen, and the best adapted for class-teaching, or private study. It contains an immense amount of well-arranged information, and a clear exposition of the most recent theories and facts pertaining to its subject.

AN EASY INTRODUCTION TO THE HIGHER TREATISES OF THE CONIC SECTIONS. By the Rev. JOHN HUNTER, M.A. (Longmans.)—This little book, as the author tells us, has resulted from practical experience of the difficulties pupils feel in the study of conic sections, and we have no doubt it will be found of much use to the class of students for whom it is intended.

NOTES AND MEMORANDA.

NORMAN LOCKYER ON THE SPECTRA OF SUN SPOTS.—The *Proceedings of the Royal Society*, No. 87, contain an account of experiments by Mr. Norman Lockyer to test the opposing theories of Faye, and De La Rue, Balfour, Stewart, and Lowry. The former regards the interior of the sun as a nebulous mass of feeble radiating power at a temperature of dissociation, and the photosphere as of high radiating power, lower temperature, and chemical action. A sun spot he supposes to be an exhibition of the interior mass through rents in the photosphere made by ascending currents. The latter refer sun spots to a downward current of the cooler atmosphere, producing condensation and absorption in the photosphere. Mr. Lockyer in an experiment, which he hopes to repeat on a larger spot, did not find the spectra of the umbra give the character required by M. Faye's hypothesis.

MAXIMUM PERIOD OF NOVEMBER METEORS.—M. Coulvier-Gravier gives a diagram in *Comptes Rendus*, showing the proportions of meteors seen on the 12th and 13th November, from 1830 to 1866. The maximum was in 1833, the minimum in 1860, and he expects the next maximum to be in 1867, which would be in accordance with the prediction of Olbers. He says that, unfortunately, there will be a full moon at the time. There has been, he states, a progressive augmentation from 1862 to 1866, and he expects this will continue and culminate in 1867.

DISENGAGEMENTS OF GASES FROM THEIR SUPERSATURATED SOLUTIONS.—M. Grenet has a paper in *Comptes Rendus*, No. 21, on this subject. Solutions of gases in liquids are made under certain pressures, and the temperature of the fluid is then raised, and if, as is usually the case, the gas is less soluble in a warm fluid than in a cooler one, it will remain for a time supersaturated. If any rod of solid matter is then introduced, it becomes covered with gas bubbles, which escape freely if the liquid is stirred by the rod. After a time the immersed part of the rod loses the power of promoting the formation of gas bubbles; heat will also destroy this power, and solid bodies which have not been in contact with air do not possess it, and it is the air, or gas, adhering to the solid body which excites the action.

POISON IN WHALE FISHING.—In *Comptes Rendus*, No. 22, will be found an account by M. Thiercelin of the employment of small explosive shells to shoot whales, and kill them by conveying strychnine and curare poison into their systems. He states that a mixture in powder of soluble salts of strychnine, with one-twentieth of curare, will kill any animal if discharged into a wound. The animals require a five-thousandth of a gramme of the poison to each kilogramme of their bulk, or less if they are extremely large. He estimates whales to weigh, according to the sort, from 50,000 to 90,000 kilogrammes, and he mentions several instances of whales killed in a few minutes by his poison shells. The animals exhibit symptoms of tetanus, followed by death.

THE ICONSCOPE.—M. Javal describes in *Comptes Rendus* the above named instrument as taking its place between Wheatstone's pseudoscope and the telescope of Helmholtz. He says, by an optical combination identical with that employed in the binocular microscope of Nachtet, and the binocular ophthalmoscope of Giraud-Teulon, the two eyes cease to receive different images of external objects. It results that if, under these conditions, a large picture is examined, the eyes preserve the same state of convergence towards whichever part of the canvas they are directed, and the spectator having no means of assuring himself concerning the plain form of the surface he examines, it assumes an appearance of relief in proportion to the time it is observed.

YEAST OF BEER.—M. Herman Hoffman states (*Comptes Rendus*) that if a little beer yeast is placed in a weak solution of honey that has been boiled, bubbles of carbonic acid rise for a few days from the liquid, but not directly from the yeast cells; after which the acid which is developed stops the fermentation. A pellicle of yeast cells and bacilliform cells, frequently in chains composed of several

members (? bacteriums), this pellicle fructifies in the form of *Penicillium*. Many yeast cells fall to the bottom, and they can be made to fructify as *Mucor* or *Penicillium*, if placed on pieces of potato. Heating the liquid to 60° or 74° (C.) arrests the fermentation for some days, after which it takes place feebly, and many of the cells fructify in the bacillar form. After exposure to a still higher temperature the yeast loses its faculty of inducing fermentation, but can still produce a pellicle. 84° (C.) destroys its vitality altogether, unless it is heated in a dry state, when it can survive a temperature not exceeding 150°, and still produce a feeble fermentation. At 215° it loses this property, but still produces the pellicle. Similar results followed the application of creosote, chloroform and sulphuric acid in appropriate doses.

A NEW GLOW-WORM, WITH TWO FIRES, has been found in the Grand Chaco, Argentine Republic. Wm. Perkins, Esq., F.R.G.S., writes from Rosario, October 20, 1886, to Wm. Bollaert, Esq., F.R.G.S.:—"I think I have made a discovery in natural history, and which you may make known to the scientific world. I found the female of the most extraordinary *Elateride* ever heard of, at least that I know off. It is a most brilliant glow-worm, one inch and a half long, with TWO FIRES. The body emits a most vivid flame of the ordinary greenish phosphorescent colour, while the head presents the appearance of a bright glowing red coal of fire. The reflection on a piece of paper is also of the two colours. I never saw anything so beautiful." Mr. Bollaert adds: "This is doubtless one of the *Cocuyos* family. One, the *Pyrophorus noctilucus*, is described as the South American *Cocuyo*, or glow-worm. Mr. Bollaert has noticed glow-worms in the West Indies, North and South America, but never in such abundance and beauty as in the wilds of Western Texas, still he never observed but the one light, the green."

GEOLOGY OF THE PARANÁ.—Mr. Perkins writes also to Mr. Bollaert: "You know how completely alluvial is all the littoral to the west of the Paraná. From Santá Fé up to the Bermejo, the right side of the Paraná is bordered to a strip of low alluvial land from two to five leagues in breadth. Then come the high *barrancos* of the Chaco, also alluvial, not a stone to be found from Rosario to the Bermejo; no clay neither. Well, I found, running in a direction S.E. and N.W. across the low lands mentioned, a large formation of conglomerate of agates and red clay, the latter of a brilliant colour, soft and homogeneous. The formation, where I found it, crossed the San Javier river, in latitude 29° 11' S. At the town of San Javier, where the river of the same name approaches, the high banks (80 feet high) of the lowlands, I found, at the depth of 90 feet, a bright red coarse sand that was going through the process of hardening into stone. I also found large numbers of old oyster shells, with very brilliant colouring inside. They seemed to me so similar to the pearl oysters I have seen at Paraná and the Gulf of Guaymas, that I made minute inquiries of some old Indians in the town of San Javier. They said that *little stones* had been found in the shells in former times. I had to take the information for what it was worth. The wonderful shell formation at Paraná, where we found them in the gradations from a perfect shell to a finished formation of fine limestone, does not leave us any room for surprise at finding them a couple of degrees further north."

μ^3 BOOTIS AND ζ AQUARI, SECCHI'S MEASURES.—Our attention has been called to the probability that the distance of the first of these stars as lately given by Secchi is too much. Mr. Webb finds it easier to divide than γ^3 Andromeda, which he ascribes to the size of the disks. In 1864, Mr. Knott's measure of μ^3 Bootis was 0".5; and in 1865, Mr. Dawes made it 0".48. We are asked, but cannot tell, what Secchi means by the note he makes against this star, "*Non è ben certo, qual sia delle due pare $\approx$ 1938.*" Mr. Knott thinks there may be a misprint in Secchi's position of ζ Aquarii, which he makes 347° 83. Mr. Knott finds it 337° 01 D. 3" 644.



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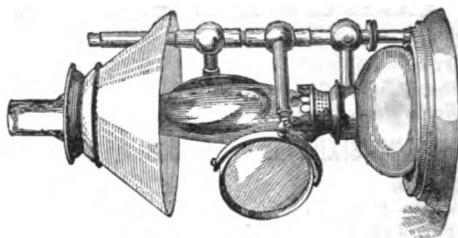
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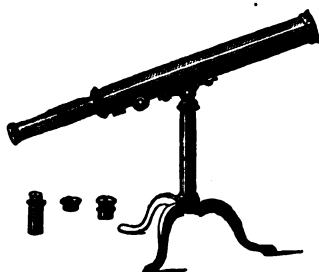


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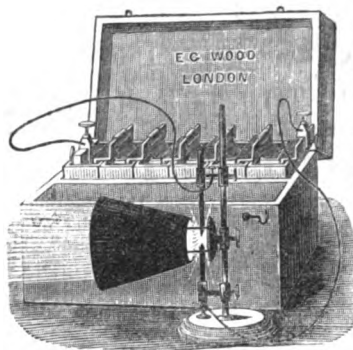
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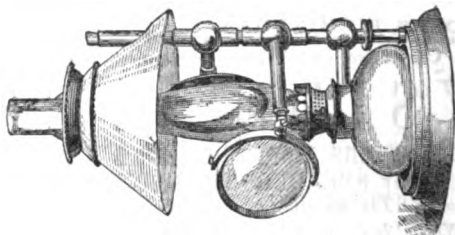
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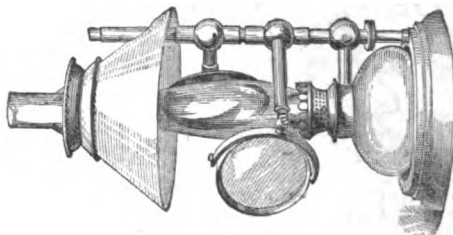
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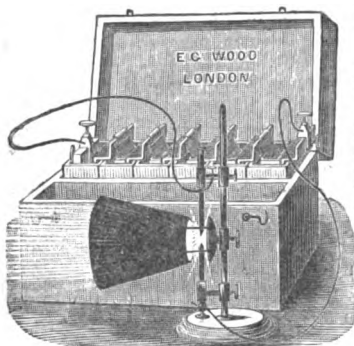


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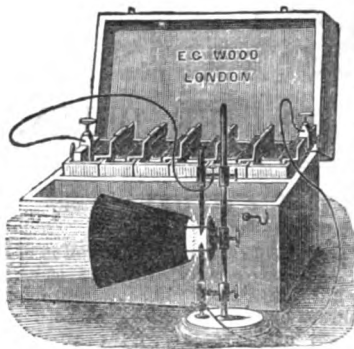
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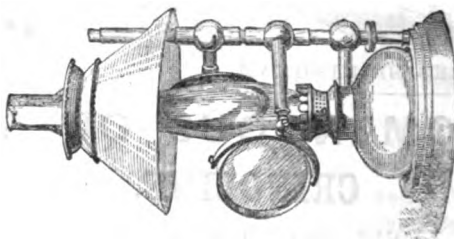
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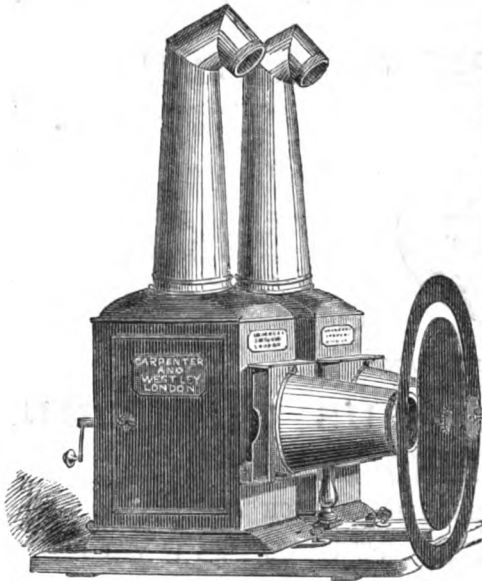
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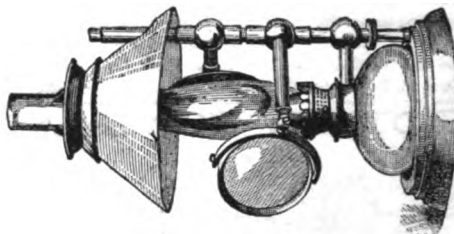
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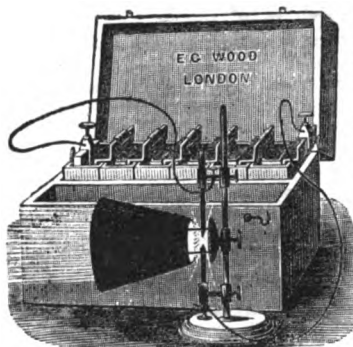
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