example, the 10th of August, or the 13th of November), and the attention should be directed below the radiant point, to that portion of the sky where the meteors will, in all probability, appear to fall vertically towards the earth. Near (*but not too near*) the radiant point, their course is also foreshortened, and their apparent motion is comparatively slow. Their course in the spectroscope will in this case appear parallel to the refracting edges of the prisms, which is an essential point to be kept in view in the arrangement of the spectroscope, so as to obtain the prismatic spectra of meteors. Some resolution, in the next place, is required to fix the attention constantly within the stipulated bounds; for the sky meanwhile is alive with meteors; and some few are of a startling kind, perhaps even calculated to shake the nerves of any but a cool observer. Paying attention to these precautions during the hours from midnight until sunrise on the morning of the 13th of November next, no difficulty, it is apprehended, of any kind will be experienced in obtaining the spectrum of a shooting-star; and as the necessity of the case seems to require it, notes should be made of their most peculiar features.

All the necessary preparations having been made, and with the prospect of a considerable meteoric shower at hand, a watch for meteors was commenced, in order to observe their spectra, on the night of the 9-10th of August last. Expectation on the first night was not destined to be disappointed, and six meteors were observed to pass across the field of view. Notes of the peculiarities were made, and of the general appearance of their spectra, and are briefly as follows:—

August 9th.—No. 1; 8h. 40m. p.m. About equal to a fourth mag. star. Passed across the body of Cygnus, in half a second; leaving no streak. The spectrum exactly resembled that of a fourth mag. star (o Cygni) close to which the meteor passed, the conclusion being that *the meteor might be a solid body, heated to ignition.*

August 10th.—No. 2; 0h. 27m. a.m. Nearly as bright as Sirius. Commenced near Polaris (in the field of view), and shot 15° or 20° (beyond the field of view) along a line directed from Cassiopeiæ, leaving a streak on its whole course for four seconds. The latter part of the meteor's course was seen with the naked eye. In the spectroscope two images of the meteor and of the streak were visible, one refracted, and one accidentally reflected at the side. These two images of the meteor and of its streak could not be distinguished apart, at least in their general appearance, the conclusion being that the light both of the nucleus and of its luminous streak was homogeneous, and that *its luminous substance was a gas.*

No. 3; 0h. 42m. a.m. A very brilliant fire-ball, with a flash

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like lightning, burst overhead, leaving a streak from θ Cygni, half-way to α Lyra, for twenty seconds. A cloud unfortunately dimmed the streak. In the spectroscope, as far as cloud would permit any judgment of the streak to be formed, its aspect was the same as to the unassisted eye. The light of the streak was therefore probably homogeneous, and *the streak itself probably a luminous gas.*

No. 4; 1h. 15m. a.m. About equal to a second mag. star. Shot in three-quarters of a second, from θ Cassiopeiæ half-way to o Honorum, and then turned round the quarter of a circle, to u Honorum, where it vanished, leaving a streak for half a second on its course. In the spectroscope the general appearance of the meteor, and of the streak in the field of view, was the same as that of the purely reflected image by the side; the conclusion being, as before, that the light, both of the meteor and of the streak, was homogeneous, or that *the luminous substance of the meteor was a gas.*

No. 5; 1h. 40m. a.m. About equal to a second mag. star. Passed slowly through a short path near β Tauri, directed from Cassiopeiæ; duration, one second; leaving a streak at the place for three seconds. The spectrum of the meteor and streak was quite equally diffused over a space about $\frac{1}{4}^\circ$ in width; its colour greyish white; the diffuse train-spectrum vanished without further change, the conclusion being that in this case *the train might, like the nucleus, be composed of heated sparks.*

No. 6; 2h. 15m. a.m. Equal to a first mag. star. Shot on the same course as No. 2; duration, one second; leaving a bright streak for four seconds. The spectroscope was turned towards the streak before it disappeared. The train was widened by the prisms to a greyish-white band, somewhat greater than a quarter of a degree in breadth. It faded from sight without further change; the conclusion in this case also being, that *the train might possibly be composed of heated sparks.*

Three spectra in the foregoing observations appeared homogeneous, like that of a luminous gas (Nos. 2, 3, 4); and three were continuous, or diffuse (Nos. 1, 5, 6), like that of an ordinary spark. The question, accordingly, whether luminous meteors might or might not contain solid substance, remained undecided, when daylight beginning to appear, put a stop to further observations.

The following night, observations could fortunately be resumed, and the perplexing appearance of the meteor spectra on the previous night, received a truly surprising and most satisfactory explanation, in the repeated appearance in the spectra of the streaks of a yellow line, *unmistakably that of the metal sodium in combustion.*

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Two observers being engaged to watch on this night, one checked the observations of the other with the naked eye. The troublesome reflected image in the spectroscope could accordingly be dispensed with, and it was kept out of sight; so that the views obtained of the meteor spectra came as nearly to perfection as could be wished.

August 10th, continued.—No. 7; 4h. 22m. p.m. Equal to a first mag. star. Shot from γ Cephei to l Draconis in three-quarters of a second; leaving a bright streak for five seconds on its course. The meteor first appeared in the field of view, and passed out of it. The brightest portion of the streak, however, was brought into the middle of the field of view; where it occupied an excellent position, parallel to the refracting edges of the prisms, for viewing its prismatic spectrum. A slight effect of distortion (produced in the prisms) caused it to appear bent, like a bow, across the field of view (Fig. 7). The spectrum presented the appearance of a narrow line of light, exceedingly brilliant, of a golden-yellow colour, and not more than 5′ in width. It faded gradually along its whole length, and disappeared in about two and a half or three seconds. Its description, noted in the register, kept for the purpose at the time, was—"neither double, triple, nor multiple, nor continuous, *but purely and positively mono-chromatic.*"

August 11th.—No. 8; 0h. 15m. a.m. Equal to a third mag. star. Shot from β Cephei to δ Draconis, in three-quarters of a second; leaving a luminous streak for two seconds. The spectrum of the streak was a remarkably slender, orange-yellow line of no appreciable breadth, without any continuous spectrum near to it, or any other neighbouring bands, or lines. It was very bright, remaining in sight two seconds; and it gradually faded away until it vanished. The spectrum of the nucleus appeared to be undistinguishably the same as that of the streak.

No. 9; 0h. 20m. a.m. Equal to a third mag. star. Shot from α Cephei to 33 Cygni (Fl.), in three-quarters of a second; leaving a streak for one second and a half. The spectrum of the streak was dull grey, diffuse, about $\frac{1}{4}^{\circ}$ in width, with a yellow line included in it, *on the side towards the red.* The yellow line and the diffuse band disappeared together. The spectrum of the nucleus, appeared to be appreciably the same as that of the streak.

No. 10; 0h. 33m. a.m. Equal to a fourth mag. star. Shot from ρ Cassiopeiæ to o Honorum, in half a second; leaving no streak. The spectrum of the nucleus appeared to be concentrated into a few faint lines with wide intervals between them, but this description is very uncertain.

No. 11; 0h. 33m. a.m. Equal to a third mag. star. Re-

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turned about half way along the course of the preceding meteor, in half a second; leaving no streak. The spectrum of the nucleus was a concentrated point of yellow light, having all the appearance of some yellow shooting-star.

No. 12; 0h. 42m. a.m. Equal to Sirius; colour white. Shot from *a* Trianguli to η Piscium, in one second and a quarter; leaving a streak for four seconds on its course. In the spectroscope the meteor slowly crossed the middle of the field of view, on a course directly parallel to the refracting edges of the prisms, producing a very superb spectrum. The spectrum of the nucleus was red, green, and blue; extremely brilliant. The train-spectrum was diffuse; $\frac{1}{4}°$ in width; in which a thin bright orange-yellow line was plainly seen *on the side towards the red.* The diffuse portion of the train-spectrum faded in about two seconds, apparently following the nucleus. The sodium line remained extremely bright for not less than two seconds longer, and faded gradually along its whole length, when it also disappeared. The singular characters of this spectrum were most distinctly and beautifully seen, and the long endurance of the sodium line, after the rest had disappeared, was leisurely watched.

No. 13; 1h. 23m. a.m. Equal to a third mag. star. Shot from P Camelopardi to *a* Draconis in half a second; leaving a streak for two seconds on its course. The train-spectrum was a diffuse band of greyish light, $\frac{1}{4}°$ wide, somewhat brighter on the side towards the red, and it so vanished.—The spectrum of the nucleus was appreciably the same as that of the streak.

No. 14; 1h. 55m. a.m. Equal to a first mag. star. Shot from *o* Custodis to 3° below Polaris, in three-quarters of a second; leaving a bright streak for three seconds. The meteor first appeared in the field of view, and passed out of it. The spectrum of the early portion of the streak, behind the nucleus, was a greyish diffuse band, $\frac{1}{4}°$ in width. The spectrum of the nucleus was appreciably the same. The brightest part of the streak, before it faded, was brought into the field of view, well situated parallel to the edges of the prisms, and in the middle of the field for about two seconds. Its appearance was that of a golden-yellow line of light, about 5° in length, some 4′ in width, tapering gently towards the ends; and perfectly sharp and well defined. It was unaccompanied by any continuous spectrum, or any bands, or other lines; and it so disappeared from the ends towards the centre.

No. 15; 2h. 15m. a.m. Equal to a second mag. star. Shot from μ to *a* Andromedæ in three-quarters of a second; leaving a streak for two seconds. The train-spectrum was a diffuse, greyish-white band; $\frac{1}{4}°$ in width, and about 6° or 7°

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long; and faded away without any further change. The spectrum of the nucleus showed prismatic colours.

No. 16; 2h. 16m. a.m. Equal to a second mag. star. Shot from θ Cassiopeiæ to β Andromedæ, in half a second, leaving a streak for two seconds and a half. The meteor was seen with the unassisted eye. The last-fading portion of the streak was examined in the spectroscope, where it appeared more widely diffused than when seen with the naked eye. Its colour in the spectroscope was a dull greyish white.

No. 17; 2h. 27m. a.m. Brighter than a first mag. star. Shot from α Cassiopeiæ to o Honorum, leaving a streak for two seconds and a half. The train-spectrum was a diffuse greyish-white band, $\frac{1}{4}^\circ$ in width, not sensibly brighter in any part; and it so faded. The spectrum of the nucleus was bright,—red, and green.

Daylight at this time began to appear, and observations were obliged to be discontinued; the streaks of the August meteors might, however, already be plainly divided into two classes. In the majority of cases, a bright yellow line, having the unmistakable appearance of the sodium line, was clearly visible in the spectrum. In a smaller number of cases the spectrum was merely a diffuse and greyish light band, or ordinary spectrum of weak intensity, resembling the spectrum of the glowworm's light. It will be interesting to observe this form of meteoric spectrum, should it be more common among the "phosphorescent" streaks of the November meteors than it was in August last; when only five such purely "phosphorescent" streaks were noticed, entirely free from sodium light.

The spectra of the meteor-nuclei were seen in a few cases only with distinctness; as they were in general overpowered by the brightness of the sodium light, whenever that was present. When the streaks were phosphorescent only, and free from sodium light, the nuclei in general presented highly-coloured spectra, like the spectrum of solid matter at a glowing white heat, or like the spectrum of an ordinary gas flame containing white-hot solid particles of carbon. A better night for observing nucleus-spectra would be the 12th of December, when meteors leaving no trains are plentiful; and they are for the most part very brilliant, radiating from some part of the constellation Gemini.

That which spectral examination of the August meteors has most certainly brought to light, is the existence of an extraordinary quantity of the vapour of sodium in their luminous streaks; so that many of the streaks, especially the most conspicuous, and the most slowly-fading amongst them, consist of nothing else but soda flames for a great propor-

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tion (that is to say the latter portion) of the time that they continue visible. Their condition is then exactly that of a flame of gas in a Bunsen's burner, freely charged with the vapour of burning sodium; or of the flame of a spirit-lamp newly trimmed, and largely dosed with a supply of moistened salt.

It is difficult to believe that the vapour of the metal sodium exists, in such considerable quantities, at the confines of the atmosphere. It is much more reasonable to suppose that it is brought into the atmosphere by the meteors themselves, so as to be deposited in the luminous trains that mark their course. The material of the August meteors is, therefore, probably a mineral substance, in which sodium is one of the chemical ingredients. Such is the rather satisfactory termination of an experiment, which it will be very easy to repeat, whenever an abundance of meteors on the night of the 10th of August offers an equally favourable opportunity for examining their spectra by the aid of the meteor spectroscope.

The connection believed by adherents of Chladni to exist between shooting-stars and aërolites is now shown, at least in August, to extend itself in some measure to their chemical composition. The meteorites of Aumale, which fell on the 25th of August, 1865, were found, on analysis by Mr. Daubrée, to contain *soluble salts* (chloride and carbonate) of sodium. A circumstance so uncommon in the composition of aërolites, allies the meteorites of Aumale very closely with the sodium-bearing streaks of the meteors of the 10th of August.

In this manner each new acquisition of knowledge, however unforeseen may be its origin, tends to support the theory of Chladni, and to confirm the belief that shower-meteors and shooting-stars are actually aërolites of small dimensions. In whatever manner aërolites and shooting-stars are related to each other in their astronomical and other peculiarities, they will certainly require a vast number of further experiments to unfold their real source.

EXPLANATION OF THE PLATE.

The meteor spectra are numbered in the plate, after the description in the text, in the order of their appearance; *a*, represents the spectra of the nucleus, and *b*, the spectra of the meteor trains. Double white lines indicate the boundaries of the field of view.

Figs. 1, 10, represent the persistent luminous impressions of the *nucleus* only, and the meteors left no streak. 1, a meteor in *Cygnus;* 10, a meteor spectrum, conveying a faint

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impression of interruptions; 11, the meteor could be followed by the eye, but it left no streak.

Figs. 2, 4, refracted and reflected images, viewed together (A refracted, B reflected), of *Polaris* (*a*); and of two meteors.

Figs. 5, 6, 13, 15, 16, 17, diffuse train-spectra.

Figs. 9, 12, ditto containing the *sodium line.*

Figs. 7, 8, 11, 14, purely mono-chromatic, or *sodium* meteor spectra; similar to Nos. 2, 4, but better defined.

Fig. 12, *bis.*, represents the appearance of No. 12, two seconds after the disappearance of the meteor. Total duration of the streak, four seconds.

Note.—The distortion or curvature of the streak by the prisms, was plainly seen in No. 7, but not in the remaining spectra. The meteor spectroscope was generally held nearly horizontally; but in No. 12 the instrument was held almost vertically, and the meteor moved in a nearly horizontal direction. The effect of producing the prismatic spectrum was the same as in the other cases.

THE LINEATED PHEASANT OF BURMAH.

BY CAPTAIN R. C. BEAVAN.

Synonyms. *Gallophasis lineatus*, Auct. Jerdon's *Birds of India*, vol. ii., part 2, pp. 531 and 535. *Euplocomus lineatus*, Belanger, who has figured it in his voyage, plate 8 of Birds. *Phasianus lineatus*, Latham. *Phasianus reynandii*. Lesson. Genus, *Grammatoptilus*, of Reichenbach. Mason's *Burmah*, edit. 1860, pp. 230 and 687. Burmese name "Yeet" or "Yit."

Dr. Jerdon, in his famous work, the *Birds of India*, describes the group of the Kallege Pheasants, amongst which he includes the species under review, as one which leads from the true pheasants (of which *Phasianus colchicus*, Linn., the Common Pheasant of the British Islands, is a type) to the Firebacked Pheasants and Jungle Fowl of India and Malayana; and as the group in question partakes of the characters of both the true pheasants and the jungle fowl, so in its geographical distribution it is found to range from the Himalayas, the head quarters of the pheasants, to the Burmese provinces, where jungle fowl and their allies take their place.

The genus *Gallophasis*, of Hodgson, or that of the Kallege Pheasants, as they are more popularly termed, embraces at least four species—two from the Himalayas—a third from Assam and Arracan, and the fourth, our species, from the

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Tennasserim provinces of Burmah. They are birds about the size of a fowl, with glossy black and white plumage in the males, the females being invariably of a sober brown hue; the fleshy orbits, or naked skin round the eyes, is bright red in both sexes, and both have a well-developed crest. The tail is moderately long, of sixteen feathers, raised in the centre as in the domestic fowl, and held demi-erect, the feathers drooping and curving outwards. Essentially hill birds, they live at various elevations of from 1500 to 7000 feet above the level of the sea, and in places where they occur abundantly, are for the most part the only species of pheasant found, at the comparatively low elevations frequented by them.

The male of the species under notice has the colouration of the neck, back, and upper parts generally, almost exactly similar to that of the domestic guinea-fowl. The two arched central tail feathers are of a pearly grey white, much more so than the rest: the throat, breast, and underparts are black, with the sides of the throat and flanks longitudinally striated with white. The head is pure black, with a long pendent crest; the orbital skin bright red, beak greenish, horny, legs duller and strongly spurred. Length, about 27 to 28 inches, and weight about 3 lbs. The female is a smaller bird, of a light brown colour throughout, without a trace of black; the orbital skin as in the male, but she has no spurs, and the crest is smaller. The irides are reddish brown in both sexes.

In 1865, when the last list of vertebrated animals, living in the gardens of the Zoological Society of London, was published, there were two pairs of this species flourishing there, besides hybrids, and in the same year I brought up two fine males with me from Burmah, which have since been forwarded, and I hope ere this been safely received by the Society.

Whilst in Burmah, I had several opportunities of seeing this handsome bird in a state of nature, and as hardly anything regarding its habits or economy has as yet been recorded, I proceed to give briefly in detail the results of my own observations, and of information procured on the spot from intelligent natives who were in the habit of capturing them, either for their own use, as food, or for sale in Moulmein.

They breed in the month of "Tagoo," that is, about the month of May, or beginning of June. The nest is always built on the ground, and the female lays from five to seven eggs of a brownish olive colour, like those of the English pheasant, but perhaps somewhat smaller; the young male is at first like the female in colour, but apparently begins to gain his proper plumage after the first moult, and has it perfected by the end of a year. The general habitat of the species may be defined as the thick bamboo and forest jungle, which

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clothes the foot and lower slopes of all the hill ranges in the Tennasserim provinces of Burmah. The elevation above the sea cannot be great, but the vegetable productions of this tract of country agree well with those found at an elevation of about 2000 feet in the Himalayas.

Their food consists chiefly of white ants, but they also pick up the roots of plants, young shoots, and when ripe the *toungyar* paddy, or hill-grown rice. In the dry season they are found about the foot of the hills, wandering somewhat as water becomes scarce, but in the rains return to the hill-sides, from which I imagine they never at that time of year move far. In fact, judging from the habits of their congeners in the Himalayas, I should say they were inclined, unless compelled to move by necessity, to keep very much to the same spots on the particular hill-sides they most like. I have found the Sikkim kallege invariably returns to the same bough every night to roost, in spots where seldom disturbed.

The Burmese bird seems to be more gregarious than the Himalayan kalleges. My informant tells me he has seen as many as twenty to twenty-five together, but I should think that this was an unusual occurrence; four or five—perhaps a family of the previous year—would apparently be more usually met with.

Mr. Blyth, a well-known authority on such matters, mentions that some varieties of this bird are scarcely distinguishable from the Assam species of kallege, *Gallophasis Horsfieldi*, Gray, the probability being that where the two species meet in Arracan, individuals of hybrids will be found to occur, in every intermediate phase of plumage; since we know that such are common, where, as in Nepaul, the white-crested bird of Simla meets the black-crested one of Sikkim.

I was lucky enough, during a short stay at Thatone, a town in the Martaban district, some forty miles to the north-west of Moulmein, to see the way in which the Burmese capture the species.

A tame male bird, for which, if a good decoy, as large a sum as twenty-five rupees is sometimes given, is taken and pegged down to the ground in an open space, between three or four clumps of bamboos, on the hill-side frequented by the wild birds. The birdcatcher is led to the choice of a good spot by the recent signs of fresh droppings, or lately upturned soil. The tame bird has a range round his peg of a diameter of about four feet only. In a circle round him, at the distance of about six feet, a row of upright running nooses are fixed in a continuous line, while further off, at the distance of some ten or twelve yards, all likely openings between clumps of bamboos are guarded by other lines of nooses. Half an onion is

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then administered to the call-bird, and his ire being aroused by shaking the hand near him, when the bird-catchers retire behind some bushes within thirty or forty yards, and there await the result. If a wild bird is within hearing of the tame bird, the latter will make a peculiar drumming sound with its wings. Jerdon mentions this noise as being also made by the male of the Simla kallege, *Gallophasis albocristatus*, Vigors, but was not aware of the cause which led to its production. "The male often makes a singular drumming noise with its wings, not unlike the sound produced by shaking in the air a stiff piece of cloth. It is heard only in the pairing season, but whether to attract the attention of the females, or in defiance of its fellows, I cannot say, as I have never seen the bird in the act, though often led to the spot where they were by the sound."*

Each wild male is apparently "cock of the walk" of a particular portion of jungle, and on hearing this insult offered to him in his own domain, quickly pushes for the spot, in order to inflict speedy punishment on the daring intruder. By following the direction of the looks of the tame bird, who gets much excited, the wild one is seen to approach quickly until within a short distance of his adversary, whose looks he measures with no friendly eye, as he marches round and round, with feathers puffed out, until he looks twice his usual size, and gives utterance at intervals to angry notes of defiance. Nearer and nearer he comes, and if he does not, in his eager haste, get noosed whilst approaching, terrific is the battle that ensues, and feathers fly in all directions. The wild bird gets so excited that he speedily becomes absorbed, so intent is he on killing his adversary, in which he would doubtless succeed, did not the hidden Burman, anxious for the safety of his pet, throw a stone, which, dropping into a bush, scares the wild bird, who runs off in a hurry through the nearest opening, and gets caught in a noose.

In case the decoy does not begin to drum of his own accord, the birdcatcher imitates the sound with some feathers tied on a stick, which he rapidly twirls between the palms of his hands, so as to cause a humming sound. The effect of this is increased by the voice, and the result is an exact resemblance to the humming sound produced by the quick vibration of the wings of the bird. The sound immediately sets off the decoy, or brings the wild bird to the spot.

The sport is carried on by two men—one carries the decoy about, carefully muffled up in a cloth until wanted; and the other takes charge of the bundle of nooses, and a dhar, or heavy Burmese knife, with which to clear away the brushwood. If

* *Birds of India*, vol. ii. part 2, p. 533.

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after an interval of from ten minutes to a quarter of an hour no response is met with to the drumming of the decoy, the bird-catchers move off to try another spot. They are at times very successful, and catch three or four birds near one place, where plentiful. Of course, males are most frequently taken by this method; but females, also, turn up sometimes, and in paying a friendly visit to the decoy, get captured. They appear to be much more difficult to keep in confinement than the stronger sex.

The method of capture here described is practised in Burmah all the year round but with most success during the pairing season.

THE STREET ARCHITECTURE OF LONDON.

In our former article we feel strongly that due justice has not been done to Gwynn, for his *London and Westminster Improved*, in 1766; or to Mr. Haywood, for his admirable report made in the present year 1860; but we must not forget that we have undertaken to note down a few remarks upon the street architecture of our metropolis as now existing; in attempting which we have the advantage of the observations of a young Parisian architect, who has lately been consigned to us by letters of introduction, and to whom we felt it both our duty and pleasure to act as cicerone. It occurred to us that we could not better commence our duties than by taking our young friend Alphonse Fontaine to the summit of St. Paul's, for a bird's eye (*coup d'œil*) of our metropolis. There is always a great charm in a general view from an elevated position, and—*malgrè* the smoke from those abominable and reeking shafts in Lambeth—our friend was delighted with what he saw, and his first observation was, "What a charming effect from your atmosphere. With us on the Continent, everything is marked out clear, crude, and distinct; but here you have an atmospheric medium, which gives an effect to objects most agreeable and enchanting. It is what your celebrated Turner has obtained in his pictures—there is a medium between the spectator and the objects—an aerial effect, adding to the perspective and to the *chiaro oscuro* of the scene. But where are your domes beyond the one I am standing on? In the distance I see two gems at Greenwich; but those on what you term your National Gallery, your London University, and Bethlehem Hospital are mere *pimples*. In Paris we can boast of several noble domes, and hence the

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magnificent appearance of our city when viewed from any of the environs."

We had no excuse to offer, and contented ourselves with the apologetic reply that formerly there was a charming cupola upon the church of St. Benet Fink, and another very picturesque dome close by us over the College of Physicians, both of them the works of Sir Christopher Wren, and both lately demolished. There were two others to the westward, which we had no little difficulty in explaining to him were called "the Brompton boilers," but which the good sense of Parliament ordered to be taken down.

The young French architect, seeing our chagrin on the paucity of domes, good naturedly replied, "Well, but you compensate for them in your spires and steeples. What charming forms are those of Bow, St. Bride's, St. Magnus, St. Vedast, St. Dunstan's in the East, and even that humble one close upon us, St. Martin, Ludgate!" and when we informed him that they were all the works of Sir Christopher Wren, he exclaimed, "He was, indeed, an architect!"

The interior of St. Paul's did not excite so much surprise or approval from our companion, beyond being astonished at the aerial effect of the dome, and its *apparent* over its *real* magnitude. Of the embellishments and decorations now in progress he was silent, although it was explained to him they were the works of *foreign* artists. A shrug only was expressive at this announcement. The exterior excited more of our friend's praises than the interior, and the picturesque towers at the west end of the Cathedral, and the circular porticos at the north and south sides he greatly commended.

Instead of adopting the usual plan of dividing the metropolis, guide-book fashion, into certain districts, it was thought better to take the buildings according to their several dates, commencing with the early English and mediæval, then the classical, and finish with the Italian and Palladian. According to this arrangement, the Tower of London first excited the deepest interest in our young friend; Westminster Abbey he thought finer than Notre Dame, but in parts inferior to Amiens or Beauvais; he rejoiced to hear of the intended restoration of the Chapter-house. The Temple Church, and that of St. Bartholomew the Great, in Smithfield, completed the list of ancient ecclesiastical structures. Of the modern, in mediæval fashion, we pointed out to him the Catholic Apostolic, in Gordon Square; All Saints, in Margaret Street; and St. Alban's, in Baldwin's Gardens, as three of the most important of a legion in this style. The first and last of these he considered of the highest merit, and was somewhat surprised that mass had not yet been performed in them, and that they were not

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already under the jurisdiction of a Roman Catholic Bishop of London.

Of modern mediæval works, the Palace at Westminster of course stood in the first rank. Alphonse was some time before he hazarded the remark that the enrichments and ornamentations were laid on with too lavish a hand, and that, if some plain surfaces had been preserved, those portions which were enriched would, by contrast, have had an additional value. The Victoria Tower he considered as a *Capo d'Opera*. The buildings at the Broad Sanctuary he found most picturesque, and admirably adapted to the site, and the Crimean Memorial a most successful performance. The numerous attempts at mediævalism springing up so plentifully in all parts, excited the young French architect's greatest astonishment. He was told that by some it was called the Victoria school, to which he replied that it was well named, as it seemed to "*règne partout.*" Many shrugs of the shoulders were given as he passed these specimens of incongruous forms and elaborate workmanship rapidly in review, considering them generally as great monstrosities. The *Music* Hall in the Strand is said to be the crowning triumph of this school. My friend observed that its claims as to being a *chef d'œuvre* might be a question, but that, at all events, the architect had endeavoured to make it characteristic, and had shown his knowledge of the science of *thorough base*. There are, however, some specimens of this style which are deserving of praise; for instance, the schools in Endell Street, St. Giles's; some buildings on the west side of Bishopsgate Street; a house built for Messrs. Alexander, in Lombard Street; and more especially a house on the east side of Mincing Lane, near the south end.

Of Greek and classic buildings, we brought forward St. Pancras Church, in the New Road; the Propylean entrance to the North-Western Railway; the British Museum; and the Post Office in St. Martin's le Grand. The beautiful little façade and entrance to Melbourne House, Whitehall, may be added to the list.

We now approach the Italian and French school, and first of all stand the churches of Sir Christopher Wren, the several towers and spires of which had so delighted our young architect in his panoramic view from St. Paul's. With the interior of these churches he was equally delighted; the ingenuity displayed in adapting the buildings to old sites; the cleverness with which they are lighted; the appropriateness and freedom of the enrichment. The interiors, especially of St. Stephen's, Walbrook; St. Bride's; St. Laurence Jewry; and, more particularly, St. James's, Westminster, all impressed him with admiration at the genius of our great architect, and

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with utter astonishment that fashion and false taste unfortunately prevail so much at the present day, that some of these beautiful interiors have been martyred at the hands of the mediævalists. Our friend, we think very justly, remarked upon the bald and incomplete appearance of the exterior of St. James's Church, Piccadilly; surely, in so wealthy a parish and royal neighbourhood, the necessary funds might readily be subscribed for the properly facing the walls with stone, and the raising a glorious tower and spire, to become as great an ornament to this quarter of London as the matchless spire of Bow Church is to the City. The church of St. Mary-le-Strand, and the glorious portico of St. Martin's, both by Gibbs, made a most favourable impression on our visitor; but, on proceeding to Whitehall, the view of the Banqueting House raised his enthusiasm to boiling heat. He jumped and clapped his hands for very joy, and pronounced it to be one of the finest works he had ever seen, either for the grandeur of the pile or the refinement and exquisite delicacy of the detail. From this fragment, judge what the effect would have been if the whole of the intended palace had been completed! Both the Escurial and the Louvre would have been inferior to it! The National Gallery and Trafalgar Square of course formed the subject of some criticism; and when it was asked how long the pedestal *vis-à-vis* to George IV. had been without its equestrian termination, and Nelson without his guardian lions, we pretended a little deafness, and hurried on to Pall Mall; here we felt more at ease, and took some little pride and pleasure in pointing out the several palatial clubs. This is certainly London's first street for architectural effect, occasioned very much by the buildings being insulated, and not mere *façades*, and the lines of some (the War Office, for instance), being set back with a *cortile* in front. The "Travellers'," the "Reform," and the "Carlton" were particularly pointed out; the former seemed to bear away the palm for grace and beauty. St. James's Palace was regarded more historically than architecturally interesting; but, as for Buckingham Palace, I don't know how many shrugs of disappointment our friend made, and, when he saw the equestrian statue in the distance, high in air, and heard that it was the Duke, he was appalled at such an outrage. He recovered somewhat in being shown Bridgewater House, and Lord Spencer's, adjoining; the one quite Palladian, the other of Rome's best period. A long discussion ensued as to their rival merits, resulting perhaps in favour of Spencer House as being the more graceful of the two.

The Marble Arch, in Hyde Park, was the next object we viewed, and our young friend was so jocose in his criticisms upon this work that we were positively ashamed that he should

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have seen it. "What!" he exclaimed, "all this expensive material of marble, and no Quadriga, no statues, no inscriptions—nothing upon the columns but those wretched scrolled blocks which I believe are called trusses? If you are at a loss for a subject, send to Birmingham foundries for a car with a Victory riding over *Mayne force*. You need not wait till Sir Edwin and the Baron have finished Nelson's lions; for, as you prefer employing foreigners, we can spare you a corps of sculptors who would turn them out for you presto-presto."

Our companion, in his walk down Oxford-street, was much struck with the meanness of many of the houses at the south side of it, and suggested what a fine boulevard might have been formed when Oxford Road was converted into a street of shops. The Paris boulevards are about the most pleasing and agreeable thoroughfares of that most magnificent of all European cities, and our humble London does not produce one—a want which is ever to be deplored, as Tottenham Court Road, the Marylebone Road, the City Road, the Borough Road, and the thoroughfares leading from the Elephant and Castle to Lambeth, would all have been most applicable for the formation of boulevards. A detour from Oxford Street into Hanover Square was much to our tourist's taste. He considered the view of the Square and George Street, with the Church, as one of the most scenic in London; the street not being parallel, and several of the houses being built of red brick and stone dressings, in a quaint Queen Anne style, renders this part of London very picturesque. A ride from the Regent's Park down Portland Place and Regent Street elicited many remarks and shrugs of the shoulders from our observant companion. The first shrug was at the Lilliputian statue of the late Duke of Kent, at the termination of a spacious avenue. The new Langham Hotel could not be passed by without an observation of its gigantic size, putting all around into shade, and thoroughly extinguishing its neighbouring church and spire. The Circus and Regent Street were considered worthy of a much better class and style of house than what prevails. The Quadrant is not altogether a disagreeable feature, although it has been shorn of its colonnades.

Victoria Street, Westminster, now in progress, was seen by our young friend, who thought that in this case the houses were rather too high for the width of the street, and that at times we should feel it dark and gloomy. The buildings at the Grosvenor Place end, now being erected, are very superior in design to those in Victoria Street. They are quite French in character, with *Mansard* roofs, terra cotta enrichments, and ornamental zinc-work on the curbed roofs. Our friend thought that one of his countrymen must have been employed; but

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we believe that the Marquis of Westminster entrusted his London architect with the work with the request that the style should be Parisian in character. When completed, the Marquis will have every reason to be proud of his estate as being one of the most attractive in London. Montague House was much to our young friend's taste. The new Foreign Office and the *façade* of the Treasury elicited no favourable expression. The screen of the Admiralty especially delighted him, but he complained sorely of the removal of the columns to form side entrances. We do not think our young architect agreed with our boastful expression that Trafalgar Square was "*the finest site in Europe.*" It possibly might have become so had a Visconti been engaged on it; but with its National Gallery, College of Physicians, its puerile fountains, its pedestal without an equestrian figure, and the base of Nelson's Column still bare of the joint productions of the pet painter and the titled Italian sculptor, made us quite ashamed of our position as *cicerone*. Our friend saw our distress, and adroitly expressed his admiration of the statue and pedestal of Charles the First, and the fine portico of St. Martin's Church. The latter, he remarked, from its skilful arrangement of plan appeared to him infinitely larger than its real dimensions would warrant. The Charing Cross Hotel was found rather too *prononcé*, and the erection of the Eleanor Cross only to be excused on archæological grounds. Somerset House was next pointed out, and greatly delighted our friend by its grandeur of outline towards the Strand, and the exquisite detail of its enrichments; the *cortile* and *façade* towards the river he did not so much approve of, but the new portion in Wellington Street he considered as most successful. *En route* to the City, Temple Bar he thought inferior to the Porte St. Denis, but at the same time clever and picturesque. Fleet Street displeased him, and he asked us to compare a pretentious example of the fashionable Victoria style, exhibited in the Crown Insurance Office, next to St. Dunstan's Church, and a little architectural gem, the London and Provincial Law Assurance Office, on the opposite side—the one protruding in boldness of deformity,* the other retiring in delicacy and beauty worthy of a Peruzzi. Turning into Chancery Lane, young Mansard was quite charmed with the exquisite *façade* of the Law Fire Office, which, in his opinion, had more of the refinement of Vignola than any building he had seen in London. The Law Institution did not produce any favourable criticism, but the

* Our Critic will find many who dissent from his strictures on the Crown Life Office; but, having long made Architecture a profound study, and being the Author of one of our most beautiful recent buildings he is well entitled to be heard.—Ed.

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Union Bank, at the corner of Carey Street, he considered of great merit, and somewhat Parisian in character. Ludgate Hill was pronounced as a picturesque approach to St. Paul's, particularly in respect of St. Martin's Church, with its elegant and unpretending spire. The Railway Bridge was abominable, and we believe there was an expression of something very like *sacre* when it first came into view. St. Paul's has been already remarked upon. The neighbouring Hall of Christ's Hospital was much approved. The Post Office and Goldsmith's Hall were both striking; Guildhall by no means worthy of the first city of the world—the Continental Hotels de Ville eclipse it entirely. The *façade* of Mercers' Hall detained our young friend for some time, and we felt somewhat humbled at not being able to inform our inquirer the name of the architect. The Mansion-House he thought noble and striking. The Portico of the Royal Exchange met his approval, but the pretentious gigantic erection immediately opposite, and soaring above it, produced an exclamation which was anything but that of approval. Why the Bank itself should be so low a structure surprised him, but the circular end of the Bank, at Princes Street and Lothbury, excited the greatest delight; he considered it perfectly unique—a choice specimen of taste and genius. Adjoining Lothbury we found the New Auction Mart, quite Venetian in character, evidently by a master hand—the same, we believe, that has given us the noble *façade* of Munt and Brown's warehouse in Wood Street. The new Insurance Office, on the site of the former Auction Mart, was passed in silence; but the noble erection, the Sun Fire Office, at the corner of Bartholomew Lane and Threadneedle Street, was recognized as one of the most successful works of the most accomplished architect the present century has produced. Our young friend hardly knew which most to admire—the beautiful effect of the mass, or the exquisite taste of the ornamentation, the proportion of ornament to plain surface, and the character and suitableness of the ornaments themselves. Proceeding along Broad Street, a number of modern erections, mostly in stone, present themselves. They are not generally of great merit, save and excepting the Imperial Fire Office. The large pile opposite the City Club quite enraged our French visitor that so golden an opportunity should have been lost. "*Detestable!*" was all he muttered. The new National Provincial Bank, in Bishopsgate Street, put our friend in good humour. It is by the same talented hand that produced the Imperial. This is certainly one of the best attempts at classic architecture that we have in the Metropolis, and the liberal application of appropriate sculpture in the design gives an appearance of Roman magnificence.

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We must not neglect Lombard Street, which has been more changed of late by the architect than almost any other street in London. The London and County, Robart's, and Barclay's Banks are all solid and important structures, but why stone was not employed throughout in the two last we are at a loss to discover, for we feel quite certain that no question of expense interfered. The Royal Insurance at the corner of Nicholas Lane is a design that has evidently been carefully studied, and the enrichments are in a great measure Greek in character and feeling.

In Fenchurch Street, Mincing Lane, Mark Lane, Seething Lane, Billiter Street, Tower Street, many new buildings of importance have been built of late years, and many are still in progress; in their style it appears to be a race between the mediævalists and the Italian. The first revelling in colour, red, black, white, and yellow, with a superfluity of carving, in which the London sparrows will build many a comfortable abode; the other, the Italian, also indulging in much ornamentation, and looking rather to Venice than to Rome for examples. With the exception of polished granite, the sober colour of Portland stone appears to satisfy the designers.

We must not quit the City without a glance at the National Provident Office at the corner of Eastcheap, designed by the Professor of Architecture to King's College. It is a very striking building, and courts approval; the principal entrance is well and ably designed. The monument with its noble pedestal and happy termination excited much more attention from the Paris architect than the column and lionless pedestal in Trafalgar Square. We were glad to take boat after our long pedestrian exercise, and with an approving glance at Fishmonger's Hall. We had an opportunity in our voyage to observe the magnificent span of the centre arch of the Southwark Bridge, and what engineers are attempting to do with the *square* instead of the *arched* openings at Allhallows and Blackfriars; we observed also with much regret how much the Railway Termini next the banks completely crush and dwarf all the surrounding buildings. The embankment in progress of course was a source of great interest, and we agreed that from what we could judge, the work was poor and tame, and more suited to the banks of the Cam or the Isis than to the shores of old father Thames. The architect of York Gateway and Stairs would have adopted a bolder and more characteristic wall of masonry, and with a nobler parapet than the ill constructed one at Westminster Bridge Stairs. Landing on the Surrey side we had a good opportunity of observing the superb effect arising from the great width of the new bridge at Westminster and although the City Engineer, as a utilita-

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rian, considers that two bridges of a moderate width would be preferable to one wide one, we decidedly gave our vote here in favour of the broad guage principle. On looking over the parapet we hope we were mistaken as to a feeling of vibration.

The site for the new St. Thomas's Hospital was pointed out to our visitor, and the plan of the buildings explained to him. We believe he was more engaged in thinking of "Les Invalides" on the Seine, than the proposed pavilion hospital on the Thames, for "he made no sign." We returned by London's "silent highway" to London bridge, noticing a large stock of warehouses on the Surrey side with a Venetian façade next the river, and the fine old Tower of St. Mary Overys rose in far greater dignity than more recent piles. We completed our days' lionizing by taking our places from Moorgate Street in one of the comfortable carriages of the Metropolitan Railway, and our *underground* works, and particularly the station connecting the line with the Great Northern, were considered by our young friend as being of far superior merit to many of our works *aboveground;* the admirable plan and arrangements, the excellent and careful construction, and the good taste of the architectural features impressed our visitor with a strong feeling of admiration for the talent displayed by the engineer of this most important work.

Upon our return home in the evening we chatted over what we had seen; and with regard to the architecture of cities, I think we came to a cordial agreement that for the general view from the environs, domes, and towers, and spires are most desirable, as witnessed in the beautiful effects produced in the large eastern cities from the outlines of the domes of mosques and by the minarets. Our next point was that open spaces are indispensable, and that they should intersect or be in close continuity with long lines of thoroughfare, as in Regent Circus and Cavendish and Hanover Squares, in respect of Oxford Street. Perhaps the finest open space in London is Lincoln's Inn Fields, disgraced by three of the most inferior entrances, and the inlets from Holborn by *two turnstiles.*

That streets should not always be laid out at right angles, but that diagonal streets should be introduced as being favourable to the traffic, and as giving variety to the different points of view must be conceded. Nothing we conceive can be more monotonous than the laying out of New York in square blocks, *ad infinitum.* Lines of thoroughfare need not always be straight. The width of streets should not exceed eighty feet. Pall Mall appears to us perfection for a street with important buildings; an excess of width occasions the buildings to look low, and dwarfed, and are most inconvenient for passengers to

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cross. Paved covered ways, as in Paris, are most desirable. Having agreed upon these points, we now, to our dismay, approached the subject of public fountains, and our companion inquired why we had not pointed out in our rambles some of the many which he understood had lately been erected; we never felt more ashamed in being obliged to reply that we could not point out a single one deserving his notice, and that we had purposely avoided what we had hoped he had overlooked. Our friend saw our chagrin, and referring to the architecture of our recent buildings, he observed that he thought our mediævalists had run wild in their productions; that buildings of that style when carefully studied and not caricatured were most picturesque, and formed a pleasing contrast with the classic and Italian; that in respect of our Italian designs they were in most instances wanting in the careful study, which is expected from the hands of a travelled and accomplished architect.

The last day of our friend's visit was reserved for a *bonne bouche;* a *déjeûné à la fourchette* at Richmond; a visit of course to the Tunnel, and a white bait finale at Greenwich, with a previous two hours round the Hospital, followed by a glorious sunset, completely smoothed down all the little disappointments he had met with in our street architecture. We made our adieux at the London and Dover Railway Station, with a promise on our parts to make the return visit to Paris next year at the great National exposition.

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THE BLACK POPULATION OF THE BRITISH COLONY OF NATAL, SOUTH AFRICA.

A PRELIMINARY SKETCH.

BY ROBERT JAMES MANN, M.D., F.R.A.S.,
Superintendent of Education in Natal.

(With a Tinted Plate).

THE British Colony of Natal lies on the south-eastern coast of Africa, about eight hundred miles beyond the Cape of Good Hope, and reaches upwards to within a little more than two hundred miles of the southern tropic. It is a strip of land included between the high Drakenberg step of mountains, which forms the threshold of the great continent, and the Indian ocean. Its sea-board is one hundred and fifty miles long, and its depth from the sea to the mountains, an extent varying from one hundred to one hundred and forty miles.

Natal, thus placed, is the very middle of what Dr. Livingstone and the geographers have termed the "Kaffir zone" of climate, as distinguished from the Bechuana and Namaqua zones beyond the mountains. This zone was inhabited, before the land was visited by Dutch, Portuguese, or Englishmen, by a distinct race of people, whose direct descendants now form the black population of the Colony. The land was first seen by European eyes on the 25th of December, 1497, when the renowned Portuguese navigator, Vasco de Gama, touched at it on his first voyage to India round the cape, and named it the "Terra Natalis," in honour of the day. The soil was first trodden by British feet in the year 1683, when a crew of men who had been shipwrecked further north, near the spot now known as Delagoa Bay, made their way through it to the Cape of Good Hope. Three years subsequently a Dutch ship was wrecked where the Port of Natal is now established, and the stranded crew spent twelve months on the shore, and at last built a small vessel from the fragments of the wreck, and sailed away for the Cape of Good Hope, leaving, however, three Englishmen and a Frenchman behind. These were finally taken away, after a longer residence, by a Dutch vessel visiting the coast; but they carried with them reports of the place which led to the Dutch forming a settlement there in the year 1721. The settlement, however, was maintained for only a brief period, and then abandoned. In the year 1823, Lieutenant Farewell of the Marines in the progress of a surveying voyage, visited the site of the old settlement. On the following year he led

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ZOOLU CHIEFS.

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back a band of twenty Englishmen, who proposed to acquire territory there, through friendly negotiations with the native chiefs. These pioneer settlers maintained varying relations with the natives in the subsequent years, sometimes retiring southwards to avoid the consequences of disagreements, at others returning to the neighbourhood of the Bay now known as the harbour of Durban. Twelve years after their first arrival a party of Dutchmen came down from the mountains in the interior and joined them. Their successors founded the towns of Durban and Maritzburg in the year 1839, and from that time until the year 1842, there was a period of dispute and strife between the Dutch immigrants and the British Government, which claimed allegiance from them in consequence of their being emigrants from the Cape Colony. The dispute was finally adjusted in this year, and in the year 1845, the first British Lieutenant-Governor was installed in Natal.

When the Portuguese and Dutch first visited Natal they found the land thickly peopled by a black race of friendly and gentle temper. The race was divided into separate communities, which lived in a quiet orderly way under distinct chieftains. When Lieutenant Farewell came to Natal, in 1824, matters were greatly changed. A warlike chieftain to the North had drawn together many separate clans under his dominion, and formed them into an army of aggression. With this army he had moved down towards the south, subjugating the land, and either carrying away the remnants of the conquered tribes, to incorporate them among his followers, or driving them before him as scattered fugitives. The tribe which first began this career of conquest and absorption, was a small clan located some distance to the north of the Tugela. It was then known as the Zulu tribe, and accordingly in its aggrandized state it still kept the designation of Zulu. The warlike chief who struck out the bright idea of extended rule bore the name of Chaka, a name which remains a potent spell among the Kaffirs even at the present time. Wherever there was black mail to be levied, or an independent clan to be eaten up, this warlike chieftain led the short javelins and stealthy steps of his disciplined warriors, until by degrees his sway extended from Delagoa Bay in the north to the great river of St. John in the south, and Zululand became a wide kingdom five hundred miles across. When Lieutenant Farewell landed his small expedition in Natal, Chaka was at the summit of his power, and had a large military kraal on the banks of the Umhlali, twenty-five miles within the boundary of what is now the colony. A few fugitives of the original Kaffir tribes lurked in concealment in the bush, as the sole representatives of the once teeming population; culti-

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vating small patches of maize in hidden ravines, or living upon wild roots and shell-fish. Beyond the military posts of the Zulu conqueror the entire country was a desert.

After some preliminary negotiation, Chaka gave the English settlers permission to occupy territory at the Bay, and promised them his protection. One of the settlers, Mr. H. Fynn, was raised to the dignity of subordinate chieftainship. In the year 1828 Chaka's term of power came to a violent end. He was murdered at the instigation of his brother Dingaan, who thereupon proceeded to throw the royal skin over his own shoulders, and as one of the first acts of his rule, summoned all chieftains, who had shown fidelity to his brother, to appear before him. Mr. Fynn knew too well what this meant, to obey the summons; and retired with his followers beyond the Umzinkulu, until he was able to come to an understanding with Dingaan. He returned in 1831, and was then recognized by Dingaan as the "Great Chief" of the Zulu Kaffirs.

So early as the year 1827, refugee Kaffirs had commenced to return into Natal under the guarantee afforded by the presence of the pale faces. Some of these refugees came from the north, and some from the south. The influx now increased. In 1836 there were 1000 adult male Kaffirs in Natal, able to bear the shield and assegai, and paying allegiance to the English. Two years subsequently the white chiefs could muster a following of 2100 armed Kaffirs. The Kaffir population at that time numbered 10,000 individuals, men, women, and children.

It was in this year, 1836, that the party of Dutch emigrants, under the guidance of Jacobus Uys, Hendrick Potgieter, and Pieter Reiteif, descended into Natal by a central pass which Reiteif had discovered through the Drakenberg Mountains. From this time fresh accessions of Dutch rapidly flowed down, and a period of conflict between these Dutch pioneers, and the Zulu chieftain ensued; which, after a series of vicissitudes, ended finally in the year 1839, in the destruction of Dingaan, after a signal defeat of his regiments, and in the establishment of Umpanda, the brother of Dingaan, who had been for some time a fugitive in the Natal territory, as supreme chief of the Zulus. Umpanda assumed his seat on the principles of white alliance, and in the interests of peace. He paid a subsidy of 36,000 head of cattle to the Dutch when he began his reign.

The Dutch settlers in their turn became involved in disputes with the British Government, as has already been stated. When, in the year 1842, the Dutch flag finally went down before the British, and the Dutchmen within the Natalian territory became subjects of the British Crown, the friendly

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allegiance of the peaceful chief Umpanda was transferred to the new masters.

Umpanda still sits in his big royal kraal beyond the Tugela River, which has been established as the boundary that separates the British territory from independent Zululand, surrounded by his wives and children, and by his flocks and herds; and sends ambassadors over from time to time to confer with the Colonial authorities, and get their advice on matters of delicacy and difficulty. But Umpanda's days have not been altogether roseate ones. Umpanda is now a very portly potentate, and a martyr to gout. He has to be dragged about upon wheels, and when he enters upon a journey his attendants take off the front wheels of his travelling waggon, and slide the royal body up; and then lift up the waggon by sheer force to re-insert the wheels upon the axle. Now, an invalid and obese king, thus absolutely dependent upon the care of his people, is very convenient and satisfactory to peaceable neighbours, but, in another sense, not altogether qualified to fulfil the cravings of a glorious tradition. Umpanda and his cart do not glitter in young Zulu eyes, when young Zulu ears have heard of the stride of the conquering Chaka, at the head of his light-footed legions. Since Chaka's time it has been the custom to band all male Zulus above adult age into regiments, and to bring these regiments in succession to the royal kraals for service. The ordinary service consists mainly in building huts and fences, and in milking and herding the cows belonging to the king. The captains and chief men of the regiments reside in huts appointed to them by the king, but receive their daily food from their own people. They have a claim, however, to certain gratuities of cattle as a guerdon for the service.

In Chaka's time there was no difficulty about these gratuities; there was then constant war, and the spoils of the vanquished readily furnished the royal pay. Umpanda, on the other hand, has no extrinsic supply of this character to draw upon. He rules in the interest of peace, and has to rely entirely upon his own internal resources to meet the expenses of his state. Consequently, the chief men assembled at his place, commonly return to their kraals empty-handed, at the end of their terms of service. Some time since, as a measure of state economy, the king gave his eldest sons permission to found kraals of their own, and to go to reside in them. A natural result of this combination of circumstances has been that these kraals have come to be the resort of dissatisfied and disaffected men, who attach themselves to the persons of the young chieftains, and encourage them to set up on their own account. This is technically termed "living

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under the tiger's tail." Through a series of years the parties of the young chieftains have been waxing in strength, and the old king has been left more and more to his gout and his old councillors. The young chiefs have, of course, been growing more jealous of each other as they have waxed in power, and more especially as it has come to be known that Umpanda has inclined to favour his younger sons in preference to his first-born. In the year 1856 there was a great fight between the party of the elder son, Ketchwayo, and that of the younger brothers, in which Umbulazi and five others of the younger sons were slain. Since then the fortunes of Ketchwayo have been in the ascendant. The person of the old king is respected, and he continues to live, surrounded by his old men, at his kraal; but it is understood that he is now too old "to move," and is only to do "the thinking." Umpanda is "*the head*" of the tribe, but Ketchwayo is its "*feet*." Two others of the younger sons of Umpanda escaped with their mothers from Zululand at the time of the great fight, and are now living as refugees in Natal under the British ægis. The brothers who remain on the Zulu side of the Tugela are considered to be adherents of Ketchwayo.

One important consequence of this curious passage of Zulu history is, that the 10,000 Natal Kaffirs of 1836, have grown into 200,000 Natal Kaffirs in 1866. Year after year, more and more of the men who had primarily sided with the younger brothers, and more and more of the middle-aged and sedate Kaffirs who have longed for quiet and peace, have passed over the border as opportunity served them, and settled themselves down among the black subjects of the British Queen. These refugees are required to enter upon three years' term of service, whenever their presence is recognized; but sooner or later they all become absorbed into the following of one or other of the petty chieftains who are distributed over the land. There are certain districts set apart as reserves for these clans, where they are allowed to live under the condition of paying a small yearly hut tax to the Government, and yielding obedience to the magistrates and laws. But many of them have built their kraals on the lands held by private proprietors, or on the lands yet in possession of the crown. In the former case they pay a small rent to the landlord, or furnish an equivalent in the form of personal service.

The black population of Natal thus consists of numerous small tribes, living under their own separate chiefs, and scattered abroad over the face of the land, either in reserves which are set apart by the Government for their occupation, or as squatters upon the crown land and private estates. These tribes are primarily formed of the original natives of the

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district, who were driven away from their hill-sides at the time of the Zulu invasion, but who returned when the colony came under the protection of European occupation and British rule, and have since been largely reinforced by successive additions of refugees from Zululand, who were themselves for the most part, it will be remembered, originally drawn from the same aboriginal source. These people are now all liege subjects of the Queen of Great Britain, and already partake in a large measure of the advantages of British rule. But they are nevertheless still barbarians in the mass; and here, therefore, arises the most momentous and deeply interesting question, What is to be done with their black bodies and barbarous minds? what is to become of them in the future? There can be no doubt they will not remain where they are as barbarians. Nature herself, and the immutable laws of human existence, have decided that this cannot be; civilization and barbarism cannot continue to look into each other's eyes at close quarters. Whenever they have been brought face to face by circumstances, one of two things has always taken place—either the barbarians have disappeared from their place upon the earth, or they have been drawn within the civilized pale, and turned to account. Which of these fates is it, then, that is in store for these black tribes of Natal? Are they to find, under the altered circumstances of their land, and after their escape from the thraldom of a savage tyranny, extermination or a new life?

In endeavouring to catch the first faint whisperings of the answer to this question, the inquirer is met by a stubborn fact, which undoubtedly has its meaning. Up to this time the results of the meeting certainly has not been in the direction of the extermination alternative. The 10,000 Natal Kaffirs of 1836, are 200,000 Natal Kaffirs in 1866! Under the ægis of British protection, and in the face of European civilization, the black race of Natal has increased twenty-fold in thirty years. This certainly looks very much indeed as if there is no early extermination to be thought of. It looks, indeed, as if the other alternative is the thing that is in progress, and must be brought about.

Before entering further upon the consideration of what indications there are that the civilization and utilization of the Natal Kaffirs, are possible and in progress, it is absolutely essential here to get some clear notion of what the uncivilized Kaffir is, upon whom the civilizing operation has to be performed. We must pause for a passing glance of scrutiny at the raw material before we entangle ourselves too deeply in the processes of the manufacture.

The Kaffir who is found in Natal, is, upon the average, of

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somewhat lower stature than the Englishman; but he has a well-proportioned and well-developed frame, of slim rather than robust dimensions, and, as a rule, more fitted for the exertion of activity than of strength. There is more of the Mercury than of the Hercules about him. He has black wool upon his head in the place of hair, and very commonly he has the large protruding mouth, thick lips, and broad flat nose of the negro type of organization, as shown in the accompanying very characteristic portrait taken from the life. But occasionally he has the narrow aquiline nose, straight lip, long beard, retiring chin, and square prominent forehead of the European.

BUST OF KAFFIR.

His eye is for the most part dark, soft, and twinkling with merry humour, and his face stamped with an open, gentle, and amiable expression. The few observers who made his acquaintance before the days of Chaka's military despotism always spoke of him as being gentle and amiable in character.

The small-boned and slender limbs of the Kaffir, already alluded to, at once distinguish him from his cousins of the negro variety of the dark skinned African family. In young individuals and among the boys, the tapering, delicate arms and hands, slim legs, and slight feet are so remarkable that they catch the attention of the most careless observer. In all probability he has some substratum of the coarse-grained,

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light-hearted, and grotesque negro in his organization; but this organization obviously vibrates between that fundamental and some nobler type. His habits and tastes point to this conclusion as forcibly as his frame. His propensities are pastoral and nomadic. He loves to have fat oxen and grazing goats about his kraal, and to wander from hill side to hill side. A stroll of fifty miles is pastime to him in a fine season. He has an inherent impatience of constraint in any form. Chaka could never have made his invading and conquering armies out of negroes.

In his wild, free state the Kaffir goes entirely naked. He has no other garment than a bunch of strips cut from the skin of a sheep, a wild-cat, or a goat, and suspended from a slender girdle as a kind of diminutive apron. He wears, however, an apron behind as well as in front, and indeed deems the posterior one the more essential covering of the two. If he has had the good fortune to win distinction in the eyes of his chief, he puts on a collar of merit upon his neck, composed of the teeth and claws of the lion and leopard, or of the claws of the eagle, and circlets of bright brass upon his arms. In some instances a necklace of fragments of certain kinds of roots takes the place of the teeth and claws. He pierces the lobes of his ears with wide gashes, which he then ornaments with knobs carved out of fragments of bone, or uses as the depository of his snuff boxes constructed from tubes of reed. He hardly ever moves from his hut without having his buckler of ox-skin upon his arm, and a bundle of five or six assegais, and a knobbed stick, or club of hard wood in his hands. Most probably this habit was primarily due to the risk he was exposed to of having to encounter some fierce wild animal at any instant. At night he lies down on the floor of his hut, and there wraps himself in a well-greased ox-skin, now often exchanged for a woollen blanket of English manufacture.

Although the wild Kaffir has so scanty a wardrobe for the ordinary purposes of life, it must not, however, be supposed that he is indifferent to the graces of personal adornment. He has plumed and furred robes of considerable complexity for ceremony and for war. Our plate gives a portrait, from the life, of the Natal Government chief Ngoza, with four of his men, in heavy war costume, in front of his hut. Ngoza is sitting in the middle. His head-dress is made of circlets and pendants of furred skins, with a crane's feather on the crest; his breast-plate is a tippet of tails of monkey-skins. His apron is mingled goat-skin and monkey-skin, and his greaves are fashioned from the skin of the white ox. The tall plumes of the attendants are of the feathers of the crane. The shields are dried ox-skins very artistically stretched on wooden frames,

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and diversified by the natural white, black, and brown patches of the hide. Ngoza has a plume of scarlet ostrich feathers in his wardrobe, which he prepared on the occasion of the visit of Prince Alfred to the colony, at a cost of thirty pounds. Ngoza is not an hereditary chieftain. He has won his spurs by faithful service to the British Government. He was placed over a heterogeneous assemblage of refugees some years ago, and now lives in a large kraal within sixteen miles of Maritzburg, and assembles a considerable following under his command whenever any special service is required by the Government. He appeared before Prince Alfred with four thousand armed men, and entertained him with an exhibition of the native ceremonial dance on a very imposing scale.

The Kaffir women are certainly of inferior organization to the men. Occasionally young girls of a comely presence are encountered. But as a rule they are far more coarse and repulsive in their aspect than the men, and they always shrivel and wither at a very early age, unless when they take to the scarcely less objectionable proceeding of turning themselves into unwieldy bundles of fat. I incline myself to think that the life of inferiority and drudgery to which the native woman is born acts through successive generations upon her frame, and brings about a real degradation in her physical organization. The Kaffir is fond of his women, but he is fond of them in very much the same fashion that he is fond of the cows, for which he barters them away. The men reserve their thews and their energies for war and for the chase. They take care of the cattle, milk the cows, build the huts, and cut down timber with the axe. But with the exception of these light tasks, which are all honourable and dignified occupations in their eyes, they engage in no kind of labour. The women do all the real work of life. They till the ground, and sow and reap the grain; prepare the food; fetch the wood and water; keep the house in repair; and carry all the burthens. It is a matter of quite common occurrence in the open country of Natal to meet a young lord of the black creation marching along the path with an erect head and a jaunty step, his ankles encircled with little fringes of white skin,—that look as if they must necessarily soon bud with winglets to establish beyond all cavil his kinship to the messenger of the old classic Olympus,—and his hands filled with assegais, while immediately behind him march in single file three or four naked women bearing on their heads the load of his household gods; rolls of his sleeping mats; pots filled with beer; bundles of tobacco, and other prime necessaries that need to be transported in his steps. The young girls in their wild state go even more naked than the men. At festive times they are adorned with necklaces and

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anklets of beads, and with broad fringed belts of beads that are arranged not untastefully across their hips. When they become wives and mothers they adopt a matronly costume, which consists of a short petticoat extending from the waist to the knee. With advancing years the petticoated wives and mothers pass rapidly into petticoated hags.

Such, in general outline, is the nature of the raw material; such is the Kaffir of Natal in his wild state, and in his simple bodily aspect. There is something more to be said of what lies a little deeper than the outward skin, for barbarian as the wild Kaffir naturally is, he is nevertheless subjected to the influence of a certain kind of culture and training even in his most savage condition. His education properly begins even before he falls within the sphere of the white man's operations. This topic, however, must be reserved for a future occasion.

EXPLANATION OF PLATE.

The engraving represents the group of Ngoza and four of his attendants, alluded to at page 191. The background is formed of the chief's principal huts, in a large kraal near the Maritzburg Table Mountain. The engraving is made from a photograph by Mr. Bowman, of Natal, and is therefore a very exact representation of Kaffir military costume. The tails of the dress are formed of strips of furred skin, often spirally curled after they have been cut. The feathers have necessarily lost some of their distinctness and splendour in delineation, in consequence of movement communicated to their light pinnæ by the wind. The greaves on the chief's legs are not altogether up to the mark. The right thing is that they should be formed of the actual tails of white oxen! It is probable that oxen are not now slaughtered upon quite so large a scale in Natal as when hostile raids and war were more the order of the day; and hence even wealthy chieftains are put to some shifts to keep up a due appearance in the altered state of affairs. Ngoza has, as mentioned above, one head-dress, which he provided, on the occasion of Prince Alfred's visit, at a cost of £30. It is principally composed of ostrich feathers, dyed crimson. He did not chance to be wearing this particular piece of costume when the group of the engraving was taken.

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THE PLANET SATURN.

(CONTINUED.)

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

FROM an early period, irregularities have been remarked in the form of the shadows which the globe and ring mutually cast upon each other. As far back as 1792, Dec. 26, when Schröter was first trying his 13ft. reflector, he noticed a jagged outline to each of these shadows, which was confirmed, Jan. 18. —Next we find Lassell, during an "unequalled view," 1849, Aug. 3, describing the shadow on the ball as "evidently knotted or notched," as though there were mountains on the ring intercepting portions of the shadow, and "almost breaking it up into a line of dots:" an appearance which he again noticed with a similar opening of the ring, 1861. He had also seen it serrated, 1850, Nov. 21. So did De la Rue, repeatedly in the spring of 1861, and very distinctly April 7, with his 13 in. reflector and a very fine $4\frac{1}{4}$ in. achromatic; the "very irregular" outline was however figured by him as belonging to the edge of the shadow, not of the ring, as Lassell. So did Jacob several times, 1861, especially May 19, with $3\frac{7}{10}$ in.; he thought it might be an illusion from the apparent projection of parts of the shadow darker than the rest; an idea even more unintelligible than the difficulty which it professes to remedy. Lassell also at Malta, 1862, Jan., found the shadow a rough line. The little roughnesses, it is true, which Huggins suspected, 1862, especially May 18, on the S. edge of the dark side of the ring, always entirely disappeared, leaving a perfectly smooth edge, under powers of 600 to 950. But this, though it suggests caution, does not negative the previous testimony. The fact is sufficiently clear, and sufficiently perplexing. Such irregularities could only, it would seem, be occasioned either, 1, by corresponding unevennesses on the ring; or, 2, by a fretted and honeycombed structure of the surface of the globe; or, 3, by very great irregularity of refraction through the ring's atmosphere (that of the ball not being distant enough). Now, if the ring were studded with mountains of sufficient size, they would be very visible in its edgewise projection upon the sky, and, unless rotation is given up, would be distinguishable by their rapid motion from the lucid points so often mentioned. If a highly irregular surface of the globe were suggested, still our eye is never sufficiently far removed from the direction of illumination to see any marked effect in the form of the shadow; and the supposition of

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irregular refraction seems too extravagant to be admissible on such slender data.

But if we pass over this difficulty as insoluble, we have yet to encounter a still more obstinate one in accounting for the abnormal character of the shadow of the ball projected upon the ring. If the latter, considered as a whole, were an uniform plane, the shadow on it would have an elliptic outline, deviating more or less from parallelism with the edge of the globe, according to the greater or less difference between the direction of illumination and that of vision (an angle never exceeding a small amount), but invariably curved in the same direction as the limb, and perfectly smooth. That the ring is not an uniform plane we have seen reason to believe, and we are so far prepared to expect some slight deviations, but only such as would be consistent with the extreme thinness, not only of the ring, but even of its apparent protuberances, at the epoch of lateral presentation. Now for the facts.*

We have already seen that, as long ago as 1792, Schröter perceived an unevenness in the shadow, not only upon the ball, but particularly, he says, upon the ring, where it was especially distinguishable by a projecting portion of the light of A. The next mention seems to be by ♄, 1806, June 9, whose description of it does not, however, specify that feature of his diagram which would now be thought most curious—the reversed curvatures of the limb and its shadow. Then after a long interval, 1850, Lassell, Dawes, and Secchi saw the outline of the shadow slightly concave towards the ball. Dawes thought that it might be an illusion from contrast with the limb, or B might be wedge-shaped, though then it would be hard to account for its edgewise disappearance. Secchi referred it to a slight convexity of B, experiment proving that a very slight one would suffice; or in some degree, possibly, to difference of planes.—1851, Sept. 5, Bond I. found the outline straight, or a little concave. 9, Lassell ditto. 10, slightly concave. 25, Dawes found the shadow on A irregular.—1852, Oct. 5 to middle, Lassell (Malta) saw a "remarkable sudden projection" of the shadow in crossing Ball's div., and an elongated spot on B on the opposite (*f*) side, close to the limb, sometimes, but not generally, extending to the division; this, he afterwards perceived, was the germ of the coming shadow on that side, as our eye travelled across the direction of illumination at the opposition. 22, shadow on both sides ball: Bond II. 28, ditto; 2 *wings* on B also fancied: Bond II. Nov. 3, shadow on both sides; "what can this mean?" C. W. Tuttle; also B.

* Secchi alludes to Cassini and Messier as having inferred, from observation, a curved surface for the ring. I am not able to say whether this may signify anything more than the irregularities of the edge-view.

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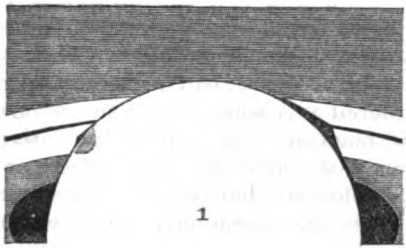

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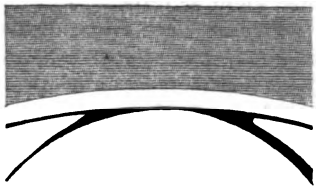

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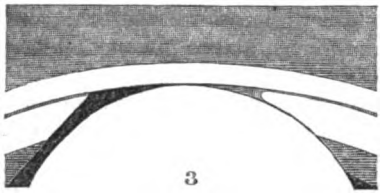

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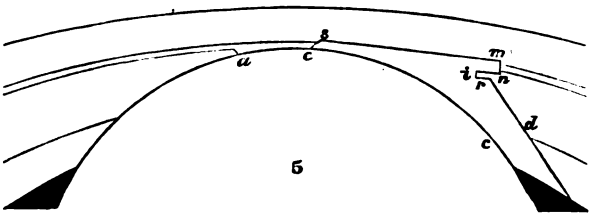

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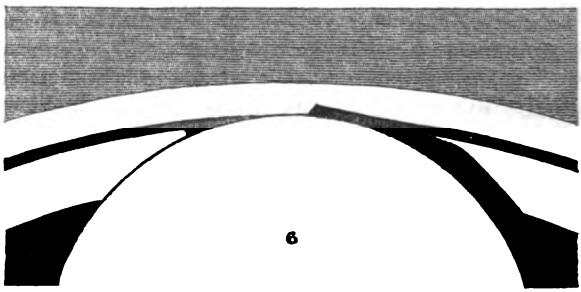

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II., and Nov. 4. 15, Lassell, the shadow had changed sides, and the "sudden projection" lingered as a similar spot *p*, so that there was shadow, though on B only, on both sides of the ball. In this month De la Rue drew the shadow *f*, with a strong discontinuity at the division, as though A lay above B (inverted). 29, on both sides, much plainer *f*; "This is very remarkable, but there can be no question as to the fact:" both like objects seen by mirage: B. I. See the diagram, Fig 1. The American memoir contains no less than 40 views in which some peculiarity of the shadow is represented, from which Figs. 1, 2, 3, 5, 6, 7 have been selected, with regret at the omission of many others equally curious, especially as the work is very little known in England. Dec. 1, *p* shadow seems to adhere to and partially overlap limb; in continuation of a dusky belt, but much darker: B. II.—1853, Jan. 8, a singular dusky spot adhering to *p* limb, as often before; *f* shadow almost makes a corner opposite to it, at Ball's div.: B. II. Oct. 24, 25, Nov. 2, Dawes saw little triangular spot *f*, just within division, considerable breadth of shadow *p*, concave to limb on B, convex* on A, and much further out on B than A, so as to make a notch at division, as though in two planes. [His drawing singularly like our Fig. 1, but reversed, and placing the small spot close to the division.]—1854, Feb. 12, and later, Hippisley observed the shadow on B conspicuously concave towards the ball, so that it should have passed over much of A, if in the same plane; this ring, however, was untouched: it seemed as though B had a convex surface. From computation and experiment he found that, allowing for polar flattening (which is material), the shade on A would have been hidden by the ball, especially if A were in the least above B. But he does not allude to the reversed curvature. Sept. 26, *p* shadow on B nearly straight; 29, a little recurved, with a small projection *f* close to division: Dawes. Nov. 23, S. region of globe (now coinciding with Ball's div.), or adjoining part of ring, singularly distorted. On each side of globe a slight shading on B, turning out right and left in 2 *corners* along division, which is quite flat between them: B. II.; Coolidge, with 5 ft., ditto. Nov. 26, Dec. 7, angular projection on both sides, up to Ball's div., something like our Fig. 2, but equally black and blunted on either hand. A unshaded: Dawes. 9, flattening of S. regions very evident: B. II. Later, and much finer air, a new distortion; *horns* of the two shadows certainly concave: S. edge of shadow (or Ball's div.) between them straight, and ball at S. edge encroaching in a protuberance

* The terms are occasionally interchanged by observers, the outline being sometimes referred to the enlightened, at others to the shaded part of the ring. The latter is always preferred here.

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upon A: S. C(oolidge), and another. 26, *f* corner decidedly darker than *p*, at times almost black; Fig. 2: B. II. *f* much stronger and blacker than *p*; *p* projects very little; ball seems to project upon A, which is a shade darker between the two corners: B. I. Mouse-coloured shading on A from horn to horn; ball less projecting upon A; *p* shadow less dark and visible; *f* increasing every way; black: S. C.—1855, Jan. 25, a nearly black spot *in* the *p* shadow [now much smaller than *f*]: B. II, S. C. Mouse-coloured shading of Dec. 26 not now to be seen: S. C. Feb. 28, *p* shadow scarcely discernible; *f* angular on A, encroaching on Ball's div., and "giving to the outline of that part seen on ring A and division of rings the appearance of a roof with broad projecting eaves:" S. C. Corner juts over upon division (but not on rings) like eaves of a roof: B. II. March 29, *s f* limb of ball straight in front of shadow; *s* sliced off; vision not very good: S. C. Spring, shadow across B straight or concave; different observers and artists differed as to form: Secchi. Nov. 9, shadow above S. limb "much less dark on the upper and right hand portions than on the left hand:" B. II. 13, *p* shadow straight; a faint shadow *f*, (Fig. 3): S. C. 26, both shadows concave near division, *f* most so; *p* straight everywhere else, even on dusky ring; adjacent limb also straight and distorted from inferior definition: S. C. [Ball overlapping A a little: S. C. 27, on the contrary, evidently not reaching division: Lassell. This seems to be the greatest amount of opening.] Dec. 6, both concave; *f* very narrow, and not so dark as *p*, which alone is seen on dusky ring, and seems to have a penumbra along outer edge; S. limb not distorted; encroachment of ball on middle of shadows may cause apparent concavity: S. C. 6, 12, a kind of "cornering:" Lassell.—1856, Jan 8, 10, outline reversed with low powers, yet illusion suspected [much as Fig. 2, but each side equally black and blunted]; "I am quite unable to imagine any section for the bright ring (compatible with its ascertained thinness) that would give such an outline to the shadow;" 22, 23, shadow convex all round S. limb, but with 2 *ears* where it crosses Ball's div.; exact form could not be made out, but rather triangular; seen distinctly crossing division, which was much paler than shadow, brown instead of black, and from form of shadow would seem below level of rings: Jacob (Madras). Feb. 4, shadow has *not* the reversed beak, and seems to extend upon A: Secchi. 28, outline changed since Dec. 6; more regular, and a slight projection upon A, but still corners at division; *p* faint and very small; *f* plainly seen on C: B. II. March 14, trace of *p* shadow at *a*, (Fig. 5); at narrowest part, *c d*, *f* is wider than C at minor axis; its "roof" overlaps division, and is projected on A; it

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slopes rapidly from *s* to *e*; "to the right the 'roof' protrudes over the shadow as it did last year; but now it overlaps both rings at *m* and *n*. The whole of this upper part of the *f* shadow is black, and darker than the rest, though the lower part is darker than the ring C, and well projected on it. Near its E. edge the shadow seems to be separated from the 'roof' by an *inlet*, *i n*, equal in depth to $\frac{2}{3}$ of *c d*, or even more." Ball does not seem to encroach upon division: S. C. [18, not at all: S. C. At greatest opening, division never seen in full breadth beyond S. limb: Dawes.] 17, roof less prominent, encroaching very slightly on A; point *r* fainter than rest of shadow: S. C. 18, roof decidedly blacker than shadow below it, but edge *m n*, till now abrupt and well-defined, seems to blend more gradually with division. *p* corner rather darker than before: S. C. 20, inlet seems rounded off on N. side; roof blacker than rest of shadow; *m n* again as sharp as ever; *p* shadow seems less prominent: S. C. 25, roof-like appearance noticed; *p* well seen: B. II. 27, limb appears straight across B, probably from its dark shade there; inlet rounded off and shadow faint at *r*; outline on B [by diagram] bent at an angle with that on dusky ring: S. C. 27, 29, De la Rue's second engraving brings *s* (Fig. 5) down to *e*, and makes *s m* a little convex; an *ear* like Fig. 2. projection on division not shown, the latter being black; shadow on B slightly concave, on C straight, and in a fresh direction; general effect, however, very similar. 31, curve of shadow expressly reversed; ring appears not plane: Secchi. April 1, never so perfectly defined before; powers to 1561; a narrow shadow over S. pole unites faint shadow *p* to black *f*; it is not the division unless refracted, because the two make an angle upon A at their junction. Roof concave to shadow near division in which it gradually disappears, without overlapping A or B; inlet rounded off, with some faint shade adhering; see Fig. 6: S. C. 2, "*l'ombre est assez curieuse, elle est renversée et ondulée;*" Fig. 4: Secchi. 4, curve reversed; a little shadow on A: ditto. 5, *p* shadow darker than division into which it blends; roof does not appear to project; is darker than rest of shadow, as black as open ansa; *f* follows regular curve of limb on B and C; inlet quite narrow, but deep as ever, and seems not rounded off: S. C. 19, shadow irregular. 25, remarkable discontinuity at division: Secchi.—1857, Jan. 1, almost exactly in opposition, no shadow visible except projecting ears crossing division, one on each side: Jacob. Jan. 13, shadow on B not black: B. II. 30, *f* shadow black, covering A except a narrow line: B. II. *p* concave and very faint; *f* black, pretty regularly curved on A, straighter on B and C; Feb. 11, *f* follows curve of ball on B and C, turns off abruptly on A: S. C. 12, faint shading *p*,

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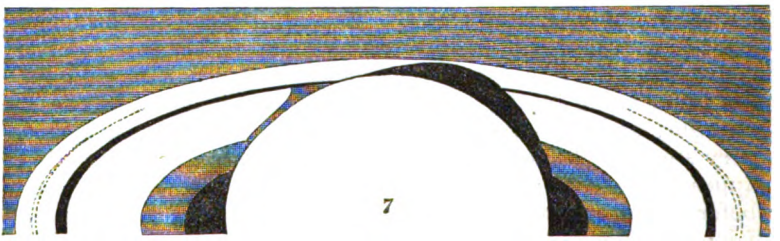
fainter than division, probably not reaching across B; *f* black, regularly curved on B and C, and not projecting at division as last year [opening of ring less]: S. C. 14, *p* very faint; *f* black, broadest at division and changing direction there, with a corner or notch, close to which division is darker: B. II. *p* seems darker and larger than Feb. 12, crossing B; *f* pretty regularly curved, a perfectly black spot in it where it meets division, not so dark elsewhere; this has the effect of breaking the curve. S. limb undistorted: S. C. Mar. 4, *p* very faint, all across B, slightly concave, and broad at division, which is plainly seen above it [and darker, in diagram]. *f* pretty uniform, but a small break at division, and 2 near apex. On this side of B "something that I cannot make out to my satisfaction. It seems as if there were a faint penumbra partly adhering to the division of rings, and partly to the shadow:" S. C. *f* black and more regular than usual; *p* a very narrow ghost-like shade, of the usual outline, all across B, broadest and darkest near division. "I was much impressed with the fact that the outline was preserved perfectly, while the intensity of the shadow was very



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feeble:" B. II. See Fig. 7. 16, *p* darker than before; *f* not perfectly regular: S. C. *p* by no means as dark as *f*, which is black: B. II. 26, *p* unaltered, *f* extends further E; its junction with division clear and sharp: S. C. Apr. 16, distortion of *f* on B suspected, but definition bad: B. II. 18, atmosphere bad, but *f* seems to be becoming concave on B again: B. II. 25, *p* distinctly visible over further half of B; *f* slightly concave on B; its breadth at division equals that of A at axis minor; at the crossing there seems a dark spot: B. II.*

Thus far extend our facts. Whall shall we say in explanation of them? Can we charge them upon personal or instrumental equation? It seems not possible, since, in the main, they are agreed upon in England, and Italy, and Malta, and India, and the United States. Some of the most singular statements, it is true, come from America alone. But as they

* Schwabe during this spring, noticed a strong convexity of the shadow on both A and B: meaning, apparently, the reversal of the outline.

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have often the concurrence of more than one observer, so the optical capacity of a telescope, which in favourable air would bear distinctly a power stated to be 1561 upon Saturn, leaves small chance of appeal. In fact, it is a remarkable circumstance that the mystery of the subject has increased under closer, more powerful, and more extended scrutiny. Some of the phenomena may admit of a more or less probable solution. For instance, the apparent concavity of outline might be explained as a deception, similar to those optical perversities so ingeniously illustrated by Mr. Proctor in our August Number; and a deficiency of shadow upon A would naturally follow from its lying in a different plane. But the "ears," projecting even when the true shadow was invisible,—the two shadows when, even after allowing for the planet's latitude, one only should have been seen,—the "roof," and "inlet,"—and the varying depths of shade in different parts, are alike too clearly attested for doubt, and too incomprehensible for explanation. We might take refuge to a certain extent in the idea of varied curvatures in the shadowed surfaces; and in order to meet the objection arising from the evanescent thinness of the lateral view, we might add a speculation as to the possibility of some force emanating from the sun, which might disturb the level of the surface, in proportion as its inclination exposed it to his influence. But even after we have ventured this daring effort, we find other features as intractable as ever. Some things look like effects of an atmosphere very irregularly distributed round the ball, and possessed of properties greatly dissimilar to those of ordinary gases; but this is undiscoverable, just where it ought to be most apparent, at the concurrence of outlines very obliquely inclined to each other.

We must therefore close this subject, already protracted to a wholly unexpected length—not, however, in despair of some better solution, but as commending it earnestly to the study of those who have the means and leisure for further investigation. It was not by recoiling from apparent impossibilities that the earlier inquirers won their way to such brilliant discoveries. It was not thus that the genius of Kepler carried him forward into the unknown, or guided him in "feeling the walls of ignorance, ere yet he reached the brilliant gate of truth." Or even if disappointment in one sense should wait upon such researches, they will bring with them in another respect their own recompense: "The works of the Lord are great; sought out of all them that have pleasure therein."

The object of the foregoing papers being to bring before the student, for his own comparison, as many original data as were accessible to the writer, the following additions and corrections may be permitted for completeness sake:—

1788, Aug. 2, ♄ suspected a little equatorial flattening.—1790. Feb. 1, ring

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reappeared brightest E: Cassini.—1792, Hl had occasionally noticed very small variations in the breadth of Ball's div. and the ring itself.—1840. De-Vico saw and measured excentricity.—1841. Schwabe saw Encke's div. 5 times; July 26, Sept. 11, on both ansæ. Ball's div. almost always plainer, or broader if less sharp and dark W. Sept. 21, indistinct, with a beautiful sharp image. His observations seem in some instances to connect its greater breadth W. with larger excentricity of ring E, as though A remaining unmoved with respect to the ball, B were somewhat displaced at those times: e. g. Aug. 19, div. only distinct W.; very large dark ansa E.: 20, div. plainer E. than W.; less difference of ansæ than 19. — 1842. Sept. 2, De-Vico, Ball's more distinct W. 5, do. E. 30, Oct. 1, best W. 17, very distinct, no subdivision whatever. 25, best W.—1843. July 14, Encke's plainest E. Aug. 6, do. W. July 19, Aug. 6, 8, Ball's broadest E. July 19, 29, two subdivisions broadest E. Aug. 6, 9h. 43m. three do. plainest W.; 10h. 18m. best E. 8, three do. best E. [Is it impossible that a careful collation of the positions of the satellites, especially Titan, at any given epoch, with these features of the ring, should lead to the discovery of some connection? A friend has suggested that the closest satellite, especially, must raise a wave in A, which, however, would hardly be visible to us.] —1848. July 11, both poles brighter than equator: Bond II. Sept. 11, 12, S. belt like clouds: Schmidt.—1850. Nov. 22, Lassell suspected Encke's on both ansæ; 23, 25, Dawes do. and 29, especially *f*. Nov. 23, Secchi and others saw C brightest W., without divining its real nature; and 1851, Jan. 19, slightly broader W.—1850. Dec., when Hind first saw C, it was very narrow, and much plainer E.—1851. Oct. 26, Dec. 6, B and C not divided; 30, C broadest and most distinct W.: Secchi.—1852, Aug. 31, C fades away, so that its half next B is invisible: Tuttle. Nov., De la Rue's fig. shows shadow of A very faint on N. ball. 29, ball nearer outer edge of C, *p* than *f*, to eye; by microm. 4″·26, 5″·25, B. I. Dec. 15, div. on *p* side of B: Breen and another.—1855. Some nights in spring, Ball's broader before than behind globe; Secchi.—1856. Mar. 27, Apr. 5, 1857, Feb. 14, faint penumbra on *sf* limb: S. C.—1857. Jan. 30, do. either on S. limb or on ring in close contact: B. II.—1861. Nov. 15, blackish irregular patch on ball: Secchi.

THE FLORA OF IRELAND.*

THE British Association for the Advancement of Science, at the meeting held in Bath, appointed seven gentlemen as a committee, for the purpose of investigating the distribution of the Irish Flora, with £25 at their disposal. This sum has been judiciously applied towards the publication of a work, entitled *Contributions towards a Cybele Hibernica,* under the editorship of Dr. D. Moore and Mr. A. G. More.

This royal octavo volume of 460 pages, which has just appeared, will excite some amount of interest in botanical circles, for our knowledge of Irish plants has greatly increased since the publication of Mackay's *Flora Hibernica* in 1836, and not only have many species been added, but others have become better understood, whilst the range of many has been greatly extended.

In the introduction to this work we are favoured with

* *Contributions towards a Cybele Hibernica, being Outlines of the Geographical Distribution of Plants in Ireland.* By David Moore, Ph.D., F.L.S., and Alex. Goodman More, F.L.S. Dublin, 1866. Royal 8vo., 460 pp.

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some details as to the climatical condition of Ireland; the mean annual temperature of the whole island is stated to be above 50° Fahr., being about the same as that for the south of England. But this moist and equable climate, and the comparatively low range of temperature does not give rise to such a diversity of forms as occurs in a like area in Great Britain. And though the ripening of corn and fruit is later and more uncertain in Ireland than in England, and wheat often a precarious crop, yet, on the other hand, many plants thrive and flourish there which would be killed by the cold dry frost of an English winter.

We regret to find that in the work before us no attention has been given to the physical features of the island in their relation to the distribution of plants; and the reader is simply informed in a few lines of the general character of the surface of the country.

Lists are given, enumerating the species which belong to the several types of vegetation in Great Britain, thus:—

I. Of the Hibernian type, *Helianthemum guttatum, Saxifraga Geum, S. hirsuta, S. umbrosa, Erica mediterranea, E. Mackiana, Arbutus unedo, Dabeocia polifolia,* and *Pinguicula grandiflora,* ally the flora of the S.W. and W. of Ireland, to that of the West and South of Europe, and range, under an exceptional climate, to a higher northern latitude than on the continent. With these are associated *Erica ciliaris, Sibthorpia europœa, Euphorbia hyberna, Simethis bicolor, Adiantum capillus-veneris,* and *Trichomanes radicans,* which occur also in Britain.

Sipiranthes gemmipara, Sisyrhinchium anceps, Naias flexilis, and *Eriocaulon septangulare,* the latter being also British, "point to a former connection with North America."

In addition to the above-mentioned species, which occur in Ireland, but not in Great Britain, the following make up a total of 22:—*Arenaria ciliata, ? Saxifraga Andrewsii, ? S. hirta, ? S. affinis, Inula salicina, Neotinea intacta, Potamogeton longifolius, P. sparganiifolius, Carex Buxbaumii,* and *Asplenium acutum.*

II. Of the plants classed by Mr. Watson under his Atlantic type, 41 out of the 70 are also Irish.

III. Of the species belonging to the Germanic type of vegetation, 18 only out of 127 have been found wild in Ireland. The majority of these are confined to the eastern counties, but *Monotropa Hypopitys, Astragalus Hypoglottis, Teucrium scordium,* and *Bromus erectus,* occur also in the west; *Orchis pyramidalis* being distributed sparingly over a large portion of the island.

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IV. The Alpine type of flora is represented by 40 species, only a little more than a third of the 113 of Watson's Highland type, most of which occur in the west and north.

"Some of the species, as *Draba incana, Dryas octopetala, Galium boreale, Arbutus uva-ursi, Sesleria cærulea, Lycopodium selaginoides,* and *Isoëtes lacustris,* occur in many places at, or a little above the sea-level, so that they cannot be termed highland species in Ireland. It is probably in consequence of the vaporous atmosphere, and the less amount of sunlight, that these plants are found at a lower level than in Scotland."

V. The northern plants, namely, those belonging to Watson's Scottish and Intermediate type, amount to 66 out of 117. Of these, *Trollius europæus, Geranium sylvaticum, Ligusticum scoticum, Melampyrum sylvaticum, Lamium intermedium, Salix nigricans, S. ambigua, S. laurina* and *Equisetum umbrosum* are confined to the north; whilst *Helianthemum canum, Potentilla fruticosa, Gentiana verna,* and *Ajuga pyramidalis* are species of the west, and *Allium scordoprasum* is met with only in Kerry and Cork.

Mr. Watson represents the flora of Great Britain as amounting to 1425 species, which has been increased, say, to 1435; of these Ireland claims about 950, to which are to be added the 22 species which occur in Ireland without reaching Great Britain, and "with the addition of *Hieraci* and *Rubi,* the whole flora may be computed at about 1000 species, thus amounting to little more than two-thirds of the plants found in Great Britain."

The authors then proceed to point out the deficiencies of the Irish flora, amongst which we notice such common British plants as:—*Genista anglica, Galium cruciatum, Helianthemum vulgare, Ranunculus hirsutus, Ononis spinosa, Plantago media, Paris quadrifolia, Valeriana dioica,* and many others of an extended latitudinal range in this country.

The island is divided into twelve districts, as shown by a map, particulars of which, such as the elevations of the highest mountains, and the more remarkable plants in each, are given. The districts are as follows:—

I. Kerry and South Cork.
II. North Cork, Waterford, South Tipperary.
III. Kilkenny, Carlow, Queen's County.
IV. Wexford and Wicklow.
V. Kildare, Dublin, Meath, Louth.
VI. Limerick, Clare, East Galway.
VII. North Tipperary, King's County, Westmeath, Longford.
VIII. West Galway, West Mayo.
IX. East Mayo, Sligo, Leitrim.

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X. Fermanagh, Cavan, Monaghan, Tyrone, Armagh.
XI. Donegal and City of Londonderry.
XII. Down, Antrim, Derry.

The introduction concludes with a table, showing the distribution of the plants in the districts.

The *Contributions towards a Cybele Hibernica* present the features of a good "Local Flora." The materials are arranged somewhat after the plan of Mr. Watson's *Cybele Britannica*—whence the title. The natural system is followed; the technical and popular names of each species are given; as also the districts in which it occurs; its habitats, time of flowering, and when known, its altitudinal range; in the case of rare plants localities are enumerated.

The body of the work is interspersed with observations on the many species discarded as Irish, either because they are not considered natives, or have become extinct, or because about which no authentic information or specimen has been obtained.

There are good indices to the Latin and English names.

From a glance at pp. vi.—xv., we gather that the editors have had a paucity of material at their command, and perhaps they have experienced a reluctance on the part of authors and correspondents to avow errors of determinations. These circumstances have clearly entailed on them much field investigation.

Too much praise cannot be accorded to Dr. D. Moore and Mr. A. G. More for the successful issue of their meritorious labours. They are, however, aware of the incompleteness of this production, and appeal to the botanists of Ireland "to assist them in the preparation of a more complete work," adding that "there is an ample field yet open in the exploration of the flora of their native country."

One interesting branch of study is recommended—"The upper and lower limits of the elevation of plants," regarding which, it is very properly observed, "that little is gained by the statement, that a species descends to sea-level in *one* district, while it ascends to 3000 feet in *another;* it is only by comparing both upper and lower limits in each different range of hills, or at least in each of the chief groups, that any useful results can be expected."

Cybele, as employed by Watson to express the distribution of plants upon the earth's surface, and adopted in the present work, is somewhat misapplied. The volume "is merely a revised list of the wild plants of Ireland, with a classified summary of their localities;" it deals in no generalizations, and is inferior in many particulars to some of our good Local Floras.

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The association of plants with certain kinds of soil is not even alluded to, although the way has been led by Mr. Foote,* who has shown that in "The Burren," county Clare, as in most districts, there is a close connection between botany and geological strata; and Mr. Tate† has pointed out the peculiar attachment of many species in the north of Ireland to certain rocks and soils. As the *Cybele* is but the sum of all the local floras, so we may reasonably expect that facts of this kind should have been collated, and some general law have been deduced.

If some regard had been paid to this department of the *Cybele*, the parcelling out of the island into districts would have been made more in accordance with the physical and petrographical features of the surface than has been done. Such an investigation has led the writer to differ from the authors who attach the county Down to the counties of Derry and Antrim to form their District 12. Now, geologically, Down is very differently constituted from Derry and Antrim; in the former palæozoic rocks prevail, yielding light and warm, and, in a few localities, calcareous soils; whereas the basaltic rocks occupy the greater portion of the surface of Derry and Antrim, with keuper marls and liassic shales beneath the escarpments of the volcanic masses. The soil of this area is cold and heavy, excepting here and there along the coast, where sand and gravel are met with, in which case a marked group of plants accompany the same. Much of the district is, moreover, elevated above the agral zone, and is greatly encumbered with wet peat bogs; in the county Down, this is not much the case, and the surface is varied by the occurrence of swamps.

In the *Cybele* I find that 112 species are recorded in the counties Antrim and Derry, which are unknown in Down, and that 25 species met with in that county are wanting in Derry and Antrim; the number of species in common being about 650. This partial incommunity of species between Down and Antrim is real, and cannot be reasoned away on the grounds that the latter county has been better worked; it is due to physical features, soil, and geographical position. For it is significant that the county Down is richer in species of the Germanic and English types of vegetation, whilst Antrim and Derry contain a superior number of Scottish and Highland plants; some of which, however, though eminently characteristic of the northern counties, pass into Down, and *vice versa*. As, for example, *Lamium intermedium* (the frequency of the occurrence of this plant appears unknown to the editors), which occurs from Magilligan, county Derry, along the coast

* *On the Distribution of Plants in Burren.* Trans. Roy. Ir. Acad. 1852.
† *Flora Belfastiensis.* 1863.

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line to Belfast, and inland at Bellaghy, county Derry, is met with on the light sandy soils of the county Down, in the immediate vicinity of Belfast, but extends as far south as Newtonards.

The incongruity of including Down in District 12 is manifest; it should—at the very least, its southern half—form part of District 5; or, with a portion of Antrim, and with Armagh and Louth, constitute an additional district.

It appears objectionable to separate the S.W. shore of Lough Neagh from District 12; the basin of the lough, and the area drained by the Lower Bann constitute a natural district; and if it be impracticable to unattach it, the whole of it should certainly form part of District 12. By this arrangement, such a restricted plant as *Calamagrostis stricta* would belong to one district, as it naturally does, and not to two, as now.

The *Cybele Hibernica* is remarkably deficient in generalizations; there is no comparison with neighbouring floras, and no allusion is even made to the late Prof. Forbes's *Origin of the Flora of Ireland.* This certainly is a disappointment, inasmuch as doubt had been raised as to the correctness of Forbes's premises, whereon he established that masterly essay on the sources whence the flora of Ireland, as well as of Great Britain, was derived; and it is not unreasonable to suppose, considering the care the editors of the *Cybele* have bestowed on the thorough investigation of the plants that have come under their notice, that they are in a position to test the soundness of Prof. Forbes's conclusions.

Another edition will be required, if the workers, which this publication will undoubtedly raise up, will respond to the solicitations of the authors, who repeatedly direct the reader's attention to the paucity of species in Districts 7 and 11. The labours of the writer during a few weeks of the summer of this year, have added *Medicago sativa, Helminthia echioides,* and *Myriophyllum alterniflorum* to the list of District 12, and have furnished new localities of species thought to be rare. He offers the following few remarks by way of addenda and corrigenda:—

Is *Ranunculus pseudo-fluitans* not merely a state of *R. peltatus?* The two grow in the Bann, at Coleraine; the former in the rapids, and therefore without floating leaves; the latter in still water, where floating leaves are developed.

It is stated that "the two sub-species, *Fumaria pallidiflora* and *F. confusa* have not been sufficiently distinguished, but appear to be about equally distributed." The latter is generally distributed in Antrim and Derry, but always on light soils; the latter is rare, and has occurred to me at the Curran of

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Larne, Carnlough, Cushendall, and Toome Bridge; all the localities in Antrim.

Lavatera arborea occurs in many stations on the east coast of Antrim, always by houses, and has no claim, in District 12, to rank as a native.

Geranium pratense grows at Dunluce and Port Ballintrae, and not *G. sylvaticum*, as suspected in the *Cybele*.

Myriophyllum alterniflorum is common in Antrim. *M. spicatum* is rare.

Arctium intermedium is a common plant on the Antrim coast; *A. minus* was not seen.

Orobanche rubra is not confined to the basalt in District 12. It was gathered on White Limestone, at Ballintoy, and at Ballyvoy, near Ballycastle.

Helminthia echioides grows wild on Island Magee, District 12.

Calamagrostis stricta, confined to the shores of, and islands of Lough Neagh, was discovered in profusion on the shores of Lough Beg, county Derry.

There is no value in retaining localities whence species have long since been eradicated, and where there is no possibility of their reappearance; preserve the record, but do not confuse collectors by the insertion of erroneous references. In the volume before us are too many examples of this kind, which, we presume, have been inserted through ignorance of the present unfitness of the locality for the growth of the species. *Typha angustifolia* does *not now* grow near Belfast. The ditch near the Belfast Linen Hall, where, in the last century, *Lemna gibba* grew, has many years been filled up.

In several instances the locality of a species appears under two or three names. This is decidedly objectionable, for not only is the bulk of the volume increased, but an erroneous impression as to the frequency of its occurrence is produced. Thus, the locality for *Rosa Hibernica*—"hedges on the shore near Holywood, Belfast Harbour"—postively includes "hedgerows half way between Holywood and Belfast" of one, and "Hedge, Tillysburn" of another author.

Despite the aid rendered by two eminent London botanists in the revision of the proof-sheets, there are very numerous errors, both of omission and commission, in the volume.

R. T.

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CHACORNAC ON COMETS.

THE following is a translation of a paper for which we are indebted to M. Chacornac. It forms part of the *Recherches d'Astronomie Physique*, which he issues from time to time:—

"Since the great comet of 1811, it has been known that the nuclei of comets as they approach the sun dilate into vaporous atmospheres, to a certain limit, uniformly round the nuclei, since if that limit is passed, these atmospheres are compelled, by the action of an unknown force, to flow back on a level surface, in the prolongation of the *radius vector*, with a velocity nearly equal to that of light.

"In seeking to interpret this grand phenomenon of nature with the aid of simple physical laws, we are led to the following conclusions. If no repulsive force emanated from the sun, and opposed their dilatation, these cometary atmospheres would extend in all directions, at least as far from the nucleus as the extreme length of the tails, since the dilatation of a gas in a vacuum appears to be indefinite. The rapidity with which these atmospheres are developed is such, that even at a temperature such as that of the earth's surface, it would be considerable.

"The aigrette of the comet of 1862 extended through a length equal to four times the diameter of the earth in an inappreciable time, since the first trace of this jet, though weak, was observed throughout the whole extent the moment it was perceived. This fact shows that the expansive force of the gaseous matter is great enough to produce effects like those repulsions which arise from elevation of temperature, and we are naturally led to conceive of similar actions in the solar photosphere.

"If we consider what must occur at the limits of the pressure of the exterior atmosphere, where the force of gaseous expansion exceeds the attraction of the solar mass, it would seem that the gaseous matter heated by the photosphere would overflow into the vacuum of space. The behaviour of the sun's external atmosphere appears in perfect accordance with this consequence of the physical causes in operation. Thus above the purple zone (*zone pourprée*), which appears contiguous to the photosphere during total eclipses, a zone of dense atmosphere is constantly noticed which reflects a brilliant light, and on this account has frequently been confounded with the reappearance of the disk on its emersion. It is from the external surface of this atmosphere that those rays of the solar aureole spring, the configuration of which indicates tho expansive force of gases projected violently into planetary space.

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"If we calculate the velocity of outflow with which a gas precipitates itself into a vacuum, we find that at the pressure of our atmosphere, and at a temperature of zero, it is greater than that of a cannon-ball; and, in fine, it is demonstrated that the pressure is insignificant in determining the velocity of the flow of different gases, which depends on their density only, and is greater as the density is less.*

"If these considerations are applied to the question of the limitation of planetary atmospheres, it will be seen that it is possible that at the temperature of planetary space there may be an equilibrium between the weight of the external atmospheric layers and the elasticity of those below them, but this cannot be the case with a vaporous atmosphere exposed to a temperature of many thousand degrees. Moreover, for an external layer to press inwards from its weight, we must conceive that it can no longer dilate itself in the vacuum of planetary space, that is to say, it must be more dense than what is beyond it. This last consideration affords mathematical ground for regarding the external layer as *crystalline*,† in order to comprehend how any atmosphere—like that of the earth—can be limited.

"At the surface of the sun such an hypothesis is not admissible, and, moreover, in the phenomenon of re-incandescence, seen in the photosphere, there must evidently be a repulsive force acting upon gases, and producing violent dilatation according to laws which are not known. We do not know what forces of dilatation would be developed at such enormous temperatures, but it is incontestable that the radiating aureoles of the sun point to a projective force acting outwards, and shooting forth perpendicularly to the solar periphery masses like innumerable and very dilated aigrettes of comets."

M. Chacornac appends sketches of aigrettes formed by the comet of 1862.

* "Et enfin ou demontre que la pression est insignifiante pour la vitesse d'écoulement des différents gaz, que celle-ci est dependante de le densité des gaz seulement, puis-ce-qu'elle est autant plus grande que la densité est moindre."

† We have before had occasion to notice the peculiar sense in which M. Chacornac uses the words crystal and crystalline. We must either suppose the elasticity of the atmosphere to be limited, or we must imagine such an arrangement of its particles as to give rise to, or be acted upon by, opposing forces. Why this should be called a crystalline state we do not see.

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A STRANGE PLACE FOR ROTIFERS.

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

One of the Hon. Secs. of the Microscopical Society of London.

In the writer's garden hangs a Mason's hygrometer, or wet and dry bulb thermometer. The supply of water to keep the wet bulb moist is held in a small glass vessel about one inch in diameter, and rather more than that in height, and having a short neck, just wide enough to allow some threads of lamp cotton to hang freely through it. It may therefore be described as a small glass, squat bottle, loosely stoppered with lamp cotton. Every two or three days in warm dry weather, and every two or three weeks in wet weather, this vessel requires replenishing, which is usually done by holding it under a tap, and suffering the stream not only to fill, but to give a good washing to the cotton and to the vessel. When the cotton is dirty it is removed, and fresh supplied. No green matter of any kind has grown in the vessel, and very little atmospheric dust could find access to it. Under these circumstances it could not be expected to be a favourable place for any kind of infusoria, but in August the cotton fibres became slimy without getting discoloured, and this circumstance led to a microscopic examination. There was no decay in the cotton fibres, and very little extraneous matter adhering to them, but the slimy matter resulted from the presence of a considerable number of infusoria, among which were many rotifers of small size and of the common sort.

The chief infusoria in point of numbers were monads of minute dimensions, some swimming freely with a jerking motion, and others jumping violently without much change of place. With the help of Smith and Beck's one-twentieth and first eyepiece, giving a magnification of 1000 linear, it was seen that these little objects were provided with single tails or filaments, and were able to adhere to the glass by the extremities of these organs, and being thus moored fast to a fixed point, they executed a series of jerking jumps in all directions, with great liveliness. The body of these little monads was white and pear-shaped, about 1—8000″ in greatest diameter, and more or less filled with smaller cells. The tails or filaments were exceedingly fine, and four or five times the length of the bodies. A few small ciliated infusoria were also present. The rotifers were numerous and very lively, though apparently stunted in growth by the limited supply of food.

Part of the cotton was transferred to a Preston salts bottle filled with cistern water, and left uncovered, so as to catch

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floating dust. The consequence was that in a week or two much more organic matter was present than had been in the hygrometer vessel, but this did not lead to increase in the rotifers, which on the contrary decreased, although some new animalcules (trachelius, etc.), made their appearance, and one very delicate round, empty test—probably of a difflugia—was observed. This was curious on account of its being covered with what appeared to be microscopic crystals of carbonate of lime.

As it cannot be supposed that clean undecayed fibres of cotton were devoured as food by any members of the colony, they must all have lived on the very minute quantity of other organic matter present, and either in decomposition or growth. The monads were probably vegetable, though possibly animal. They appeared to form the food of the rotifers, and had nothing noticeable to live upon.

This accidental experiment affords an illustration of the fact that very minute quantities of organic matter in decay are sufficient to lay the foundation of, and for a time support, a numerous infusorial colony, which may include objects of comparatively high organization. The wind may have carried small rotifers, or their eggs, on to the cotton; or, which is more likely, one may have been imported in the cistern water with which the hygrometer vessel was filled; and, notwithstanding the limited supply of food, the creature and its progeny flourished for many weeks.

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FAMILY LIFE OF THE MIDDLE CLASS.

THE good qualities of the English middle class, as developed in their family life, are amply recognized; indeed, an exaggerated estimate of them too often occasions a blindness to very striking, if not perilous, defects. The term "middle class" usually designates those families whose income is, wholly or chiefly, derived from personal exertion in trade, commerce, or a so-called "learned profession," and this description will be sufficient for the purpose of this paper. The family income in this great section of the community may be supposed to range from two or three hundred to as many thousands a year; but there are many whose resources are smaller, and others who are able to rival and exceed the expenditure of the wealthiest houses of the aristocracy. Social custom divides the middle class into several grades, partly on the ground of diversity of wealth, and still more on that of occupation. As a rule, retail trades are held to be inferior to those that are wholesale, and it is thought to be "genteel" to sell goods in a warehouse, and comparatively "vulgar" to sell them in a shop. The greatness of London tends to swamp many minor distinctions, and hence the popular estimate of the dignity or inferiority of occupations has less action in the metropolis than in smaller towns. The fashionable world rigidly excludes from its private assemblies all who are known to be guilty of the serious offence of dispensing articles in small quantities. Mr. Jones, who sells cotton in the bale, is admissible; Mr. Thompson, who will accommodate his customers with a skein, could not possibly be tolerated. This exclusion of retailers is more or less broken into when the shop is in the city, and the family reside in a villa a few miles off.

In small towns the artificial distinction of social grades has more rigidity and completeness. One or two successful professional men are allowed to visit "county families," and the same high powers will sometimes look benignly upon a local merchant, if his transactions are large. In such towns it frequently happens that the most intelligent and useful man for rendering service in public questions, local or national, keeps a shop, and he is thus placed in an awkward intermediate state. His talents and services compel a certain amount of consideration from those above him; but as they cannot condone the shopkeeping, they do not freely admit his family into their circles, and probably those of his own precise rank are not sufficiently cultivated to be his natural companions. In many little towns social visiting is well nigh impracticable, except amongst relations, as every man in the

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place is a little too high, or a little too low, to be socially civil to anybody else.

In country towns there are other peculiarities, as, for example, the position assigned to manufacturers, which is chiefly, though not entirely, dependant upon the style in which they live. The great manufacturer ranks as an important man in the county as well as in the town, while the smaller maker of the same article is held in little estimation. This is also noticed in such businesses as brewing. Those upon whom the vats and coppers have, in Johnsonian phraseology, conferred "a potentiality of becoming rich beyond the dreams of avarice," are freely welcomed by great landed, or noble families, while those whose vats and coppers are of smaller dimensions would be snubbed if they attempted any intercourse of the kind. In agricultural districts the precise position of farmers' daughters is often difficult to settle, and we remember serious conflicts of opinion in a little town, as to whether certain young ladies of this description might be invited to public balls. The general opinion of the young men was in favour of the girls, whose beauty was admired; but the puzzle was how to admit them without their brothers, who were voted too rough.

It is not our purpose to inquire into the complicated rights and wrongs of these social divisions; but their existence materially affects the conditions of middle-class family life. They make the co-operation of large bodies of the middle class very difficult, and they tend to prevent the best manners and the wisest opinions from spreading throughout the mass.

As a rule the education of middle-class families is bad; on the whole that of the richer sections, though still bad, is the best, while that of the poorer sections is not equal to that which the working class enjoy in the *best conducted* British or National schools. All through, there is a deplorable want of any species of culture that tends to enlarge the mind. Physical science is woefully neglected; political economy and social sciences usually ignored, though remarkably well taught, as part of the instruction supplied for sixpence a week, in the famous Peckham School, founded by Mr. Ellis, and conducted by Mr. Shields. Only the dry bones of geography are usually imparted in the shape of names of places and rivers, with their latitudes and longitudes, and history figures as a dull catalogue of battles and dates. Very rarely does any school-teaching develop a capacity for enjoying or understanding the great literature of our own or any other country, and many a boy is cured for life of any fancy for poetry, by its being made an instrument of torture in Latin or Greek.

It would not be fair to the schools if we were to forget that

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their profit depends upon their supplying what their customers demand, and until the heads of families entertain more worthy ideas on the subject of education, or are willing to be led by those whose judgment is enlightened, it will only be in rare cases that a schoolmaster or mistress can get a living by doing justice to the pupils. At the present moment there are many schools in advance of the average requirements of their supporters, and the best schoolmasters evince a laudable anxiety to improve the system of instruction. We must also recollect that it is very hard work for a schoolmaster to be continually engaged in pulling his pupils upwards, if the family life to which they are periodically remitted pulls them down again.

The composition, habits, and education of middle-class families leads to a general deficiency in taste for intellectual pursuits. It is the exception, not the rule, even for a single member of the family to have a decided taste for science, literature, or art, or to cultivate it so as to reach any considerable degree of proficiency or knowledge. Taking the whole of our middle class, with its vast numbers, it is, of course, easy to select some thousands of persons to whom these remarks do not apply; but they are unfortunately applicable to the great majority of those who are rich, as well as of those who are comparatively poor. The number of families in which any member has attempted to make a study of Shakspeare, Milton, or Bacon, is—relatively—very small; and still smaller the number of those who systematically study, for pleasure, a science or an art. One conspicuous proof of this may be found in the absence of demand for lectures of a high class, and in the small number of copies of first-rate books that any publisher can sell. Many excellent works are with difficulty pushed through a sale of five hundred copies, and few first-class books reach a sale of a thousand copies, except after years of recognition, and strenuous efforts on the part of the bookseller. Rubbishing books, on the contrary, often enjoy a large immediate sale.

The ordinary middle-class family is not much given to the purchase of books. If somewhat feeble in intellect, it will have its Tupper; if stronger, its Longfellow or Tennyson: but what thousands of homes in which the upholstery is excellent, the comestibles costly, and the grand piano unexceptionable, both for cabinet work and tone, in which not a readable book is to be found in secular literature, and in which, if any question arises on points of history, science, or art, it is in vain to appeal to the "library" for a reply! England is, in this respect, far behind the New England States of America. The close of a school career leaves "young ladies and gentlemen" as euphuism always describes them—boys

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and girls, as we prefer—at an age when help to continue old studies, or enter upon new ones, is peculiarly desirable; and, as a rule, nothing of the kind is provided. Some years ago, in the metropolis, there were in full activity, the Royal Institution, the London Institution, the City of London in Aldersgate Street, the Mechanics in Southampton Buildings, and some others, which were thronged by the members of middle-class families, who attended considerable courses of lectures on important subjects by eminent men. Classes were also common for the further pursuit of the same branches of knowledge. Now, the Royal is in full vigour, the London in genteel decay, the Mechanics in doleful dirt, and others have disappeared. Only the Royal Institution in London, and less than half a dozen other institutions in the three kingdoms, can attract an audience for a course of first-class lectures on any subject whatever. Eight hundred or a thousand institutions exist throughout the country, of which many neither have lectures nor form classes; while nearly all in which lectures figure confine them to subjects that are trivial, or to graver ones treated in the most useless and flimsy way.

Even in London, if any family of more than common intellectual ambition would like its boys and girls, when their school time has passed, to acquire a reasonable knowledge of any physical science, or to get help in the more difficult branches of literary or artistic study, they are not encouraged by facilities, but staggered by difficulties. A district in which five or ten thousand families of moderate means live, ought to be able to co-operate and provide the necessary machinery of lectures, classes, and libraries; but nothing of the kind is done. The social demarcations to which we have adverted, no doubt, constitute a serious difficulty, but the chief obstacle is the absence of desire.

Much drudgery falls upon many members of the middle class, but in cases where pecuniary means are sufficient to preclude the necessity for over-toil, the dignity that should belong to home-life is damaged by idleness and frivolity. In too many cases, if the young men are not in business, they may be found in the billiard-room of a public house; and if the girls are not required for household duties, their hours are passed in the idle gossip of morning calls, or evening parties. Thousands of families, which do not fall into these special errors, set up for their standard, propriety, not excellence; and if they escape the blame of doing mischief, they are still open to censure, as they contribute nothing to the active forces by which society is prevented from running to decay.

Young men, prematurely emancipated from parental authority, usually take to their own courses, while girls, perhaps of finer tastes and more sense, are subjected to too

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much control. A possibility of isolation at fitting times, liberty in the choice of pursuits, facilities for gratifying them—these are requisites for the best development of girls. If their home-life is always passed in the common sitting-room of the family, if at years of discretion they cannot buy a book, obtain an instrument, and take a walk to look at a picture, or pick a flower, without interference and supervision, their characters are dwarfed, and their faculties have no fair play. The "fast young lady" may be an unpleasant symptom of social disorder, but the tame young lady is a more hopeless product of social disease.

The want of tastes is a serious family evil, as well as an individual fault. A life without excitement is impossible for many, and objectionable for all. Good honest tastes form the springs of useful exertion, and in the endeavour to gratify them a wholesome excitement is to be found. Exclude the tastes for good things, and tastes for bad things will spring up; because some human faculties will be active, and if the finer elements of our nature are enfeebled by want of exercise, lower propensities and passions are left in sway. There are painfully respectable natures, incapable of any but cheap virtues, and without the vigour needful for great defects; but they are not objects to be contemplated with any approval. There should be something heroic and dignified in every life, and no human being should be permitted to grow up without throbs of aspiration towards that which is noble, beautiful, and true.

Tastes for good things are, in the higher natures, so strong as to command their means of cultivation, even under adverse conditions; but in ordinary mortals they must be cultivated, or they will never exist. Even in childhood, the family atmosphere, or the influence of some special person, determines for the major part of mankind whether they shall grow up with or without strong tastes for something useful and elevating. If circumstances hinder, or fail to favour, such cultivation and growth in early years, it becomes exceedingly difficult or impracticable afterwards. Parents often wonder why the young man of sixteen or eighteen is headstrong and dissipated, when the seeds of such conduct and character were sown in his childhood, through the inaptitude of the family life to stimulate a higher sense of duty, or cultivate a taste for worthier pursuits.

Family life presupposes the daily meeting of the same persons, often with a very moderate allowance of intercourse with outsiders. The male part of a quiet family, through their occupations, usually get most change, while the women suffer, like greenhouse plants under a bad gardener, who keeps the doors and windows shut. Even frivolity of admixture with other fellow-creatures is better than the damp, mildewy influence of isolation, with nothing elevating to do. But a family

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ought to contain within itself no small share of the elements of happiness and growth; and with anything like proper education and cultivation, it would be difficult to find three or four people, even of the same parentage, without a wholesome diversity of character and tastes. If the various members of a family have their own occupations and pursuits, some from the necessities of business, others from the promptings of choice, and each does his own work well, the meeting together will neither be tame nor tiresome, nor will the only bond that keeps them together be a notion of duty, or a mere instinct of affection.

There can be no greater contrast than exists between two sections or orders of middle-class families—the larger one, in which there are no particular tastes or pursuits of a high character; and the smaller one, in which they exist in force. To the smaller category, public events, and social movements, scientific discoveries, the labours of art, the appearance of noteworthy books, supplies daily food of an intellectual and exciting kind, upon which each comments with earnestness and intelligence. In the larger class, the mental food is scarce or bad, the mental appetite languid, and the digestion weak. The women, as the weaker vessels (and brought up to be so), accept the situation as they find it, while the young men too often seek in dissipation for an excitement which domestic emptiness does not afford.

"—— Winds blow and waters roll,
Strength to the brave."

So says Wordsworth. And if our middle-class families can summon up courage enough to assail the evils we have pointed out, they will find abundant help from the cultivated minds within their own ranks. Let us endeavour to sketch a few of the changes to be desired. In the first place, every member of a family ought to be able to read aloud either prose or verse sufficiently well for the performance to be intelligible and pleasurable, while in many instances a considerable degree of artistic skill should be attained. This demands practice in acquiring power over the voice, accurate and critical knowledge of the thing to be read, and such aid as can be obtained through hearing really good (not clap-trap) professional performers. Each family ought to be able, with certainty of response, to address one or more of its members, and invite him or her to

"Lend to the rhyme of the poet
The beauty of thy voice."

It is exceedingly difficult for any one to appreciate the blank verse of Shakspeare, with its wonderfully-varied rhythm, or the grand, though less flexible, verse of Milton, without hearing it well read; and the same remark may be made of the finest prose passages, such as those which abound in Bacon,

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Jeremy Taylor, or Sir Thomas Brown. The foundation of a fine taste in literature is often laid by good reading, and good family reading does not require the acting style in which certain favourite public performers over-indulge. Boys as well as girls ought to learn music, if they have any aptitude for it, otherwise the time so spent is wasted; but whoever pretends to learn music should not be satisfied with playing or singing the fashionable pieces of the day. Some knowledge of music as a science should be acquired. This involves a little thorough bass, and a little accoustics; and music should further be studied as a fine art, and some notion obtained of the peculiarities of the leading schools of the great composers, and the methods by which their effects were produced. If music is worth learning at all, it should, like all other things, be learned properly, whether the study be elementary, or carried to a great extent. Drawing and painting should be studied on the same broad principle, whether the time devoted to them be more or less. A study of drawing and painting would be useful to thousands who could never be proficient in either art. It assists the comprehension of what great artists have accomplished; and those who have paid no attention to perspective, colour, and shadow, have not learnt to see. The beauty of form, and its idealization, will be brought within the mental grasp of those who have learnt how to look at a fine figure-piece, while the landscape artists (and especially Turner) will teach those who study them how to enjoy the aspects of nature in all the gorgeous subtleties of atmosphere and light.

Some elements of science, such as physics, chemistry, geology, and astronomy, should be deemed essentials in any system of education, and also the rudiments of physiology and natural history.

No family that can afford the money ought to consider its house furnished if it does not contain a telescope and a microscope, neither of which need be very expensive for general purposes; and there should be a fair collection of books, for reference on all the leading topics likely to interest rational persons living in a civilized country. Diversities of taste would make some tend more to art, some more to science, and some more to literature; and, although certain elementary information on a variety of topics ought to be communicated to all, it would be a grave mistake to endeavour to force all to pursue the same career of study without regard to difference of mental constitution. Let us suppose a family of half a dozen persons. It is most probable that all will like, at times, to be well read to, and most, if not all, will enjoy the good music that those most proficient in that art can give at leisure intervals. If one has a fancy for observational astronomy, all are sure to

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like to take a frequent glance at solar spots, lunar mountains, and double stars, if accompanied by such explanations as will enable them to understand what they are looking at. If another works with a microscope, all will be glad to see any new object of remarkable beauty or curiosity, provided its nature is explained. A geologist can always interest ordinary mortals, if they are not in a state of preternatural stupidity, by showing and explaining appropriate objects; and so can a botanist, or any other student of special matter. Each member of a family should be expected to contribute something to its intellectual life, as well as to its moral excellence, and no child should be brought up to be an uninteresting and mentally unprofitable member of the circle. Lectures ought to be made systematically available for what they are worth; they can never replace class teaching or private study, but they are admirable introductions and stimulants, and useful for keeping up knowledge already gained, and bringing it up to date.

In addition to such larger combinations as may be necessary for the support of public institutions, why should not a few families combine for the general encouragement of intelligent pursuits. With mutual help, the study of difficult subjects might be facilitated, and very interesting gatherings might advantageously replace many dolefully stupid and sorely afflicting parties, in which nobody has anything useful or entertaining to say.

We do not want to flatter our readers, but we do look upon them, and upon those like them, who *ought* to be our readers, as the leaven that is to leaven the lump. Progress takes place when superior minds, or better cultivated minds, come into frictional contact with, and excite less advanced minds. It is for families who have learned to rejoice in the fulfilment of those intellectual duties which devolve upon human beings endowed with noble faculties, and placed in a noble universe for their exercise, to lead others in the same path. Let them exclaim, with Wordsworth—

> "———————— What we have loved,
> Others will love, and we will teach them how;
> Instruct them how the mind of man becomes
> A thousand times more beautiful than the earth
> On which he dwells: above this frame of things
> (Which, 'mid all revolution in the hopes
> And fears of men, doth still remain unchanged)
> In beauty exalted, as it is itself,
> Of quality and fabric more divine."*

* This grand passage, which forms the conclusion of the *Prelude*, is a *pons asinorum*, or donkey's bridge, for bad readers, who are sure to break down before getting through it. We recommend families to have a try at it, each member at a time, and the one who can bring out its full sense and majestic rhythm, will deserve at least as much credit as the boy or girl who gets over the famous proposition of Euclid, to which we have likened it.

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THE STONE AGE IN CHINA.

BY M. CHEVREUL.

THE following paper is translated from *Comptes Rendus*, 13th August, 1866 :—

"It is now the custom to designate by the expression 'age of stone' those pre-historic times when men, not acquainted with metals and the methods of working them, fashioned out of hard stones implements such as hammers, chisels, knives, hatchets, etc. A passage from the life of Confucius, by Père Amiot, printed at Paris in 1788, shows that the Chinese passed through the stone age.

"Confucius, so states his biographer, being in the kingdom of Tchen, stayed at the house of a sage named Tcheng-Tsee, when the king of Tchen perceived on the terrace of his garden a bird of prey which seemed to have *three wings*, and a strange mode of flight. The king ordered that the bird should not be lost sight of, and should be brought to him alive or dead. The bird soon fell lifeless on the steps before his palace. The bird had only two wings, but the feathering of an arrow that transfixed its body explained how it appeared to have three; and the extraordinary fact was that the arrow, quite different from those then in use, was armed with a hard-pointed stone instead of with iron, and its wood was peculiar. Tcheng-Tsee, the friend of Confucius, was commanded by the king to explain the matter, but being unable to do so, he spoke of Confucius as one capable of fulfilling his majesty's desire. Confucius, having recognised the bird as a *sun*, a kind of hawk, whose peculiarity it is not to chase the birds it feeds upon, at their love season, or when they are incubating, said, 'This kind of bird of prey is a native of the land of Sou-chin, to the north of Tartary; it never comes to our climate. Inasmuch as the arrow is armed with a piece of hard stone instead of an iron point, it resembles that which Ou-ouang presented to the prince in whose favour he erected into a kingdom the country of Tchen, when, having extinguished the dynasty of Chang, he gave the fiefs to his chief assistants in that glorious expedition. This arrow was thirteen inches long, without reckoning its stone armature, and was given as the sign of sovereignty of him who was created King of Tchen. Seek, Sire, in your armouries, and perhaps, in spite of the different revolutions which have happened since the creation of your kingdom, the arrow may still be preserved. If it can be found, let us compare it with that which has occasioned the death of this bird, and we may conclude from it that heaven favours your majesty,

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since it allows the authentic sign of the sovereignty of the kingdom to fall into your hands.'

"The text adds that the king caused search to be made amongst his antiquities, and that an arrow was found precisely similar to that in the bird of prey.

"Does it not appear from this passage that at the succession of Ou-ouang to the empire, the date assigned to which is 1122 B.C., iron-pointed arrows were used, but that tradition preserved the reminiscence of sharp, stone-pointed arrows, and that Ou-ouang availed himself of this tradition, and gave a sacred sanction to the kingdom of Tchen by an imperial gift of a weapon used by the ancient Chinese?"

To this paper of M. Chevreul is appended a note by M. Stanislas Julien on the "Age of Stone in China." He quotes the dictionary *P'ing-tsen-loui-pien*, printed in 1726, to the effect that stone arrows were found in digging the earth in the district Sin-thou-hien, where in old time there was a tower and a camp. In the *Annals of Song* (biography of Tchang-sun), soldiers are spoken of as fighting with stone arrows. These annals were composed under the Youen dynasty, which lasted from 1260 to 1341. The *Annals of Northern China*, composed under the Thang dynasty, founded in 1618, states that 'in the country east of Fo-ni all the arrows have iron points.' In another passage in *P'ing-tsen-loui-pien*, arrows are spoken of 'pointed with bluish-black stone.'

"The Chinese have a particular character, *nou*, signifying a stone, from which arrow-points are made (*Dic. du P. B. de Glémona*).

"We read in *Kouc-yu* (a Discouse on Kingdoms), a work anterior to our era, this passage, relating to the kingdom of Lou, the land of Confucius, 'When Confucius was in the kingdom of Tchin, a hawk rested on the palace of Prince Tchin, and was killed (or died?) there. It was pierced with a stone arrow-point fixed to the wood of Khou. This arrow was twenty inches long. Hoei-kong, Prince of Tchin, ordered a man to carry the hawk to Confucius, and inquire of him concerning it. The philosopher said, this hawk comes from afar. The arrow which has killed him is an arrow of the country of So-tchin.'

"In *P'ing-tsen-loui-pien*, vol. xlii., fol. 38, we read, 'In days of yore Wou-wang (who mounted the throne in 1122) having conquered the dynasty of Chang, opened a way in the midst of the country of nine barbarous tribes, and ordered them to bring tribute of the produce of their land. Then the inhabitants of the country of So-tchin offered arrows made of the wood of Khou, and pointed with stone. These arrows were twenty inches long."

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"I omit other passages of the same kind. In the *Annals of the Dynasty of Thang*, founded in 1618, I find mention of stone hatchets; and in other passages a stone knife, a stone sword, and a stone agricultural implement for stirring the soil are spoken of."

OBSCURATIONS OF THE SUN.

BY M. ED. ROCHE.

THE following paper appears in *Comptes Rendus* for 27th August, 1866:—

"The term obscuration has been applied to transitory diminutions of solar light not connected with eclipses by the moon. Historians have recorded several phenomena of this kind; and Humboldt notices a certain number in *Cosmos*, doubtless selecting those which seemed to him the most important and the best established. He admits, without hesitation, that at certain epochs the disk of the sun was momentarily obscured, and the light so weakened, that stars were visible in daytime. Arago, in his *Astronomy*, has reproduced the same assertion. An obscuration of the sun, therefore, is analogous to a total eclipse, but longer in duration, and resulting from abnormal conditions.

"Having had occasion to examine the texts cited by Humboldt, I perceived the necessity for rectifying the interpretation of several, which have led me to very different conclusions. The greater part of these phenomena of obscurations were veritable eclipses, badly observed, or inaccurately described. Thus, to cite only one example, the obscuration which took place on the 28th February, 1206, is nothing else than the eclipse of the sun of 28th February, 1207, seen in Spain, France, and Italy; and if certain historians of the time referred it to 1206, this was because the year then commenced on the 25th March, and not on the 1st January.

"Except at the periods of eclipses due to the interposition of the moon, the sun has never diminished in splendour, so as to produce a kind of night, and allow the stars to appear. The small number of authentic cases in which stars seem to have been visible in full day, lose their marvellous character when subjected to a searching examination. These pretended apparitions of stars are usually thus reduced to some planet which was visible in the daytime during an obscuration.

"One of the most remarkable of these facts is that of

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April, 1547. According to a tradition reproduced by Kepler from a passage of the *Cosmo-Critico* of Cornelius Gemma, the sun was so enfeebled for three days, that the stars appeared. In a note on this subject (*Comptes Rendus*, t. lx., p. 653), M. Faye has shown the unlikelihood of such a phenomena. Nevertheless, the recital of Kepler rests on something real, and by research amongst contemporary witnesses, the explanation is discovered. There was certainly, about the 24th April, 1547, the day of the battle of Muhlberg, an obscuration—that is to say, a mist of fog obscuring the sun and the moon, according to Gemma Frisius.* As for the appearance of stars, Cornelius Gemma does not say that he or his father saw them, which would have given his assertion great value. He appears to have borrowed the statement from *De Meteoris*, of Frytsch, of Lanbach, who first mentioned it.

"According to Frytsch, it was on the 12th April that the stars were seen, and it was exactly on this day that the planet Venus was at her maximum of illumination, and up to the end of the month she remained under conditions favourable to her being seen in full day. The unusual appearance of Venus, close to the time of the obscuration which occurred a few days later, seems to have been the veritable foundation of the story, which Kepler accepted the more readily, as it tended to confirm his theories.

"I have studied various phenomena of obscuration, and a comparative view of them leads us to refer them to a particular state of the atmosphere, known as a *dry fog*. The origin of these fogs is quite uncertain. They are commonly ascribed to volcanic exhalations, and they may likewise be due to meteoric dust suspended in the air, and diminishing its transparency. But, whatever may be their cause, the connection between them and the obscurations is not doubtful; and to explain the latter we need not have recourse to gratuitous hypotheses, such as perturbations in the photosphere, occultations of the sun by a cosmical mass, or by a cloud of asteroids."

* Reinier Gemma, the father of Cornelius, so called from his birth-place, Friesland.

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ARCHÆOLOGIA.

THE Kent Archæological Society has issued the sixth volume of its collection of papers, published under the title of *Archæologia Cantiana*, the contents of which do great credit to the management of the Society. The most remarkable of these is Mr. Brent's account of the researches in the early ANGLO-SAXON CEMETERY AT SARR. Mr. Brent has already opened a hundred and eighty-three graves in this cemetery, and we believe that much still remains to do. The very numerous objects found in these graves present a singular and almost perfect picture of Anglo-Saxon life. We have the arms of the warrior sufficiently complete, the ornaments of his personal attire, and especially the various ornaments of the person of the Anglo-Saxon lady, and the articles of her toilette. We have the characteristic pottery and glass which loaded the Saxon festive-board, and the various domestic implements of the household, the money the Saxon spent, and even the dice with which he gambled. The contents of one of the graves were very remarkable—it was that of a man. Near the feet, and about two feet three inches from the surface, was a small black earthern vessel; on the left side lay the umbo of a shield, and near it, all together, as if the contents of a bag or purse which had undergone decay, about fifty small circular counters of bone or ivory, one or two apparently made of the teeth of an animal. A sword, thirty-seven inches long; a spear-head eight inches and a quarter, and the ferule of the shaft; a small brass coin of the Emperor Magnentius; some rivets, a knife, an iron ring, and a small bronze buckle, were also taken from this grave. All these objects are characteristic of the pagan Saxon gentleman, and it may be remarked that he seems to have placed his implements of gambling under the protection of his shield. Such draughts or counters have been found in several instances in Saxon graves. They vary a little in size and shape; but they are all circular and flat-bottomed, and some nearly conical, while others are but slightly convex. A pattern of little double circles, with a dot in the centre, appears on the upper side of most of them. Some of them had decayed, and it was judged that the original number had been about sixty. In a grave opened subsequently, a second set of similar counters was found, the number of which was about forty, and there were with them two dice, which leave no doubt of the use of the counters.

The contents of another of these graves were equally interesting, the more so, as similar objects have been found in other Anglo-Saxon cemeteries. Near the skull of the occupant of the grave lay the umbo of a shield, and on the left side a spear. On the breast a fine buckle, brightly plated, and what appeared to be the mounting of a purse. On the left side were some iron keys, and an iron lock, with a bronze plate containing a hole for its lock, no doubt the remains of a box. At the left foot lay a small BALANCE AND SCALES, WITH NINETEEN WEIGHTS. The other contents of the grave were a knife or dirk, with a smaller knife in one doubled sheath of wood,

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a circular iron plate, another knife, and a pair of shears. In the case above alluded to, the Saxon had been a warrior; in this he was evidently a dealer in some articles which required weighing, as well as cutting and dividing. The beam of the balance was about five inches long, and slightly chased; the end of the thread or silk which suspended the scales remained still adhering to its end, and some of it was found attached to the scales, which were an inch and seven-eights in diameter. The weights, in number about twenty, were formed of Roman coins, rubbed to the exact quantity, and most of them were marked by dots, which seemed to indicate a multiple of weight. The lock had a bolt made to ascend diagonally into the bronze plate, which was rather more than six inches long, and one and a quarter wide, and was very like such a plate on our own door-posts. The double sheath with two knives, an object which has never been found in an Anglo-Saxon grave before, presented the exact type of the Highland *scian*, or dirk and knife in a double scabbard. The whole of these discoveries are of a very remarkable character, and furnish a satisfactory evidence of the utility of our local archæological societies.

Among some ROMAN INSCRIPTIONS recently found at MESVE in France, there is one of peculiar interest, as giving us the name of a goddess previously unknown, Clutonda—no doubt a local divinity, but as proving that the village of Mesvé on the right bank of the Loire, is the site of the *Masava* of the Romans indicated in the Peutingerian table. The inscription, which is read as follows, informs us that one Medius Acer, the son of Medius Annus, gave to the statue of Masava "a wall between two arches, with its ornaments:" *Augusto sacrum, deæ Clutondæ et Vicanis Masavensibus: Medius Acer, Medii Anni filius, murum inter duos arcus, cum suis ornamentis, de suo dono dedit.*

A few days ago, at SUTTON HILL, in Corve Dale, Salop, some excavations were made which, though as yet of little extent, are of some interest. It may be remarked that Sutton Hill—which is the property of Charles Powell, Esq., a gentleman who has for some half a century held the office of Chairman of the Board of Magistrates—is composed of limestone rock, with a rather shallow covering of earth. A part of the summit is uncultivated, and has been long quarried for the purpose of obtaining stone for making lime; and, in the course of this process of quarrying, many human skeletons, according to the information given by the labourers, have been found at different times, and with them objects of various kinds, some of them of iron. The accounts of these former discoveries are so circumstantial and apparently truthful, that they cannot reasonably be doubted, although all the objects discovered have long been dispersed, and no sufficiently scientific account of the discoveries has been preserved. In the earlier part of the present month, at the suggestion of Mr. T. Wright, an attempt at more careful exploration was made, under his immediate direction, which resulted in the discovery of a skeleton, laid on its back, with the head to the west and the feet to the east, and of some of the bones of a second skeleton, apparently a secondary interment, at a slight

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elevation above the other; but the inclemency of the weather prevented the continuation of the excavations for the present. No objects of any kind were found to help us to fix the people or date to which these interments belong; but there can be no doubt that they were of very great antiquity; and they probably still remain undisturbed over some part of the top of the hill, which has never been quarried. The occurrence of implements made of iron would lead us to suppose that this was an early ANGLO-SAXON CEMETERY, in which case, it would be the first discovery of Anglo-Saxons found on the Welsh border; and, as the Mercians (Angles) and the West-Saxons met and appear to have overlapped each other in this district, the objects found with the bones would perhaps enable us to decide which of those two divisions of the Teutonic settlers in our island first established itself in South Shropshire. The graves appear to have been cut into the decomposed and soft upper part of the rock, in the same manner as, in Kent, they are dug into the chalk.

Further explorations have been made among the SEPULCHRAL TUMULI on the YORKSHIRE WOLDS, some account of which has been given in the contemporary papers. From these descriptions, which do not appear to us to be entirely satisfactory, it appears that the objects found consisted of human skeletons, of broken pottery, and of flint flakes, and presumed flint implements, with nothing to suggest any decided opinion as to their date. The tumuli opened were three in number, situated on the Sherburn wolds, near Scarborough. In each of them, bones were found, thrown together very confusedly, and independent of the entire skeletons; and it is assumed, we think rather unnecessarily, that these are the results of the practice of cannibalism among the race who are buried in these tumuli. It must not be forgotten, that all these tumuli are described as having been much crushed and broken down by the process of tillage, and that the bones may therefore have been, at some former period, dug up accidentally, and reinterred in this confused manner.

T. W.

LITERARY NOTICES.

CHARLES WATERTON: HIS HOME, HABITS, AND HANDYWORK. Reminiscences of an Intimate and most Confiding Personal Association for Thirty Years. By RICHARD HOBSON, M.D., Cantab., Leeds. With Sixteen Illustrations. (Whittaker & Co.)—Dr. Hobson has produced a very pleasant, rambling, but readable collection of reminiscences of Charles Waterton, and of his famous residence, Walton Hall, a large mansion, built on an island in a great pond, or lake, in which all kinds of water-fowl found a happy, undisturbed home, while land creatures were equally cared for and protected in the adjacent park. The house was full of stuffed specimens, exemplifying its owner's remarkable skill as a taxidermist, and justifying, according to the general opinion of those who were

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fortunate enough to see the collection, the peculiar methods which Mr. Waterton adopted. Mr. Waterton belonged to a class of eccentric characters, found more often in out-of-the-way country places than in towns. When, as was the case with him, these singular specimens of humanity are remarkable for benevolence as well as for intelligence, no one has a right to criticise their peculiarities harshly. The manners and modes of thought of our age tend too much to destroy individuality, and we ought to be thankful that a few persons stand out from the monotonous ranks, winning respect for their substantial goodness, and reminding us that humanity in a civilized country need not be reduced to a series of mechanical imitations of a few favourite types. Doubtless Mr. Waterton would have been a greater naturalist and a greater man if something like a crack or craze had not run through his character, but his life was a useful and valuable one, and he had the great and rare merit of being true to himself. With great physical courage, and that sort of moral courage which enabled him to pursue his own course in defiance of what Mrs. Grundy, and even more rational authorities might think expedient, he was nevertheless in bondage all his life to superstitious ideas, and he had not the slightest notion of the way in which free political and religious systems contributed to human advancement. His mind was mediæval rather than modern, and new processes and improvements in agriculture seem to have been viewed by him as heresies to be avoided rather than as practices to be pursued. His body he called his "ass," and he took care that it should never be pampered. An old suit of clothes, a "shocking bad hat," with ventilating apertures worn in its crown, and a plentiful coat of dirt adhering to its surface, formed his regular costume. He slept on a board, with a log for a pillow, and a rough wrapper for a covering. When very ill, he would, under medical orders, betake himself to a sofa, but a bed he would not enter, as he considered that would be indulging the body more than was necessary for good health. Ordinary visitors were rigidly excluded from his domains, but he would admit large parties to occasional picnics in his park; and if persuaded that any one really wanted information on natural history or taxidermy, he was happy to afford it, on condition of the recipient's repaying his teacher with an abundance of reverence and faith. He was rigid in all the fasts which the Roman Catholic Church ordained, and his favourite remedy for any kind of illness was copious bleeding from the arm. That he should have survived this treatment to extreme old age is a proof of the wonderful strength of his constitution, and, indeed, in all physical matters he was an extraordinary man.

"Mr. Waterton," says Dr. Hobson, "during his long life, never partook of either wine, spirit, or malt liquor. In addition to simple water, a cup of excessively weak black tea was his favourite, indeed his only, beverage, on all occasions, into which he put a large quantity of sugar, but no cream." He went to bed about nine o'clock, and rose at half-past three, when he lighted his own fire, which had been laid for him the previous evening, and began some

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natural history work. Great benevolence, not restricted by conditions of creed, and a habit of incessant Latin quotation (in which his friend, Dr. Hobson, participates), and a strong perception of humour, were other characteristics of the "old squire;" and it is no wonder that he should have conciliated much affection while living, and that his friends should delight to honour his memory now that he is dead.

Many of the stories told by Dr. Hobson are highly amusing, including the famous rattlesnake scene at the doctor's house. An assembly of professional friends was arranged to try the comparative effects on rabbits of the rattlesnake bite, and the wourali poison which Mr. Waterton obtained in South America. An American showman, with a collection of the dangerous reptiles in glass cases, was invited to the party, and Mr. Waterton astonished them all by the boldness with which he put his hand into the cases and caught any snake that was wanted by the neck. One of the reptiles nearly escaped; the doctors fled pell-mell and helter-skelter down stairs, some rushed hastily into the street and did not return, but Dr. Hobson pressed the lid of the case door so as to obstruct the complete exit of the snake, and Mr. Waterton quietly took hold of it and remitted it to its prison. Mr. Bartlett of the Zoological Gardens, and Dr. Günther of the British Museum, handle venomous snakes with equal confidence and impunity; but Mr. Waterton's performance caused him to be looked upon as little less than a conjuror by those who were not acquainted with the character of reptiles, and the circumstances under which they may be safely seized.

The Waltonian mode of stuffing animals consisted in soaking the skins in a solution of corrosive sublimate, and moulding them from within before they dried to the exact form of the living object. A few mechanical supports were used while the skins dried, and they retained their shape for ever after.

On Force: Its Mental and Moral Correllates; and on that which is supposed to underlie all Phenomena with Speculation and Spiritualism, and other Abnormal Conditions of Mind. By Charles Bray, Author of the "Philosophy of Necessity," the "Education of the Feelings," etc. (Longmans.)—Mr. Bray commences his work by reviving the proposal to dispense with the belief in matter, and confine our credence to "centres of force." The objection to such a proposal is that we cannot get on without the idea of matter, however incomplete, and possibly incorrect that idea may be. The one term centre of force will not carry us far, either in the description of phenomena or in reasoning upon them. Let us take one of Mr. Bray's sentences and see if we can make it fit his philosophy. He says, "It is a limited quantity of force that is derived from the food, and the mode of its action depends upon its distribution over the body . . . . . while digestion is going on the powers of thinking and feeling are proportionably increased." Are we to say it is a limited quantity of force which a man derives from eating centres of force for breakfast. While he is digesting centres of force, his powers of thinking and feeling, themselves consisting of other centres of force, are proportionably decreased, and so forth? Most persons will

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find it difficult to conceive of a force without its resulting from some substance in action; and whether the term spiritual or physical is applied to a force, it is equally supposed to be the effect of a something acting, and not a self-existent entity. With many of Mr. Bray's speculations we agree, but we think he sometimes fails to see the bearing of his own words. For example, he says, "As all actions are the necessary result of pre-existent force, they are *morally* alike in themselves—right and wrong, virtue and vice, having no existence but as they affect the well-being of the sentient creation." The introduction of the word *morally* is surely a mistake. All actions may be alike, in that they are the results of pre-existent forces, but the morality of an action involves questions of obligation, duty, etc., and hence the moral likeness of a set of actions will depend upon circumstances quite distinct from the physical cause of the actions themselves. Again, Mr. Bray says, "Truth, justice, and wisdom are only relations to *finite* things, and cannot therefore be infinite, or absolute in their own nature." Surely if these be infinite things, there may be truth, justice, and wisdom concerning them. Infinite truth would be truth concerning all existing or possible things. A particular truth relating to a particular thing, has no claim to be called infinite, and this may be all that Mr. Bray intends. Mr. Bray quotes with approbation Bentham's dictum, that an immoral action results from a miscalculation of self-interest; but, with great admiration for Bentham, we must agree with those who think his notions of moral philosophy defective. It is possible to make the term "self-interest" comprehend a devoted promotion of the interest of others; but by such an enlargement of the scope of the term we destroy its special meaning, and leave it like an algebraic symbol, the significance of which is determined by its position. Man has self-regardant faculties, and extra regardant faculties, and it tends to confusion to designate the happiness which springs from self-sacrifice by the same term as that which denotes self-seeking. We do not see that Mr. Bray in anywise proves his assertions that "there is nothing underlying phenomena—phenomena are correlatives of force, and force is all." After having demolished matter, Mr. Bray still finds his *force* as "one infinite substance," "force changing into life, and life into sentience," etc., and he endeavours to explain what are called "spiritual phenomena," as resulting from modifications of mental force. For those who are fond of metaphysical speculations—carried often into the regions of the unknown, Mr. Bray's new work will provide ample suggestions, but before undertaking to reduce the so-called "spiritual phenomena" to some sort of cohesion with general philosophy, we must learn exactly what phenomena really occur in table-turning, spirit-rapping, etc., etc. Under all ordinary circumstances no obstacle is placed in the way of applying physical science tests and methods to alleged physical effects, but the spiritualists demand faith at the wrong end, and their tables will not rap, and their sideboards will not walk across the room, if sceptical persons with experimental modes of verification or disproof happen to be present. Mrs. De Morgan's recent book, written in

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manifest honesty, shows, as other works have shown, that an anti-scientific believing frame of mind is essential to what is called spiritualistic success.

TAPE WORMS; HUMAN ENTOZOA: THEIR SOURCES, NATURE, AND TREATMENT. By T. SPENCER COBBOLD, M.D., F.R.S., Lecturer at Middlesex Hospital. (Longmans.)—We suppose Mr. Cobbold hopes to tempt readers by this little volume to study his large work on Entozoa. We should not have thought it worth while to publish the present small treatise, which is little more than a portion of the larger work.

ELECTRICITY. By ROBERT M. FERGUSON, Ph.D., of the Edinburgh Institution. (Chambers.)—This volume, which forms part of "Chambers' Educational Course," is a compact and well arranged treatise on the subject indicated by its title. Magnetism, Frictional Electricity, Galvanism, Electro-dynamics, Electro-magnetism, Magnetic Electricity, Thermo-Electricity, and Practical Applications of Current Electricity, are treated of in separate chapters, and praiseworthy pains seem to have been taken to bring the whole fairly down to date.

A DICTIONARY OF SCIENCE, LITERATURE, AND ART. Comprehending the Definitions and Derivations of Terms in General Use, together with the History and Descriptions of the Scientific Principles of nearly every branch of Human Knowledge. Edited by the late W. T. BRANDE, D.C.L., F.R.S.L. and E., of Her Majesty's Mint, and the REV. GEORGE WILLIAM COX, M.A., late Scholar of Trinity Coll., Camb. Part X. (Longmans.)—The present number, finishing "Radient Heat," and progressing as far as "Rules," contains many excellent papers supplying the information most likely to be needed by those who resort to a Cyclopædia.

THE ANTHROPOLOGICAL REVIEW. Journal of the Anthropological Society, and Popular Magazine of Anthropology, Part XIV. (July, 1866). (Trübner.)—Contains some interesting papers; and though we should, in a detailed review, repeat some of our old objections, we think this magazine is improving, and it certainly deserves credit for calling popular attention to a highly important and neglected class of subjects.

DATE STONES; OR, MNEMONICS OF GENERAL AND CONSTITUTIONAL HISTORY AND OF LITERATURE. By NEWENHAM TRAVERS, B.A., formerly scholar of Lincoln College, Oxford. London.—This book, small in dimensions but important in contents, is published by the Author at his own residence, 25, Tolmers Square, N.W.; we suppose he has not published it in the usual way because he has especially designed it to assist in a short series of lessons of which we find a notice accompanying the book. Mr. Travers is well known to hundreds of young men educated at University College School, in which he was for many years a remarkably able teacher. The subject matter of his "Date Stones" is well selected, both for general students and for those who desire to pass examinations for the civil service or for university certificates. The mnemonic plan is substantially the same as that employed by Dr. Grey, but worked out with much originality. Mr. Travers dissents from Dr. Pick's

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view that real words should always be employed, but in his artificially compounded words he preserves a suggestive portion of the name of the person or incident to be remembered. At the close of each chapter are some hexameter verses, in which the chief incidents with their several dates are mnemonically epitomized, and though, like all similar combinations, they look as if they would distress the jaws that utter them, we cannot doubt their utility after many proofs that have reached us that Mr. Travers' pupils really do use them with success.

WAYSIDE FLORA; OR, GLEANINGS FROM ROCK AND FIELD TOWARDS ROME. By NONA BELLAIRS, Author of "Hardy Ferns," "Going Abroad," etc. (Smith, Elder and Co.)—The inexorable requirements of society compelled Miss Nona Bellairs to go to Rome, and being fond of wild flowers, she provided herself with the necessary apparatus for collecting and drying them. She enjoyed her trip, and describes it in a pretty volume, giving the names of some of the flowers that took her fancy, and of the pictures and buildings that pleased her eye. A good-tempered reviewer—and those who are admitted to our columns are all of that happy character—does not know what to say of books of this kind. There is not enough in them for especial praise, or description, and yet it would be hard to blame them because they do not reach some ideal standard of which their author's never dreamt. Miss Bellairs certainly merits commendation for having a taste and a purpose, and her books, though slight, may help other young ladies to acquire similar good things.

THE HANDBOOK OF THE STARS; containing the places of 1500 Stars, from the first to the fifth magnitude inclusive, upwards of 200 of which are noted as Double, Multiple, or Variable: a list of Star Names; a Table for determining the position of the Constellations on the celestial concave at all hours and seasons; and other Useful Tables. With an examination of the properties and projections used in mapping, and hints on the selection, use, and construction of Star-Maps. By RICHARD A. PROCTOR, B.A., F.R.A.S., late Scholar of St. John's College, Cambridge, and King's College, London. Illustrated by maps and diagrams. (Longmans.)—The voluminous title of this little book amounts to a catalogue of its chief contents, and, from the merit of Mr. Proctor's previous works, the scientific public will be prepared to receive this with favour. Some of the chief topics have been recently discussed in our pages, so that all we need say now is, that the explanations of star maps and their principles will be found compendious and valuable. The sixth of the tables supplied by Mr. Proctor strikes us as particularly useful. It is easily understood, and gives by simple inspection the names of the constellations occupying the zenith, and other parts of the heavens, at any hour for any day of the year. As a guide to a knowledge of the constellations, and to their changes in position, according to the time of the year, this book will be found remarkably useful. The list of double-stars, though not going below the fifth magnitude, will also be of service. In a few instances, we think, an error has been made in giving their distances. Thus, the

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components of Castor are put down as between two and three seconds apart, while Engelmann's measure gives 5″526; δ Herculis and *comes* are given as between seven and eight seconds apart, which is surely much too little.

ELEMENTARY TREATISE ON PHYSICS, EXPERIMENTAL AND APPLIED. For the use of Colleges and Schools. Translated and Edited from *Ganot's Eléments de Physique* (with the author's sanction), by E. ATKINSON, Ph.D., F.C.S., Professor of Experimental Science, Royal Military College, Sandhurst. Second edition, revised and enlarged. Illustrated by a coloured plate, and nearly 700 woodcuts. (Ballière). Part II.—In a notice of the first part of the new edition of this excellent work we expressed a decided opinion that it is the best book of the kind which has appeared. To that opinion we adhere, though there are some minor points in which Professor Atkinson ought to have improved upon the original. Thus, at p. 447 we are told that the new silvered glass mirror telescopes "are much shorter than the old ones, their focal distance being only about six times the diameter of the mirror." The celebrated Short made his 'dumpy' metallic telescopes with focal lengths as short as have been given to any successful glass ones, and it is incorrect to say that the usual focal length of fine glass silvered telescopes is only six times the diameter of the mirror. The figure given of the mounting (p. 448), though pretty looking, is bad—very inferior to Mr. Browning's pattern, and students will be misled who suppose from M. Ganot's work that a 6½ inch mirror should only bear a magnification of 150 to 200. One of that size in our possession, the mirror by With, and the mounting by Browning, bears from 600 to 700 well on bright objects. The microscope in this part fares worse than the telescope. Instead of figuring a good instrument by one of the great English makers, a very poor one by Chevallier is represented, giving no idea of the best constructions, and nothing is said concerning the formula of the best objectives. These, however, are trifles in comparison to the general merit of the work, but they ought not to be passed over.

THE BIRDS OF MIDDLESEX; a Contribution to the Natural History of the County. By JAMES EDMUND HASTING, F.Z.S. (Van Voorst.) —A very pleasantly written work, giving accounts of the birds habitually living in, or visiting Middlesex. Mr. Hasting has judiciously left technical descriptions and systematic information to be obtained from well-known ornithological works. His remarks are thrown under heads corresponding with the principal divisions of birds into orders and families, and frequently enlivened by good anecdotes. For example, a very interesting account is given of a black-backed gull, caught and tamed by the author:—"A curious fact with regard to this gull is that he catches sparrows for himself very dexterously, and the way in which he does it is this. About the time that the fowls are being fed, he makes his way to the poultry-yard, and mingling with the hens, walks very slowly about with his head drawn in so as to make his neck look very short, and as if, in fact, he were trying to look as much like a fowl as possible. As soon as the general rush for grain is over, the sparrows drop

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down one by one, and then it is that the gull, drawing gradually within reach, suddenly darts out his long neck, and seizes an unfortunate sparrow by the head. So rapidly is this done, that escape for the unsuspecting sparrow is hopeless, and in another second he is crushed and devoured." On one occasion this same bird seized a young kitten, which the cat had brought out on the lawn, and tried to swallow it whole. He was discovered with the kitten's head down his throat, making frantic efforts to swallow the body, and was greatly disappointed when the little creature was rescued by one of the family. This book is illustrated by musical notations of the song of many of the birds, and by a frontispiece in a deplorable style of art. A very tolerable engraving of Kingsbury Reservoir is quite spoilt by printing a dingy rhubarb tint all over it!

PROGRESS OF INVENTION.

IMPROVEMENT OF THE HYPSOMETER.—The boiling points of fluids depend on the pressure of the air. The greater the altitude of any place above the ordinary level of the earth's surface, the lower the boiling point of a given fluid, because the less the barometric pressure in that place. And hence the height of any place may be found by means of the boiling point of water in that place. With this object a peculiar kind of thermometer, termed a *hypsometer*, or more correctly, a *hypso-thermometer*, has been constructed. It is marked, not with degrees of temperature, but with barometric pressure corresponding to these degrees, or, better still, according to the latest improvements of M. Abaddie, with the altitudes corresponding to the temperatures, supposing them to be the boiling points of water. The boiling point of a fluid can be accurately determined by placing the thermometer in the escaping vapour; but unfortunately the results are liable to vitiation, on account of the tendency which the zero of thermometers almost invariably has to alter spontaneously. The danger of error from this cause is, however, greatly diminished, if two or three hypsometers are used in each experiment, and the mean of their indications is taken. The hypsometer is, for several reasons, more suitable for the purposes of travellers than the barometer. It is more easily carried, it is less easily injured; and it requires, not an observation, but an experiment which is made with greater facility, and is less subject to error.

MAGNESIUM AND ITS SALTS AS ILLUMINATING AGENTS.—The complication necessary when the magnesium wire is fed by means of clockwork, has been hitherto a great obstacle to the use of the magnesium lamp for the purposes of illumination or photography. This difficulty has, however, been obviated by the lamp exhibited in operation at the recent meeting of the British Association at Nottingham. The magnesium passes down in the form of a very fine powder from a reservoir, through two small tubes, the lower aper-

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tures of which are placed opposite to, and at a small distance from, each other. To dilute the magnesium powder, and thus render the feed more gradual, and the light more diffused, it is mixed with fine sand before being placed in the reservoir. And to prevent the tubes through which the mixture of sand and magnesium issues from being choked with magnesia, on account of combustion of the magnesium taking place within them, coal gas is transmitted through them with the mixture, and burns along with the magnesia. Finally, to remove the small quantity of magnesia which, forming at the aperture of the tubes, might ultimately stop them up, the sand, after separating from the magnesium during the combustion of the latter, falls into a small receiver; and this, tilting over every few minutes, on account of the weight of the sand, gives motion to a wire to which are attached nippers that seize the magnesia and separate it from the tubes. When the sand has fallen out of the receiver, it again assumes its ordinary position. The cost of this lamp is, however, very considerable. The amount of coal-gas used with it is, indeed, very trifling, but the magnesium is very expensive, and will probably continue so. This very serious objection is likely to be got rid of by the use of the oxide of magnesium, which M. Carlevaris, of Geneva, has found to answer, in conjunction with the oxy-hydrogen flame, as well as the metal itself. Oxide of magnesium is in this case volatilized, though to a very small extent; but this minute quantity of vapour imparts a pure white light that may be used either for ordinary illumination or for photography, having all the properties of solar light. The effect is due to oxide of spongy magnesium, and this may be conveniently produced from several of the magnesium salts, especially from chloride of magnesium or carbonate of magnesia. For this purpose a small piece of chloride, for example, is placed on a prism of gas-retort graphite, and the flame of the burning gases is thrown upon it. The use of pure oxygen is not indispensable; common air and hydrogen answer extremely well. Also, the chloride, after having been compressed into the form of a prism or cylinder, may be merely introduced into the flame, no graphite being employed.

Prevention of the Spark produced by the extra Current.—In electro-magnetic experiments, the oxidation caused by the sparks due to extra currents, is highly inconvenient, as it prevents perfect metallic contact, and thus greatly diminishes the electro-magnetic effect. There are two kinds of *extra* current. One of them is opposite in direction to the battery current, and is produced when connection with the battery is established. It is perceptible chiefly by its neutralization to a greater or less extent of the battery current. The other, which is in the same direction as the battery current, is produced when connection with the battery is interrupted. It retards the demagnetization of the electro-magnet, and causes oxidation so as to prevent perfect metallic contact between the different portions of the conductor. The latter evil is prevented by a very simple means, due to Dr. Dugardin, of Lille. He provides a separate conductor for the extra current. For this purpose he permanently connects the poles of the electro-magnet

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with a small helix of wire, which, however, offers so little resistance to the ordinary galvanic current, on account of its low intensity, as to divert but a very small amount of it from the helix belonging to the electro-magnet. Were the wire of the resistance coil, thus introduced, of any considerable length, the effect produced upon it by induction would be very mischievous. But its resisting power is derived, not from its length, but from the material of which it is formed. This being a very thin wire of iron, or, better still, of maillechort, an alloy of zinc and cobalt. A helix containing only one metre of the latter will produce as much resistance as many kilometres of telegraphic wire, and thus the interposed helix may, for the largest electro-magnet, be extremely minute.

PHOSPHORUS A METAL: THE SO-CALLED AMORPHOUS PHOSPHORUS CAPABLE OF CRYSTALLIZATION.—Certain properties of phosphorus lead to the conclusion that it is a metal very similar to the other metals arsenic, antimony, and bismuth, belonging to the group in which it is found: but the supposition is strongly confirmed by recent experiments, in which the property possessed by lead of dissolving phosphorus is applied to the production of phosphorus in the crystalline form. The phosphorus is put, along with the lead, into a thick tube of hard glass, the interior of which is next exhausted of air, and hermetically sealed. The glass tube is then placed in an iron tube, capable of being closed at the ends; and the space between the tubes is filled with magnesia, after which the apparatus is kept at a high temperature for eight or ten hours. On cooling, the surface of the lead is found covered with crystals of phosphorus, which, like those of arsenic, antimony, and bismuth, are rhombohedric. They have a metallic appearance, and are black by reflected, but red by transmitted light. Their specific gravity is greater than that of the ordinary and even of the amorphous phosphorus, being 2·34, while that of the others is 1·82 and 2·14. The volatilities of these three different kinds of phosphorus differ in a similar way.

The so-called amorphous or red phosphorus can now be easily crystallized. For this purpose, M. Blondlot, who discovered the fact, draws out the neck of a matrass in a lamp until it is about the size of a quill. He then fuses phosphorus under water in glass tubes capable of passing through the contracted neck, and introduces two grammes of the cylinder thus obtained into the matrass, having previously wiped them with filtering paper: after which he hermetically seals its neck, keeping it during the process wrapped in a moist cloth to prevent the phosphorus from igniting. It will, however, emit light while combining with oxygen, and this combination will be complete in twenty-four hours, after which its temperature is to be raised to that of fusion, solar light being excluded by covering the matrass with a truncated cone formed of cardboard. After a few hours, brilliant points will make their appearance in the upper part of the matrass, and after two or three days crystalline arborisations will have covered its whole surface. The crystals thus formed are cubes, sometimes octohedrons, and sometimes in the form of long projecting needles. As long as they are kept from light they are colourless, but even diffused daylight

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changes them very quickly to red, without, however, diminishing their brilliancy or transparency. That, in becoming red, the phosphorus has not changed its properties is evident from the fact that if heat is again applied, it will be covered with the white crystals. The latter, as might be expected from the eminently electro-positive properties of the phosphorus, rival the diamond in brilliancy.

Simplification of the Soda Manufacture.—Sulphide of sodium is, in the ordinary process of manufacture, changed into sulphate of soda, by means of nitrate of soda, which involves considerable expense. It has been found, however, that the oxidation of the sulphide may be effected by far less costly means. For this purpose it is only necessary to utilize the oxygen of the air, which is effected in the following way:—The crude liquor is placed in a vessel with a false bottom, having a great number of small holes. Into the centre of this false bottom has been inserted a pipe, the upper end of which projects over the top of the vessel, and terminates above by a funnel-shaped throat. Steam of about forty pounds pressure being made to issue from a jet, which is situated a little above the throat, in rushing into the funnel it carries along with it a large quantity of air: and this issuing through the holes of the false-bottom, and passing into the fluid in a finely-divided state, so as to come in contact with a very large surface, all the oxidisable matters present are oxidized, and thus a considerable quantity of sulphite is changed into sulphate in a very short time. The manufacture of alkalies is carried on at present on so vast a scale that any improvement of the processes used in it must be productive of an immense saving.

Improvement of Glass for Optical Purposes.—Great refractive power is the chief desideratum in glass for optical purposes. This is obtained by means of great density, which hitherto has been due to lead. It has been found, however, that replacing the potash or lead, and especially the former, with thallium, affords a highly refractive glass of the finest description. 300 parts sand, 200 parts peroxide of lead, and 335 parts carbonate of thallium give a glass which has a greater specific gravity and a higher refracting power than any other known, its specific gravity being 4·235, and its index of refraction for the yellow rays, 1·71. It is perfectly homogeneous, and has a slight yellow shade which is very pleasing. It may, perhaps, be found useful to makers of artificial gems. A much greater specific gravity and higher refractive power may be attained by altering the relative amounts of the ingredients.

New Electric Alarm.—An electric alarm of extreme delicacy, the invention of M. Robert Houdin, is formed by soldering together a blade of copper and another of steel, fixing one end of this compound blade to a board, along which it lies parallel, something after the manner of a knife used in chopping, but not in contact, that friction may be avoided. Near the free extremity of the blade is a metallic knob, which is capable of being moved to different distances from it, and is in conducting communication with one pole of a galvanic battery, the free end of the compound blade being in connection with the other. When the temperature of the surrounding air is increased, the compound blade becomes curved,

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on account of the metals of which it consists being unequally expanded; and coming in contact with the metallic knob, battery connection is completed. This causes a small bell, similar to that used to attract the attention of the attendants in telegraph offices to ring; and thus notice is given of any undue rise of temperature in the place containing the instrument. Information of fire having broken out may thus be obtained, and the necessary means for its extinction may, in consequence, be promptly taken. The temperature at which the bell will ring may be regulated by adjusting the metallic knob: and the apparatus is so sensitive that a lighted cigar or taper placed within a very few inches of it will cause the bell to ring.

THERMO-ELECTRIC PROPERTIES OF IRON.—The small quantity of carbon which causes the difference between malleable and cast iron produces so considerable a modification of thermo-electric properties, that, while a thermo-electric battery of malleable iron and bronze causes the needle of the galvanometer to be deflected to the left, a similar battery of cast iron and bronze causes a deflection to the right. The discovery of this curious fact led M. Arnould Thenard to make experiments with a battery consisting of malleable and of cast iron; and the results he obtained indicated other anomalies which could scarcely have been anticipated. Thus, with a battery consisting of malleable iron and bronze, the deflection was found to be + 23°, and with a battery of cast iron and bronze —11° 5; and it might be supposed that with a battery of malleable and cast iron the deflection would be 23 + 11°·5 = 34°·5. Such, however, was not found to be the case; the deflection actually produced being only 27°. The electro-motive force of the three kinds of battery was in accordance with what might be expected: that of malleable iron and bronze, cast iron and bronze, and malleable iron and bronze being represented respectively by the numbers 691, 263, and 953: the last being very nearly the sum of the other two taken together.

OXYGEN OBTAINED FROM ATMOSPHERIC AIR.—Our ordinary modes of obtaining oxygen for experimental and other purposes are very costly or very troublesome. It may, however, be procured with great facility through the medium of permanganate of soda, which, as it may be used over and over again, for the purpose, will entail but a trifling expense. Atmospheric air is passed over a solution of the permanganate, which, after a while, becomes saturated with the oxygen it has absorbed, the nitrogen having passed off. To separate the oxygen from the solution, a current of vapour at a proper temperature is substituted for the current of air, this, almost without producing any change in the permanganate solution, further than dilution, causes the oxygen to be evolved. Concentrating the solution by heat renders it again fit for use, especially if a very small quantity of the permanganate is added to it.

MISCELLANEOUS.—*Substitute for Amalgamated Zinc in the Galvanic Battery.*—M. Zaliwski-Mikorski has recently informed the Academy of Sciences that if the zinc of a galvanic battery, instead of being amalgamated, is moistened all over with oil, or even with ether, or any of the liquid hydro-carbons, the duration of the current

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is greatly increased. ——*New Textile Fibre.*—If, as soon as its flowers have been gathered, the stalks of the hop-plant are made into bundles, and well steeped in water, then dried in the sun, and beaten like hemp, a fibre will be obtained which, after being combed, is admirably adapted to being spun into thread, that furnished by the larger stalks being well suited for cordage or twine. This is very important as the flower is not in any way interfered with.——*New Application of Cork.*—Springs of India-rubber, used in the buffers of railway carriages, etc., under the influence of great pressure soon lose their elasticity. Cork, which may be of an inferior kind, has been found an excellent substitute for them. To render it soft and permanently moist, it is soaked in a mixture of molasses and water. It is then cut into discs which have a central hole, and are placed in a cylindrical cast-iron box, and over them a flat iron disc. Being then subjected to great hydraulic pressure, their thickness is reduced to one half, after which a bolt is run down through the metallic and cork discs, and the bottom of the cylindrical box, and is fastened by a nut. This, when the pressure is removed, prevents the cork from regaining its original dimensions. The apparatus is now ready for use. Cork discs about eight inches in diameter are found to exhibit extraordinary elasticity under a pressure of 20,000 lbs.

NOTES AND MEMORANDA.

Chemical Poisoning.—M. Melsens states, in *Comptes Rendus*, that chlorate of potash and iodide of potassium may be administered in considerable quantities *in succession* to dogs, without injuring them, while if they are given simultaneously, the animals are poisoned, apparently by the formation of iodate of potash. He observes that the two salts do not react in this way under ordinary circumstances, but they do so in strong acid solutions, or when in fusion, and when mixed and decomposed by the electric pile.

Medical Properties of the Teazle.—M. Beullard informs the French Academy that the leaves of the teazle, *Dipsacus sylvestris*, pounded, and applied to wounds and bruises, has a powerful action in the prevention and cure of gangrene. He removes mortified flesh, washes the wound in chlorurated water, and then applies a poultice of the leaves. He states that he used this remedy with success for fifteen years.

Bolide at Vichy.—M. Veriot describes a bolide, seen at Vichy on the 21st August (20th ?), at 7h. 20m. P.M., as like an enormous fusee, and brighter than the moon. It was visible for ten seconds, passing from N.W. to S.W. in a line making an angle of 20° or 25° with the horizon.

Shooting Stars near the Earth.—In *Astronomische Nachrichten*, No. 1606, is a communication from C. Behrmann, of Göttingen, stating, that on the 30th of July, about 9½h. P.M., shooting stars appeared to come out of a thick cloud, about 15° above the horizon, and vanished in about four-tenths of a second, having a visible path of five or six degrees. The cloud covered the entire sky, and was so thick, that a bright meteor could not have been seen through it; hence he concludes "that the shooting-stars were manifestly driven on this side of the cloud." He thinks these stars must have come within 0.1 mile of the earth.

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NEW FRESHWATER POLYZOA.—Mr. C. Parfitt describes, in *Annals Nat. Hist.*, two new freshwater polyzoa he found in Devonshire, *Plumatella lineata* and *Limnas*. The first is characterized by eight or ten dark brown longitudinal lines running the whole length of the tubes. The polyp cells are barrel-shaped, and hyaline, the mouth entire, each having five or six dark brown annulations, slightly constricted at each annulus. Tentacles sixty-two; statoblasts dark reddish brown, elliptical, with a broad yellow margin. It was found on the underside of water-lily leaves, in a pond in Mr. Veitch's old nursery, Topsham Road, Exeter. The other (*P. limnas*) belongs to that section of the genus which includes *P. emarginata*; "but the line of demarcation between the diaphanous portion of the tube in this species and the thick opaque walls of the inferior half gives it even at first sight a very distinct and marked appearance. Another striking peculiarity is that the tubes grow mostly in pairs, and are very closely adherent to the matrix, except the polyp cell, which stands up conspicuously near the end of the tube." The lower half of the tubes are opaque, and coated with grains of reddish-brown matter. The opaque walls are white inside, and made up of pentagonal cells. Tentacula fifty to fifty-four; calyx festooned. "Statoblasts elliptical, yellow, with a narrow blackish ring dividing the cell from the narrow purple rim or annulus which surrounds it." The orifices are conical, not quite at the end of the tubes, and stand at right angles to the tubes, being raised by three or four folds or rings.

SILVERED OBJECT-GLASSES FOR SUN-VIEWING.—M. Foucault proposes that, for the special purpose of viewing the sun, large achromatic objectives should have their outer sides silvered by chemical precipitation. He finds that a silver film, such as that deposited on the silvered mirrors for telescopes, does not interfere with the definition of an object, like the sun, bright enough to be seen through it.

THE SPONTANEOUS GENERATION CONTROVERSY still occupies the French Academy. Recently, M. Al. Donné, who formerly took the opposing side, adduced experiments on the affirmative side. He punctured the shells of eggs with a red-hot wire, enveloped the eggs in cotton that had been heated, with a view to destroy germs, and then immersed them in hot ashes. In the course of three weeks or a month he found moulds growing on the organic matter of the egg. M. Pasteur pointed out that the precautions to exclude germs of small organisms were by no means sufficient, and hence the experiment must be rejected.

THE CHOLERA MIST.—Should the blue mist described by Mr. Glaisher still appear in any part of the country, it is most desirable that the organic particles it may contain should be accurately examined by the aid of the microscope. Mr. Glaisher and other observers have detected some small bodies of a blue colour, the nature of which has not, we believe, been thoroughly investigated. Microscopists should endeavour to ascertain whether such particles exist in sufficient quantities to account for the colour, and whether they represent known forms of sporules.

AN APPLE CONGRESS.—The French Pomological Congress began its eleventh session at Melun on the 14th September. Its object is to induce the rejection of all mediocre and bad sorts of apple-trees, and to promote the cultivation of the finer and more profitable kinds. It is expected that the export of French apples will be extended by these measures; and we have need, as Mr. Roach Smith has pointed out, of something of the sort in this country, where the supply of good apples is below the wants of the population.

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RECENT SHELLS.

2. Dentalium elephantinum.
4. Vermetus lumbricalis.
6. Sihquaria anguina.
11. Wal comma australis.
12. Isocardia cor.
13. Aspergillum vaginiferum.
14. Crioceras spinosum?

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THE INTELLECTUAL OBSERVER.

NOVEMBER, 1866.

ON THE FORM, GROWTH, AND CONSTRUCTION OF SHELLS.

BY THE LATE DR. S. P. WOODWARD, F.G.S.

Edited from his MSS. by Henry Woodward, F.G.S., F.Z.S., of the British Museum.

(With Two Plates, one Coloured and one Plain.)

Shells are often called the "habitations" of fishes, or of marine animals, or snails. Every one has seen the device of a snail, with the motto, "always at home," on juvenile letters. The quarrymen of the Cotteswolde Hills go so far as to call some fossils "snail-houses," the same epithet which they apply to empty shells of the common garden snail. The term is not quite correct, for they are more properly *skeletons*, and we do not "inhabit" our bones, though Byron calls the *skull* a "tenement," and "the palace of the soul." Nevertheless, the expression is sufficiently indicative of the sense in which it is popularly used, and may pass muster without any further challenge on our part.

One afternoon last summer we visited the fish-house of the Zoological Gardens, and paused to watch the manœuvres of a hermit crab housed in a whelk-shell. Just then a lady of distinguished appearance called the attention of her friends to the same truculent animal, and expressed her lively satisfaction at having thus become acquainted with *the creature which made that kind of shell!*

We hope before long to introduce our readers to a better acquaintance with the original fabricator of that common object of the shore, and to show how the forms and patterns of shells are suited to the wants and welfare of their proper owners. But at present we intend to look more especially at certain specimens put together to illustrate the structure of shells in general, and to show their architectural rather than their physiological peculiarities.

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It may be seen at a glance that many shells are *bivalve*, like the oyster and cockle (see Coloured Plate, Fig. 12, *Isocardia*); while a few, called "Chitons" (see Coloured Plate, Fig. 14, *Chiton squamosus*, and Woodcut (1) of *Chiton piceus*) are *multivalve*; but the great majority are *univalve* (see same Plate, Figs. 1—10), and sometimes tent-shaped (Fig. 6, *Patella*), or tubular (Fig. 13, *Aspergillum*; Fig. 8, *Dentalium*; Fig. 9, *Vermetus*; Fig. 10, *Siliquaria*), but for the most part spiral (Figs. 2, 3, 4, 7, 9, and 10), though exhibiting an endless diversity in their proportions, as well as in their sculpturing and colour.

FIG. 1, *Chiton piceus*, (side view).

All insects, crabs, and other articulate animals are symmetrical, having the organs in pairs, *i.e.*, the right side like the left. In corals and star-fishes the bilaterality is usually disguised by a radiate arrangement of the parts. But in snails the symmetry of the eyes, tentacles, and other organs of the head, is lost in the body of the creature. Instead of a double heart, and two series of gills, these organs are single, and placed on one side. When on the left side, the growth is from left to right, to provide space; but in shells which are symmetrical, like the pearly nautilus, the keyhole limpet, and the *Ampullaria*, the gills are developed symmetrically on each side, or nearly so.

The tendency to grow in a *spiral form* is very characteristic of the class Mollusca. Some writers have accounted for it in a very matter-of-fact way. "Molluscous animals are long and worm-like; therefore Nature has coiled them up, that their tails may not be an incumbrance to them."

It is easily ascertained that the snail has a small spiral shell when it first quits the egg, and the young whelk may be examined while still a prisoner in the same capsule with its brothers and sisters.

The convenience of the arrangement is obvious, and that may be sufficient for us at present, but the time is coming when naturalists will desire to look more closely into these things.

How happens it that the embryo-snail coiling itself up closely in its narrow cell, almost always takes a direction from left to right, following the course of the sun, and forming a dextral spiral, or *right-handed* shell, like an ordinary screw? Such a course is not absolutely necessary, neither is it accidental. A few whelks and garden-snails—perhaps one in ten thousand—are *left-handed*; and certain kinds of whelks and land-snails (see Coloured Plate, Fig. 2) are as frequently reversed

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as right. The greater part of the genus *Clausilia* (numbering upwards of two hundred species) is reversed. The species of the genera *Physa* and *Triforis* appear to be all reversed. All the specimens of *Fusus contrarius*, Sby., so abundant in the Red Crag, and also found living in Vigo Bay, on the coast of Spain, are left-handed. But, after all, these latter are the exceptions. Every one familiar with garden plants will have noticed that the hop turns round its pole in one direction, going to meet the light, while the scarlet-runner takes an opposite course, as invariably as the sun it follows.*

The tendency to *spirality* is observable in bivalve shells, especially in *Isocardia*, whose separate valves resemble two spiral univalves—one right-handed, the other left-handed (see Coloured Plate, Fig. 12), with small spires and large apertures.

In this shell, as in the common cockle, one valve is placed on each side of the shell-fish, which is usually symmetrical, and lives in a vertical position as regards the plane of its valves.

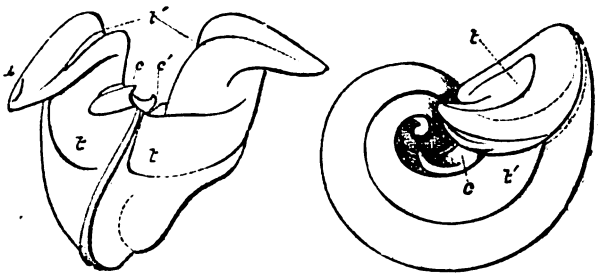

Fig. 2. Fig. 3.

Fig. 2 represents the internal cast of *Diceras arietinum*, Lamk. Coral Rag, France, ¼ nat. size, *a*, point of attachment; *c,c,c'*, casts of dental pits; *t,t,t, t',t'*, furrows produced by muscular ridges.

Fig. 3, internal cast of *Requienia Lonsdalei*, Sby. sp., ½ nat. size, Lower Greensand, Bowood, Wilts. From *Quart. Journ. Geol. Soc.*, 1855, Vol. XI. p. 53, Figs. 28 and 29.

To this there are some exceptions; for example, the oyster and scallop, which, like the turbot and sole among fishes, lie, the former on its left side, and the latter on its right side, and fatten at their ease.

The valves of the cockle are united by an elastic ligament, and articulated by projecting teeth, which form a very complete hinge. It is obvious that the valves of a shell cannot grow so freely along the hinge, as on the rest of the margin, but it may shoot out to a great length, as in the "razor-shell" (*Solen*), or in three directions, as in the "hammer-oyster"

* Unluckily the botanists have chosen to reverse the terms employed in mechanics, and call the spiral of the hop right-handed.

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(*Malleus*), while in the "heart-cockle" each valve takes a spiral (see Coloured Plate, Fig. 12).

There are some fossil shells called *Diceras*, in which the two valves resemble horns, and others called *Requienia* (see Woodcut, Figs. 2 and 3), with one valve produced into a horn. In *Chama* the *umbones* are also spiral.

In many bivalves the beaks are turned *forwards*, towards the head of the animal (*not always*, as stated in some big books). But the oyster is again an exception in this respect; and if among the exotic or fossil species you find some with spiral growth, the spiral is turned *backwards;* indeed, the number of exceptions is so great, that one fears to make any general assertion. *Anomia*, when it grows inside other shells, may have its umbo a little removed from the margin, and the fossil genera of *Hippurites* exhibit every condition between a marginal ligament and a spiral beak, like *Chama*, and a patelliform valve, with a ligament wholly internal, and a central umbo.

The shell, considered *as a defence*, is most complete in those bivalves, like the oyster, which shut up close (see Coloured Plate, Figs. 11 and 12), and in those univalves which have an *operculum*, or door, to their houses (same Plate, Fig. 3).

Many *bivalves* gape a little at the sides (or ends), where the foot and the respiratory tubes are accustomed to be pushed out; and many *univalves* are too large and bulky, in proportion to their shells, to be completely housed and protected in them.

The cowry owes the glassy polish of its whole exterior to the amplitude of its mantle, whose folds meet over its back, and ordinarily conceal the shell entirely.

In the shining Marginellas and Olives, and some Volutes, the shell is partially glazed by the same envelope.

One sort of garden-slug, the *Testacella* (see Woodcut,

FIG. 4. *Testacella haliotidea*, side view; *s*, shell; *b*, end view of a specimen which has been disturbed from its winter sleep, showing the mantle partly expanded round the shell.

Fig. 4), has a small, shield-like shell on its tail, while the rest appear to have no shell at all, it being always rudimentary, and usually internal. Such is also the case in *Aplysia*, the "sea-hare," in which the shell is entirely concealed by the mantle. On the other hand, *Cyclostoma elegans* (see Woodcut, Fig. 6), a snail found in hedgerows and thickets of the chalk districts, covers the aperture of its shell with a close-fitting, shelly plate,

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Fig. 1. Operculum of Turbo fluctuatus; *a*, outside.

Fig. 2. Operculum of Imperator olivaceus; *b*, outside; *c*, inside.

Fig. 5. Conus tesselatus, transverse section.

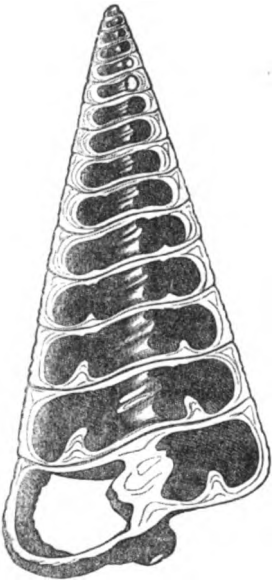

Fig. 8. Cerithium telescopium, longitudinal section.

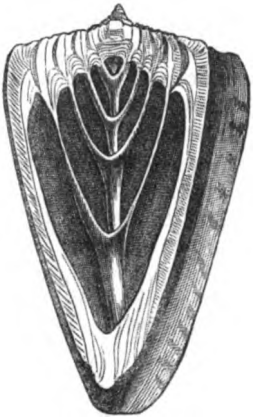

Fig. 4. Conus tesselatus, longitudinal section.

Fig. 6. Marginella glabella, longitudinal section.

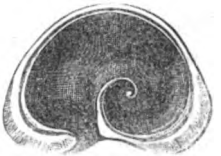

Fig. 7. Cyprœa Turdus, transverse section.

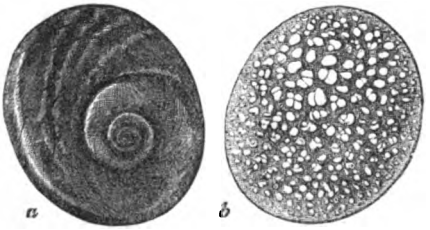

Fig. 3. Operculum of Turbo Sarmaticus—*b*, exterior surface; *a*, interior surface.

OPERCULA AND SECTIONS OF SPIRAL SHELLS.

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which enables it to resist the summer drought, and exclude all enemies.

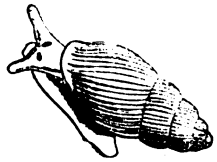

FIG. 5. *Carychium minimum*, highly magnified.

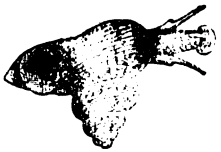

FIG. 6. *Cyclostoma elegans.*

In the Coloured Plate, at Fig. 3, is represented a specimen of the foreign land-snail, *Tropidophora carinata*, presented to the author by that indefatigable traveller, the late Madame Ida Pfeiffer, which was brought *alive* by her with other specimens from the Mauritius. It was perfectly lively and well after six months' close confinement, wrapped up in an old sock in a tin pot.

The periwinkle has a similar operculum, of a horny consistency and spiral structure; but the exotic Turbos have a solid, shelly operculum (see Plate, p. 245, Figs. 1—3), coated inside with rich brown, and spirally marked with lines of successive growth; while the exterior is smooth, or corrugated, like the tufa of a dripping well (same Plate, Fig. 3, *b*), or variously carved.

In the great pearly *Turbo marmoreus*, so often used for a sideboard or mantelpiece ornament, the operculum frequently weighs several ounces. A specimen in the shell-gallery of the British Museum weighs more than half a pound.

The whelks and all their tribe have horny *opercula*, and the pattern is often characteristic of the genus; the operculum of

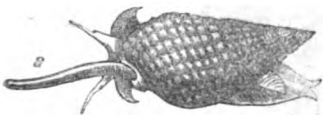

FIG. 7. The Dog-whelk, *Nassa reticulata.*

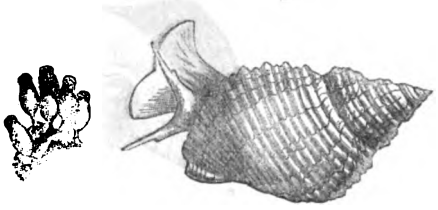

FIG. 8. The Dog-whelk, *Purpura lapillus*, and a small cluster of its egg-capsules.

the whelk is *never spiral.* (See Woodcut, Fig 9.) Gregarious animals, such as the whelk and periwinkle exhibit malformations more frequently than others; thus we have whelks with double opercula, others with shells repaired after injury or curiously contorted. Mr. W. H. Rich, of No. 14, Great Russell street, Bloomsbury, W.C., has devoted much time to the collection of anomalous forms of British shells. He will be

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happy to gratify any of the readers of this article with a view of his collection, which is well worthy of inspection. There are also several cases for the exhibition of abnormal shells in the gallery of the British Museum.

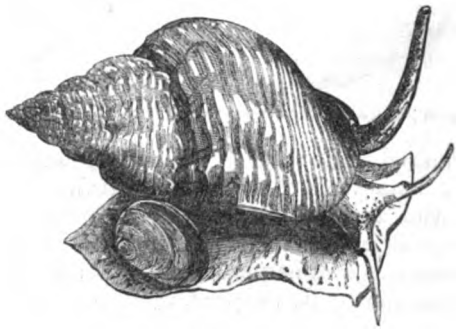

FIG. 9. The Common Whelk, *Buccinum undatum* (British).

The *Epidermis*.—The exterior of the shell of the whelk (see Woodcuts, Figs. 7—9) is invested with a thin, straw-coloured membrane whose existence is scarcely recognized. Shells from a quiet soft sea-bed often have a coat like brown velvet. Many exotic Tritons are remarkable for their rough cuticle. Arctic shells, also, such as *Modiola, Astarte, Cyprina,* have, when taken alive, a very dark-brown epidermis, entirely covering their surfaces. Fresh-water mussels and melanias (see Woodcuts, Figs. 10—12) are also conspicuous by their olive or chesnut-coloured skin.

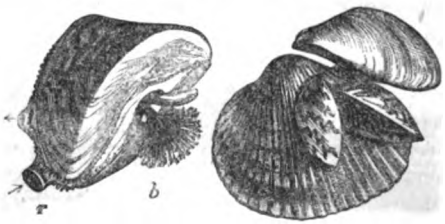

FIG. 10. *Dreissena polymorpha*, showing foot, byssus (*b*), and respiratory siphons.

FIG. 11. Three *Dreissenas* attached to Caspian Cockle.

This living membrane extends beyond the margins of the valves in a fringe or sheath, and protects the shell from decomposition by chemical action.* The mollusca inhabiting fresh water are especially exposed to corrosive action, either from

* In fact, it fulfils exactly a similar office to the human scarf-skin, having life without sensation, it protects the shell whilst the animal lives.

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carbonic acid in solution, or dilute sulphuric acid from the decomposition of iron pyrites. But the action is especially manifested in those stagnant waters where the first probe of the collecting-rod disengages from the mud an abundant stream of bubbles of sulphuretted hydrogen. In such situations the spiral shells—for example, *Bithynia*—have lost the ends of their spires, and the discoidal shells, like *Planorbis*, have been found with a small hole caused by the dissolution of the inner whorls.

The great and ponderous mussels of the American rivers, and even the fresh-water unios and anodons of our own streams (see Woodcut, Fig. 12) are often externally eroded, and the cause has been the subject of much speculation. The umbo is the part first formed, and consequently that where the epidermis is thinnest and has been longest exposed to the action of the elements, and it is this portion of the shell which is most corroded. The epidermis of *Trigonia* is formed of a layer of nucleated cells, difficult to detect, however, in the state in which they are usually sent home (*i. e.*, well cleaned).

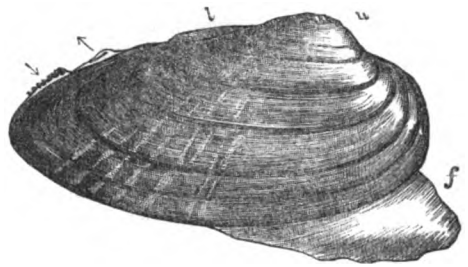

FIG. 12. *Unio tumidus*—River Lea. *u*, the umbo of the right valve; *l*, the ligament; *f*, the foot; the arrows indicate the respiratory currents.

Dr. Bowerbank wrote a paper to show that the epidermis was a very highly-organized structure, not only endowed with vitality like our cuticle, but furnished with vessels appropriate for and capable of repairing any injury it might sustain (*Micr. Soc.*, 1843). These observations, however, have not been confirmed.

Shell-structure.—Shells are composed of carbonate of lime, with an animal basis. There is no appreciable amount of phosphoric acid, so that shells or shell-sand have no chemical value as fertilizers. The French chemist, M. E. Fremy, found that the composition of shell was carbonate of lime, with not more than one or two per cent. of phosphate of lime. When treated with hydrochloric acid, there was left a brilliant felt-like organic residue, not soluble in hot water, like horn or gelatine, and insoluble in alcohol and ether.

This substance, which is isomeric with *osseine* in bone, he named *conchioline*. It sometimes exists in such large proportions that, like the animal basis of human bone, the lime may be dissolved out with weak acid, and the film of conchioline will remain with its peculiarities of structure.

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Formerly, shells were supposed to have a merely crystalline structure; in fact, that they were a mere inorganic exudation. Look, for example, at the exterior of the operculum of *Turbo sarmaticus* (see Plate, p. 245, Fig. 3, *b*) how exactly it resembles tufa formed by spray on a limestone rock (the mantle of the animal does not continuously cover it, on the contrary, it is the door which, when closed, shuts in and protects the mantle; but at times it certainly does cover it, for it deposits on each little eminence an additional layer of shell-matter); or at the broken tube of the great *Teredo* (*Furcella*) of Java, which is more than two feet in length, and half an inch in thickness; or at the shell of the fossil Belemnite and recent *Pinna*, they have a fibrous structure, which might easily be mistaken for mineral. Drs. Bowerbank and Carpenter have advocated the views taken by botanists and anatomists, namely, that the hard tissues of shells are formed by deposits of lime in cells, or upon layers of membrane. Mr. G. Rainey, having observed that when salts crystallize in syrup, they assume a globular or other concretionary form, not geometrical, was led to imagine that a close imitation of shell-structure might be produced by causing carbonate of lime to deposit in minute concretions, which, coming in contact, become polygonal in the course of their growth. We have every reason to believe that the cells are formed *first*, and then that lime is deposited in them afterwards, just as the hard tissues of seed-vessels, the albumen of the vegetable ivory, and the silicious cuticle of grain is formed.

Dr. Bowerbank, however, has been misled in the attempt to compare the shell and the formation of shell too closely with that of *bone*, a highly vascular structure capable of absorption and internal repair, being permeated by canals in which the blood circulates.

If we examine any immature shell, we shall find the lip, or growing margin of the shell, much thinner than the rest of the shell, and, indeed, quite soft. The mucus of this soft, growing edge is found to contain granules, which are, in fact, incipient cells destined to unite and form the calcareous matter of the future shell-wall. The gradual formation of shell may readily be traced in all its stages.

There is an intimate connection between the mantle of the mollusk and its shell. The oyster, as we see it on the supper-table is much smaller than its shell, and adheres only by its glistening shell-muscle; but when alive, its *mantle*, extended to the very edge of the valves, lining the whole interior, and having a slight adhesion, especially at the edge of the valves, which is speedily ruptured, however, when the poor animal is forcibly invaded.

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The "carrier-shell" (*Phorus*) cements other shells, and stones, and fragments of coral to the growing lip, and they remain firmly attached, forming a spiral round the suture. In this case, the hold of the mantle must be strong, or the animal must remain quiet for a while every time it adds a fresh bit to its grotto.

The section of any pearly shell exhibits an immense succession of fine and smooth layers. If polished or worn ever so little, these laminæ will be cut through, and their edges will present a series of parallel lines. In the nacreous shell of *Haliotis*, the layers are corrugated, so that a single layer might serve to give the pearly effect. In porcellanous shells, the entire structure is composed of layers of cells, much metamorphosed, arranged in three distinct strata, the direction of each of which is different (see Plate, p. 245, Fig. 5, transverse section of *Conus tesselatus*, Born). When seen in section, each stratum is found to be composed of many vertical plates arranged sometimes transversely, sometimes lengthwise, according to the genus. Pearly shells and fibrous shells, such as *Pinna*, are like aragonite, biaxial, and prismatic, when examined with the polariscope. Porcellanous shells, like calcite, are rhombohedral and uniaxial.

The prismatic structure of certain shells is well illustrated by the fossil *Hippuritidæ* from the cretaceous beds; the annexed Woodcut (Fig. 13) taken from the author's paper on Hippurites (Quart. Journ. Geol. Soc., 1855, vol. xi., p. 47, Fig. 12), represents part of the rim of *Radiolites Mortoni*, of Mantell, from the lower chalk of Sussex. (Traced from the original specimen in the Museum of the School of Mines, Jermyn Street.)

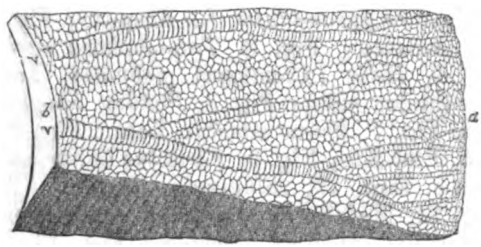

FIG. 13. Portion of the shell-wall of the lower valve of *Radiolites Mortoni*, Mant. Lower Chalk, Sussex. *a*, the outer edge; *b*, the inner edge; *v*, *v*, dichotomous impressions.

A structure analogous to the chambered shell of the cephalopod occurs in the thorny oyster, or *Spondylus*; in aged specimens, the shell, instead of increasing in size, becomes thickened in its interior by the addition of inner layers of shell,

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which are distinct from the outer, and from each other. The cavities thus formed are found to contain water, which, however, evaporates after the specimens have been placed in a dry situation for a long period: but the water is again absorbed by immersing the specimens for a sufficient number of hours. This reduction of the inner space appears to be effected in order to counteract the continued increment of the shell (by deposits of new shell-matter, along its margin from the border of the mantle) at a greater rate than is required for the accommodation of the soft parts of the animal.

The tubes of *Vermetus* (see Coloured Plate, Fig. 9), and *Magilus*, and the apices of *Triton*, *Turritella*, and *Euomphalus* become either partitioned off or filled up solid, in the continued growth of the animal.

Shells owe their variations in form to a number of circumstances. Those which assume a spiral, vary in being either turbinated or discoidal in their growth, and again, in the infinite gradations between the extremes of these two. The shape of *Conus* (see Plate, p. 245, Fig. 4), is an inverted triangle, that of the telescope shell (*Cerithium telescopium*, Fig. 8) trapezoidal, and so on. The turbinated shells again merge into forms in which the whorls become detached with age as in *Vermetus* (Coloured Plate, Fig. 9), and *Siliquaria* (Fig. 10), or a nearly straight tube like *Dentalium* (Fig. 8). The discoidal shells graduate into forms having fewer and fewer convolutions, and wider and simpler mouths, until at last, in forms like *Patella* (Coloured Plate, Fig. 6), all spirality is lost, and we have only a tent-shaped cover.

DESCRIPTION OF COLOURED PLATE.

Fig. 1, *Cleodora pyramidalis*, L., Atlantic; Fig. 2, *Bulimus regina*, Fer., Amazon; Fig. 3, *Tropidophora carinata*, Mauritius; Fig. 4, *Helix* (*Anastoma*) *globulosa*, Lam., Brazil; Fig. 5, ditto (under side); Fig. 6, *Patella longicosta*, Lamk., West Indies; Fig. 7, *Murex adustus*, Lam.; Fig. 8, *Dentalium elephantinum*, Red Sea; Fig. 9, *Vermetus lumbricalis*, Gm. sp., West Africa; Fig. 10, *Siliquaria anguina*, Linn., New Guinea; Fig. 11, *Waldheimia australis*, Quoy, Port Jackson; Fig. 12, *Isocardia cor*, Lin., British; Fig. 13, *Aspergillum vaginiferum*, Lam., Red Sea; Fig. 14, *Chiton squamosus*, Linn., West Indies.

DESCRIPTION OF PLATE (PAGE 245)—OPERCULA AND SECTIONS OF SPIRAL SHELLS.

Fig. 1, Operculum of *Turbo fluctuatus*, Mazatlan—*a*, external surface; Fig. 2, Operculum of *Imperator olivaceus*,

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also from Mazatlan—*b*, external surface, *c*, interior; Fig. 3, Operculum of *Turbo Sarmaticus*, L., from the Cape of Good Hope—*b*, exterior, *a*, interior; Fig. 4, Longitudinal section of *Conus tesselatus*, Born., to show the thinning of the internal whorls; Fig. 5, Transverse section of the same shell; Fig. 6, Longitudinal section of *Marginella glabella*, Canary Islands, showing four spiral ridges on the columella; Fig. 7, Transverse section of a Cowry (*Cypræa Turdus*); Fig. 8, Longitudinal section of telescope-shell (*Cerithium telescopium*, L.), from Indian rivers, showing one spiral ridge on the column, and a second on the wall of the shell.

(*To be continued.*)

NOTES ON THE HABITS OF SOME LEPIDOPTEROUS LARVÆ.

BY THE REV. D. C. TIMINS, M.A., M.E.S. LOND. ET OXON.

THE processionary-moth (*Bombyx processionea*) is tolerably abundant in European collections, but the very singular habits of its larva seem to have escaped the notice of writers on entomology. I have never met with a detailed description, so venture to note the following facts, results of personal observation.

The larvæ of *B. processionea* lives in society; fifty or sixty individuals uniting to spin a common "nest." These "nests" are generally spherical, or nearly so, and are composed of very coarse network of hairs spun together. Their colour is a dull brownish grey, and they are extremely dangerous to handle, the hairs of which they are composed being highly irritating, producing very painful swellings, attended with inflammation. Within these nests the larvæ spend their days, issuing forth toward evening for the purpose of devastating the neighbouring trees. Most species of pine and fir are exposed to their ravages; but the picturesque "umbrella pine," so common along the coast of Provence, sometimes escapes without injury, *B. processionea* preferring any other species of pine if accessible. I have sometimes met these larvæ feeding during the day, but for the most part they are certainly night-feeders. They march forth in a long line, single file, one after another, each touching the one in front. They go wherever the individual who leads chooses to take them, and it would be a subject of curious speculation to imagine *how* these larvæ elect their

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leader, and *why* they follow him so obediently; and by what means one individual obtains authority over his fellows. The line marches along until a suitable tree is reached, then the larvæ dispersing among the branches, commence their work of destruction. It is probable that they return in the same order in which they set out, but I have never had the good fortune to see them re-enter their nests. When they are on the march, if you knock the leader away, the whole line halts and remains stationary until the chief has resumed his place. If you kill the leader, the line at first remains quiet, then after a little time falls into confusion, various individuals going hither and thither, apparently bewildered, possibly searching for their leader. Presently they reform line under a new chief, whose direction they obey as they obeyed his predecessors, and continue their march. If you knock some individuals out of the line, their fellows will halt and wait until they have resumed their places, but if you kill or disable any, the remainder, after waiting for some little time, will close up their diminished rank and proceed on their way. They march straight on, heedless of danger, and well they may, for you had better not touch them without gloves. The hairs with which they are covered are so poisonous that it is said death has followed upon handling these larvæ; this, however, I should think due to a very diseased state of the blood. Birds, those enemies of the insect tribe, do not seem to prey upon these larvæ, which appear thus to increase unmolested. The ravages which they commit among the firs and pines near Hyères and Cannes are very great; I have often counted 100 nests in the course of a single ramble. I am at a loss to account for the very poisonous nature of these creatures; I have subjected their hairs to careful microscopic investigation; they are certainly formidable looking weapons, jagged and barbed on each side; but this is the case with the hairs of other species, which are harmless (*e. g.*, our common *Bombyx pudibunda*). There is a long bulb at the root of each hair, which I have conjectured to be a poison-bag, similar to that found in venomous serpents. This is merely a conjecture, however, as the bulb in question *may* be only the usual root of the hair, but I give it here as being the only way of accounting for the poisonous nature of these hairs which has occurred to me.

When about to assume the pupa state, about the month of April, these larvæ quit their nest in the usual order, and often traverse very considerable distances before finding a place suited to their purpose. They bury themselves, and form a rough cocoon of earth, hair, etc., at a depth of an inch or two below the surface. Hence the choice of a proper locality is a matter of importance, as the larvæ cannot form their cocoons

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in stony ground, nor among the rocks of mica schist which abound in Provence. Accordingly they wander about, still under the guidance of their leader, until a suitable place is reached; then, as if by common consent, the line breaks up, and each larva proceeds to bury himself, near his fellows, so that where one cocoon is met with by digging, others are sure to be found close at hand. I may mention that I have never succeeded in rearing the perfect insect, all my pupæ having died, probably from not having the choice of ground when in captivity.

Another larva, whose habits are worthy of note, is that of the magnificent *Charaxes Jasius*, the prince of European butterflies. This glorious insect is very local in Europe, occurring only in Provence, near Hyères for the most part; and, it is said, in one or two localities in Spain. The larvæ I have found pretty commonly near Hyères: at Cannes none were to be seen, nor were any met with in the Estrelle mountains, although the food plant (*Arbutus unedo*) abounds there. This larva is of a curious shape, the middle segments being very thick, and those toward the head and tail gradually tapering. The head has a species of mask with four horns, corresponding quaintly enough with the four tails on the wings of the perfect insect. This larva feeds only in the sunshine, and must of course be looked for only on those leaves which are exposed to the sun's rays; all attempts to induce it to feed in the shade prove fruitless. The creature would sooner die than eat except in the bright sunshine! It forms a slight silken web, very soft, and of a brilliant white colour on the leaf, not for a *covering*, strangely enough, but for a *couch*. This is, as far as I know, the only instance of silk being produced by a member of the *diurnal Lepidoptera*. The larvæ being of a bright green colour, similar to that of the food plant, are very difficult to find, and often are overlooked, even by sharp-sighted entomologists. They adhere with wonderful tenacity to the leaves on which they feed. No amount of shaking or beating will dislodge them; in order to obtain them it is necessary to examine each leaf carefully (that is, of course, each leaf on the *south* side of the plant). The larva grows very slowly, being hatched about July, and rarely attaining its full size until the following May. Before each change of skin it suspends itself from a branch by the tail, and when the change is effected, the skin of the head is left behind, horns and all, like a mask! This insect is exceedingly difficult to rear, a very slight touch will kill the larva or pupa; and to rear it in England is next to impossible, first, on account of the scarcity of its food plant; secondly, because we have so little sunshine during the spring; thirdly, because our summers are not warm enough to bring

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the pupæ to maturity. However, I have managed to rear a *very few* out of a large number of larvæ; several emerged crippled in the wings, and the experiment altogether was almost a total failure, as we only obtained *two* good specimens out of twenty-three healthy larvæ, which we brought from Hyères in April last. Feeding them during the journey was of course very difficult, and the change from a hot climate to a cold one did much mischief. When this larva is full fed, it suspends itself by the tail, the head curled round towards the tail in the usual manner of diurnal lepidopterous larvæ. In this position it remains for ten or fourteen days, during which time the *least* touch is fatal. At the expiration of that period the skin cracks at the fourth segment, and the bright green pupa emerges, the old skin shrivels up (leaving the pupa free) the "mask" alone remaining. The pupa state lasts but a few days, the markings on the wings soon appear, and are rapidly developed, the antennæ and legs assume their proper colours, and the perfect insect emerges (always, it is said, at *noon*) about the first week in June, sometimes earlier. The perfect state is usually of very short duration; for the young larvæ are found in July and August, the parent insect disappearing about the same time. Occasionally, however, the perfect insect survives until the winter; indeed, *once* I saw it on the wing in December, but this was considered by French entomologists as quite an abnormal appearance. *C. Jasius* flies with amazing rapidity, and it is very difficult to catch on the wing, taking alarm at even the distant approach of the entomologist, and flying off at a marvellous speed.

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IRON AND STEEL IN THE CONSTRUCTION OF SHIPS AND BRIDGES: THEIR ADVANTAGES AND DISADVANTAGES.

BY PROFESSOR McGAULEY.

A GREAT revolution has taken place in two of the most important branches of construction: the "wooden walls of Old England," which for ages were justly considered its impregnable bulwarks at home, and the infallible means of asserting its superiority abroad, have been discarded; stone and brick, which were relied upon as affording a power of crossing rivers, since the progress of civilization enabled mankind to be independent of fords, inflated skins, and other such rude, inconvenient, and unsafe appliances, are now almost equally fallen into disuse for such purposes. The transition has been, in many respects, so sudden, and iron and steel, which have supplanted wood in the building of ships, and stone and bricks in the erection of bridges, are so different in properties from the materials hitherto employed—while, at the same time, so brief has been our experience with regard to them—that we may be considered as, in a great measure, working in the dark, as far as they are concerned. This is a circumstance the more serious, as on the proper construction of our ships depends even the safety of our country, and on the proper construction of bridges the security of our lives, when passing on or beneath them.

It is certain, such are the inducements held out to the use of iron and steel, both for ships and bridges, that a return to the materials formerly employed is out of the question. A wooden ship would be exposed to almost certain destruction by the projectiles employed in modern warfare. And such are the spaces now, in so many cases, to be spanned in bridge-building, that the erection of the structures indispensable to our present system of engineering would be, not only very expensive, but often impossible, with either stone or brick. The widest stone arch in existence, that over the Dee, near Chester, is only 200 feet in span; the main spans of the Menai tubular bridge are each 460 feet wide.

That iron should be so generally used for almost every purpose, is but the natural consequence of its abundance, its cheapness, and its great strength. Comparing the cost of its production at present with what it was in former times, it is evident that it could not be employed, until now, on the present enormous scale of consumption. Many circumstances contributed to limit its use, until a recent period. From the method adopted in smelting, it could be obtained only to an

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amount that was practically limited; and such was the imperfection of the machinery employed in moulding it to the forms it was subsequently required to assume, that it could be worked only in masses of a size which at the present day would be considered utterly insignificant. The possibility of using it on the present immense scale supposes a combination of circumstances which did not formerly exist, and which could be brought about only by long-continued exercise of enterprise and ingenuity.

Iron is the most generally diffused of all the metals. This, looking to the ordinary economy of Providence, evidently points to its wide-spread application. It is, however, one of the metals most difficult of reduction. This arises from its powerful affinities, which also cause it to be so extremely perishable. The difficulty which attends the extraction of iron from its ores prevented its use until long after mankind had attained a considerable amount of civilization. Hence in prehistoric, and even in the earlier portions of historic times, recourse was had to metals which are still both scarce and dear. Bronze was the universal substitute for iron; but, though great hardness was imparted to it—greater, perhaps, than is possible to us—its attendant brittleness, in some cases, and a limited supply in all, placed very narrow bounds to its application. Iron possesses a combination of good qualities which, taken in connection with its abundance, causes it to leave every other metal far behind, when there is question of utility.

One of the most valuable properties of iron—its capability of being cast in moulds—and one which it still retains in its best form, that of steel, was most probably unknown, and most certainly was unapplied in former times. Cast iron, with us, is far cheaper than malleable, and for a great variety of purposes answers at least as well. But, by the modes of manufacture anciently practised, it could not easily have been obtained; and were it even attainable with facility, the methods of manipulating it, now employed with such success, were then undiscovered. Casting iron is, with us, a very simple operation: it could not have been so in former times, on account of the difficulty of forming suitable moulds. This difficulty has been entirely overcome, within a comparatively recent period, by the adoption of sand, an improvement due to a Welsh shepherd boy. The use of sand for the purpose had been previously attempted, but without success: its general application to this most important purpose afforded facilities in the manufacture of cast iron which had been until then unknown.

The exclusive use of wood in the manufacture of iron, in

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former times, imparted to the product qualities which it now rarely possesses, but set very narrow limits to its production. When the value of that metal began to be properly understood, and the demand for it, in consequence, became considerable, the rapid destruction of the forests which ensued had so injurious an effect upon its manufacture, that the quantity of iron made in this country fell to one-fourth of what it had previously been.

A mode of escape from this embarrassment, also, was soon devised. It might be supposed that mineral coal, in the form of coke, would be universally employed as a substitute for wood, when its applicability to the purpose was once ascertained. Such, however, was not the case. The use of coke is attended with difficulties which were not suddenly overcome—which were not, indeed, entirely surmounted before the power of the blowing-machine was augmented by the invention of the steam engine: until then blowing had been effected by that clumsy and imperfect contrivance, the bellows. When steam power came into use, the bellows gave place to the cylinder and piston, the capabilities of which were, practically, unlimited.

The progress of the iron manufacture towards perfection, once begun, was very rapid. It was again almost revolutionised by the introduction of the hot blast. Though the saving effected by this may, at least plausibly, be disputed, there can be no doubt that it is accompanied by peculiar advantages. Thus it renders possible the employment of coal, and even anthracite, and it enables us to utilize inferior ores. The adoption of coal instead of coke leads to an immense saving, on account of the gases, which are the most valuable portions of the fuel, and which formerly were wasted, being economized.

There are, it is true, certain serious objections to the use of coal in the smelting of iron. Thus, the sulphur it usually contains, and from which even coke is not free, causes the iron made with it to be *red short*—that is, to have the very objectionable property of being brittle under the hammer at a red heat. So little as 0.03375 sulphur destroys the property of welding, and a still smaller amount of it renders the metal utterly unsuitable for armour plates. The phosphorus, which also is likely to be present in coal, causes the iron to be crystallized—that is, renders it *cold short*, or brittle when cold. It is worthy of observation, that phosphorus, to a certain extent, counteracts the effect of sulphur; it sets free carbon, which combines with and removes the sulphur. It is possible, however, to get rid of all these mischievous ingredients: but the hot blast cannot yet be entirely depended on for the production of superior iron.

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Numerous other improvements of great importance have been introduced into the iron manufacture, and valuable machinery connected with it has been invented. As an example of the former may be mentioned the process of *boiling*, and of the latter the *steam hammer*, without which it would be impossible to mould the enormous masses of iron required for ship-building and other purposes. But, of all the modifications which the manufacture of iron has undergone, that of Bessemer is probably the most valuable. It enables us to obtain excellent steel at a cost little higher than that of iron; and when the great difference between the strength of iron and steel is considered, the advantage of this will easily be understood. We may observe that, while the tensile strength of pure malleable iron is only 18,000 lbs. per square inch, that of good steel is 130,000 lbs. As with the hot blast, so with the Bessemer process, there are some difficulties yet to be overcome, since, when steel for very important purposes is required, it must be made by the old method.

In considering the fitness of iron as a material for ships and bridges, and particularly for the latter, one most dangerous defect to which it is liable must be taken carefully into account, namely, its tendency to crystallize, and thus to lose a very large portion of its strength. It appears from Mr. Fairbairn's experiments, that with constant changes of load, or with the same load, but with constant disturbance of the metallic molecules, from vibration, fracture will, in time, certainly ensue of itself. And it has been ascertained that an iron girder will break with about 400,000 changes of load, accompanied by vibrations: a fact which but too clearly shows that the spontaneous destruction of our iron bridges is but a question of time, and not even of a very long one. The explanations of this very alarming fact, the danger from which is, unfortunately, not even confined to bridges, but extends to the axles of locomotives and carriages, and to the various portions of machinery, which from time to time so unexpectedly give way, is found in the restoration to their primitive form of the crystals which had been elongated and mutually entangled by the hammering to which the iron is subjected during its manufacture.

It might be supposed that steel, from its tensile strength, being so much greater than that of iron, would be, in every instance, far preferable to iron. Such, however, is not the case. If, for example, steel is used in the formation of a girder, its thickness may be much less than if iron were used. But this very circumstance, as it is almost equally liable to oxidation, causes its strength to be impaired with much greater rapidity. Thus, a plate of iron half an inch thick is much less weakened by oxidation to the depth of the sixteenth of an inch than a

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plate of steel, which at first is only a quarter of an inch thick. In the one case, the strength of the plate is diminished only to the extent of one-eighth: in the other, with the same amount of oxidation, to the extent of one-fourth. In the former case the plate would stand, when in the latter it would be sure to give way. Again, it might be supposed that steel would answer, best where violent concussions are to be withstood, and that, therefore, it would be an excellent material for armour plates. The reverse is, however, true. Steel is strong only when exposed to a force that is slowly applied. A cannon-ball which would cause only indentations in iron, or, at the worst, merely pass through it, would dash a plate of steel to pieces, dealing destruction, most probably, to all those in its vicinity.

The construction of ships and bridges of iron, and especially of the former, supposes the power of producing iron bars and plates. As the mode of forming these, except on a very limited scale, and in a very imperfect way, was unknown until near the close of the last century, iron ships and bridges must necessarily be of very modern invention. There has been by consequence very little experience regarding them: it is, therefore, the more necessary that we should bring to bear on so important a subject, everything we know regarding it.

In comparing the fitness of iron as a material for ships with that of wood, it is requisite to know their relative strength. The tensile breaking strain of iron greatly exceeds that of the very best wood. That of malleable iron is to that of dry English oak as about four to one; and, taking into account the weakness caused in the case of plates by riveting, as two and three-tenths to one. If, however, the riveting diminishes the strength of the iron, on the one hand, it increases the strength of the ship, as a mass, on the other; since, by means of it, the plates are united firmly in every direction. Considering the injuries to which ships are liable, it is not enough to bear in mind mere tensile strength. A compressing strain is often a great source of danger to them. The resistance of malleable iron to such a strain is to that of dry English oak, as seven to one. On the whole, however carefully constructed, a ship of timber is greatly inferior in strength to one properly made of iron.

Iron may be used either partially or exclusively, in the construction of ships. Each mode of proceeding has its peculiar advantages and disadvantages. Thus an iron vessel, timber-sheathed, and copper-fastened is greatly superior to one of iron, as far as fouling is concerned, and it is considerably lighter. But these advantages would be at an end, if a means were discovered of preventing the adhesion of animals or vegetables to the bottom of iron ships, and if steel were to

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become so cheap as to be applicable to the ordinary purposes for which iron is now used.

Whatever the materials of which merchant vessels shall still be constructed, we have scarcely a choice with regard to ships of war. Our wooden walls belong to the past. We must henceforward depend on our walls of iron. The rams and improved projectiles at present in use would soon send the largest vessel of timber to the bottom. The contest between projectiles and armour is still undecided. It may, perhaps, be admitted that the projectiles already in use would, under favourable circumstances, penetrate any armour a ship could carry. But in battle such circumstances can scarcely ever exist. A projectile fired against a certain plate in a direction exactly at right angles to it may penetrate it without difficulty, while impinging at a less angle, it will glance off, after having done little or no mischief. The chances are many to one that in battle the angle of incidence will not be a right angle. There is, therefore, no well-founded reason for hesitating about the use of armour, and this can scarcely be applied with effect except to an iron ship.

Our only considerations at present are the comparative strength and durability of timber and iron ships. We have nothing to do with their form or armament, their sailing power, or their capability of efficient ventilation; though all of these must be more or less modified by the use of iron in shipbuilding. The superior strength of an iron ship is derived, not only from the nature of the material, but from the forms which may be given to it. The ponderous beams of the timber ship have been replaced by a much lighter, and at the same time stronger combination of plates and angle iron, so arranged as to afford the greatest amount of strength with the least expenditure of material. The resistance to fracture in every direction, afforded by a hollow iron beam or girder, consisting of plates judiciously arranged so as to prevent a yielding in any direction, is marvellous to those who have not studied the subject. Of all the forms which have been given to the ribs and other portions of a ship requiring enormous strength, the cellular is the most effective. It has the additional advantage of affording spaces for the stowage of water, without its occupying any otherwise disposable room, a circumstance of great importance on board a ship.

There is, however, one objection to the use of iron in shipbuilding, which has often caused serious doubts as to the propriety or even the possibility of continuing to employ it for the purpose. Iron is the most perishable of the common metals, not even excepting zinc, which, though more strongly electronegative, is more durable, being to a greater or less extent

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protected by a coating of oxide, which in ordinary cases soon forms upon it. The pecuniary loss caused by the rapid corrosion of iron ships has given rise to very serious anxiety both to our own and to foreign governments. This loss is so enormous that about twenty years ago the government of this country determined to abandon the use of iron ships of war. The evil is of the greater magnitude, as iron ships cost nearly four times as much as those of timber formerly in use in our navy.

Few persons have any idea of the rapidity with which iron ships are eaten away under the action of sea water. Large holes have been produced in two or three years, plates and rivets have been destroyed over a large surface, so as to put even the safety of the ship in peril. The vast number of the patents taken out for paints and other protective compounds, shows the seriousness of the difficulty, and at the same time proves the futility of the efforts which have been made to grapple with it.

The rapid destruction of the ship is not the only serious evil that accompanies the use of iron in shipbuilding. Iron ships are peculiarly liable to fouling, and this to an extent which is not only a cause of great delay, but often of imminent danger. When copper sheathing is used with wooden ships, the slight galvanic action which attends its slow solution in the sea water completely prevents the adhesion of marine plants and animals. This trifling corrosion formerly gave rise to considerable annoyance on account of the loss it entailed, and efforts were made, not without success, to prevent it. The sagacity of Sir Humphrey Davy suggested to him as a protecting agent the use of a metal at once more strongly electronegative and less costly. Such a metal was found in zinc, which, in suffering the electric action, would save the copper. But the removal of such action from the sheathing led to an amount of fouling which soon caused all attempts to preserve the metal to be given up, and it was even considered very fortunate that at the expense of the copper, fouling could be prevented.

A sheathing of copper having been found so advantageous with wooden ships, it might be supposed that it would be equally useful with those of iron. But, instead of the copper protecting the iron, the iron would but too effectually protect the copper, and an enormous galvanic battery being produced, the destruction of the vessel would proceed with fatal rapidity. Were it possible entirely to prevent contact between the iron and the copper, the destruction of the former might be averted, but all attempts in that direction have been vain, so many circumstances are liable constantly to occur which render every precaution that may be taken unavailable.

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Neither can the iron be protected by paint, or any other similar composition. All those compounds hitherto tried have failed, the corrosion, commencing in points, and spreading under the paint in every direction. Indeed, in proportion as they are successful in preserving the iron, they are mischievous in giving rise to fouling, large quantities of barnacles and weeds accumulating rapidly on the protected portions. The retardation thus caused is a source of serious additional expense. A comparatively small deposit would give rise to a loss of speed to the extent of one knot an hour, and the additional cost of fuel, seamen's wages, etc., consequent on this, is a matter of very simple calculation. Thus, supposing, for example, the average speed of the vessel to be ten knots an hour, the expense would be increased by one-tenth.

Fouling can be averted only by a clean metallic surface, on which electricity is constantly developed. It is vain to attempt the destruction of marine plants and animals by poisonous substances, the only way to prevent their adhesion is to present to them such a surface as will afford them no means of adhesion. This is best effected by the slow removal of the surface itself, on account of gradual corrosion, and the washing off of the resulting compound.

We may, therefore, conclude, that with iron, as with wooden ships, some metal must be sacrificed, and the only question that remains for solution is what that metal shall be. It is fortunate that in considering the important subject of the electro-chemical preservation of iron ships, we are not confined to the use of copper, on the contrary, a far less expensive and a thoroughly effective substitute for it is in our hands. If iron perishes in presence of copper, because it is electro-negative with reference to the copper, to preserve the iron as completely as the iron would preserve the copper, we have only to place in contact with it a metal which bears the same relation to it that it bears to copper. Such a metal is zinc, and it is the better suited to the purpose since its conductivity and other properties only just permit that amount of corrosion which is enough to secure a surface sufficiently clean to prevent fouling.

The efficiency of zinc, as a sheathing for iron ships has already been tested, and the experience of several months at a time has shown that its surface remains perfectly clean, under the ordinary conditions of immersion in the sea. The necessity for the substitution of zinc for copper as sheathing is fortunately not accompanied by increased expense, but rather the contrary. The cost of zinc is, indeed, only about one-third that of copper, but as sheathing it costs very nearly the same as copper.

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There is no reason why only the outside skin of an iron ship should be carefully protected. It is true that this portion is corroded, if unprotected, with great rapidity, but every part, especially if exposed to the action of bilge or other water, rapidly decays. This general destruction might be, at least in a great degree, prevented by a judicious application of zinc, which when dissolved, or otherwise rendered ineffective, might be easily replaced. Experiments recently made at Portsmouth show that when the zinc sheathing and the iron of the ship are in perfect metallic contact, the zinc remains clean, and free from a coating of any kind. The interposition of felt, or any other imperfectly conducting material, as might be anticipated, has been found injurious. Complete contact of the metals is no more than sufficient to secure just enough galvanic action to preserve the one metal and keep the other clean.

The advantage of protecting iron ships from corrosion, is evident from the immense numbers of them annually constructed in the United Kingdom. The tonnage of the iron ships built on only six of our large rivers, during last year, amounted to nearly half a millon of tons. The value of all those at present in use must, therefore, be enormous; and their preservation from a decay which has been found alarmingly rapid must be a question of the highest importance. The application of zinc to the protection of iron, especially after its having been employed long since for the protection of copper, is a proceeding so obvious that we can only wonder it has not been long ago, and universally, adopted with iron ships; its use in that way being rather the application of a well-known principle, than a novel discovery in science. And, indeed, as Sir Edward Belcher observed at the recent meeting of the British Association at Nottingham, its application to this purpose is not new.

Among the important advantages which accompany the use of zinc as a protection for iron ships, not the least is the absence of the necessity for insulation. If copper or "yellow metal" is employed as sheathing, it must be perfectly removed from conducting communication with the iron: or it will, so far from protecting the iron, cause its destruction to be far more rapid; since the least contact between the metals will not only transfer the chemical action to the iron, but render it far more intense than it would have been had the iron been merely left to its fate. The effect on iron of contact with copper is very great. The accidental dropping of a copper coin into the bilge-water, so as to come in contact with the iron of a ship, has more than once given rise to the formation of large and dangerous holes. In the attempts made to use copper sheathing with iron ships various means have been vainly used to

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secure its insulation. Thus plugs of ebonite were inserted in the iron skin, and over the latter was spread, first sheets of felt, and then sheets of india-rubber. But unforeseen and accidental circumstances have rendered every such attempt to preserve insulation unavailing.

It may be asked, Why, if zinc is so much cheaper than copper, and at the same time so effective, it did not supersede copper as a sheathing even for wooden ships. The reason is very satisfactory: it would not have prevented fouling, since the condition which is secured by its contact with iron—namely, galvanic action—would not have been sufficiently secured by its contact with wood.

There is one rather serious difficulty that attends the use of zinc as sheathing for iron ships—its attachment. The drilling of numerous holes in the iron skin would be, not only expensive, but very objectionable for other reasons. This, however, has been obviated, and by very simple means. The edges of the plates forming the skin of the vessel are kept asunder by a slight interval, which is filled up with compressed teak, and into this are driven the zinc nails which are used to attach the sheathing, and which are rendered more secure by their points being, where they come in contact with the iron rib, turned back by it into the teak. The sheets of zinc can thus be nailed to the iron skin as easily as if it were wood, and the insertion of the nails in the teak serves to wedge it more tightly in the joint. In forming the latter, it is obvious that the edges of the iron plates may be left as they come from the forge, dressing of any kind being superfluous—a circumstance which considerably lessens the expense.

Iron supplies to the engineer a most excellent material for the construction of bridges. Not only is it cheaper for the purpose than stone or brick, and more durable than wood, but it allows the construction of bridges of immense span. It may be in the form of cast iron, wrought iron, or steel. Cast iron answers well enough within certain spans, but the soundness of the casting can never be entirely depended on. In the form of voussoirs or ribs, engineers have ventured to employ it in spans of 240 feet. Malleable iron is most generally used, and invariably with very large spans—almost always in plates varying from less than a quarter to little more than five-eights of an inch in thickness. Looking to the rapidity with which iron is corroded, even in the atmosphere, how short is the period during which these plates will retain any amount of strength, without a degree of care which no one thinks of bestowing upon them. The danger from this source is not imaginary. The best constructed and most carefully preserved of our iron bridges are, as it were, melting away perceptibly.

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Very recently more than *forty tons* of rust were removed from the Menai tubular bridge; but, large as this quantity was, it does not represent anything like the entire corrosion which has taken place in this bridge during the few years it has been in existence, since it consisted only of the rust which had formed on the exterior. How many additional tons would the interior and inaccessible portions have furnished, places where corrosion may be going on with an unsuspected but most dangerous rapidity. A very small extent of surface deeply corroded would suffice to endanger the stability of the largest constructions of iron, and might at any moment give rise to its sudden destruction.

The effect of air and moisture upon iron bridges must be greatly increased when, as is but too often the case, not only no effective means are taken to preserve them, but they are wantonly exposed to the most injurious influences. How long can they reasonably be expected to last, when moist clay and gravel are kept constantly heaped up against and in immediate contact with them, or when the pillars on which they, at least partially, rest are immersed in salt or brackish water. Experiments have shown that cast iron is rapidly changed, by the action of salt water, into a friable mass, closely resembling plumbago in both texture and weakness.

Independently of the danger which must arise to the public from the rapid decay of so many iron bridges, their renewal within a comparatively very short period, which, under the circumstances, will be unavoidable, must hereafter entail a most serious expense and inconvenience on railway companies, and indeed, indirectly at least, on the public. This consideration should lead to the adoption of a more rational treatment of iron bridges, and even to some attempt at a retardation of that decay which seems almost inseparable from them. Protection from moisture, with the exception of that contained in the air, is, in many cases at least, possible. But our electrochemical knowledge might, perhaps, if properly employed, supply us with the means of imparting to iron constructions a degree of permanency almost without limit. Why do we not avail ourselves of the principle which is now being applied to the protection of iron ships—the transfer of the corrosive action to zinc. The cost of the metal which would thus be consumed, especially taking into account the ease with which it could be replaced, would bear no proportion to the expense and trouble which the frequent renewal or extensive repair of so many iron bridges must necessarily entail.

The subject of iron as a material for ships and bridges is one of the most important that can be considered. There is not one whom it does not, in some way or another, concern.

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The owner of an iron ship is seriously interested in its preservation; the shareholder in a railway company ought to be anxious that the bridges on his line should last as long as possible, since the cost of their repair or renewal must be effected with money which otherwise would be his. The traveller, whether by sea or railway, is also deeply concerned, as there is the question of his safety. The general public is concerned, since it is impossible to proceed in any direction without passing under one or more railway bridges; and this, if they are allowed to corrode as rapidly for the future as at present, cannot but be attended with peril.

Iron and steel as materials for ship and bridge building possess advantages which will render their use for these purposes still more general than it is. We never can return to the materials they have supplanted. It behoves us, therefore, to make every effort to lessen or remove the inconveniences by which their use is at present accompanied. Science, if it does not now, will certainly hereafter supply us with the means for effecting this. But future safety, and a large saving in the time to come, must not be sacrificed to a trifling advantage in the present. The precautions that are taken must be wise and not specious ones. It is not unusual, for example, to contract for iron-work by weight, in the hope of securing the required amount of strength; but this important object is not to be attained in such a way. For the strength of iron and steel depends not only on their massiveness, but their quality; and the contractor may exactly fulfil his bargain as to weight, while at the same time he supplies what is vitiated by dangerous weakness.

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DINOCHARIS COLLINSII; A ROTIFERON NEW TO SCIENCE.

BY PHILIP HENRY GOSSE, F.R.S.

(*With a Coloured Plate.*)

Class *Rotifera.* Fam. *Euchlanidota.*

Gen. DINOCHARIS (Ehrenb.). "Eye single, cervical: foot forked: lorica closed ventrally, with the lateral margin sharp."

Sp. *D. Collinsii* (Gosse). Lorica about as broad as long; furnished with four spines at the posterior edge, and four longer ones in the centre of the back: front and lateral margins denticulate.

Description:—Total length, when extended in swimming, ·008 inch; length of lorica along dorsal line, ·0032; ibid. to tips of posterior spines, ·004; breadth of lorica, ·0038. The lorica, viewed dorsally, has a somewhat square outline, with rounded angles; the front hollowed, the posterior edges nearly even, but set with four spines directed backwards, of which the dorsal (and inner) pair slant diagonally upwards and outwards, the ventral (and outer) pair are nearly in the line of the body. The dorsal surface is much arched longitudinally, particularly the anterior half (See Fig. 3), the highest point being about one-third from the frontal excavation. From this highest point spring two stout, long, rigid, slightly decurved spines, rather wide apart, and point backward almost horizontally. Another pair, very similar, arise from a more central point, close together, but diverge towards their tips. The lateral margins of the lorica are beset with small spines, about twenty-five on each side, like the teeth of a circular saw, the seventh, eighth, ninth, and tenth being larger than the rest. The frontal excavation is similarly toothed, but much more minutely. The whole ventral surface is delicately puctulate; the dorsal surface only in the central region, where the punctuli have a tendency to run in convergent rows. The ventral surface is wholly closed, so that the lorica is testudiniform. It is strongly convex in transverse section (See Fig. 4).

The head is quite retractile, thick, and massive in form, sub-cubical, with rounded angles; the lateral edges appear to become shelly, carrying two or three rows of small spinous teeth. The occiput forms a shelly projection, also edged with rows of teeth (See Fig. 1); this, though nearly lost in the general outline, when the head is fully extended, yet is often

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left isolated when it is suddenly retracted. The front is set with strong cilia, which in action produce a vigorous vortex on each side.

The foot consists of four joints, of which the first is thick, and carries at its extremity on the dorsal side a pair of divergent spines; the second joint is very short, and slenderer; the third is longer, but still further attenuated, expanding slightly at the tip; the fourth consists of two straight, slightly decurved, moderately long, spine-shaped toes.

An eye of conspicuous size, transversely crescentic in form, and of rich ruby hue, is seated just in front of a large globose mastax, which displays the ordinary structure. I have not been able to discern the cerebral mass on which the eye, doubtless, rests. The alimentary canal is ample, commonly filled with the digestive secretions, of a clear yellow-brown hue, and with granular food. The viscera are difficult of exact definition, from the complex nature of the integument, and its appendages; but seem to present no remarkable feature.

This very attractive form was brought under my notice nearly a year ago by Francis Collins, Esq., M.D., Assistant Surgeon in the Royal Military College, Sandhurst. He kindly communicated specimens to me, from which the preceding description, and the accompanying figures were prepared. As the species appears to be hitherto unrecognized, I honour it with the name of its discoverer. Dr. Collins favours me with the following notes concerning it:—

"The new species of *Dinocharis* is found in the parish of Sandhurst, in Berkshire, and as yet only in one small pool in a fir wood between the Royal Military and Wellington Colleges, about two miles from the former and one from the latter. The pool is not more than eight feet in length by five in breadth, and from four to five in depth. It receives the surface drainage of a very small portion of the wood. The drains are open, and are almost choked with moss, and it is chiefly in one of these, close to the pool, that this interesting and curious species has been found. Both the pool and the drains are peculiarly rich in rare species of *Rotifera*. They contain also many varieties of Diatoms, Desmids, Infusoria, and indeed microscopic objects without number.

"The history of our little creature is rather curious. In September, 1864, a lady (Miss S.) was staying with me. On leaving my house she took away a bottle of water from our favourite little pool, which proved to contain specimens of our new *Dinocharis*. It was not until the autumn of last year that I for the first time saw a specimen, but then I found it in abundance. In the winter it disappeared entirely. In April

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of the present year, Miss S., who had been spending a few weeks with us, again took away a bottle full of the water from the same pool. We had searched it well while she was here, but could find nothing of particular interest. After she had kept this bottle of water, however, for more than four months, she suddenly found it swarming with these interesting creatures. I may add that about three weeks ago [at the end of July] I obtained water from the same place, but could not then find anything of interest. Some of the drains leading to the little pond had been cleaned out during the course of the summer, which may possibly account for the absence of the *Rotifera*."

In captivity our little *Dinocharis* is active, rarely still, rooting among the sediment, or swimming with a smooth, gliding motion, of no great speed. If I may judge of its behaviour in freedom from what is seen while under our notice, it seems to be specially a bottom-frequenting form; for, in a phial, the pocket lens never detects it roaming freely through the water, while a pipette thrust down to the sediment invariably captures several specimens. I am not acquainted with any other form in the class with which this well-armed species can possibly be confounded, unless it be the *Polychætus subquadratus* of M. Perty, figured (without any description) in Dr. Arlidge's *Infusoria*, Plate xxxviii., figs. 31, 32. To this species there is certainly much resemblance, but at the same time much dissimilarity, particularly in the shape of the lorica, the number of long medial spines (eight in *Polychætus*) and in the situation of these, which are represented on the *ventral* surface. This, however, may be mere inaccuracy of observation. Indeed, considering all things, I would not be quite sure that this form of Perty's was not founded on our *Dinocharis*, very carelessly and untrustworthily delineated. Should it, however, prove to be so, M. Perty's name cannot be retained, since there can be no doubt of the generic affinity of our species with the other members of *Dinocharis*. Dr. Leydig, indeed, supposes Perty's *Polychætus* to be a crustacean; but in this he is certainly mistaken.

EXPLANATION OF THE FIGURES.

Fig. 1. *Dinocharis Collinsii;* dorsal aspect. Fig. 2. Ibid. ibid. (the armature of the lorica omitted, in order to a clearer display of the viscera). Fig. 3. Ibid., lateral aspect. Fig. 4. Ibid., outline of transverse section of lorica.

Postscript.—I subjoin a list of *Rotifera*, which Dr. Collins has detected in the tiny pool above-mentioned, remarkable, not only for the number, but for the rarity of the species, as will

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be apparent to those who have made this beautiful class of animals their special study:—

Floscularia cornuta	abundant.
„ campanulata	scarce.
„ (an undescribed species)	very scarce.
Melicerta (an undescribed species)	rather scarce in this pool, but abundant in the neighbourhood.
Œcistes crystallinus	scarce.
Megalotrocha velata	scarce.
Microcodon clavus	abundant.
Notommata aurita	
„ centrura	
Furcularia cœca	common.
Plagiognatha felis	
Lindia torulosa	abundant.
Monocerca bicornis	
Dinocharis tetractis	scarce.
„ Collinsii	abundant.
Salpina mucronata	
Colurus caudatus	abundant.
Stephanops muticus	
„ (an undescribed species)	
Rotifer (several species)	common.
Actinurus Neptunius	
Philodina (several species)	common.

FROM KURRACHEE TO MOOLTAN.

BY FRANKLIN FOX,

Superintendent Oriental Inland Steam Company, Limited.

The monotonous chant of the Lascars calling the soundings in feet, as they dip their coloured bamboos to the river's bottom from the flatly-built steamer's bow, warn us in our gradual and winding passage up the Indus, when we may look for the grounding bump that stops our progress for a time.

"Bonée paunch poot!" "Sara char poot!" quarter less five, and a-half four feet, hint that we have not very much water to spare under us. In the dry season, from November to February or March, though the journey up the Indus is formidable from the time it occupies, the channels of the river being shallow, winding, and comparatively dried up, the climate is cool and invigorating, and the trip from Kotree to Mooltan, affords to those making it, a not by any means unpleasant experience of Indian life. But to begin at the beginning, one must "take a departure" from Kurrachee, a seaport close to the creeks forming the delta of the Indus, and which presents to us, on arrival, an appearance different from any other harbour in the world.

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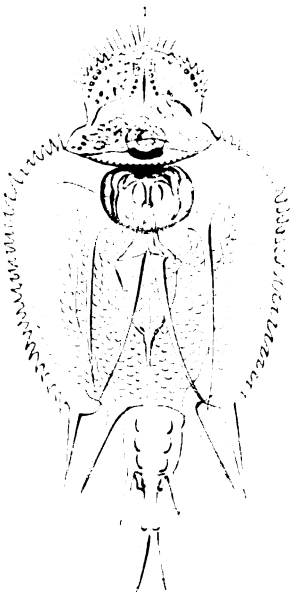

P. H. Gosse, ad viv.

DINOCHARIS COLLINSII.

Mag. 400 diam.

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The shore, as seen approaching it, is a flat tract of yellow haze-covered sand, looking as heat-radiant as the desert itself: an intensely blue sky, of course, over it. On the right of the harbour-inlet's mouth, a cluster of dark rocks of fantastic shape, half pyramid, half ninepin, stand boldly out against the yellow beach, and on the left another mass of rock, the top of which is fashioned into a light-house, and flag-staff, has a Robinson Crusoe looking aspect. Rough stone winding steps cut out in the rock, show it to be accessible by water at all events, if not from the promontory of land which joins it, and forms the inner part of the harbour. This is the establishment of the harbour-master, and the sandy beach adjoining, devoted to ship-yard and river-steamer work, is called Manora.

The entrance to the harbour is obstructed by a bar, on which there is at high water but nineteen feet, rendering the port inaccessible to vessels of large draught, and a very uncomfortable place for ships of lighter burden when the south-west monsoon, to which it is exposed, thunders, in heavy seas and stormy squalls, at its mouth.

Large government works have been undertaken, and about three hundred thousand pounds expended for the purpose of clearing away the bar, partly by narrowing a creek called Chinee Creek, which joins the upper part of the harbour, and partly by the construction of a groyne on one side of it, ex-ending into the sea, by which it is intended to increase the rapidity of the tide in the harbour, and thus, it is hoped, sweep away the obstruction at the entrance.

The water of Kurrachee harbour, or some creature peculiar to it, so affected the plates of an iron steamer's hull in the course of eighteen months she had lain there, that a pen-knife could be thrust with ease through her plates at places, some a few inches, some farther, apart, as if the iron were rotten wood. The appearance of the iron at these places, indicated by little circular spots, being also like rotten or rust stained wood. To test whether this is the work of an animal, or of the water, or in consequence of the plates being defective, the authorities have, I believe, sunk plates to the bottom of the harbour to try the effect upon them.

The landing at Kurrachee is at a wooden pier or jetty, and facing you, mounting its steps, is a wooden building marked "Post-office." A drive of a mile or two along a narrow causeway-road, bordered by Chinee Creek on one side and the harbour mud the other, brings you to a stone arched gate and building, the Custom House. Here you enter the town, which is laid out in square blocks of buildings of stone, of rough construction, but solid, and nearly all standing in square inclosures (compounds), surrounded by rough stone walls. Far-

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ther on, past the houses of business and banks, you reach the camp, divided into civil and military lines. In the centre, nearly, is Trinity Church, with a square, stone-built tower for its steeple. Close by is the flag-staff, on which a red pendant announces once a fortnight the advent of the English mail and home news.

The train from Kurrachee to Kotree—the terminus of the steamers on the Indus, now that the railway has superseded the tedious navigation of the creeks, or the passage by the mouth of the Indus, by which formerly the water passage from Kurrachee to Kotree was made—starts at half-past six every morning, and its whistle is sounding impatiently, otherwise I might pause and dwell a little on the lions of Kurrachee—its Government Gardens, its Government House (the Commissioner's residence), its Cutcherry, and its Rere Hall, lately built, its Library and Museum, its evening drive, where an enormous rifle-target and a "blasted heath," appear to have suffered as much scorching as no doubt the reputations discussed there do: its sea-view at Clifton, and last, not least, its famous picnics and drives to Muggerpoer,* that shady abode of priests and muggurs (or crocodiles), held equally sacred in the native eye. There are some three hundred crocodiles here in about as many yards of shallow muddy streamlets, bordered with muddy grass, in which these brutes wallow. Close by is a hot sulphury spring, said to be of great medicinal power. A shady grove of trees covering in this spot renders it a pleasant retreat for visitors as well as residents, and part of the amusement of the day is supplying the resident muggurs with a live kid or goat to see the summary way in which it is disposed of; a stock of these animals for sale is kept on the spot by the natives. Occasionally a child is carried away, I suppose when a dearth of visitors (and consequently kids) make the muggurs unusually voracious, and then the Government threaten to "put down" that sort of kidnapping. But there it exists at present, and a famous old temple, and shrine, and tombs of holy men also to look at, make a visit to the shady oasis not by any means an unpleasant day's trip.

The man who, as Sterne says, travelled from Dan to Beersheba, and found "all barren," would certainly not find much to notice from Kurrachee to Kotree except an "embarras" of barrenness, which the total want of water during part of the year imparts to the level, monotonous tract of sand and stunted shrub that Lower Sind is at the delta of the Indus. A few dry water courses spanned by railway bridges that look now in the

* Sometimes spelt Mugga Poer.

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"dry" season absurdly long, tell of the rushes of water that in the rains flood these plains.

Kotree, or Little Cairo as it is sometimes called, presents an agreeable contrast when you reach it full of the sand of Sind internally and externally. The shady road from the railway station, overtopped by bright green trees, arching over head till they meet, the beautiful flower-gardens round the houses, the placid river, the white-painted steamers and flats moored to the bank, recall Cairo and the Nile to one's mind's eye; and also suggest what the other parts of Sind might be with the aid of the water that makes Kotree so bright. A shady road runs parallel to the river, leading to a fort-like building and the steamers depôt where we embark for Mooltan. There is nothing in the width or appearance of the Indus here to indicate its real size and grandeur, as the father of the five rivers of the Punjaub. "Paunch" signifies five, and "aube" waters, in Hindustanee, and refer to the five rivers, the Jhelum, the Sutlej, the Chenaub, the Ravee, and the Beās, joining each other, and eventually the Indus, after running through the north-west provinces of India.* On the arrival of the morning train from Kurrachee (which has been all night on the road), and generally a few days after the mail from England *viâ* Bombay, a steamer starts for Mooltan. Each steamer takes a flat lashed on each side of its paddle-boxes (for cargo), and with these encumbrances, and little more than four feet of water to depend upon at times, the reader may imagine the navigation is peculiar and not without its difficulties. A train of barges or flats joined to the steamer and each other, so as to form a serpentine tail, of which the steamer was the head, was a plan tried, but the windings of the river are so abrupt, the stream so rapid and shallow, that this did not succeed, and it is found now the more the steamer and her barges are assimilated together to move rapidly and in unison, the more successful they are in combating the obstacles the river opposes. To the energy and enterprise of the Oriental and Inland Steam Company are due the experiment alluded to, and the merchants of Sind and the Punjaub are indebted (although the experiment failed) to the same company for having placed the new and fast steamers on the river, where there were only the old vessels of the moribund Indian navy, since replaced with some additions by the Indus Flotilla Company.

* Thornton says in his *Gazetteer of India*, "With respect to the propriety of the designation, it is, however, to be observed that there are in fact six rivers,—the Indus, the Jhelum, the Chenaub, the Ravee, the Beas, and the Sutlej; but as the Beas has a much shorter course than the others, it seems to have been disregarded when the name of the country was bestowed."—ED.

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November 5th, 186—. Shook myself down on board the river steamer! Reached the first wood station, Onapore, at dark, here we lash to the bank, and take in wood fuel. All sleep on deck on account of mosquitoes taking charge below.

The river's bank here is a low sandy plain, patches of sandy islets intersect the river course frequently, and now and then the bank is a bluff of muddy sand, with trees of larger growth than the shrubs which appear to border it. The course of the stream is apt to vary through the sand it carries with it, which, lodging on these islands, in time changes the channel. We take a pilot at every wood station. The great guide in the navigation (in addition to local knowledge) appears to be the eye; the pilot is constantly on watch, altering the vessel's course where little peculiar ripples on the smooth, muddy surface of the river indicate shallow water. Our steamer draws only four feet of water, and we keep sounding with bamboo poles, marked to feet, on her and on the flats all day, the Lascars constantly chaunting the depth they have. The pilots are Sindians—intelligent fellows, who have worked in the Bherrie, or large river boats, up and down the river, all their lives. They are organized by Government, and under the control of the Conservator of the Indus. Each one wears a red sash, with a brass plate on it, as a badge of office; and they get about eighteen rupees (twenty-six shillings) a month as pay.

November 6. Passing the same sort of scenery as yesterday, all day. A line of trees in the far distance shows the difference between the river's breadth to-day and in the floods. Sometimes it is so capricious in its direction, that villages originally on one bank are discovered, when the floods subside, to be on the opposite side to where they were before; and it not unfrequently happens they are washed away altogether. At night we reached Gopang, the second wood station. Went on shore; found a fine beaten road, and a village of mud huts. During the latter part of the day we had passed some small forests blossoming with yellow flowers; at other places groups of breeding camels and their little ones, watering; and some picturesque native boats being tracked up stream by their crews, the towline being led from the top of the boat's mast. At places, as you pass, the stream comes with a rush, and you see large masses of sandy bank crumbling into the river bodily. They said, a man on horseback, riding by here, was suddenly engulphed in this way, and his body picked up fifty miles down the river.

November 7. The same sandy shore, with here and there small forests. Current very strong, so we did not reach the wood station.

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November 8. Reached Bembra (the next station) at half-past ten A.M. Went to see the village mud huts, and two seedy-looking plaster mosques. At night, pulled up at the bank. Went for a walk through a real Sind wood; startled a lot of grey partridges roosting on trees overhead; gathered some cotton flowers and pods in various stages of maturity.

November 9. Approaching the first town of any importance, Sehwan, by name, eighty-four miles from Kotree only by land; stuck in the mud for an hour as we near it; passengers set to at whist, catch mosquitoes, and drink beer; captain, crew, and steam-pipe all roaring, and very busy till she comes off again. At Sehwan you observe a chain of hills—the Lukkee Range—extending the length of Beloochistan down nearly to the sea, and originating far off in the Hala Mountains. Every turn and winding of the river seems to bring us near to their base, though of course in reality they are a long way off. Went to see "the lion" of Sehwan, which is a magnificent tiger, kept in a rattle-trap bamboo cage. The town is composed of streets of mud houses; but there is a fine mosque, into which, after taking off my shoes, I was allowed to penetrate, across an inner square court of stone, to the tomb, where, amid crowds of worshippers, and tom-toms, reposed (which was more than I could have done) the remains of some great departed. Backsheesh, of course; and back to the steamer, hoping the tiger would not break out of his cage that evening, as he seemed pretty certain of doing some time or other soon, if he felt inclined.

November 10. Left Sehwan at daylight. The next station is called Kukan; then Seta, then Jumalli, then Baradera, then Suliana, and then Sukkur, the great place between Kotree and Mooltan. Here we arrived November 16, having passed through a continuous tract of vast sandy plain, day after day, following a winding course wherever clayey strata in the bed of the stream altered its course through the soft sand. Where there is no clay the banks of the stream are soft and yielding, crumbling away trees and all under the wash of our paddles as we pass. At intervals we passed numbers of native boats, employed in carrying the produce of the country, though many are lost in their passages. It occupies them generally about six months to get up from Kotree to Mooltan, partly sailing and partly tracking, though the passage down stream is comparatively easy. Some are employed conveying wood to the fuel station on the river, large quantities being used by the steamers.

The sails of some of these boats are as peculiar as their shape, those from Ferozepore and the Sutlej River being different to the Mooltan and Kotree ones. Some have sails laced to a

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boom, making them set like a board—a "wrinkle" our yachtsmen took out from the "America's" canvas.

We now begin to find blankets on deck acceptable at night, but prefer the cold to facing the mosquitoes below. At Seta I saw large quantities of cotton growing, and came across, in my walk, a lot of green parrots, some wood-peckers, and some enormous orange-coloured bees, having honeycombs in a tree hard by. Persian wheels for irrigation are at work, everywhere there is vegetation, on the river bank, and the results show the marvellous effect even of these partial supplies of water.

As we approach Sukkur and the Sukkur Pass, the country becomes more picturesque; the usually flat banks of the river change to hill; and getting a glimpse of the town as we approach, one sees in the setting sun square buildings, with deep pillared porticoes, looking like the pictures of ancient Greece; but the massive-looking structures prove to be mud when one comes a little closer. Nevertheless, Sukkur is the most remarkable place on the passage up. The river narrows to a gorge formed by steep, rocky shores; in the centre is a fortified island, looking like a miniature Malta in its yellow clay construction, which somewhat resembles the yellow-white stone of that place in colour. This is called Sukkur Fort; and past this place the river, pent up in narrow limits, rushes with great force. This is called the Sukkur Pass, and steamers often find it hard work here to get through.

Sukkur is near Jacobabad, where the famous Sind Brigade hold their head-quarters, and keeping a line of frontier videttes, the looting Belooches are kept in check. Here our whist party was broken up; it had been composed of a Sind horseman, a post-office inspector, about to commence his tour on relays of camels and elephants, and other wild animals, and an agreeable Italian gentleman.

November 17. At evening reached Rhoda, the first wood station after leaving Sukkur. We get now out of the jurisdiction of the forest ranger of Sind in wood supplies, and depend on our own arrangements, instead of those of Government, for that necessary article.

November 18. Reached Ghobla. Here we wooded from boats.

November 19. Passing sandy islets, with armies of birds, pelicans, storks, cranes, sandpipers, swarms of geese and ducks. Here and there an alligator appears, and occasionally a white porpoise. We have a bluff sandy mud cliff on one side, a shallow sand spit on the other, and a winding channel in and out. Did not reach the station to-night, the current being very strong—not that there is much difference here between the bank

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anywhere and "the station," except that at the latter there are a few stacks of cut wood on a small clearance, and at the former it is all jungle. A puttywallah, or watchman, keeps guard on the wood, and the pilots are here obtained for the next day's run.

November 20. Reached Kordrewallah at breakfast-time; a few miles from here we pass the boundary line between Sind and the Punjaub; and here also ends the patrol line of the Jacobabad warriors (Sind Horse).

November 21. Found the river a little slacker in its currents. At one o'clock reached Mulochwallah; saw some jackalls, some grey partridges, and some tiger tracks.

November 22. Getting on faster, the stream being slack, but winding amid large patches of sand-banks, much more numerous than lower down stream; the sand-patches are tenanted by alligators, looking like logs of wood with pointed ends, which, when they are startled, prove to be very ugly heads, with large jaws and fishy eyes. Their teeth are not large, but there are plenty of them. The natives don't seem to mind them a bit; and when any one—say the pilot—wants to return down the river after a day's run, or some one wishes to cross at a bend of the river, they inflate their goatskin (or mussick) with air, stream it, and jumping astride, away they go down the road cheerily! To-day we had a fine breeze, and set sails on the steamer and flats. We reached Essanpore at two P.M., and started off again at four P.M.; but there was a shoal in the river just off the wood station, which brought us up—bump, oh!—and there we stuck for an hour. The pilot, in awe of the captain's wrath, fled into the woods; and I afterwards saw him mount his mussick and ride off. After a time the steamer was got off, and the current, very strong here, spun her round, with her flats, at a marvellous rate, like a teetotum. After this, we pulled up at this station for the night.

November 23. Started again, and stuck again until the steamer was lightened, by putting what cargo she had, and her fuel, into the flats. Just as we began to get on again, smoke is observed down the river. A steamer sent with a party of surveyors for the Indus Valley projected line of railway is known to have left Kotree after we did, and it is supposed to be she. The vicinity of another vessel stimulates our crew, apparently, for we steam away at a greater speed to-day.

November 24. At daylight, up steam and away, our rival after us. At seven A.M. passed Mittenkote, now six or seven miles inland, but which last year the river washed so close, it used to be the station of the Punjaub Flotilla steamers. Here we turn eastward, entering the Chenaub River, which at this point joins the Indus. Navigation becomes now more intri-

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cate, sand-banks more frequent, the current stronger, and the alligators larger. After breakfast, reached Chercha, five stations from Mooltan. Wooding here is performed very rapidly, the steamer astern stimulating every one to increased exertion. We are off again in a very short time; but it is quite plain, in spite of every effort, our friend astern is overtaking us; and when we stop for the night one of the river steamers passes, and makes fast close to us.

November 25. Very slow work; boat sent away sounding for the passages constantly. Reached Tibbee, the next station, as our rival left it. Wooded, and went on for Buckree. At night, an alarm, caused by a native deck passenger, who was sick, ending his sorrows by stepping quietly into the river in the dead of night, and drowning himself. Despatched a boat in vain to save him, the river sweeping by like a sluice. At Buckree the Sutlej joins the Chenaub; up the Sutlej to Ferozepore the water is shallower even than the Indus at this time of year, there being only about two feet six inches as a reliable depth.

November 27. Reached a narrow part of the river at Sultawgoshawur, only thirty-five miles from Mooltan; and here our steamer, our rival, and two others coming down stream from Mooltan, were all stuck at a dead-lock for some time. I began to despair, and sending for camels, made preparation to finish my journey in that way, when at last one of the steamers (our rival) was with difficulty got over the bad place, and ignominiously abandoning my vessel, I transferred myself to the rival; and on the 29th reached a part of the river's bank called Shershah, where there was a painted board announcing the Punjaub Railway premises, and where there was a house called a railway station; and, what was more, a railway for the rest of the twelve miles to Mooltan, which enabled me to finish my jaunt from Kurrachee to Mooltan in as comfortable a manner as could be expected.

Two facts strike me forcibly—the length of time occupied in doing six hundred miles, and the wonder that steamers can't be devised to go without barges, and still carry enough cargo to pay; and the other is the contrast between the country where there is water near, and where there is not. That the irrigation of India must be fairly considered as a question by which its future prosperity will be affected in no small degree, no man in his senses who has travelled through Sind and the Punjaub can deny. The point to decide appears to be, who is to do it?—whether it is to be left to the enterprise of the age, or whether the Government will undertake what must necessarily be more or less a Government work, under any circumstances.

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COMETARY LIGHT.—NEBULÆ.—OCCULTATIONS.

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

It is curious to remark the occasional revival, perhaps in a modified form, of speculations which have for a time been laid aside. At the period when much attention was drawn to the "Nebular Theory" of Laplace, and the condensation of luminous mists into blazing suns was commonly spoken of as the probable history of the universe, an idea was entertained by Sir W. Herschel that comets might be detached portions of nebulous matter attracted to our sun from the depths of space; and though his speculation was not announced in terms corresponding with the requirements of mathematical accuracy, yet it was in itself sufficiently remarkable, and would be rendered additionally probable by what he did not refer to in this instance, though he himself discovered it—the proper motion of the sun through space, which would be still bringing fresh portions of nebulous material within the sphere of his attraction. The doubt subsequently thrown upon Laplace's theory by the real or supposed resolution of certain nebulæ into stars with increased optical power, of course restored the comets to their independent rank. But the researches of later times, without giving countenance to Laplace's speculation—for the materials of the gaseous nebulæ do not appear capable of being condensed into suns like our own—have yet tended to re-establish the connection between these two most mysterious classes of bodies. Our readers are acquainted with the great fact that Huggins has obtained evidence of the gaseous nature of the nucleus of Tempel's comet (I. 1866); or at least of the identity of its constitution with that of the "planetary nebulæ" of H. This was the first precise intimation that had ever been obtained as to the real composition of these wandering members of our system. It is true that as a spectroscopic investigation it had been anticipated by Donati at Florence, in the case of Comet II. 1864, but his results are more equivocal, as he was less distinct in his interpretation of what he saw; nor could this be wondered at in any one who neither had the extraordinary experience of eye and hand which distinguishes our great observer, nor was previously aware of the peculiarity of the nebular spectra. At first Donati says that he perceived distinctly two dark bands in the comet's light; but he adds that the spectrum resembles that of the metals, the obscure being broader than the luminous spaces; and that it might be equally said to consist of three light bands. Hence, little more, indeed, could be inferred with safety than that it was elementary

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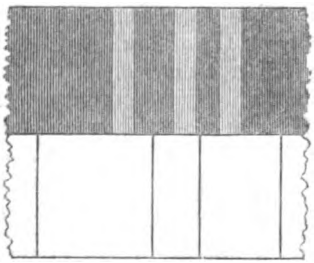
and not reflected light, but even this was a long step in advance, and afforded great promise of future discovery. His very curious diagram is but little known in England, and we shall therefore give a reduced copy of it, which will be the more intelligible and interesting since, chiefly through the enterprise and perseverance of Mr. Browning, the spectroscope bids fair to become a more popular instrument amongst us; as it well deserves.

The uppermost portion of the diagram is the spectrum of the comet, exhibiting the three bright bands; the lower is the corresponding portion of that of the sun, showing the four dark lines, and close groups of lines, named by Frauenhofer D *b* F and G; D, the "sodium-line," being to the right-hand. From this it appears that the light of the comet, being coincident with the blue and green spaces of the spectrum, must have had that hue. It may be presumed, however, that though this comet did not reflect solar light, in which case a more continuous spectrum would have been produced, yet its composition, however analogous, could not have been identical with that of our recent visitant. Mr. Huggins has spoken of the bright lines in the spectrum observed by him as resembling those of some of the nebulæ, and taking those of 37 H IV. as a specimen (see INTELLECTUAL OBSERVER, vi. 402), we find their magnitude and arrangement very different, the whole of the nebular spectrum being comprised within the left-hand half of the space between *b* and F, and consisting of extremely narrow stripes, perhaps not exceeding one-fiftieth of the breadth of the bands in Donati's figure. Unless, therefore, there were some essential difference in the two instruments or modes of observation, it must be inferred that there was a wide dissimilarity in the composition of these two comets. This, of course, might have been expected. A very little attention to the descriptions of former comets would convince us that with complete identity of type there is considerable variety in detail; and some of these differences are such as to indicate diversity of materials, not merely as between different comets, but as co-existing in the same individual. One very remarkable feature of this kind is the combination of a straight with a curved tail; the one streaming right out into space, and piercing the ether, as it would seem, without resistance; the other swept backwards and condensed at its advancing edge, according to Kepler's striking comparison, like the corn in the winnowing-



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floor. From such a division Bessel was led to the idea of a heterogeneous composition in 1807; and in 1858, though the pale thin narrow beam which preceded the grand flowing train of "the Donati" was totally missed in England, and found few spectators anywhere, yet its existence is too well established to admit of doubt, and inevitably leads to a similar conclusion.

Diversity of colour, too, points strongly in the same direction. This has always been a recognized peculiarity among comets; not only in ancient and less accurate, but in our own careful, modern days. Virgil's beautifully picturesque description—

> "liquida si quando nocte cometæ
> Sanguinei lugubre rubent,"

would lead us to suppose that since the epithets would hardly apply to the majority of cases, he must have witnessed some such portent of an unusually deep and fearful hue; and the Chinese record of Ma-tuon-lin, compiled in the thirteenth century, vague as it is in some respects, yet careful and precise in this, speaks not only of red, but white, blue, yellow, and violet comets. In our own times, no one who recollects the different aspect of the two great comets of 1858 and 1861 could doubt of the fact; while, as far as I can remember, the orange tint even of the last was exceeded by the very fiery and angry aspect of that of 1854, the sabre-like precursor of the Russian war. Even between the different parts of the same comet a curious difference of tint has been noticed. In 1811 ☿ remarked the very peculiar greenish or bluish-green colour of the head, while its central point had a pale ruddy tinge; and in 1858 the very feeble and wide-spread nebulosity surrounding the head was thought by Winnecke and Fearnley to be of a light-blue colour, while the head and tail were yellow. Here the reflected light, which was probably concerned, seems to speak sufficiently of diversity of material; but with the native light of the nucleus the case is still more evident, for spectrum-analysis teaches us that in all such instances a difference of colour, at least at corresponding temperatures, indicates the presence of a different element. We have no reason therefore for surprise at the contrast between the two spectra, one figured by Donati, the other described by Huggins.

In one respect, however, the comparison is not fully satisfactory. It does not appear how Donati's spectrum was obtained. Huggins, on the contrary, examined separately the nucleus and the coma, and hence possibly succeeded in obtaining more decisive evidence of its gaseous nature than can be deduced from Donati's figure. One great fact comes out in

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both—the existence of elementary or unborrowed light. This indeed was nothing new; it had been maintained by Hᵊ and Schröter in 1807 and 1811, though subsequently discredited by other authorities. But the very curious distinction between the light of the central body and its envelope, though previously indicated by polarization experiments, was reserved to be demonstrated by the spectroscope of Huggins. Schröter, the strenuous assertor of electric light in comets, was so unsuspicious of this distinction that some of his chief proofs were drawn from the rapid changes and coruscations of the tail. On the other hand, Arago, the great advocate of reflected light, was somewhat less confident. His examination of the comet of 1819 with a doubly refracting prism showed two images of somewhat unequal intensity indicating polarization, and consequently reflected light; and at the return of Halley's comet in 1835 he obtained more decided evidence by the interchangeably red and green colours of the images in his polariscope, and thus he satisfied himself that the light of the body was not, at least in general, native, though he is very cautious in his conclusion, candidly admitting that the whole light might be partly intrinsic and partly reflected, since bodies becoming incandescent do not thereby lose the power of reflection. From this, however, it appears that he had less idea of the really native character of the light of the nucleus than of its becoming enkindled by its approach to the sun. In the same manner Bruhns at Berlin in 1858, and Murmann at the Vienna Observatory in 1862, found that the light of the great comets of those years, taken as a mass, was polarized, and therefore reflected.

In 1861 Secchi had obtained a better result from the magnificent apparition of that summer. He found the polarization of the tail and rays near the nucleus very strong, but no trace of it in the nucleus till July 3 and following days, when it presented decided indications of it, notwithstanding its very minute size (hardly 1″, July 7). This he thought a fact of great importance, as showing that the nucleus had possessed native light on the former days, being perhaps rendered incandescent in its perihelion. The following year brought us a less brilliant but curiously developed comet, which has been described at length in one of our earlier volumes, and in this again he could detect no polarization in the nucleus, except a feeble trace on the last day of observation, while the aigrettes, or jets, unpolarized at their origin, became more so as they passed into the strongly polarized condition of the surrounding nebulosity. Non-polarization, however, is no conclusive evidence of native light, though polarization is a test of reflection; and hence Secchi supposed that the nucleus and aigrettes, if not incandescent, which he thought a less probable

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idea, might consist of vapour in a vesicular state, like our clouds, which do not polarize, while the coma and tail were in a gaseous and polarizing condition. Huggins, however, by his more refined and critical mode of analysis, may be considered to have decided this question. An important remark of his should not be omitted here. He thinks that the dark spaces which so frequently intervene between the multiple envelopes of comets, may represent an intermediate condition of the matter originally derived from the nucleus, when it has ceased to be self luminous, but, from still retaining its gaseous state, is capable of reflecting but little light in its transition to a more visible condition, analogous to fog or cloud. Many curious questions of detail, however, remain to be considered, and it is to be hoped that before long the near approach of some magnificent and fully-developed comet, such as that of 1744, which nearly rivalled the splendour of Venus, and was visible to the naked eye at noon-day, may give full scope to the employment of his extraordinary means of investigation. Even before the arrival of such a phenomenon, some out of the ordinary profusion of smaller comets may furnish materials for keeping us on the alert. Eight of them, of very various sizes, were recorded in 1858, and the recent scarcity may be fairly considered the precursor of renewed abundance.

The comet whose light Huggins so successfully analysed, though not a brilliant, is in some respects a remarkable one. D'Arrest observes that it is the sole instance hitherto known of retrograde motion combined with shortness of period. The latter he fixes at 3930$\frac{1}{3}$ days, the course all lying within the orbit of Saturn. Pechyle has given 53 years, Oppolzer about 30, but D'Arrest considers the elements very uncertain. At its first discovery, by Tempel, its motion was so rapid that it passed in 5h. through 2°, or about four times the breadth of the moon. D'Arrest remarks that its present orbit may be of modern date, and that it is more and more probable that comets of short period have not long pertained to our system, and are rapidly tending to dissolution. This he thinks is indicated by the unquestionably decreasing brilliancy of Encke's and Faye's comets, and notices Kepler's anticipated description of the fate of that of Biela, when he suggests the possibility of their division and dissipation.

The total loss, as it would seem, of the latter comet, though not an unprecedented occurrence, as that of 1770 never appeared again according to computation, is an event of considerable significance. It is an additional proof that the stamp of mutability has been impressed upon all created matter. From the comparatively small dimensions of its orbit, and the known character of the space which it had to traverse and the

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perturbations which it would undergo, such a termination was not to be foreseen. But, considering the multitude of minor planets (now amounting to 89), and the probability that their number is by no means exhausted, there is no extravagance in the supposition that it may have encountered some such member of our system, and may thus have changed alike its mode of existence and of motion; destroyed, possibly, in the ordinary sense of the word, but, in the design of an omniscient and omnipotent Creator, merely transmuted into some newer form, not less valuable in itself, nor less conducive to the well-being of the great whole.

NEBULÆ.

We will proceed to some additional details on the subject of nebulæ, which could not be included in our former paper.

Up to October, 1864, Prof. D'Arrest had carried on the Copenhagen Review of Nebulæ, begun in the autumn of 1861, to upwards of 2500 objects, and looked forward to its completion after a year or two more. Of his 215 new nebulæ, a few, he found, had been anticipated by H and the E. of Rosse. 32 out of them he classes as B(right), though generally recurring as F(aint) in some of his revisions. 3 are of H's first class. He speaks of 2 great groups of Nebulæ in R. A. 11h. 58m. D. N. 21°, and R. A. 12h. 53m. to 56m. D. N. 28° to 29° (in *Coma Berenices*), neither of which had then been investigated by Lord Rosse, where, under particularly favourable circumstances, he has seen an extraordinary number of unknown nebulæ. They are, especially in the second group, "incredibly numerous and crowded, and, though extremely small, of a diversity of which no idea could have *a priori* been formed. Occasionally, in the most favourable moments, I have had the very exact impression, as though the nebulæ, often containing only a few seconds in diameter, though intermixed with larger ones—round, longish, stellar, or comet-like—lay packed together like oysters in a barrel."

Of Rosse's 35 "nebulæ not found," D'Arrest had seen 12, and confirmed the invisibility of 4 others. He had repeatedly seen that most curious object, 55 *Andromedæ* (INTELLECTUAL OBSERVER, vi. 448) quite clear of nebulosity subsequently to Aug. 1862; and, still later, Huggins had found its spectrum similar to that of other stars. "This instance," says D'Arrest, "is one of the few which deserve especial attention in future." It will be readily found a little way *sp* γ, being of $5\frac{1}{2}$ mag., and the nearest star of that magnitude in that direction.

He has given a catalogue, up to the beginning of 1861, of 50 of those most singular and suggestive objects, Double Nebulæ, including about $\frac{1}{3}$ of the whole number visible with

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the Copenhagen telescope. Of these 11 or 13 are new. On his No. 1—R. A. 8° 2′ (*not* 8h. 2m) D. N. 0° 2′, both equally bright, *p* longish, *f* round, distant 3′, he remarks, "What has been observed in this place by W. and J. Herschel and by Bond, cannot be brought into sufficient accordance either with one another, or with the existing sky. It is triple." He thinks proper motion possible in 2 members of a triple group; R. A. 137° 50′, D. N. 34° 19′.—113 H. I. H. 581. (These, however, are not identical in Gen. Cat.—582 may be meant, but the locality is very puzzling.)

The interesting question of Variable Light still continues to attract attention, as well it may. Of the 3 supposed variable nebulæ in *Taurus*, we have recently heard very little. Hind's was just caught with Mr. Gurney Barclay's 10 inch achromatic at Leyton, in the winter of 1863-4. I am inclined to think that the nebula in the *Pleiades* (No. 6 of our list) is fainter than it was in 1863-4. In looking for it with 5·5 inches of aperture, on a transparent night, 1866, Feb. 12, I could scarcely perceive it with a power of 30 or 65, while the eye was in in its usual position, or turned sideways to the left, but when twisted sideways to the right, in one of those contortions to which the possessors of achromatics are occasionally subjected, I saw its *f* border—or thought I saw it—distinctly crossing the field of 65, just like the edge of a faint comet's tail. Possibly it may be found that a varied position of the eye may be of use in detecting extremely faint phenomena. The lovers of scenery well know how curious and beautiful an effect is produced upon a landscape by viewing it with the head inclined to one side.

D'Arrest had previously remarked how singular it was that 3 variable nebulæ should be found only 9° and 8° respectively apart, and in a portion of the sky where nebulæ are rare; all of them becoming invisible, or nearly so, about the same time. Contrary to his idea that the list of such objects was nearly exhausted, a fourth has since been added to it, and, strange to say, in the same region. In April, 1863, Chacornac perceived a nebula a few minutes of arc distant from *ζ Tauri*; in Sept. it had become invisible in the achromatic at Copenhagen. And now that the fact of variation may be considered established, and does not rest upon a solitary or doubted instance, older observations and drawings, as our authority remarks, acquire an importance which would by no means have been accorded to them a few years ago. Other suspicious cases have been mentioned. Schmidt, at Athens, had recorded, in 1864, 4 nebulæ surrounding M. 49 (G. C. 3021, R. A. 12h. 22m. 39s. N. P. D. 81° 13′ 44″). They were extremely small and faint, even in his lovely sky. This, unfortunately, is no

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matter of surprise, as he informs us that his dialyte is so injured by the deterioration of its polish, that it may be considered "a wholly ruined instrument;" an announcement which all lovers of astronomy will hear with sincere regret, and earnestly wish that so diligent an observer may soon be armed with a larger achromatic of English glass, which is not subject to decomposition, or with one of the silvered reflectors which are now attaining such perfection. On the contrary, D'Arrest found 3 of these nebulæ bright and pretty large, but one decidedly invisible at Copenhagen, and only 2 minute stars in its place. This struck him the more, as he could see without the smallest difficulty a feeble nebula, which neither Schmidt nor any one else had perceived except its discoverer, Struve II. It is singular, too, that $\mathrm{H}_{\odot}$, in 1785, had pointed out a faint nebula (498 $\mathrm{H}_{\odot}$ II.) very near the site of Schmidt's missing object, which, as nothing could subsequently be found there, was supposed to be a mistaken double entry of 18 $\mathrm{H}_{\odot}$ II.

Rümker, at Hamburgh, with nothing more than a 5ft. achromatic, found that 68 $\mathrm{H}_{\odot}$ IV. (G. C. 1888), R. A. 9h. 32m. 18s. N. P. D. 30° 31′ 15″, instead of being, as $\mathrm{H}_{\odot}$ called it, "considerably faint, very small," might be better described as "very bright, large," and he remarked, on two occasions, that a companion star, 11·2 mag., seemed surrounded with faint nebulosity.

We must return to this subject at a future opportunity.

OCCULTATIONS.

Nov. 11, B. A. C. 6287, 6 mag. 5h. 7m. to 5h. 23m. B. A. C. 6292, 6 mag. 5h. 16m. to 6h. 31m. (This will be a noteworthy observation, from the near coincidence of the immersions. The conditions also will be favourable, the moon being a crescent, 5¼ d. old).—12th, ρ^1 Sagittarii, 4 mag. 5h. 22m. to 6h. 34m.—14th, 9 Aquarii, 6 mag. 5h. 9m. to 5h. 45m.—15th, B. A. C. 7620, 6 mag. 6h. 12m. to 7h. 26m.—16th, 67 Aquarii, 6 mag. 5h. 16m. to 6h. 19m.—20th, ξ Arietis, 5½ mag. 6h. 58m. to 7h. 58m. B.A.C. 755, 6 mag. 7h. 48m. to 8h. 50m.—22nd, 75 Tauri, 6 mag. 6h. 43m. to 7h. 38m. B.A.C. 1391, 5 mag. 7h. 39m. to 8h. 15m. α Tauri, 1 mag. 9h. 58m. to 10h. 52m. (But for the nearly full moon, a night of especial interest: it also includes a near appulse to θ^1 Tauri, 4½ mag. at 7h. 8m.)—24th, 26 Geminorum, 5½ mag. 9h. 29m. to 9h. 57m.—27th, o Leonis, 3½ mag. 11h. 13m. to 12h. 9m. (The reader will be struck with the curious *run* of the hour-numbers in this unusually full list.)

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WILD KAFFIR LIFE AND WILD KAFFIR INTELLIGENCE.

BY ROBERT JAMES MANN, M.D., F.R.A.S.

Superintendent of Education in Natal.

AT page 188 of the October number of the INTELLECTUAL OBSERVER it is stated that the 10,000 "Natal Kaffirs" of 1836 have grown into 200,000 Natal Kaffirs in 1866; and the inference is drawn that the native race in that colony is increasing in numbers rapidly, and not dwindling away, under the presence of British enterprise and rule, and that therefore the question of the capabilities of that race is an important one. It may be necessary to explain that the Natal Kaffirs thus alluded to were Kaffirs who acknowledged English authority, and came within the sphere of civilized observation at even that early period, or very soon afterwards. The Kaffirs spoken of by Mr. Fynn as "Natal Kaffirs" were natives who had gathered round his settlements at the Bay. The rapid increase in numbers was, in all probability, due to the addition of more and more resident clans to the white man's following, as well as to the return of exiles, and the influx of refugees. The Secretary for Native Affairs in Natal has recently ascertained by direct investigation, that there are at the present time forty-three distinct clans, or tribes, within the colony, which were aboriginal tribes of the district, and which have never dwelt elsewhere, excepting for any brief period that they may have been compelled to remove themselves into concealment during the Zulu invasion and occupation. There are also twenty-two other native tribes in Natal, of which nine are composite and made up of a fusion of the fragments of aboriginal tribes, and of which seven are Zulu tribes which have removed themselves from the territory that is still under Zulu rule.

Before the rise of the Zulu power these aboriginals were neither warlike, nor aggressive. Disputes occasionally arose, both between families and between tribes; but such disputes were always speedily settled. There was no attempt at military organization. The several tribes were, for the most part, on friendly terms, and intermarried with each other. They possessed cattle, sheep, and goats; and cultivated the ground, and drew the principal portion of their subsistence from their gardens. They were, indeed, to a considerable extent what the Natal Kaffirs are now seen to be in the colony. The notion of Zulu-Kaffir ferocity, which has become

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prevalent in late years, does not properly belong to these people. It has come from an accident in their history; the development of the Zulu military despotism under Chaka, which has been already described.

The chiefs of these aboriginal tribes ruled as patriarchs, and possessed absolute and uncontrolled power over the lives and property of their people. There was no other check to this irresponsible power than that which arose from the necessity, even in this state of affairs, of conciliating public opinion.

At the present time the several chiefs of the sixty-five tribes of Natal Kaffirs retain only the shadow of their old authority. They are allowed to settle disputes between their people, and to punish petty offences, but all criminal cases are now tried by the magistrates and the Supreme Court of the Colony; and even in cases adjudicated by the chiefs, an appeal can be made to the magistrates, to the Secretary for Native Affairs, and to the Lieutenant-Governor in Council. All supreme power has been transferred from the petty chief to the proper head of the State; and the chiefs now only consider themselves lieutenants, responsible to the Governor for the management of their tribes. They can no longer assemble their people in arms, unless under the order of the Governor. The attempt has been made, and with a considerable measure of success, in Natal, to turn the natural and inherent sentiment of respect for the patriarchal chiefs into a means of orderly government. By leaving a show of authority, and a harmless jurisdiction in the hands of the chief, his dignity has been saved from the evil effects of rude shock, while, at the same time, he has been made the direct link which connects his people with the institutions of the Government. The tribes themselves are divided into territorial districts, villages or kraals, and families. The chief presides over the tribe with a head-man, or Induna, under his authority. Each territorial division of the tribe has also its own proper head-man, or Induna; and there are also heads of groups of kraals, heads of kraals, and heads of families. Each head is practically responsible to the one immediately above him; and in the ascending series the chief of the tribe is responsible to the resident magistrate of his county; and the magistrate to the Secretary for Native Affairs, who is the head-man, or Induna, of the Governor, *par excellence, the* great chief. This organization is so complete, that any order emanating from the Governor can be at once made known to every native hut in the land, although the communication has necessarily to be made without the intervention of written or printed documents.

The huts of the native Kaffirs are nearly always grouped

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together into villages, which are technically named "kraals." The huts are planted upon sloping ground, whence the water can run away easily, and are ranged in circles larger, or smaller, according to the number that has to be accommodated. The head of an ordinary family will have perhaps from six to ten huts in his kraal. The chief Ngoza's kraal near Table Mountain, to which the hut of the Tinted Plate at page 185 belongs, has some eighty or ninety huts in it, and is a pretty long walk across. Old Umpanda has a royal kraal at Nodwengu in Zululand, containing six hundred huts arranged round the circle in triple ranks. The huts are fenced in with stakes and wattle, which thus form an outer wall to the kraal. But there is also within the circles of huts, an inner wall of similar construction, which encloses a kind of court-yard, that is entered by a single opening, and that is employed for herding cattle at night. The huts thus stand in a clear, ring-shaped enclosure of their own. The interior space of the kraal of Ngoza, to which the hut of the Tinted Plate belongs, is so spacious, that upon one occasion, when it contained the wagons and travelling oxen of the writer, and of the Lieutenant-Governor, with the tents of their encampment, in addition to the very large herd of oxen belonging to the chief, it still looked like a large and nearly empty field.

A very good idea of the appearance and size of the Kaffir hut may be gleaned from the plate, where Ngoza and his men are seen at the back of his own immediate dwelling. This structure is not very unlike a squat bee-hive, large enough to hold men, instead of insects. It is unquestionably a rude affair, when compared with the dwellings of an older and higher civilization. But there is another point of view from which it may be contemplated. Taken as a structure made almost out of nothing, by hands that are almost innocent of instruments, it is really a surprisingly ingenious and complete contrivance. In order fairly to understand this, the reader must conceive a man, just in the state in which nature has made him, planted down on a piece of wild pasture, with nothing but a rudely-fashioned lance in his hand, and told that he must fabricate there for himself a structure that shall at once be both clothing and house, and that shall efficiently shelter him through day and night, through storm and sunshine, through summer and winter. If the reader himself could be made the actual hero of the situation, he would be better able to comprehend what the task is that the wild Kaffir has accomplished, when he has made this straw house, than he can be without the experience. In constructing the hut a frame-work of wattle is first bent into a hemispherical shape. A thatching of dried grass is then laid over the

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wattle, and bound compactly down upon it by fibres. A low arched door, very much like the bee's door, is left at one point, through which passage is made horizontally, either for ingress or egress. The correct position is something even more abject than that which is familiarly known as on all fours. This doorway is closed at night by a frame of wicker-work. The floor is a smooth, hard, and almost polished pavement, constructed of beaten earth and cow-dung. If the hut is of large dimensions, it has four or six posts inside; but if of small size, these internal supports are not used. There is a saucer-like and rimmed depression in the middle of the floor, to serve as a hearth in cold weather, and the smoke and air permeate the grass with just sufficient freedom to secure ventilation, but not one drop of water enters from the sky. Round the walls, in the interior, the scanty Lares and Penates of the master, consisting principally of beer pots, milk pots, mats, skins, and shields and assegais, are distributed. Upon the floor with rush mats unrolled beneath them, the dusky household squat to gossip by day, and lie outstretched to sleep at night. Each hut affords sleeping-room for several individuals. The chief, or head-man of a kraal has a principal hut for himself, where his visitors come to gossip and feast with him, and also a hut for each of his many wives, whose families dwell therein with them until the children attain a certain age. In most kraals there is also a hut set apart for the use of young men.

The Kaffir is eminently a creature of sunshine. In cold or wet weather he keeps himself close within the shelter of his hut, and gossips and doses away his time. When the sunshine is genial and warm he sits outside squatting upon the ground, surrounded by his dogs and his children, and fashioning some article for household use, for employment as a weapon, or for personal adornment; or with a small shield upon his arm, and a bundle of short light assegais, and a knob-headed stick in his hand, he strides off over the hills bent upon some business of gossiping or feasting. The cattle are principally tended and herded by the young boys, roaming free over the pastures by day, and being driven into the inner enclosure of the kraal for protection at night. In some convenient nook on a hill side, or in a sheltered ravine near to the kraal, a space is rudely fenced in as a garden, and here crops of the Indian corn, the millet, the sweet potato, and occasionally of the pumpkin, a wild sugar-cane (Impheè), and wild hemp, and tobacco for smoking, are grown. The ground of the garden is broken and tilled by the women, working with a curious kind of hoe, now imported largely into Kaffir lands for native use. The Indian corn and millet are produced in large quantities, and ordinarily form the staple of a Kaffir's food. The grain is stored, after

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harvesting, in pits dug in the ground, with only a narrow opening left at the top, which is carefully and skilfully closed by placing a flat stone over it, for protection against the rain. The food is prepared by the women, sometimes aided by the children and young lads. The Indian corn is roasted, when green, upon the cob; when ripe the grain is crushed by hand, between stones, and the meal converted into a kind of porridge. The milk from the cows is chiefly consumed in a half sour and clotted state by the children. The millet is ground between stones, and made into a sort of infusion or decoction, which undergoes spontaneous fermentation, and so becomes converted into a liquor that is known as Kaffir beer (Tywala). In its choicest state, as it is found in the cellars of distinguished men, this liquid is limpid and clear, and possessed of considerable inebriating power. It is unquestionably very nourishing. In more common-place households it bears a considerable resemblance to a mixture of bad gruel and table beer. The beer drinking is the most ordinary form of native carouse. When there is a good brewing ripe, the men assemble and drink the liquid in rotation out of capacious gourds or pots, made of closely and thickly-woven grass, or more rarely of hardened clay. The beer is kept during fermentation in these vessels, which stand in the interior of the hut, opposite to the doors, something like the jars of the Forty Thieves, in a long row. The milk is held in similar vessels. The beer pots and milk pots are carried by the women and girls, very skilfully balanced upon their heads. A jovial spark, off on a visit, may be sometimes met, with a string of women or girls, each with a full beer pot balanced on her head, behind him. The water for household use is brought in by the women from the nearest stream, in gourds.

Under ordinary circumstances the gardens furnish a fairly ample supply of food for the daily wants of the household. But occasionally from some accident of season, or from some other cause, the supply runs short, and periods of great privation have to be endured. One of the first benefits which the barbarian reaps from the neighbourhood of civilized men is the alleviation of this unavoidable misery of barbarous life. So soon as he has white neighbours within reach of his kraal, he is pretty sure to have some additional resource to draw upon in seasons of dearth and famine. In olden times, and still in remote districts, the Kaffirs occasionally die of famine in great numbers; and those who survive subsist to a large extent, even for weeks at a time, upon wild roots dug up out of the ground.

Animal food, among the Kaffirs, is entirely a matter of carouse and feasting. If a distinguished visitor comes to a

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Kaffir village, or kraal, the principal man makes a present to the visitor of a goat, or of an ox, as the case may be. The animal is graciously received, and turned over to the attendants of the guest for slaughter: some choice part is retained by the guest, and the rest is handed over to the inhabitants of the kraal, to be eaten in honour of the visit. Animals are also killed and eaten upon certain other ceremonial occasions, when set invitations are given, and set feasts made. Upon such occasions, if it is an ox that is to be eaten, it is taken near to the entrance of the kraal, and stabbed behind the shoulder with an assegai, wielded by some expert hand. A fire is kindled near, and almost before the animal is dead it is hewn to pieces, and the selected portions being removed, the rest is divided in what seems to the uninitiated observer to be a sort of scramble; but it is in a scramble that has in itself some underlying order of accepted etiquette and custom. The fragments of meat are just laid for a brief interval upon the embers of a wood fire that has been prepared close at hand, and are then rapidly transferred to the throats and stomachs of the feasters. The eagerness for the unusual, and rare, gorge is far too keen to allow any refinement of culinary art to be either learned or exercised. A couple of hours is pretty well enough, in Kaffir handling, for the conversion of a living ox into a remnant of stripped skin and bare bones.

Well-to-do Kaffirs rejoice in a multiplicity of households. In the kraal of a chief, or of a wealthy patriarch, each hut near to his own, contains a wife, and that wife's offspring, and the more distant huts are appropriated to the other members of the family or clan. Polygamy is an institution among the Kaffirs, that is intimately and inseparably interwoven with the privileges of wealth and the rights of property, and that will therefore be very difficult to eradicate. The Kaffir has strong natural instincts of affection for his wives and his children, as a rule; but the peculiar position which he holds as a polygamist, of necessity introduces some relations and characteristics into his domestic life and social history that are not calculated to awaken interest or respect. In all probability some of the incidents and occurrences that arise out of these relations are but imperfectly understood by European censors and critics. Kaffir men do not acquire wives until they are able to pay a stipulated number of cows to the father of the bride for the privilege. These cows are differently viewed by the different authorities who speak of Kaffir practices and customs. By some they are held to be an actual purchase price paid for the girl. By others they are considered to be a sort of deposit made in her interest to her family. In case of a wife leaving her husband within a limited period, he is allowed to have some

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claim against her parents for cow-restitution; but matters are held to be in some way changed when she has bestowed female offspring upon her husband. In some instances a family of girls confers a measure of freedom and independence upon the mother, because the value of the cows, price or deposit, is thus restored. At any rate the women are looked upon as possessing material and substantial value in a household, because they bring girls, who in due time turn into cows; and because they perform hard and productive drudgery. The children of any particular wife speak in common of all the other wives of their paternal parent as "mothers;" and, as a general rule, there is a surprising amount of harmony maintained in the household under the circumstances. According to the old and time-honoured custom of the Kaffirs the father's property in his daughters was so absolute and complete, that his sole will determined all matrimonial arrangements, and he possessed, and not unfrequently exercised, the right of punishing a refractory child who refused to obey his commands with death. Since the subjection of the Kaffir chiefs to British supremacy and rule, all coercion of girls to an unacceptable marriage has been generally forbidden, and in any case where an appeal is made against parental authority upon this ground, the magistrates discountenance, and even punish, its exercise. It is the intention of the colonial government, at the earliest possible opportunity, to introduce some arrangement which shall make a full and clear declaration of a woman's personal consent indispensable to the legality of a native marriage. In the meantime two very important alterations in the old Kaffir practice have already been brought about. Every marriage now consummated is held to be irrevocable and final, so far as the parents of the woman are concerned; and a widow is now free to marry any one that pleases her without reference to the opinion or will of her natural guardian. These important modifications have been made by the Lieutenant-Governer, acting in his capacity of supreme chief, and have received the general assent of the natives on the ground that they admit them to be just and reasonable. It is obvious that some caution and judgment is required in the introduction of changes that are directly aimed at the root of a practice which is intimately bound up with the customs, habits, ideas, and laws of a race, and which the people believe to have been created with them.

Mr. Crawfurd considers the negro to be a very unmanageable and unpromising piece of humanity. He remarks of him that he has no literature, and no architecture; that he cannot tame elephants; that his religion is nothing but witchcraft, his wars merely the incursions of savages, and his government only a brutalized despotism. Without at present meddling with the

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inferences which Mr. Crawfurd draws, it must be admitted here that these allegations apply as accurately to the Kaffir as they do to the pure negro. It is a very remarkable fact in human history, that the Kaffir, with such inherent capabilities, should have remained utterly savage so long; that even, after seeing with his own eyes the wonders that are worked by his white cousins, in matters that come so immediately home to him, as flocks, herds, and food crops, he should still be willing, if left alone, to lead the indolent, unproductive, and unprogressive life that has been described. Whatever may be the case in regard to the principle that Sir S. W. Baker enunciated so prominently at the last meeting of the British Association for the Advancement of Science, namely, that all negro races would infallibly fall back into barbarism, if left to themselves; there can be no doubt, at any rate, that these races will not advance out of barbarism, if so left. But here there occurs one consideration, that perhaps has not yet received all the attention it deserves, and that really carries with it much important and practical suggestion. Mr. Crawfurd argues, "The negroes are uncivilizable, or nearly so, for, after years of social existence, they have no literature." May it not be that the negro races have not advanced into civilization *because* they have no literature? A race which is incapable of originating a literature, may, nevertheless, be quite capable of being deeply and permanently influenced by a literature that is brought to them from without. This literature may indeed ultimately prove to be the very panacea and influence that makes progress possible and advance permanent. It is by no means an unheard of thing in human history, that races have received and benefited by a written and recorded language, although they had failed to contrive the instrument for themselves.

It is a very curious, and certainly a most noteworthy fact, bearing indirectly but instructively upon this view, that the wild Kaffir, even when quite removed from the influence of white men, and from civilized appliances and practices, has, nevertheless, *an education* of his own. This becomes strikingly apparent to even the most careless and most casual observer, when the young men and the old men of the race are compared. The young men are all wild, impulsive, restless, and full of savage fire, which generally burns itself out in howling, dancing, boasting, and laughing, but which is quite capable, as proved in Chaka's experience, of being turned to less desirable account. The old men are all quiet, astute, thoughtful, and full of "wise saws and instances." The countenances of the young men are commonly savage and furtive, even when good humoured. The countenances of the old men are constantly dignified, grave, and intelligent. In Zululand, at this

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present hour, the young men are nearly all turbulent, quarrelsome, boastful, and aggressive; the old men are nearly all quiet, peaceful, and full of admiration and friendship for their Dutch and English neighbours. There is a very simple and obvious reason for this difference. The young men are all of the raw material of barbarism; the old men are all *educated!* The education of the Kaffir race is talk. The remark of Sir S. W. Baker and others, that the negroes acquire their full intellectual development at a very early period, and are incapable of subsequent advance, certainly is not true in regard to the Natal Kaffirs.* The wild Kaffir leads a life of indolence, and puts the amount of drudgery that is requisite to provide for the absolute essentials of this indolent life upon his women. But he also leads a life of *gossip;* he talks incessantly, and much of his talk concerns the doings of his relatives and neighbours, and the general relations of his social state. When he walks forth over the sunny hills to pay his visit to some neighbouring or distant kraal, he carries with him matters that have to be made there the theme of patient discussion and grave deliberation. It is not possible for men to gossip through long years without doing some thinking as well, and, wherever there is thinking, there is also intellect and progress. But, in the case of the wild Kaffir, the progress is individual, and not collective. Each man has to go through the same process for himself, and the result dies when the man dies. Tradition may carry on some very small shadow of the sum total and gain to the next generation, but the main bulk of the personal advancement and experience must disappear. And can it be said that it would not be the same, even in England, if there were no permanent and recorded accumulation to be transferred on from generation to generation? if there were no books and no formal teaching? Men may say that the negro races cannot be raised much, or at all, above their present stand points, and they may be right; but, at any rate, an appeal necessarily lies from such judgments to events and time; and, not until it has been seen what the modifications are, that a formal, a designed, and a well considered training and education can introduce, can the question of Kaffir civilization be held to have received a practical settlement. It yet remains to state, indeed, that something has already been actually achieved in Natal, which does give promise of a higher capability in the native race than the theory of unprogressive stagnation and ready retrogression would allow. This is reserved for another opportunity.

* There is no satisfactory ground for believing it true of the negro. The balance of evidence is on the other side.—ED.

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AIDS TO MICROSCOPIC INQUIRY.—No. VIII.

Organic Substances and Formations.

In a former paper of this series, entitled *Notes on Organic Chemistry*, vol. vi. p. 428, some illustrations were given of the general principles upon which the elements of living bodies are combined, and we shall now consider the nature of some of the principal substances found in organic beings.

It astonishes a pretty young lady to tell her that, chemically, she consists of a pail of water, a few gases, some charcoal, lime, iron, phosphorus, and a few et ceteras; but the statement is, nevertheless, very near the truth. Organized beings are composed of very similar materials whatever may be their zoological rank, and they do not differ so much from vegetables in mere composition as was formerly supposed. They contain, for the most part, hard structures and soft ones—the former being for supports, frame-work, etc., and the latter constituting the more vital portions. In man, the hardest material is the enamel of his teeth, and among the softest are his nerves and brains. Human bones, and bones in general, are composed of a soft material, which when extracted from them is known as *gelatin*, and a hard one strengthening the former, consisting almost entirely of phosphate of lime. It is interesting to compare a hard firm bone of one of the higher vertebrates with the soft bones of cartilaginous fishes, sharks, etc., the magnates of the fish world, whose elevated position is demonstrated to the satisfaction of naturalists by their superior power of devouring their brethren, to which end they are elaborately organized. A terrestrial beast of prey with the soft bones of the shark would not be a successful animal, and should any morbid condition turn out a lion as a gristly monster, "Natural Selection" would take no steps for his preservation, but his days would be soon finished in the stomach of a more earthy-boned brute. In the water, things are different, and the lightness of the shark bone more than compensates for its slighter strength, while its pliability is no doubt convenient.

The combination of phosphorus, a soft highly combustible solid, of oxygen, the gas that gives its life and fire-sustaining qualities to atmospheric air, and of lime the well-known earthy mineral, results in *phosphate of lime*, to which bones owe their hardness and solidity; and which meets us again as one of the constituents of wheat flour, and many other substances used as food. The animal derives his phosphates from the vegetable, and when the animal has done with them, and

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passes them away in secretions, or lays them down with his bones to rest in their mother earth, fresh plants catch them up again, and bring them once more within the circle of organic life.

The simplest animals are composed wholly or chiefly of *sarcode*, the soft stuff of which the infusoria are made, and which with a little modification constitutes the bodies of the polyps. As it occurs so commonly as a chief constituent of the lower kinds of animals in their adult form, it is not surprising that it is found in the larval or embryonic stages of higher ones, including man himself. One of the best ways of getting a notion of the appearance and properties of *sarcode* is to look at an *amœba* through a microscope. Chemically it has a close relation to the muscular tissues of higher animals, as it belongs to the *proteic*, or *albumenoid* group of bodies. The principal substances composing albumen, the type of this group, are, carbon, hydrogen, oxygen, and nitrogen, but small quantities of sulphur, and some saline ingredients are always present. Albumen is easily studied in its well-known form, white of egg. Albumen, and its near relative *fibrin*, can exist in two conditions, soluble and insoluble. The white of egg readily coagulates on the application of heat, and fibrin, which the blood holds in solution coagulates on being withdrawn from the vessels of a living animal. Substances closely resembling, or identical with albumen and fibrin, exist in the vegetable world, and especially in seeds, which are found useful for food. The albumenoid group are essential to animal life, and probably to organic life, though their quantity in many plants may be infinitesimal, and they are remarkable for the facility with which they undergo chemical changes. They give its chief nutritive value to milk, to the meal of peas, beans, and other bodies standing high as food.

As the object of the present paper is solely to help beginners and those who are not special students of chemistry, we shall not introduce any of the complicated questions relating to the chemistry of the constituents of animal bodies, but add a few words on some important compounds, beginning with *muscular tissue*. It consists chiefly of coagulated fibrin, "but being highly vascular, and containing nearly three-fourths of its weight of water, it is permeated with a fluid consisting partly of blood and partly of substances secreted from it, independently of a small portion of nervous and adipose matter."*

The portion of muscle which is soluble in cold water consists of albumen, salts of the blood, and two crystallizable animal principles named *kreatine* and *inosite*, several acids, and

* Prof. Miller's *Elements Chem.*

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a peculiar red colouring matter. All kinds of flesh contain an immense quantity of water, and unless the chief animal tissues and substances are very moist, active life appears impossible, though some creatures may be very nearly dried without being killed. In such a condition they are torpid, from suspended functions. By drying animal substances their susceptibility to chemical change is destroyed, as is illustrated by the fact that in some parts of the Andes, and in other very dry, cold places, the bodies of the dead shrink into natural mummies, and suffer no decay.

Ready susceptibility of chemical change is the condition of those substances on which life mainly depends, and the nerve materials exhibit this quality in a high degree. The human brain contains in one hundred parts, about seven of albumen,* five of peculiar fatty acids—one of which, cerebric acid, contains phosphorus—and about eighty of water. Cerebric acid contains no less than five bodies, carbon, hydrogen, nitrogen, phosphorus, and oxygen, and many other important animal compounds are equally complicated. As might be expected from the complex character of the substances we have mentioned, blood, from which they all spring, is remarkable for its numerous and complicated components. Chemists recognize in it four kinds of fatty matter, fibrin, albumen, common salt, and other soluble salts, together with other materials, amongst which iron is conspicuous. We have seen that the chemical composition of animals and vegetables is substantially the same, but the proportion of the various compounds entering into both, vary very much, the animal series being remarkable for the quantity of their highly complex nitrogenous elements, while the hydro-carbons with oxygen prevail in plants. A comparison of fibrin with wood may be interesting and instructive. The former contains more than half its weight of carbon, about 6 per cent. of hydrogen, about 15 per cent. of nitrogen, about 23 per cent. of oxygen, and small quantities of sulphur and phosphorus. The latter varies a little according to its kind, but a piece of oak will contain about 49 per cent. of carbon, about 6 per cent. of hydrogen, about 43 or 44 per cent. of oxygen, and, in some cases, a little nitrogen, say 2 per cent.

The essential part of wood is its fibre, called in chemical language *cellulose*. This contains 36 definite portions of carbon, united to 30 definite portions of oxygen, and as many of hydrogen. In a very delicate form, cellulose is digestible and nutritious, but as soon as it concreted into firm fibres like hemp, cotton, etc., it is no longer fit for the food of human beings.

* See Miller.

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The horse can digest cellulose in a more compact form than man, the camel perhaps still more so, and certain wood-devouring insects possess additional faculties of the same sort. A clean cotton fibre is nearly pure cellulose, and so is that elegant material erroneously called "rice paper," and made by the Chinese from the pith of the *Aralia papyrifera*.

The hair, hoofs, horns, and feathers of animals are very similar in chemical composition, and silk is very like them, and belongs to the same series. Speaking generally, we may say that these substances are rather more than half carbon, about one quarter oxygen, about a sixth nitrogen, and they contain about 3 per cent. of sulphur.

The solid parts of insects, such as the elytra and hard skin of beetles, their jaws, ovipositors, etc., and the shells of certain rotifers, etc., are composed of *chitin*, a substance chemically resembling the preceding, but with a larger allowance of oxygen. This substance is also found in the organic matter of the shells of crustaceans—those of water fleas (*Entomostracea*), for example, contain little else.

Professor Miller says "sugar appears to be the basis or foundation of organic matter in general, and from it all the varieties of organized products might be obtained by the addition or subtraction of water, oxygen, and ammonia."* This is cited not to convey the impression that all organic bodies do actually arise out of such a mode of treating sugar, but to illustrate the relation which different organic compounds bear to each other.

Organic compounds placed under appropriate conditions are susceptible of endless changes and modifications, first by simple addition of definite quantities of materials they already possess; secondly, by removals of certain constituents, wholly or partially, but always in definite proportions; thirdly, by *substitution*, that is, by taking away certain elements in definite proportions, and adding new elements in *equivalent* proportions. Living beings take matter into their system in one condition, and change it by processes of this kind. The plant is remarkable for the extent to which it can convert inorganic matter into organized combinations, and the animal with some power of this sort is chiefly occupied in receiving from plants, or from other animals, materials belonging to the organic series, and modifying them according to its needs.

The chemical processes carried on by organized beings range from comparatively simple ones to others that are highly complicated. A vegetable cell, such as a yeast cell, is able through its delicate walls to allow a certain intercourse between its internal contents and the matters which the fluid in which

* *Elements of Chemistry*, vol. iii. p. 723.

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it grows contains. It takes from the fluid or solution what it requires for its development and reproduction, and in so doing determines certain decompositions and recompositions, which are termed fermentation, and which give rise to special products. In more complicated organic beings a great series of processes, more or less similar, are going on, and every organ is engaged in a series of transactions with fluids and gases, one result of the whole being the orderly building up, and the equally orderly taking to pieces, of the various parts which make up the entire structure.

Starches and sugars are among the most interesting products of vegetable life. Common starch consists of carbon, oxygen, and hydrogen (the proportion being C_{12} H_{10} O_{10}); and if the elements of water (oxygen and hydrogen) be added, starch sugar is the result. There are many varieties of sugar, and many substances allied to sugar, and belonging chemically to the same group. They consist of the same elements combined in different proportions. Cane sugar crystallizes in four or six-sided rhombic prisms; grape sugar in cubes or square tables; sugar of milk in four-sided prisms. Fruit sugar is not crystallizable. Gums are much like sugars in composition, and abundantly found in plants. Gum arabic has the same composition as cane sugar, C_{12} H_{11} O_{11} , and may be converted into sugar by the action of dilute sulphuric acid, which first removes one equivalent of water, and turns it into *dextrin*, a substance in properties between gum and starch.

Vegetable jelly (pectin) gives their gelatinous character to the juice of many fruits, and *pectose*, which may be converted into it, abounds in carrots, turnips, etc.

Silica, or flint, pure in white quartz crystals, is often met with by the microscopist in vegetable bodies, such as wheat straw, the glazed surface of canes, the spicules of certain sponges, and so forth. In these cases it has been deposited by organic agency in an organic structure. Silica is composed of silicon and oxygen, and is one of the most abundant constituents of the earth's crust. Silica or silicic acid crystallizes in six-sided prisms, terminated by six-sided pyramids. It requires an intense heat to melt it, and is insoluble in all the acids except hydrofluoric. One of its modifications is slightly soluble in water, and it may be precipitated in a gelatinous form from solutions of silicates of soda and potash. Diatoms, and many other organized beings, can separate from water the minute quantity of silica necessary for their hard structures. When the microscopist is in doubt whether a substance is silica, or carbonate, or oxalate of lime (the last common in plants as raphides), he should apply a drop of muriatic acid. If lime it will be dissolved, if silica not. Oxalate of lime crumbles to an

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opaque powder when heated red hot. Silica, if pure, remains unchanged in form, and keeps its transparency, or it becomes white, if minute portions of other earths are present. In sponge spicules an animal substance is present, and this blackens with heat.

Silica is contained abundantly in common minerals, agates are chifly composed of it; the opal has it for its chief constituent; sharp sand is mostly composed of particles of silex, and sandstone contains it in large quantity.

The few hints given in this paper, and in the preceding one on *Organic Chemistry* will, it is hoped, give young microscopists some help, but they must make a special study of chemistry if they wish to do more than approach the threshhold of many very interesting questions in the growth and decay of living beings on which the microscope is able to throw light, but which without chemical knowledge must remain more or less unintelligible.

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RESULTS OF METEOROLOGICAL OBSERVATIONS MADE AT THE KEW OBSERVATORY.

LATITUDE 51° 28′ 6″ N., LONGITUDE 0° 18′ 47″ W.

BY G. M. WHIPPLE.

1866. Day of Month.	Reduced to mean of day.		Calculated.			Temperature of Air.			At 9·30 A.M., 2·30 P.M., and 5 P.M., respectively.		Rain—read at 10 A.M.
	Barometer, corrected to Temp. 32°.*	Temperature of Air.	Dew Point.	Relative Humidity.	Tension of Vapour.	Maximum, read at 9·30 A.M. on the following day.	Minimum, read at 9·30 A.M.	Daily Range.	Proportion of Sky clouded.	Direction of Wind.	
	inches.	°	°		inch.	°	°	°	·0—10		inches.
July 1	...	...	...	...	...	66·8	53·5	13·3	...	... ...	0·857
,, 2	29·375	54·0	46·8	·78	·427	64·6	49·7	14·9	10, 7, 5	WSW, WSW, W.	·064
,, 3	29·367	53·7	47·6	·81	·423	62·9	50·0	12·9	9, 8, 9	W, WSW, SW by S.	·010
,, 4	29·478	55·5	49·4	·81	·450	65·8	50·7	15·1	10, 8, 9	SW, W by S, SW.	·160
,, 5	29·508	55·4	47·6	·77	·448	64·7	51·1	13·6	6, 7, 8	SW by W, SW, SW.	·116
,, 6	29·626	56·6	47·9	·74	·467	67·2	49·7	17·5	9, 7, 4	WSW, NW by N, W.	·106
,, 7	30·009	56·5	41·8	·60	·465	64·8	48·5	16·3	7, 5, 4	W, NNW, NW by W.	·096
,, 8	...	...	...	...	...	66·1	48·6	17·5	...	... ...	·000
,, 9	30·184	65·3	58·4	·79	·623	74·8	57·7	17·1	10, 7, 7	W, W by S, SW by W.	·004
,, 10	30·287	70·9	57·6	·65	·748	79·7	58·0	21·7	0, 3, 2	WSW, WSW, NW by W.	·000
,, 11	30·277	70·4	57·6	·66	·736	77·5	56·7	20·8	1, 2, 7	—, NW by W, E by N.	·000
,, 12	30·163	74·9	61·4	·64	·851	84·3	56·3	28·0	0, 4, 1	—, SE, SE.	·000
,, 13	30·058	75·0	59·8	·61	·854	82·7	60·2	22·5	0, 1, 7	S, W by S, W by S.	·000
,, 14	30·125	71·0	59·8	·69	·750	80·6	57·9	22·7	4, 6, 4	—, SW, SSW.	·000
,, 15	...	...	...	...	...	79·2	58·0	21·2	...	... ...	·000
,, 16	30·079	63·5	54·9	·75	·587	72·9	59·0	13·9	7, 4, 5	E by NE, ENE, E by S.	·000
,, 17	30·022	61·0	52·5	·75	·540	68·8	58·6	10·2	10, 9, 9	NE, NE, NE.	·000
,, 18	29·963	61·6	47·0	·61	·551	70·6	48·7	21·9	4, 4, 2	NE by N, NE, NE.	·000
,, 19	29·894	60·0	51·6	·75	·523	69·7	49·3	20·4	1, 8, 7	NE by N, NE, NE by N.	·000
,, 20	30·051	59·3	46·4	·64	·511	69·6	47·5	22·1	9, 3, 0	NW by N, NE by N, NW by N.	·000
,, 21	30·057	67·4	51·8	·60	·667	77·3	48·5	28·8	0, 1, 3	—, W, W by N.	·000
,, 22	...	...	...	...	...	66·8	52·2	14·6	...	... ...	·000
,, 23	30·006	57·6	48·1	·73	·483	67·8	47·5	20·3	9, 1, 2	N by W, NE by N, N.	·000
,, 24	30·047	56·2	46·7	·72	·460	67·7	52·8	14·9	10, 10, 9	NE, NE, NE.	·000
,, 25	30·213	56·0	48·6	·78	·457	65·9	52·3	13·6	9, 9, 10	NE by N, NNE, N by E.	·000
,, 26	30·098	60·1	50·3	·72	·525	70·1	48·7	21·4	9, 10, 10	—, SW by S, SSW.	·000
,, 27	29·767	58·3	56·7	·94	·494	66·7	55·0	11·7	10, 10, 10	S, S by W, S.	·084
,, 28	29·642	60·2	55·9	·87	·526	69·5	53·5	16·0	7, 10, 10	ENE, SE by E, SE by S.	·050
,, 29	...	...	...	...	...	67·7	58·1	9·6	...	... ...	·424
,, 30	29·795	58·1	42·2	·58	·491	65·4	50·1	15·3	7, 8, 5	NW by N, NW by W, NW.	·005
,, 31	29·666	50·1	48·0	·93	·374	58·4	45·6	12·8	10, 10, 10	WSW, WNW, NW by W.	·004
Daily Means.	29·914	61·1	51·4	·73	·551	...	...	17·5	...	... ...	1·930

* To obtain the Barometric pressure at the sea-level these numbers must be increased by ·037 inch.

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HOURLY MOVEMENT OF THE WIND (IN MILES), AS RECORDED BY ROBINSON'S ANEMOMETER.—JULY, 1866.

Day.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	Hourly Means.
Hour.																																
12	16	11	7	5	16	7	5	6	12	6	3	2	3	4	4	9	12	7	2	3	3	11	3	7	8	2	6	3	3	9	4	6·4
A.M. 1	16	10	10	7	18	7	3	6	12	7	2	1	6	4	1	7	14	7	2	6	2	11	5	8	9	2	6	3	2	9	5	6·7
2	13	10	10	8	22	5	4	5	13	9	1	2	5	3	2	8	11	8	1	6	1	12	5	8	8	1	5	3	5	10	6	6·8
3	12	11	7	8	16	6	3	7	12	9	1	3	5	3	2	7	11	5	1	7	1	5	6	7	7	2	5	3	6	10	7	6·3
4	10	11	9	6	9	4	3	8	12	9	1	4	4	2	2	6	12	6	2	7	1	7	8	7	6	3	6	2	8	9	8	6·2
5	8	13	9	9	10	4	3	9	10	7	3	4	3	2	1	10	13	7	2	5	1	9	3	7	8	2	5	4	7	10	6	6·2
6	12	14	13	9	13	5	4	10	10	9	6	3	5	2	2	13	14	11	3	7	0	10	5	7	8	1	5	7	11	13	10	7·8
7	10	15	16	12	16	5	8	15	12	10	6	5	8	3	7	12	13	12	4	9	2	12	7	8	8	3	7	9	12	18	12	9·5
8	8	15	17	14	18	5	8	15	13	10	6	6	10	4	6	13	13	13	6	7	2	11	10	11	9	7	6	10	13	15	17	10·2
9	8	15	16	14	19	5	9	14	12	9	4	5	9	1	3	13	12	14	7	13	3	10	11	12	9	7	3	12	13	17	17	10·2
10	10	10	17	17	17	8	12	15	14	11	7	7	10	4	4	16	11	15	7	15	4	9	12	13	10	8	4	13	16	17	18	11·3
11	13	13	15	16	15	4	8	17	16	10	5	7	11	6	4	17	12	12	7	13	3	9	13	15	8	9	7	15	16	15	16	11·2
12	15	14	15	19	19	5	12	14	15	11	5	8	11	7	9	19	14	13	11	15	5	10	12	16	9	11	6	15	14	16	15	12·2
P.M. 1	16	15	20	20	16	7	11	17	16	10	6	10	10	6	8	18	14	10	13	9	5	9	15	15	10	11	8	14	18	14	16	12·5
2	14	10	18	20	19	8	12	15	16	11	9	10	12	7	8	18	13	10	15	8	6	9	14	16	13	13	8	10	16	13	21	12·6
3	13	10	20	20	20	10	15	12	15	12	7	10	12	6	8	18	14	12	13	7	4	11	13	17	11	13	8	13	20	13	16	12·6
4	17	16	26	18	19	6	14	15	15	10	5	9	10	5	8	18	14	13	12	5	3	11	15	15	11	12	8	9	13	11	16	12·2
5	15	14	18	14	17	6	12	12	13	10	4	9	9	4	7	19	13	10	11	1	3	10	17	11	8	10	6	8	21	6	15	10·7
6	17	15	18	16	14	5	11	10	12	6	4	6	7	5	5	18	13	9	9	3	8	12	17	12	3	7	7	9	18	12	14	10·4
7	10	13	14	13	15	4	5	13	11	3	5	5	6	4	9	15	11	6	14	2	12	5	13	15	7	5	8	10	13	5	18	9·3
8	9	10	8	16	9	4	5	11	8	3	2	6	4	1	11	17	8	4	10	3	8	2	9	9	5	6	5	11	18	4	16	7·8
9	6	8	3	16	9	3	5	11	6	5	2	5	5	2	14	17	7	5	5	3	8	2	5	9	3	7	6	10	7	4	14	6·8
10	9	9	3	18	7	2	7	11	8	3	2	6	5	3	13	11	10	2	4	5	11	3	10	10	3	7	6	6	12	4	15	7·2
11	8	8	3	15	10	3	6	11	6	2	2	4	4	3	8	9	8	1	1	2	12	3	8	7	3	6	5	5	10	6	10	6·1
12																																
Total Daily Movement.	285	290	312	330	363	128	185	279	289	192	98	137	174	91	146	328	287	212	162	161	108	203	236	262	184	155	146	204	292	260	312	9·1

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RESULTS OF METEOROLOGICAL OBSERVATIONS MADE AT THE KEW OBSERVATORY.

LATITUDE 51° 28′ 6″ N., LONGITUDE 0° 18′ 47″ W.

1866. Day of Month.	Reduced to mean of day. Barometer, corrected to Temp. 32°.*	Temperature of Air.	Calculated. Dew Point.	Relative Humidity.	Tension of Vapour.	Temperature of Air. Maximum, read at 9·30 A.M. on the following day.	Minimum, read at 9·30 A.M.	Daily Range.	At 9·30 A.M., 2.30 P.M., and 5 P.M., respectively. Proportion of Sky clouded.	Direction of Wind.	Rain—read at 10 A.M.
	inches.	°	°		inch.	°	°	°	0—10		inches.
Aug. 1	29·901	59·5	50·3	·73	·514	69·3	50·6	18·7	10, 6, 4	W by N, S, S.	0·127
„ 2	29·566	60·9	56·9	·87	·539	70·7	55·9	14·8	10, 9, 10	SW by W, WNW, NW by W	·084
„ 3	29·744	62·0	54·6	·78	·559	71·2	55·2	16·0	10, 7, 9	SW by W, SW, W.	·065
„ 4	29·704	57·3	42·8	·61	·478	66·0	50·7	15·3	9, 8, 5	SW by W, WSW, SW by W.	·000
„ 5	...	...	...	...	...	64·5	51·1	13·4	...	... ...	·000
„ 6	29·715	52·0	50·8	·96	·399	...	49·3	...	10, 10, 10	SW by W, SW, SW.	·472
„ 7	29·446	55·5	50·0	·84	·450	66·6	...	...	5, 6, 4	SW by S, W, W.	
„ 8	29·653	55·8	48·5	·78	·454	64·8	50·3	14·5	7, 7, 6	SW, SW by S, S by W.	·111
„ 9	29·564	58·0	42·7	·59	·489	66·1	51·2	14·9	6, 6, 5	W, W by N, W by N.	·147
„ 10	29·721	54·3	44·8	·72	·432	64·6	48·2	16·4	5, 8, 7	WNW, W, SW by W.	·002
„ 11	30·083	58·0	46·8	·68	·489	67·9	49·3	18·6	6, 7, 9	WNW, W, W.	·134
„ 12	...	...	...	...	...	65 7	51·4	14·3	...	... ...	·316
„ 13	29·918	...	...	...	...	...	55·4	...	9, 10, 10	NE by N, —, —.	·051
„ 14	29·777	58·5	53·7	·85	·497	66·7	...	...	10, 9, 6	SW by S, NNW, NW.	·050
„ 15	29·950	55·6	46·4	·73	·451	64·0	52·1	11·9	10, 10, 8	W, W by S, W.	·005
„ 16	29·69	55·3	48·9	·80	·447	63·7	52·1	11·6	10, 9, 6	SW by S, SW, WNW.	·000
„ 17	29·788	56·2	43·0	·64	·460	64·4	49·2	15·2	8, 8, 8	W, W by S, WNW.	·060
„ 18	29·946	58·5	46·9	·67	·497	68·8	45·9	22·9	5, 6, 2	W, WSW, S by W.	·001
„ 19	...	...	...	...	...	70·8	42 2	28·6	...	... ...	·000
„ 20	29·691	62·1	54·4	·77	·561	70·6	54·8	15·8	7, 5, 5	NNW, N, N by W.	·062
„ 21	29·830	58·5	55·2	·89	·497	67·7	56·0	11·7	10, 8, 8	NW by N, N by W, W by N.	·010
„ 22	29·979	60·9	54·3	·80	·539	70·4	55·7	14·7	10, 7, 5	SW, —, —.	·000
„ 23	30·010	61·8	56·9	·79	·555	73·5	51·7	21·8	10, 7, 2	E, E by N, E.	·000
„ 24	29·996	63·2	61·9	·96	·581	69·7	56·8	12 9	10, 10, 10	E, W, E by S.	·000
„ 25	30 059	62·8	57·4	·83	·574	71·7	50·4	21·3	4, 8, 8	WSW, S, SSW.	·070
„ 26	...	...	...	...	...	75·7	54·2	21·5	...	... ...	·008
„ 27	29·804	63·8	52·8	·69	·593	72·9	59·4	13·5	8 7, 3	SW by S, SW by W, WSW.	·000
„ 28	29 514	59·7	54·9	·85	·518	68·8	53·2	15·6	9, 10, 9	SE, ESE, S.	·000
„ 29	29·308	51·7	53·0	1·00	·395	59·5	52·3	7·2	10, 10, 10	SE by S, WNW, WSW.	·096
„ 30	29·716	56 0	46·0	·71	·457	65·7	52·9	12·8	1, 10, 8	NW, W, S by W.	·500
„ 31	29 860	60·0	48·2	·67	·523	69·4	46·5	22·9	1, 5, 3	SW by S, SSW, WSW.	·064
Daily Means.	29·776	58·4	50·8	·74	·498	...	...	16·2	...	... ...	2·435

* To obtain the Barometric pressure at the sea-level these numbers must be increased by ·037 inch.

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Day.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	Hourly Means.
Hour.																																
12	12	15	13	9	11	6	23	16	13	7	9	6	7	8	7	5	14	8	1	5	2	5	3	10	3	2	6	6	3	13	5	8·2
A.M. 1	11	13	10	11	12	7	25	14	12	7	8	8	9	8	6	5	15	7	1	3	4	3	3	10	4	1	7	4	1	14	5	8·0
2	9	13	7	11	11	6	19	10	12	6	8	6	8	8	5	5	16	7	1	3	5	5	3	8	3	3	7	3	2	16	2	7·3
3	8	12	5	10	11	6	20	10	11	7	6	9	10	8	4	6	17	4	3	8	7	3	4	6	1	2	5	3	3	15	1	7·3
4	6	10	9	13	12	7	19	11	12	7	5	12	7	6	4	5	14	4	1	2	6	3	2	6	2	3	5	3	2	17	1	7·0
5	6	10	7	17	10	6	12	10	9	5	7	11	6	8	7	5	10	3	3	3	4	5	6	6	2	2	3	2	1	15	1	6·5
6	7	10	10	18	10	7	14	10	14	6	8	10	8	10	10	8	13	4	4	3	4	3	4	7	2	3	5	6	2	16	1	7·6
7	7	8	13	21	13	10	8	13	17	10	11	9	9	8	10	10	15	6	5	4	6	5	4	7	5	1	9	7	3	12	1	8·6
8	6	8	15	22	14	14	17	14	13	11	8	6	10	9	11	13	16	6	5	2	7	4	5	7	8	1	11	8	5	14	3	9·4
9	5	9	19	32	10	16	20	17	10	10	8	5	7	9	9	17	17	8	7	4	7	3	7	5	8	6	14	8	6	13	3	10·3
10	5	9	17	29	16	16	19	17	13	13	7	4	7	8	10	19	16	12	11	2	7	6	7	2	9	12	12	12	9	13	4	11·1
11	5	9	17	25	14	15	23	11	16	11	8	4	4	10	10	15	16	10	12	4	5	4	5	4	10	16	13	13	9	11	7	10·8
12	5	10	19	24	12	15	25	24	13	13	8	4	5	13	10	15	13	9	11	4	8	3	8	2	10	15	16	14	15	14	6	11·8
P.M. 1	8	6	17	24	16	18	22	18	15	10	10	5	4	12	8	14	13	9	12	4	8	3	10	4	7	18	16	14	8	12	4	11·2
2	7	11	18	20	14	20	22	25	16	9	9	5	2	16	6	17	16	10	10	5	9	5	15	5	8	17	14	12	10	9	6	11·9
3	12	13	11	20	15	21	25	30	17	13	10	4	1	12	11	20	18	11	9	4	12	4	17	3	8	18	16	11	13	9	6	12·8
4	19	12	22	23	15	22	22	27	13	13	8	4	2	9	10	18	16	9	10	4	8	4	16	5	10	16	16	8	18	6	6	12·6
5	17	10	19	22	12	25	23	23	13	8	4	2	3	12	8	13	15	11	10	3	5	4	16	4	9	10	15	7	16	14	7	11·6
6	17	7	18	20	9	26	20	25	11	4	11	3	4	10	4	10	12	9	10	2	4	1	14	3	5	9	17	3	15	8	6	10·2
7	12	9	14	13	7	25	22	24	9	7	12	2	5	12	4	10	16	10	8	4	4	3	17	3	5	7	8	6	13	10	6	9·9
8	10	10	9	14	5	24	19	21	6	5	10	3	7	11	4	6	8	6	7	5	4	4	15	6	5	7	9	4	11	6	7	8·6
9	10	9	12	13	6	25	17	14	7	7	8	2	6	10	6	12	7	5	7	5	5	7	13	2	4	6	6	4	7	6	7	8·2
10	10	10	13	13	7	22	17	14	6	7	9	4	6	7	6	13	8	3	5	1	4	5	17	6	2	4	5	4	9	6	4	8·0
11	12	10	10	11	7	21	15	16	6	8	7	5	8	6	5	14	7	2	5	2	5	4	12	5	2	4	7	2	9	6	5	7·7
12																																
Total Daily Movement.	226	243	324	435	269	380	468	414	284	204	199	133	145	230	175	275	328	173	158	86	140	96	223	126	132	183	242	164	190	275	104	9·4

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RESULTS OF METEOROLOGICAL OBSERVATIONS MADE AT THE KEW OBSERVATORY.

LATITUDE 51° 28′ 6″ N., LONGITUDE 0° 18′ 47″ W.

1866.	Reduced to mean of day.					Temperature of Air.			At 9·30 A.M., 2·30 P.M., and 5 P.M. respectively.		Rain—read at 10 A.M.
Day of Month.	Barometer corrected to Temp. 32°.*	Temperature of Air.	Calculated. Dew Point.	Relative Humidity.	Tension of Vapour.	Maximum, read at 9·30 A.M. on the following day.	Minimum, read at 9·30 A.M.	Daily Range.	Proportion of Sky clouded.	Direction of Wind.	
	inches.	°	°		inch.	°	°	°	0—10		inches.
Sept. 1	29·871	60·2	48·0	·66	·526	67·6	51·6	16·0	2, 6, 4	SW, SW, SW.	0·000
„ 2	...	...	...	...	...	64·1	54·3	9·8	...	... ...	·082
„ 3	29·849	56·2	43·2	·64	·460	64·7	45·5	19·2	1, 2, 2	WNW, W, W.	·138
„ 4	29·609	58·8	58·8	1·00	·502	66·4	51·9	14·5	10, 10, 10	SSW, SSW, SW.	·061
„ 5	29·403	61·0	55·9	·84	·541	68·4	61·4	7·0	10, 6, 3	SW by W, SSW, SW by W.	·447
„ 6	29·574	57·9	54·8	·90	·487	65·4	54·8	10·6	5, 10, 10	SW, S, S.	·025
„ 7	29·604	58·7	53·9	·85	·501	65·6	57·2	8·4	8, 9, 10	WSW, W, SW.	·655
„ 8	29·688	54·0	53·5	·98	·427	60·9	55·0	5·9	10, 10, 10	E, NNE, —.	·007
„ 9	...	...	...	...	...	65·0	53·1	11·9	...	... ...	·248
„ 10	29·525	58·1	51·7	·81	·491	66·3	55·6	10·7	8, 4, 2	SW, SW by S, SW by W.	·130
„ 11	29·535	54·1	49·2	·85	·429	61·8	52·3	9·5	10, 7, 7	SW by S, SW, W.	·143
„ 12	29·923	49·0	44·3	·85	·361	57·8	49·3	8·5	5, 10, 10	W, SW by W, SW.	·007
„ 13	29·799	55·4	47·0	·75	·448	63·4	49·7	13·7	10, 6, 10	SW by W, WSW, W.	·026
„ 14	29·548	54·4	45·9	·75	·433	63·3	52·9	10·4	8, 6, 8	SW, W, W.	·367
„ 15	29·713	53·1	47·1	·82	·415	63·5	47·3	16·2	2, 7, 8	SW by S, S, S by W.	·022
„ 16	...	...	...	...	...	59·9	47·4	12·5	...	... ...	·079
„ 17	29·737	54·0	42·7	·68	·427	61·5	48·3	13·2	4, 6, 6	NW by W, W by N. N.	·204
„ 18	30·053	53·0	47·1	·82	·413	60·1	38·5	21·6	3, 10, 10	SW by S, S, SSW.	·012
„ 19	29·929	55·1	51·7	·89	·444	64·1	53·9	10·2	9, 10, 9	SW, SW by W, WSW.	·005
„ 20	29·930	52·6	47·6	·84	·408	59·8	47·5	12·3	10, 10, 9	W by S, SW by W, SW by W.	·052
„ 21	29·608	52·1	43·1	·74	·401	59·5	52·3	7·2	7, 8, 7	W, WSW, SW by W.	·140
„ 22	29·278	47·0	45·0	·94	·337	54·1	46·1	8·0	10, 10, 9	NNW, W by S, SW.	·449
„ 23	...	...	...	...	...	57·1	44·8	12·3	...	... ...	·009
„ 24	29·701	52·4	48·7	·88	·405	59·0	46·1	12·9	9, 8, 3	S by W, WSW, SW.	·081
„ 25	29·971	53·4	44·8	·74	·419	60·9	34·7	26·2	0, 1, 4	S, S, SSW.	·047
„ 26	29·936	55·8	53·7	·93	·454	62·5	50·9	11·6	10, 7, 1	S, W by S, WSW.	·017
„ 27	29·925	55·5	50·3	·84	·450	63·7	50·2	13·5	10, 4, 1	W, WSW, W by N.	·107
„ 28	29·793	58·9	55·1	·88	·504	69·1	49·3	19·8	9, 10, 8	E by N, ESE, ESE.	·021
„ 29	29·892	58·5	56·1	·92	·497	66·5	56·2	10·3	9, 10, 8	W by S, —, —.	·000
„ 30	...	...	...	...	...	64·6	56·5	8·1	...	... ...	·007
Daily Means.	29·756	55·2	49·6	·83	·447	...	...	12·4	...	... ...	3·588

* To obtain the Barometric pressure at the sea-level these numbers must be increased by ·037 inch.

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HOURLY MOVEMENT OF THE WIND (IN MILES), AS RECORDED BY ROBINSON'S ANEMOMETER.—SEPT., 1866.

Day.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	Hourly Means.
Hour.																															
12																															
1	4	10	8	5		18	28	3	2	17	17	14	8	14	10	10	16	3	20	8	23	9	2	6	2	3	2	2	13		9·9
2	6	10	9	5	241	15	27	2	4	18	12	14	8	16	11	9	16	3	18	7	25	11	1	5	1	3	2	2	9		9·6
3	8	10	9	7		12	27	1	3	17	16	12	9	19	9	8	13	5	20	8	21	9	1	6	2	5	1	4	6	170	9·5
4	8	11	10	6		14	30	2	1	13	16	12	11	15	8	9	13	4	22	7	17	6	2	5	1	6	3	5	8		9·4
5	6	16	7	6		15	26	2	2	10	14	10	8	13	8	11	11	3	19	6	10	7	2	2	2	8	6	6	6		8·6
6	11	15	8	5		10	34	1	2	7	13	10	6	13	8	9	11	2	12	9	10	5	2	8	2	9	4	6	6		8·5
7	9	15	11	7		12	43	2	4	9	17	10	9	10	6	10	9	3	12	7	12	11	2	8	2	11	1	6	4		9·3
8	12	16	14	10		15	37	4	2	10	22	11	12	12	10	15	10	5	13	7	12	12	5	10	1	8	0	9	3		10·4
9	13	17	17	16		14	34	3	5	11	23	12	11	19	12	16	10	5	20	11	13	12	2	14	4	7	1	11	4		12·0
10	15	17	18	19		15	32	3	8	12	21	12	14	22	16	18	12	10	17	11	20	12	4	12	13	7	4	10	8		13·4
11	12	22	17	19	25	17	18	7	8	16	24	13	13	19	15	20	13	13	18	13	16	13	2	14	17	5	3	11	3		14·0
12	16	11	17		25	16	20	8	9	16	24	10	10	23	18	21	10	13	19	15	16	12	4	15	17	7	5	11	5		14·4
1	19	14	18		22	19	17	7	11	18	25	13	10	23	17	25	10	15	22	15	21	11	7	16	19	6	3	14		7	15·5
2	20	14	16		23	18	13	5	14	19	25	10	12	22	18	18	11	16	22	15	17	10	7	12	19	8	2	11		5	14·3
3	21	15	15		25	16	13	7	15	19	24	10	12	11	22	16	12	18	19	15	21	10	4	15	17	3	2	16		6	13·5
4	19	15	18		23	19	11	4	15	23	22	10	14	19	13	13	9	17	16	16	16	11	2	15	15	7	2	14		3	13·6
5	21	15	17		26	26	11	5	13	19	25	9	11	19	14	25	10	17	18	18	17	10	2	15	9	6	1	10		3	14·0
6	16	8	13		23	27	9	7	14	15	24	9	7	14	13	18	6	19	15	16	16	10	3	9	7	5	1	6		0	11·7
7	15	13	9		20	30	10	5	12	15	21	7	8	12	6	12	3	20	12	18	8	7	3	6	6	5	0	6		3	10·4
8	12	11	9		27	25	9	2	12	13	20	6	11	12	6	10	4	19	11	17	13	8	5	4	9	5	2	10		8	10·7
9	13	12	8		23	25	5	5	14	17	19	4	11	13	10	11	4	20	11	24	12	6	4	5	8	4	2	10		5	10·9
10	10	8	7		20	25	4	4	11	13	19	2	13	13	8	4	3	18	10	23	13	5	4	6	11	2	3	9		6	9·8
11	8	8	10		18	24	4	6	14	17	16	5	10	13	11	9	3	18	10	27	11	4	5	3	13	2	3	10		9	10·4
12	9	7	8		17	31	3	3	14	15	12	8	10	13	9	11	4	19	9	25	11	3	6	12	6	3	2	12		10	10·4
Total Daily Movement.	303	310	293	422		458	465	101	209	359	471	233	248	379	278	328	223	285	385	338	371	214	87	223	203	135	55	211	305		10·9

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THE NEBULAR HYPOTHESIS OF LAPLACE EXPLAINED BY DELAUNAY.

RECENT investigations into the nature of nebulæ have strongly revived public interest in what is called the "Nebular Hypothesis," and as fresh facts, which we may expect to be made known by further research, promise to supply arguments for and against this theory of the origin of suns and planets, it is well that clear ideas should be entertained concerning the views which Laplace held. Professed students of astronomy are sufficiently acquainted with them; but to the general scientific reader, the following explanation, given by M. Delaunay, in his *Cours Eléméntaire d'Astronomie*, 4th edit., will be acceptable. He tells us that "in adopting the ideas of Herschel concerning the progressive condensation of nebulæ, and their transformation into stars, and in applying these ideas to our planetary system, Laplace arrived at the most satisfactory mode of explaining their formation. No peculiarity that observation has disclosed relative to planets or their satellites, has escaped the ingenious explanation which he has developed at the close of his *Exposition du système du Monde*, of which we shall proceed to give an idea."

"Laplace supposes that in the beginning, the sun, and all the bodies circulating round him formed a single nebula, animated by a movement of rotation about a line passing through its centre, and extending to the orbit of the most distant planet, or beyond it. He further conceives that by reason of a progressive cooling, larger and larger portions of nebulous matter were condensed at its centre, so as to form a nucleus, the mass of which gradually enlarged. Starting from this supposition, he demonstrated that in the course of time the nebula would be reduced to the state in which we actually find the planetary system."

"In proportion as the cooling caused the condensation of new parts of the nebula, the materials so condensed would fall towards the centre just as drops of rain fall through the condensation of the vapour contained in our atmosphere. But this fall of condensed matter could not take place without occasioning an acceleration of the velocity with which the entire nebula turned upon its axis. Matters condensed and falling towards the centre of the nebula would acquire a movement of rotation about its axis more rapid than that of the rest of the mass. Then the friction of different parts of the nebula, one against another, would accelerate the motions of those turning less rapidly, and would lessen the rapidity of those moving with greater velocity, and after a certain lapse of

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time, the entire mass of the nebula would revolve with an angular velocity greater than that which it had in the beginning. Thus the progressive condensation of the primitive gaseous matters of the nebula, and their agglomeration about its centre, necessarily produces a continual augmentation in the velocity of the nebula's rotation about its own axis."

"A nebula such as we have imagined, animated with a movement of rotation about its axis, cannot extend itself in the plane of its equator beyond a certain limit, the position of which depends on the velocity of its motion. Any molecule situated in the plane of the nebula's equator, and participating in its movement, must be subjected at one and the same time to the attraction which the entire mass can exert upon it, and also to the centrifugal force resulting from its rotatory motion. The dimensions of the nebula cannot remain such as would cause the second force to prevail over the first even at any part of its equator, for should this happen, and any molecules be impelled by centrifugal force beyond the control of gravitation, they would cease to form part of the nebula, and move off, independently of it, with the velocity that they possessed at the instant of their starting away."

"The progressive condensations of different portions of the matter forming the nebula would, as we have said, accelerate its rotation, and by consequence give rise to a corresponding augmentation of centrifugal force for any point situated at a given distance from its axis, and thus the limit beyond which the nebula could not extend and cohere would become more and more restricted."

"If at a certain epoch, this limit, measured from the centre, terminates at the surface of the nebula, the condensation to which this further cooling will give rise must cause the limit to fall within the surface, and then the outside molecules of the nebula surrounding its equator will be beyond this limit, and consequently this excess of matter beyond that which the nebula can retain by means of its attraction, will cease to be a portion of the mass, and will separate in the form of a ring, rotating in its own plane about its own centre with the velocity which it possessed at the moment of its detachment. It is only about its equator that the nebula can abandon portions of the matter composing it; for in no other place, except in the plane of this circle, can a molecule be acted upon by the attractive force in the same line as that in which the centrifugal force operates. These two forces compose a resultant force,*

* For those who are unacquainted with this term as used in mechanics, we may explain its meaning by stating, that if one force impels a ball straight forward, and a second force of the same amount impels it exactly across, or at right angles to, the line of the first force, the two forces will combine into a *resultant* force, sending it in an intermediate direction..

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which tends more and more to make the molecule approach the equator, in proportion as the centrifugal force is increased. The increase of angular velocity in the rotation therefore causes the surface molecules to move from all parts towards its equator, and then to be abandoned into space as we have described."

"It will be understood that our nebula, in its process of cooling, has thus abandoned successively, in the plane of its equator, divers rings of nebulous matter, which continue to revolve in the same plane, and about a common centre. The central mass to which successive condensations have reduced the nebula, is no other than the sun; and the concentric rings of nebulous matter thrown off in succession in the plane of its equator will give rise to planets, as we shall proceed to show."

"Each ring must be perfectly regular, in order to preserve its annular form for an indefinite time. This regularity can only exist under exceptional circumstances, and it is natural to suppose they are wanting in the case before us. Thus the matter belonging to each tends to assemble about certain centres of attraction, and their partial condensation divides the ring into fragments, which continue to move separately very much as they did when united. The velocity of the various parts which once formed one ring not being rigorously the same, either because they were not equal at the moment of separation, or were subsequently changed by the perturbing action to which the whole system is exposed, it follows that the different portions can rejoin each other, and end in forming a single mass, circulating round the sun in an orbit nearly corresponding with the circumference of the ring from which it originated, and this mass condenses itself into a planet. It may, however, happen that the various fragments into which a ring was decomposed will continue to revolve as separate bodies, and give rise to many distinct planets moving in almost the same orbits, and it is thus that the planetoids between Mars and Jupiter may have resulted from the fragments into which one nebulous ring may have been divided."

"Let us now see what becomes of the materials of an entire ring, united together about one point of its circumference as we have supposed, and let us endeavour to understand how the mass thus formed has been able to produce a planet turning upon its own axis, and accompanied by satellites, as is generally the case in our planetary system. In the progressive condensation of such a mass, the molecules most remote from the sun have approached nearer to that body, and the molecules which were nearest have become more remote; the first having a greater, and the latter a smaller velocity, than that of the mean portions towards which they are moving by the

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process of condensation, and hence must arise a movement of rotation round a centre, and in the same direction as the revolution of the whole mass round the sun. Henceforth the materials of a ring abandoned by a nebula become a system analogous to the nebula, but of much smaller dimensions. They have given rise to a new nebula moving round the centre of the original nebula, and in the same direction. This new nebula would, by successive condensations, throw off in succession different rings of nebulous matter, and would at last form a planet turning on its own axis, and revolving in the same direction round the sun. The abandoned rings of matter would behave just as those thrown off by the original nebula, and give birth to the satellites of the planet. Some rings may preserve an exceptional regularity, and thus, as in the case of Saturn's appendages, be able to retain their original form."

"The matter united at a certain distance from a planet to form a satellite, would elongate itself in the direction of a line joining the planet, just as the action of the moon determines an elongation of the sea in the direction of a line joining the earth and moon. This elongation of a satellite while in its fluid state—much greater than in the comparison just made—would give it a tendency always to turn the same points of its surface towards the centre of the planet; and thus may be simply explained this remarkable fact with reference to the moon, which, as Herschel thought, was also exhibited by Jupiter's satellites."

"We see that the hypothesis of Laplace on the origin and formation of our planetary system takes due cognizance of all the peculiarities by which it is characterised. Almost complete coincidences in the planes of the orbits of the planets, slightness of the eccentricity of their orbits, identity of direction in the movements of rotation and revolution throughout the system—all is explained in the most natural manner, and in conformity with the laws of mechanics."

"In this hypothesis the body of a planet formed by condensations such as we have described, would at first be a liquid mass affecting the form of a spheroid flattened in the direction of its axis of rotation, and surrounded by an atmosphere the residue of the nebula from which it sprung. This liquid mass, continuing to grow cooler, would solidify little by little over its whole surface. The solid crust thus formed would be gradually altered in shape, and at last would split in several parts, by reason of the progressive diminution of the liquid volume in its interior, as the temperature was lowered. In the mean time if the atmosphere contained a great quantity of aqueous vapour its condensation would form enormous masses of water, which would occasion degradations of the surface,

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and a transport of matter which would be deposited in horizontal layers at the bottom of the vast basins in which the waters would congregate. These phenomena would continually be reproduced through the successive evaporations and condensations which the water would experience through the high temperature of the surface of the globe, and through the continual refrigeration of the atmosphere. Thus the successive formations on the terrestrial globe, which it belongs to geology to elucidate, would arise naturally out of the circumstances we have considered."

"The comets which from time to time pass near the sun cannot be regarded as arising from the nebula which we have supposed to be the origin of the sun and planets, and of their satellites. These comets must be regarded as small nebulæ moving in immensity, and which on approaching our system are drawn into it by the sun's attraction, and which after coming near him, recede, often never to return. When a comet thus journeys near our sun and planets, their actions upon it may modify the line in which it moves, so as to convert it into an ellipse with a major axis not extravagantly great; and thus the comet may become periodic, and an integral part of our system. Four known periodical comets seem to be in this condition, but it may happen that the disturbing actions of the planets, near which they pass, may so modify their orbits as to elongate them indefinitely from us, without absolutely preventing their return; and there are instances of comets whose movements have been effected by actions of this kind."

"The zodiacal light is readily explained according to the hypothesis of Laplace. It cannot be regarded as due to the atmosphere of the sun, as it extends beyond the orbits of Mercury and Venus, and thus exceeds the limits within which the solar atmosphere must be circumscribed through the velocity of the sun's rotation; but we might conceive that some of the matter successively abandoned by the nebula which formed our planetary system, might not be totally condensed into the various masses out of which the planets were formed. Small quantities of this matter might remain and form a very diffuse lenticular nebula, such as the zodiacal light. Many examples of such elongated nebula are found in the heavens. It may also happen that nebular matter diffused in the space surrounding the sun might be condensed into an immense number of little planets, and in this way we may explain the origin of shooting stars, whose periodical return gives some countenance to such a theory."

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LITERARY NOTICES.

RELIQUIÆ AQUITANICÆ: being Contributions to the Archæology and Palæontology of Périgord, and of the adjoining Provinces of Southern France. By EDWARD LARTET and HENRY CHRISTY. Part III. (Baillière.)—The present part of this important and remarkably handsome work, commences by describing the mode in which the Indians of California fashion their stone arrow-heads; and cites from Sir. E. Belcher the way in which the Esquimaux of Cape Lisburne manage, by pressing the hard points of reindeer-horn upon fractured pieces of chert, to produce saw-like edges, which it might be supposed required the agency of metallic tools. The caves of Dordogne then form the subject of remark, and it is stated that, besides ossiferous deposits which may have resulted from water action, others must have been accumulated when the caves were the abodes of wild animals or of men. "Some have been the resorts of beasts alone, and some only inhabited by men. In the comparatively few in which they have been tenanted by both, there are usually indications that the earlier occupancy has not been that of man." "It is especially in the valley of the Vezère, a tributary of the Dordogne, which is an affluent of the Garonne, that these remains are in great abundance, and are indisputably contemporaneous with the remains of animals extinct in that country before history or tradition." The cave deposits are composed of broken bones, pebbles, nodules, and chips of flint of various sizes, intermixed with charcoal in dust and in small fragments. Besides these, a multitude of implements of deer-horn have been discovered, some finished, and others in process of formation. "These consist of square chisel-shaped implements; round, sharp-pointed, awl-like tools, some of which may have also served as the spikes of fish-hooks; harpoon-shaped lance-heads, plain or barbed; arrow-heads with many and sometimes double barbs, cut with wonderful vigour; and lastly, eyed needles of compact bone, finely pointed, polished, and drilled with round eyes, so small and regular that some of the most assured and acute believers in all other findings, might well doubt whether, indeed, they could have been drilled with stone, until their actual repetition, with the very stone implements found with them, has dispelled their honest doubts. More than this, all but two of the many deposits explored, have given more or less examples of ornamented work; and three of them (Les Eyzies, Laugerie Basse, and La Madeleine) drawings and sculptures of various animals, perfectly recognizable as such." Thus it appears that these early inhabitants of France were considerably removed above what is ordinarily meant by the savage state. They had, as the remains clearly show, abundance and variety of food, they could make implements requiring considerable skill, and they amused themselves with rude, though by no means despicable works of art. To estimate the date of their existence is extremely difficult, and indeed sufficient means for estimating the precise geological time, and converting that into common time, do not exist. Not only have animals

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then living become extinct, but, as the following passage shows, there is reason to believe that considerable changes of climate have taken place. The writers say, "In addition to the presumption of a once colder climate, which is furnished by the fauna, it is difficult to suppose that, at the period when these remains were left, the climate was the same as it now is; for, though we may have examples in the habits of the present Esquimaux, that in their cold climate it is possible to live, without detriment to health, amid an accumulation of animal remains, the case would be very different in the south of France, where, at the temperature of the present day, such accumulations would, except in winter, speedily become a decomposing mass. That the inhabitants of that day had no such difficulty to contend with, may be inferred from their having almost invariably chosen a southern exposure, and the warmest and sunniest nooks for their residences." The plates given with this number continue the depiction of stone, bone, and horn implements, and are very well executed.

A Dictionary of Science, Literature, and Art. Comprising the Definitions and Derivations of the Scientific Terms in general use, together with the History and Descriptions of the Scientific Principles of nearly every branch of Human Knowledge. New Edition. Edited by the late W. T. Brande, D.C.L., F.R.S.L. and E., of Her Majesty's Mint; and the Rev. George Wm. Cox, M.A., late Scholar of Trinity College, Oxford. Assisted by Gentlemen of Eminent Scientific and Literary Acquirements. To be completed in Twelve Parts. Part XI. (Longmans.)—This part commences with "Rules" and ends with "Sigurdr." The various articles appear well adapted to give the information required for all ordinary purposes. Some subjects, such as "Screw-propeller," "Shooting-stars," "Siege," etc., are treated at considerable length.

A Brief Account of the Scholarships and Exhibitions open to Competition in the University of Cambridge; with Specimens of Examination Papers. By Robert Potts, M.A., Trinity College. (Longmans.)—The title, which gives the contents of this little book, will show persons intending to become students at Cambridge the useful information they may derive from it.

The Scientific and Literary Treasury. By Samuel Maunder, author of the "Treasury of Knowledge," "Biographical Treasury," etc. etc. New edition, thoroughly revised and in great part re-written, with upwards of One Thousand New Articles by James Yate Johnson, Esq., M.Z.S. (Longmans.)—This popular work was well worth revising and improving. In its present state it is a very compendious little encyclopædia, admirably adapted for family use. To get an enormous quantity of matter into a brief space the print is very small, but it is clear; and after referring to a good many of the articles, we feel justified in recommending it.

Chart of the Characteristic British Tertiary Fossils, Stratigraphically Arranged. Containing upwards of Eight Hundred Figures. Compiled and Engraved by J. W. Lowry. (Tennant.)—This beautifully engraved chart of British Tertiary Fossils will be invaluable to students and fossil collectors. It consists of a series

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of folding plates, which commence with the newer and post pliocene fossils, and finish with the lower eocene. In columns on the right hand side of each plate, information is given concerning the various strata in which the organic remains are found, and the nature of the principal fossils. Many of the figures are drawn in their natural size, and in other cases their proportion is given. Mr. Lowry's name is a guarantee that due pains have been taken in all the details; and it must be admitted that he has rendered an important service to students of tertiary geology.

PROCEEDINGS OF LEARNED SOCIETIES.

MICROSCOPICAL SOCIETY OF LONDON.

THROUGH the zeal of the President, Mr. Glaisher, assisted by his council, a royal charter has been obtained for this Society, and the patronage of the Prince of Wales. Fellows will use the letters F.M.S.L. The first meeting of the season took place on the 10th October, when the charter was read, and other business transacted. The President, in the name of the Society, presented an elegant silver inkstand to T. W. Burr, Esq., F.R.A.S., F.S.C., in acknowledgment of his gratuitous services in the legal steps necessary for obtaining the charter. Mr. Slack read a paper describing a new diaphragm eye-piece, which is described in our *Notes and Memoranda*. Mr. Suffolk exhibited some metal rings, made according to his directions by Mr. Collins, and adapted for microscopic cells of various sizes and depths.

PROGRESS OF INVENTION.

THE TERRESTRIAL DARK LINES OF THE SPECTRUM.—From the moment that Wollaston observed that certain rays are wanting in the solar spectrum, their places being occupied by dark lines or bands, philosophers have been occupied in attempting to investigate their origin. These attempts have been in a great degree successful. They arise from a cause which, applied to spectrum analysis, enables us not only to detect the presence of elements so minute in quantity as to elude the most careful researches of the chemist, but to pronounce with certainty regarding the elementary substances of which the most distant stars are formed. But there is one great source of uncertainty in the application of spectrum analysis to the purposes of astronomy, the difficulty of determining whether the dark lines in the spectrum of a heavenly body belong to the light emitted by that body, or have been caused during the passage of that light through our atmosphere. This difficulty is now in a fair way of solution, if it is not already resolved. M. Jansen has

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proved by the most satisfactory experiments, that a large portion of the dark lines of the solar spectrum are terrestrial, and are due to the vapour of water. When, in 1864, he ascended the Faulhorn, he found that these dark lines became feeble in proportion to the height above the level of the sea; while, on the contrary, when the light of firewood, which affords a continuous spectrum, was made to pass through several miles of air in contact with the Lake of Geneva, and therefore saturated with its watery vapour, all the dark lines of the solar spectrum were produced. And he ascertained, that with a given altitude of the sun above the horizon, the higher the dew point, the more distinct the dark lines produced in the spectrum, scarcely any being perceptible on very dry days. He verified these facts by a very effective apparatus. Having placed an iron tube of considerable length, in a box, and filled the vacant space round the tube with sawdust, to prevent radiation of heat, he transmitted the light of sixteen gas-burners, placed in a line which was a prolongation of its axis, through this tube, and a continuous spectrum was thus produced. But when he filled the tube with vapour, supplied by a steam boiler, and then transmitted the light, nearly all the dark lines were reproduced, the spectrum obtained corresponding with that formed by sunlight when the sun is very near the horizon. A detenuation of the lines produced by the earth's atmosphere renders observations regarding the constitution of the heavenly bodies founded on spectrum analysis more reliable. It also enables us to find the amount of moisture in portions of the atmosphere inaccessible to us. The solar lines predominate in the green, the blue, and the violet portions of the spectrum; the atmospheric in the red, the orange, and the yellow, being ten times more numerous than the solar lines in the same places.

NOTES AND MEMORANDA.

LIGHT OF NEBULÆ.—The *Philosophical Transactions* contains a very important paper by Mr. Huggins on the spectra of some of the nebulæ, in which estimations of the amount of light emitted by some of these bodies is given. Mr. Huggins took for his standard of comparison a sperm candle of the size known as sixes. This was placed at a certain distance, and its light reduced by a neutral tint glass to $\frac{1}{817}$ of its original intensity. It was then found that nebula No. 4628 gave a light equal to $\frac{1}{1180}$ of that emitted by the unscreened candle, the annular nebula in Lyra was equal to $\frac{1}{1087}$, and the dumb-bell nebula to $\frac{1}{1185}$ of the same standard.

PLUMULES OF THE PIERIS OLERACEA (CANADA).—These "plumules" are peculiar scales found only on males. They occur under the ordinary scales, and Mr. Watson considers that when inflated they raise up the other scales. Those of the *P. oleracea* most resemble those from *P. rapæ*, figured in *Microscopical Dictionary*, but they are not of exactly the same shape. The form is something like that of a battledore, with a pear-shaped hole at the thick end, and the handle terminating in a fringe. From the centre of the pear-shaped recess springs a peduncle with a round bag at the end of it. By this bag or bulb it is attached to the wing. A paper by Mr. John Watson on these plumules will be found in the *Entomologist's Monthly Magazine* for June, 1865. We are indebted for our

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Canadian specimens to one of our Canadian subscribers, who signs himself "J. J. B.," and dates from Napanee. We beg him to accept our thanks. He compares the plumules, which he rightly designates "puffy," to a "boxing-glove with two fingers or thumbs." Mr. E. C. Rye was kind enough to compare this Canadian butterfly with others. He tells us that it is closely allied to the American *P. cruciferorum*, and that both are most likely localized forms of our common green-veined white.

STAR MAGNITUDES.—In the *Transactions of the Manchester Philosophical Society* will be found a paper by Mr. Knott on the Comparative Magnitudes assigned to Stars by Admiral Smyth in the *Bedford Catalogue*, by Struve in the *Mensuræ Micrometrica*, and by Argelander in the *Bonner Stern-verzeichniss*. "It appears that the scales of the *Bedford Catalogue*, of the *Bonner Stern-verzeichniss* are practically identical down to the 9th mag., and assuming with M. Pogson that the 13 mag. of Argelander's scale corresponds with the 16 mag. of Admiral Smyth, we may tabulate the results below the 9th, thus:—

MAG. SM.	MAG. A.
10	9·6
11	10·1
12	10.7
13	11·3
14	11·9
15	12·4
16	13·0"

So far as Mr. Knott's observations go, this proportion is found to hold good. He says further, "The coincidence between the scale of the *Bedford Catalogue* and that of the *Mensuræ Micrometrica* ceases practically with the naked eye magnitudes. At the 6th mag. the scales diverge, and the 11th mag. of the one corresponds with the 13th mag. of the other. Five magnitudes of Admiral Smyth's scale, below the 11th, are represented by only one magnitude in the scale of Professor Struve."

MR. SLACK'S DIAPHRAGM EYE-PIECE.—At the October meeting of the Microscopical Society of London, Mr. Slack exhibited a microscopic eye-piece which he had devised, and which was made by Mr. Ross for the purpose of protecting the eye against the glare of a large and strongly-lit field. It has four shutters, each capable of separate motion, and enables objects of any form to be exhibited in a field of any dimensions required, and bounded by straight lines. This field may be long or short, broad or narrow, as the object may require, and it is found that the exclusion of unnecessary light makes the objects more distinct, and avoids fatigue to the eye. The shutters are moved by small milled heads attached to the flange of the eye-piece. A similar eye-piece will probably be found convenient for astronomers when viewing the moon, or the solar disk.

SPIDERS AND EARWIGS.—An illustration of the tact and skill of the spider in dealing with a dangerous foe, may be obtained by putting an earwig into the web of the *Epeira diadema*, common in all gardens. On perceiving the earwig, the spider advances cautiously, and when near the creature turns her abdomen towards it, and shoots out a sheaf of threads which immediately adhere to the earwig. She then pats him round and round as if she were roasting him on a spit, and in the course of a few seconds he is effectually rolled up in a silk mummy cloth, from which there is no escape.

SOAP BEANS OF CHINA.—*Comptes Rendus* contains a paper by M. Payen on the beans of a plant belonging to the genus *dialium*, which are used instead of soap in many provinces of China. The Chinese remove the outer skin with a knife, and then rub the bean against wet linen which they wish to wash. A rinsing completes the process. The pericarp, which is dry in most beans, is of a fleshy character, and contains *saponine*, besides many other substances. M. Payen, also found in these beans a gelatinous substance, differing from pectin, pectose, etc., and which he calls *dialose*.

EARTHQUAKE IN FRANCE, SEPTEMBER 14, 1866.—M. Rovet describes the particulars of this earthquake to the French Academy. It occurred about ten minutes past five, a.m., and there were two oscillations, the first from west to east, the second south to north, and with an interval of a few seconds between them.

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The spots at which the shocks were felt might be enclosed in a polygon, of which Paris, Auxerre, Tournus, Montbrison, Bordeaux, Nantes, and Rouen would form the principal summits. The west-east shock was particularly felt in Dordogne, Haute Vienne, and Charente on one hand, and Loire Inférieure and Orne on the other. The south-north shock was chiefly felt in Indre, Indre et Loire, Loire-et-Cher, Eure et-Loir, Seine-et-Oise, and Seine, being most violent in Indre et-Loir and Soir-et-Cher. In Paris it was slight. At Perigueux the west-east shock damaged many houses, and at Luche people at work were obliged to lean against the walls to prevent their being thrown down. At St. Marc, near Orleans, two persons were thrown down, the windows broken, and doors opened. Heavy noises were heard at various places.

Flint Cores from the Indus.—The *Geological Magazine* for October has a plate of remarkably neatly worked flint cores discovered by Lieut. Twemlow three feet below the rock in the bed of the river, near Shikapoor, Upper Scinde, and described by Mr. John Evans, who remarks that further details of the rock must be obtained before their age can be determined. From their form alone he would refer them to the neolithic rather than to the palæolithic period of India. The cores are composed of fawn-coloured flint, and flakes were struck from them so as to have a regular polygonal pattern.

The "Glass Rope" of the Hyolonema.—Dr. Gray has a paper in the *Annals of Natural History* on the structure of the sponge *Hyolonema Sieboldi*, and he considers that the researches of Professor Borboza du Bocage, who has found the "glass ropes" with attached polyps off the coast of Portugal, show that the long glass, or silica spicules do not, as Schulze and some other observers have thought, belong to the sponge, but are formed by the polyps, as he affirmed long ago. M. de Bocage did not find any object attached to these spicules, and as it is plain they must have had some support, the evidence is inconclusive. We shall shortly publish a paper on this subject, and therefore say no more now.

Field Adjustment for Object Finding.—A "Subscriber" writes:—"When the position of a good specimen in a slide of Diatomaceæ has been marked, the recovery of the view is more difficult than would appear at first sight, owing to the smallness of the marking, or indicating circle, and the size and propinquity to the slide of the end of an object-glass such as Smith, Beck, and Beck's one-eighth. If, however, the observer will incline the body of the microscope towards the horizontal position, and set the *plane* side of the mirror to give an easy and convenient view of the end of the object-glass, the slide may be put in exact position at once."

The 90th Planet was discovered by Dr. Luther, of Bilk, near Düsseldorff, on the 1st of October. It is of 11 mag. 2 Oct. R.A., 0h. 8m. 42s. 07 D—2° 35' 42".7. Daily movement in R.A. 44s. in D—4'.2.

Porosity of Caoutchouc.—M. Payen states in *Comptes Rendus* that a microscopic examination of thin sheets of caoutchouc discloses minute holes or pores, which are rounded, and communicate with each other. Contact with liquids makes these pores more distinct. Vulcanized indian rubber exhibits narrower cavities and concentric circles spreading from one pore to another, showing successive zones of diminishing action of the sulphur. By exposure to water the caoutchouc becomes whiter and opaque through absorbing the fluid. M. Payen considers this porosity to be concerned in the dialytic action of indian rubber on gases discovered by Professor Graham.

Silvered Object Glasses for Sun Viewing.—M. Le Verrier describes in *Comptes Rendus* successful experiments made with an object-glass of 25 centimetres aperture. The silvering allowed excellent views of the sun to be made with magnification up to 300. It is found that the blue tinge of light that has passed through the silver film results from an elimination of the extreme red rays; nearly all the other rays passing through.

Metallic Film Spectacles.—M. Melsens states in *Comptes Rendus* that having suffered from an accident, by which his eyes were rendered exceedingly averse to light, he found the greatest relief by employing spectacles containing glasses covered with gold leaf, through which he could see the contour of bright clouds.

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CHAMELEON.

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THE INTELLECTUAL OBSERVER.

DECEMBER, 1866.

OBSERVATIONS OF THE CHANGES OF COLOUR AND MODES OF TAKING FOOD IN THE CHAMELEON.

BY JONATHAN COUCH, F.L.S.,

Corresponding Member Z.S., etc.

THE chameleon has ever been an object of curiosity, and in the times of great ignorance of natural history it was a special subject of wonder, as well as of much fable, in consequence of its frequent and unaccountable changes of colour, and its supposed faculty of living without food: its only diet being the air, of which it drew within itself a large abundance, and from which it was believed to acquire a considerable increase of size. But its habits in these respects were differently represented, even by those who appeared to be careful observers; and it was therefore with much pleasure that I had an opportunity of observing them in an example which was presented to me, and which was embarked on board of a ship at Cadiz, with several others, the larger number of which died on the voyage to England. It came to my hands about the end of the month of July in perfect health; and when presented to me the only caution given with it was, that I should be careful to provide it with water; and, it was added, that those which had died on the passage had refused it, whilst such as drank freely remained alive. To this observation and recommendation, however, I paid no attention; as a Mr. Jackson, who studied the habits of this creature in its native country, in his *Account of the Empire of Morocco*, had asserted that the chameleon was not accustomed to drink.

The example which thus came into my possession measured ten inches in length, of which the tail was four inches and a half. The head compressed, jaws of equal length, furnished with slight cartilaginous teeth. From above the upper jaw commenced on each side a ridge, which passing

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backward formed an elevated crest of a triangular shape, the posterior edges of which passed down, one on each side, to the hindmost angles of the jaw. The eye large, projecting, conical, covered with the common skin; the pupil deeply seated in a hole scarcely larger than would be made with a pin. It is black and lively, and encircled with a gold coloured iris that is not wider than a thread. The projecting eyeball is capable of very extensive movement, and the movements of each eye are independent of its opposite; so that they are rarely seen directed to one object, except when this creature is intent on seizing its prey. The body is usually much compressed, but on the inhalation of air it becomes greatly distended; and it may be readily supposed that the difference in its appearance from this cause was what led to the opinion that air formed the material portion of its diet. The back is ridged, and, on account of the tubercles on it, slightly serrated; the belly also has an obscure ridge. Above the hind legs the body is slender; the tail flattened at its origin, round and tapering through its posterior half; the legs long, those behind longest and with a very extensive motion at their articulation with the body: the claws sharp, five on each leg, and united in sets; that is, on the anterior legs two of the toes are joined together on the outward side and three inward; on the hind legs three are joined together on the outward side and two inward. The body is covered with slight papillous elevations.

This creature moves slowly and with much apparent deliberation, especially when on the ground; but its favourite place of resort is a bush or branched stick, along which it proceeds with great care, never losing its grasp with one hand —as its singularly formed feet may well be termed—until it has secured a firm holdfast with the others; and the tail at the same time is employed in keeping itself safe by twisting round the branch on which it is to advance. This last named expedient is especially needed, in order to keep the body erect when on a slender twig; since for this purpose the feet alone appear to be of comparatively small service.

The colour of the chameleon is subject to continual change; but if a creature that rarely retains the same hue for ten minutes together can be said to possess one which may be termed its own, it is dusky brown, or almost black, nearly approaching to the darkness of soot. This it is which it assumes when it compresses its sides, and places its body with the plane of its surface to be exposed to the direct beams of the sun, so as to receive the full benefit of its rays: of which, as we shall have further to remark, the light is of more importance to its health and comfort than the heat. And when thus enjoying itself even the mouth is extended to receive the influence, although

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at other times it is kept closely shut. It was noticed also that as a dingy black was the common colour when enjoying itself in the usual habit of basking in the sun, a light, or whitish yellow prevails when it is asleep; during which time it never changes its position.

Desirous of obtaining a knowledge of the temperature of its body, at nine o'clock of the evening of the 18th of August, when a thermometer in the room stood at 64°, this instrument was moved carefully to the side of the chameleon, when the colour changed from yellow to greenish, and then to deeper green, followed by purple spots, and it expanded itself by inhaling air, an action which sometimes is accompanied with a rushing or hissing sound, the lungs appearing to occupy the lower portion of the belly. While the thermometer lay in contact with its side, in a few minutes it rose to 68°; and a few hours afterwards, when the animal was still asleep and distended with air, with the colour a light yellowish green, and the thermometer in the room stood at 63°, on its being applied to the side it again rose to 68°. At this time, although the touch of the thermometer did not cause it to awake, two rows of purple spots made their appearance on the former ground; and it was observed that whenever two rows of spots were produced they were large, and in one situation and direction.

On another evening, at eleven o'clock, when the thermometer stood at 62°, and the chameleon was asleep, with the colour light yellow, although the touch of the instrument did not cause it to awake, yet the colour changed to darker, and it became covered with numerous purple lines; and then, in a few minutes the colour was dark green with obscure purple spots. But both sides do not always adopt the same colours; for while basking in the sun with the side towards the light a very dark brown, the shaded side was lighter, with green tints and two large rows of purple spots, and yet sometimes spots in the same order are altogether white. When asleep at night the colour was light yellow, with two rows of white spots, on holding a lighted candle at only a sufficient distance to communicate warmth, the side thus acted on became of a uniform brown, while the other side continued of the former light yellow. Afterwards, while still asleep, and the colour was yellow with two rows of white spots, when a candle was held within the distance of three inches, the side exposed to the candle became brown with a row of deeper brown spots, and the other side continued with the unchanged light yellow and white spots; the change when it took place not requiring more than a minute, and within a minute afterwards, on removing the candle both sides were of a greenish yellow with

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two rows of large purple spots. When the stick on which it rested was touched gently, without waking it, it became instantly covered all over with minute brown spots. On another occasion, when the colour was altogether yellow, a book was held so as to cast a shade on the anterior part of the body, while a candle was held within four inches of the hindmost portion; and then presently the illuminated part changed to a light brown, while the shaded portion remained as before; and when the screen was removed the exact limit of the shade was visible. When again the colour was yellow with two rows of white spots, in breathing on it so gently that nothing beyond the warmth of the breath could have been perceived, it immediately became covered with minute brown spots on both its sides; and at all times it was discerned by examination with a lens, that the colours existed entirely in the very small tubercles with which the body was covered, and not in the skin which lay between them.

I had hitherto paid no attention to the question whether it was necessary to its health that it should be supplied with drink; but it was not long before an opportunity was afforded for removing all doubt on that subject. Whilst the chameleon was near me at a window, basking in the sun, I was engaged in drawing the figure of a fish; and in order to preserve it alive, it had been wrapped up in sea-weed that was charged with salt water. Having removed the weed, some fresh water was poured on the fish, on perceiving which the chameleon immediately left its station at the distance of about a foot, and hastened with unusual speed to the place; where it scrambled into the vessel, and began to lap the water by repeatedly placing its tongue in contact with the fish, in which action the fleshy portion of its tongue being thrust a little beyond the lips, and then lifting its head, it swallowed the water in repeated efforts. When the fish was removed to different parts of the vessel, the chameleon followed it, without being alarmed, as it usually was, at my meddling with it. In order to ascertain whether it was the salt that might be still on the fish which attracted its attention, I sprinkled a portion of the fish with salt; but when it touched this part with its tongue, it turned away to where the water was fresh; but having lapped it for a moment it returned and applied its tongue to a portion of the fish which I had newly turned up; and it was from this manner of proceeding that I concluded its habits to be to quench its thirst by taking moisture from some fixed surface rather than by drinking from a pool or floating liquid. At this time the quantity of water swallowed appeared to be equal to a tablespoonful, and when satisfied its sides had become very much distended. From the 23rd of August this

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chameleon did not again drink until the 12th of September; and I afterwards observed that it required water once in about a fortnight. As the opinion that the chameleon does not drink was thus proved an error, so it seemed equally clear that the popular opinion of its assuming the colour of any substance on which it rests is equally so. It has passed over and rested on carpets variegated with different colours—a large green cloth, a large growing myrtle, with other coloured substances, without my being able to discern that there was ever any connection between the colour of its surface and that of the material on which it rested. On one occasion, indeed, there appeared something like this; for when it had made its escape to the outside of the window, it became so much like the stones on which it rested—black and white—as to escape observation for a considerable time; but it has been known to assume precisely the same appearance under other circumstances, and when surrounded with substances very different in colour. It was not kept in greater restraint than was afforded by a large room; but after continuing for several hours on a green or scarlet cloth, or on green vegetables, it was not seen to assume these colours; nor, indeed, was it ever seen to assume the colour of scarlet.

It was only after it had been a fortnight in my possession, that I had an opportunity of seeing it take a fly; but after this it not only took all that came in its way, but would seize them as fast as children would bring them; and it even became so familiar with the act as to take them repeatedly from the hand. It was thus easy to measure the distance to which it was able to dart its tongue in seizing its prey, which was found to be six inches—or rather more than the length of its body; but the more usual distance was about three inches, and it was very rarely seen to miss the mark. In approaching a fly, the motion at first was slow and cautious, and within a favourable distance the mouth opened and the tongue protruded slowly to the extent of about an inch, beyond which it darted swiftly, although not as has been represented, for it has been described as more sudden and swift than human sight could follow it. The extremity of the tongue is usually flat and pointed; but when darted forward to its prey, the end is formed into the shape of a (large) pea, the middle being the most projecting part. To this the fly adheres by means of the tenacious mucus with which it is covered, and it is instantly conveyed into the mouth. But it is necessary to the success of this operation that the fly should be on some fixed substance, and almost, if not entirely, at rest; for if otherwise the chameleon will not attempt to take it, and repeatedly it has been observed to protrude a portion of the tongue,

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and then withdraw it as the fly has been in motion, until at last it has either secured the prey, or given up the attempt.

About the middle of September, when the weather had become moist, and the thermometer had ceased to stand at 60° at noon, its activity was greatly lessened, scarcely moving when awake, and sleeping the greater part of the day; but the appearance of sunshine restored some degree of activity. It was noticed also that when asleep at night, with the thermometer below 56°, the colour had ceased to be yellow or whitish, as was formerly the case under these circumstances of rest, but pea green. But the greatest changes were in the first week of December, when, with the thermometer at about 50°, it ceased to take the flies presented to it; and when the thermometer was at 46° it had become so torpid as, although taken in the hands, it seemed unable to move or open its eyes. As the coldness of the air appeared to be the cause of this insensibility to impressions which at one time effected visible alterations in its actions, as well as in its changes of colour, it was often brought within the influence of artificial heat; but this appeared to produce little effect, and it never spontaneously sought the aid of the fire; whereas the faintest sunbeam was a source of enjoyment, in which it would bask, and for the sake of which it would change its position as the gleam moved in the room. Its breathing at this time appeared distinctly to be counted; the portion of its body presented to the sunbeams was darker than the rest, and when, on the 5th of December, it was found dead, the general colour of the surface was dark.

From later and extensive observation of the change of colour found in fishes, it seems certain that there is no physiological analogy between what occurs in them and in the chameleon, but that the circumstances, as well as the causes, are altogether different.

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ON THE VARIATIONS OF CERTAIN CRUSTACEA, IN RELATION TO THE THEORY OF THE ORIGIN OF SPECIES BY NATURAL MODIFICATION.

BY GEORGE S. BRADY, M.R.C.S., C.M.Z.S.,

Secretary to the Tyneside Naturalists' Field Club.

DARWIN'S theory of the origin of species has outlived the virulent abuse of an extreme school of scientific, or one might more correctly say, of unscientific opinion, and has entered upon a second phase of existence. It has now to undergo the ordeal of a searching comparison with the phenomena of nature; with phenomena not only old and familiar, but with many others which have been brought to light since the publication of Mr. Darwin's treatise, and with a still greater multitude which must before long reward the efforts of such laborious students as are now engaged in the pursuit of natural history. The time must come, though we do not yet see it, in which educated men will be willing to receive new truths of biological science, however much these may conflict with preconceived ideas, in a temper as calm as that with which they now contemplate those revelations of geology and astronomy which a past generation counted no better than damnable heresies.

It is obvious that the lower orders of animals present a field on which the many details of descent and variation can be examined with much greater facility than amongst more highly-organized beings. The great numbers in which members of many of the lower groups may be obtained, both in a recent and fossil state, their excessive fecundity, their curious metamorphoses, and other circumstances, render it highly probable that amongst them we shall look with the greatest chance of success for information regarding the true relationships of species, and the modes in which they have originated.

There is, doubtless, at the outset, a considerable difficulty in accurately defining what we mean by a *species*. This must, in the long run, be left to the discretion of each observer in the department which he specially cultivates. We can lay down no recognized rule by which one nearly allied species may be absolutely, and without fear of contradiction, separated from another, and the practice of different naturalists varies in this respect very widely. Thus while "M. Grenier enumerates only twenty-three roses for the whole of France, M. Dèsèglise describes or mentions one hundred and seven in his elaborate monograph of the French Roses; and M. Boreau, in the last edition of his Flora, gives seventy-four for the

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Central Departments only."* Our common bramble, *Rubus fruticosus*, is a parallel example. By some botanists it may still be, as it used to be, considered as one very variable species; by others it is divided into a multitude of distinct species: that these are "good" species, according to any possible morphological or physiological test, I cannot believe, though their distinction by specific names may be very convenient to the botanist. But suppose a few links in different parts of this chain to be lost, then there would be no question as to the "goodness" of the several species. And this continuity is equally apparent in the animal kingdom. Dr. Carpenter's conclusions with respect to the *Foraminifera* are that their range of variation is so great as to include, not merely the differential characters which have been accounted specific, but also those upon which the greater part of the genera, or even in some instances the orders, have been founded; that the ordinary notion of species as assemblages of individuals marked out from each other by definite characters that have been genetically transmitted from original prototypes similarly distinguished, is quite inapplicable to this group; since even if the limits of such assemblages were extended so as to include what elsewhere would be accounted genera, they would still be found so closely connected by gradational links, that definite lines could not be drawn between them; that any arrangement of genera and species which may for convenience be adopted, must be regarded merely as assemblages of forms characterized by the nature and degree of modification of the original type, which they may have respectively acquired in the course of genetic descent from a common ancestry; that even as to the family types it may fairly be questioned whether analogical evidence does not rather favour the idea of their derivation from a common original than that of their primitive distinctness.†

My object, however, in the present paper, is to give a brief account of some recent researches of two German naturalists, Dr. Müller, and more particularly Dr. Claus, the Professor of Natural History at Marburg. The work of Dr. Fritz Müller, *Für Darwin*, I know only by some extracts given about a year ago in the *Annals and Magazine of Natural History*. These are especially interesting, inasmuch as the author conducted his investigations on a deductive, instead of on the usual inductive plan; that is to say, instead of in the first instance ascertaining a number of facts, and then looking for some general explanation of them, he, to begin with, set before himself Darwin's theory of descent, and said, "If this theory be

* J. G. Baker, *Review of the British Roses*.
† Dr. Carpenter, quoted by Mr. Grove, Address to British Association.

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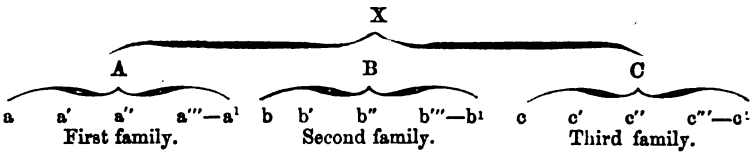
true, we ought in such and such a case to find such and such peculiarities." He then set to work to investigate on this basis, and the following is a very striking example of his results.

Crabs are divided into several natural families, so grouped because all the species of each family possess certain characters in common which distinguish them from those of neighbouring families. This, according to Darwin's hypothesis, is the natural result of their descent from one common ancestor. Then the species of all these families, which we may call A, B, and C, present certain ordinal characters common to all, and due to the fact that the families A, B, and C, descended from a more remote type X. This may be more plainly shown as follows :—



Now it is remarkable that in each of these families we find, as exceptions to the normal mode of life of the crabs, certain terrestrial species. It is permissible to suppose, *à priori*, that these must present certain modifications of the respiratory apparatus, enabling them to breathe air, and if each terrestrial species has gradually renounced, for itself, the aquatic mode of life, there is every probability that each would present a modification, *sui generis*, very different from those presented by others. If, on the contrary, observation proved that all these terrestrial species present the same modification of the respiratory apparatus, the Darwinian theory could only account for them by assuming that these terrestrial species belonging to various families, which we may distinguish as a^1, b^1, c^1, descended from a common type, O, which had already acquired the organic conditions of aërial respiration. But then the theory would contradict itself; for while the study of the respiratory organs would compel us to make a^1, b^1, c^1, descend from O, the distinctive characters of the families to which they belong lead us to assign to them a different origin, namely, from X through A, B, and C.

The details of the organization of the respiratory apparatus in the land crabs have hitherto been unknown ; and thus a fine field of investigation was open to Dr. Müller. If he found in the terrestrial species of different families the same arrangement for effecting aërial respiration, the Darwinian theory would be irrevocably condemned, but if he should discover differences so complete as not to be reducible to the same type,

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this would certainly furnish a strong argument in favour of the theory, and the latter alternative has proved to be the true one.

In an *Aratus* which climbs upon the branches of the mangroves, and in a *Grapsus* which runs about the rocks of Santa Catharina, the air finds entrance to the branchial cavity by a fissure situated above the last pair of feet. These crabs open the respiratory fissure by elevating the posterior extremity of the carapace. This aperture is consequently at the extremity of the branchial cavity opposite to that by which water enters and issues; for the apertures for the ingestion and egestion of *water* are in the same position in all crabs.

The genera *Sesarma* and *Cyclograpsus*, belonging, like the preceding, to the family *Grapsidæ*, contain species living in holes on the shore. These possess the same posterior respiratory fissure: but it is difficult to see the gaping, as the animals rarely open it, indeed only when they have been a long time out of the water. This is due to a very curious arrangement, which does not exist in the preceding species, and which enables these animals for a long time to respire the air dissolved in the water that bathes the branchiæ. The region which separates the aperture for the reception and emission of water is, as it were, reticulated, and bristles with small recurved hairs. The water issuing from the egestive orifice spreads in an instant over this network of hairs, and becomes saturated with air, after which it is conducted by a special arrangement into the ingestive aperture. The same portion of water may thus pass through the branchial chamber a great many times, carrying always a fresh supply of oxygen with it. In moist air this circulation of water may be maintained for a very long time, but when the provision of water is evaporated, the crab has recourse to the posterior aperture for aërial respiration.

The arenicolous *Ocypodæ* have been so completely estranged from an aquatic mode of life that a stay of one day in sea-water is sufficient to kill them. It has long been observed that in these animals the third and fourth pairs of feet are exceedingly close together. Their contiguous surfaces are clothed at the margins with a dense coat of hairs. It has been supposed that these hairs were intended to diminish the friction of the surfaces, but this is evidently a mistake. Dr. Müller has discovered between the bases of these approximated legs an aperture leading into the respiratory cavity. This arrangement exists in several species of the family, particularly in certain *Gelasimi*, some of which inhabit the mangrove swamps, whilst others run about upon the sand in open day. It might, perhaps, be said that this arrangement was necessary

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to protect the respiratory cavity from the entrance of the sand in which the creatures live, but a species of *Gelasimus*, which lives far from the sands, in the mangrove forests, in company with several *Grapsidæ*, nevertheless has the respiratory orifice concealed between the third and fourth pairs of feet.*

The limits of this paper do not permit me to follow Dr. Müller in his investigations into the development of various crustacea. The metamorphoses which these animals undergo are amongst the most wonderful in the whole range of natural history, fully equalling, and perhaps, from their significance even exceeding in interest, the more generally known changes of the *Lepidoptera*. The phenomena of embryonic development in all kingdoms of nature lend very strong support to Darwin's theory, and are indeed perfectly inexplicable without recourse to some such hypothesis, and Dr. Müller has, by his recent investigations, added considerably to our knowledge of these amongst the crustacea, and given additional reasons for belief in the theory of transmutation. For the details of his researches I must refer the reader to the translation from which I have already quoted largely.

The *Ostracoda* belonging to the families *Cyprinæ* and *Cytherinæ* have been hitherto divided into genera and subgenera on the strength of characters taken in great measure from the carapace, or outer shell of the animal, and more particularly from those of the hinge-joint. This mode of classification must in time give place to one founded on the structure of the animals themselves; but these are often so difficult to obtain in a living or unmutilated state, and are withal so difficult to examine thoroughly and minutely without the aid of a large supply of specimens, that a thorough knowledge of their organization must involve the labour of a lengthened period. Meantime, a good beginning of the work has been made by Dr. Zenker, Professor Lilljeborg, G. O. Sars, and other naturalists. But by far the greater number of *Ostracoda* hitherto described are fossil species, which can be known only by their shells; or recent species, which have as yet only been examined in a dry state. In these cases the characters of the hinge-joint are very valuable, exhibiting peculiarities which seem to coincide pretty definitely, so far as we at present know, with certain differences of the animal organization.

When I began the study of the *Ostracoda*, I supposed that every species (I refer now to those of the families *Cytherinæ* and *Cyprinæ*, which comprise a vast majority of the British species) might unhesitatingly be placed, by virtue of the peculiarities of the hinge and external shell-surface, in one or other of the established genera. What I wish now to show, is that

* *Annals and Magazine of Natural History*. Third Series; vol. xv.

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no such arrangement is possible without leaving numerous intermediate forms—evidently, as it appears to me, links in a chain of descent—which cannot be referred with certainty to any genus. Up to a very recent period, the recognized genera of these two families, founded upon characters of hingement, were as follows:—(1) *Jonesia**, the hinge of which is perfectly simple, the edge of the valves being quite straight, and held in opposition by ligamentous tissue; (2) *Cytherideis*, in which the edge of one valve projects sharply at each extremity, and articulates with corresponding excavations or notches of the opposite valve; (3) *Cytheridea*, bearing on the right valve two knurled or crenulated elevations, which are received into shallow fossæ of the opposite valve; (4) *Cythere*, which, instead of knurled elevations, bears two strong projecting teeth, articulating with corresponding fossæ of the left valve, and between the two teeth a bar which is received into a furrow of the opposed valve; (5) *Cythereis*, similar to the foregoing, except that the bar and furrow are obsolete; (6) *Bairdia*,† in which the left valve is much the larger, overlapping considerably the edge of the right valve, which is received within it.

But between the typical forms of *Jonesia* and *Cytherideis* there are many gradations of hinge character, no two species being exactly alike in this respect. Many species, instead of having margins either absolutely straight or angularly notched, have more or less pronounced curvatures. In this category may be placed *Cythere variabilis*, Baird, *C. contorta*, Norman, and other species. The genera *Cythere* and *Cytheridea* are not, so far as we at present know, so closely interwoven; still there are several species which are intermediate in character. One of the commoner littoral species, *Cythere lutea*, Müller (*C. reniformis*, Baird), has hinge-processes which are distinctly crenulated, and many species possess a crenulated bar between the two terminal teeth. *Cythere* and *Cythereis* are so inextricably united that it is impossible to draw any line of separation which at all takes into account the character of the hinge, and even if we look to more general peculiarities, the task of discrimination is scarcely more practicable. The genus *Bairdia* is very distinct indeed in its most strongly marked forms, the great inequality in the size of the two valves, and the peculiar overlapping of the left hinge-margin being unmistakeable characters. But besides that the tendency to a

* The genus *Jonesia* was proposed by myself (*Trans. Zool. Soc.*, vol. v.), but appears to be equivalent to *Bythocythere*, G. O. Sars, a genus founded on exclusively *animal* characters. When my paper was written, I was not acquainted with the valuable memoir of M. Sars, which indeed was probably not printed at the time.

† The genus *Bairdia* is related to *Cypris*, belonging to the family *Cyprinæ*, and not *Cytherinæ*, with which it has been hitherto classed.

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slight inequality of the valves is very general amongst the *Ostracoda*, there are some species which possess this character strongly developed, and are at the same time not at all referable to the genus *Bairdia*. *Cythere convexa*, Baird, is a well-marked example, the carapace having the general form of *Bairdia*, and also the unequal and overlapping valves, but exhibiting at the same time the strongly-developed hinge-processes of *Cythere*.

It may also be noted as a most interesting fact that there exist several genera of marine *Ostracoda*—not hitherto described as British*—which are distinctly intermediate, in the character of the contained animals, between the (chiefly) marine ambulatory genus *Cythere*, and the purely fresh water, natatory genus *Cypris*. These intermediate genera are—*Bairdia*, *Pontocypris*, *Paracypris*, and *Argilloecia*. The first-named group is represented in the British seas by several species, *B. inflata*, Norman; *B. acanthigera*, Brady; *B. intermedia*, Brady; *B. obtusata*, G. O. Sars; *B. minna*, Baird. Of *Paracypris*, we have one British species, *P. polita*, G. O. Sars; of *Pontocypris* two species, *P. semilata*, G. O. Sars; and *P. trigonella*, G. O. Sars, while the genus *Argilloecia* seems to be unrepresented on our shores.

The object which I have now more especially in view is to give a brief abstract of a memoir recently published by Dr. Claus‡ on the *Copepoda* of Nice. This paper has not, so far as I know, been yet translated, or even noticed, in England. The object of the author, besides the description of new species, was to give an account of some remarkable variations which have come under his notice during a long study of this tribe of animals, and I propose now to notice, very briefly, some of the facts which he describes.

The *Copepoda* of Nice, are, as might be expected from geographical considerations, much more nearly related to those of Messina than to those of the North Sea, but the following particularly northern forms are found likewise at Nice:—*Anomalocera Patersonii*, an Atlantic *Pontella*, *Cetochilus septentrionalis*, which forms the chief food of the Arctic whales, but attains in that northern region to a much greater size; also *Tisbe furcata* and *Euterpe gracilis*. Other species occur less commonly, such as *Ichthyophorba denticornis*, of which the Nice variety is of strikingly slender form, and has, in the male, remarkably small clasping feet. The variations noticed in *Dias longiremis* are also remarkable.

* Some of these species have been described from the external shell characters by British authors, but of the animals themselves nothing has been published in this country.

‡ "Die Copepoden-Fauna von Nizza: ein Beitrag zur charakteristik der formen und deren Abänderungen im sinne Darwin's." Marburg und Leipzig, 1866.

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Some northern species are, at Nice, represented by very nearly related forms. Thus the northern *Dactylopus Stromii*, gives place to *D. similis*; the northern *Harpaticus chelifer* to *H. nicæensis*. Similar differences may be noted between the *Copepoda* of Nice and Messina, the species and genera of which places are for the most part the same, and, in many cases, of invariable form, *e.g.*, *Euchæta Prestandreæ*, and *Candace melanops*. But there is a constant deviation observed in *Calanus mastigophorus*.

The most important distinctive characters met with amongst the *Copepoda* are in the size and colour of the body, the form and length of the tail, the form and number of joints of the upper antennæ, the character of their appendages, the character of the eyes, etc. The colour of a species may, however, be due to the distribution of pigment in various form through the external tissues of the body, or it may result merely from masses of food lodged in the alimentary canal, or from the natural colour of organs such as the ovaries. Indeed, it is often very difficult to decide how far in particular cases variations of colour may depend upon outward conditions, such as those of food and temperature.

It is worthy of remark that some very common species have a large and a small variety, and that we do not find intermediate sizes. These may, perhaps, exist, but they are seldom seen. Thus a large form of *Dactylopus similis* is 1·2 mm. in length, the small variety only 0·7 mm. *Tisbe furcata* also varies at Nice from 1·4 mm. to 2·3 mm., and there is a form of *Antaria mediterranea*, in which some of the middle segments are wholly, or in part, wanting. As connected with this part of the subject, I may note that I find a variety of *Dias longiremis* in brackish water at Burgh Marsh, Cumberland, also in similar situations at Hartlepool and Alnmouth, the length of which is only one-thirty-fifth of an inch, that of the normal form being one-twentieth of an inch.

The characters of the tail setæ, and the joints of the antennæ are of great specific importance amongst the *Copepoda*, and there are many striking variations in these respects, as, for instance, in *Cyclops serrulatus*, *Antaria mediterranea*, and various *Corycei*. Differences in the size of the various joints of the antennæ are very common. In *Harpacticus nicæensis* the third and fourth joints are often much elongated; in a large variety of *Tisbe furcata*, the size of each joint is subject to much variation; and there is also a variety of this species which bears a very large secondary branch on the lower antenna; the terminal joint being excessively elongated. In *Dactylopus similis* the fifth and sixth joints are very variable,

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and the nearly related *D. Stromii*, of Heligoland, likewise shows a similar tendency to variation. Circumstances of this kind prove that closely-allied species are subject to changes of a similar nature. *Dactylopus Stromii* seems especially liable to great divergence. The seventh antennal joint is of very uncertain length, and is even sometimes divided into two joints. This Dr. Claus has observed only in one instance, the antennæ having nine, instead of eight joints, and in their relative size simulating those of the allied genus *Thalestris*. Of thirteen known species of *Dactylopus*, far the most have eight-jointed antennæ, two species have ten joints, one has seven and one five. *Nine*-jointed antennæ are not met with normally in any species of *Dactylopus*. Thus it appears that through individual alteration characters may be acquired which one is accustomed to regard as being even of generic importance. In the same way, the Mediterranean species of *Harpacticus* have *nine*-jointed antennæ, the northern species being eight-jointed. Greater and smaller individual differences may occur in all parts of the body, and these often occur in such wise that though there may be no intermediate forms, it is quite impossible to regard the animals as belonging to distinct species. We must in such cases allow the influence of "time's effacing fingers." Highly interesting and important in this view are the variations in the length of the third and fourth antennal joints of *Harpacticus nicæensis*. The stronger, and, on the average, the larger form, has a heavy, strong body, ill-bred apparently, inactive and wanting in mobility, the antennæ clumsy, with their third and fourth joints short and thick, the second joint very long; the second foot-jaw ends in a strong, massive, clasping hand; the first pair of feet are armed with doubly-curved claws; the feet, especially the last pair, are strong and clumsy, all the setæ showing a tendency to become plumose. The smaller and slenderer breed has longer antennæ, the third and fourth joints of which are much elongated; the prehensile apparatus of the foot-jaws and first pair of feet more slender, and there is also a much slimmer, slenderer form of the limbs. In general structure and conformation of body, in the peculiar arrangement of setæ, the serration of the abdominal segments, in short, in those points where distinct species mostly diverge, there is here a striking agreement. "After diligent inquiry," says Dr. Claus, "these differences remained unexplained, and I was inclined to consider them as mere individual variations. But further investigation of all portions of the body convinced me that two distinct forms, with qualities diversely useful, had originated two separate races, one slender, swift, and agile; the other, clumsy in figure, but robust and powerfully armed. The two

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races are so far separate, that intermediate individuals, partaking of the characters of both, are not met with. The upper antennæ, however, in each case, show a tendency to similar variations. At the same time, these variations are not so profound that they might not have been acquired singly or in combination. The differences in the relative size of the claws and prehensile organs may be traced back to the youngest stages of growth. . . . Many species may, no doubt, have been founded on characters no more distinct than these, and on mere deviation of character in the joints, which a critical investigation would prove to be worthless."

When the advocate of immutability urges the absence of forms intermediate between distinct species, he forgets that between acknowledged *varieties* it is mostly impossible to obtain connecting links.

Besides forms, varieties, and nearly allied species observed in places near to each other, Dr. Claus notes examples of variation depending on influences of climate and other external conditions. He lays little stress on varieties of colouring, but much upon difference of size, instancing the *Cetochilus septentrionalis* as found at Nice, which is only one-third of the normal size of the species. The little *Calanus mastigophorus* which he distinguished at Messina by the long, whip-shaped, antennal setæ, occurred also at Nice, but without these setæ. Very remarkable also are the differences of form in the male prehensile foot of *Dias longiremis*. While the fifth feet of the females of Nice and Heligoland are in all essential respects the same, that of the Nicæan male has a stronger claw and appendage, to allow, as it seems, of a stronger grasp. We have here, as in the case of *Orchestia Darwinii*, two different males in the same species, and can only explain the deviation as the result of natural causes connected with different localities. The difference of the feet is indeed so striking as to have led to the supposition of the two forms being distinct species. An instance of concurrent variation of different parts of the body occurs in the *Ichthyophorba denticornis* of Nice and Heligoland. The former is not only smaller than the northern species, but has proportionally far more slender armatures of the antennæ, and a much less marked angular projection of the last segment of the body, and in the males much weaker prehensile apparatus of the fifth foot. It thus stands, in size and conformation, between the northern *I. angustata* and *denticornis*, the distinctions, indeed, are here so sharply defined that according to some schools of naturalists they might properly constitute species rather than varieties. "The opponent of the origin of species by descent," continues Dr. Claus, "asks to see forms of an intermediate character. When we succeed in showing

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these, which, from the requirements of natural selection, must be but seldom, he immediately answers that the two extreme forms are not good species, but only varieties. This is a vicious style of argument. Darwin rightly says that facts seems to prove the fruitfulness or sterility of animals *inter se*, to be a criterion of no value whatever, but his opponents maintain that the descendants of varieties are fruitful, and of species sterile, *inter se*. So when Rouy in Angoulême obtained many successive generations of a breed between the hare and the rabbit, they directly affirm that these animals had been hitherto misunderstood, and that they are evidently only varieties of the same species. In the same way, however, as we discriminate species by characters occurring either singly or in combination, we are entitled to believe in the general unfruitfulness together of animals belonging to those forms which we designate by the name of species—a peculiarity imparted to them along with many other characters, and having in itself nothing requiring separate explanation."

A great many people fear to believe in the derivative origin of species, because they vaguely fancy that the doctrine leads to materialism, and even worse phases of belief or unbelief. They charge its advocates with inability to appreciate whatever cannot be weighed and handled, with a want of reverence for the spiritual and unseen. And, indeed, it is obvious that material organisms must be subject to the laws which regulate *matter*, just as much as spiritual entities must obey the laws of spirit. But though we believe that the phenomena of origin and creation are the result of the operations of immutable law, no less as regards species and races than as regards the individual; we believe likewise that these laws are at once an expression of the will, and a revelation of the wisdom of the Eternal, and that through them "the whole round earth is every way bound by gold chains about the feet of God."

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A NEW CHARR* FROM BRITISH COLUMBIA.

BY JOHN KEAST LORD, F.Z.S.,

Naturalist to the North American Boundary Commission; Author of "The Naturalist in Vancouver's Island and British Columbia."

Sp. Ch.— Scales minute. Head and body rather compressed; the height of the head equals the length of the head, and is two-ninths of the total (without caudal); the length of the head is one-half the distance between the snout and the vertical from the origin of the dorsal fin. Snout very obtuse, scarcely longer than the diameter of the eye, which is three-fourths of the width of the interorbital space. The lower jaw is a little shorter than the upper; maxillary of moderate length, scarcely reaching to the vertical from the margin of the orbit. Teeth of moderate strength; those along the medium line of the hyoid are very small. Præoperculum with a very distinct lower limb. Fins rather small; the length of the pectoral is less than that of the head (without snout), or one-half of the distance of its root from the ventrals; caudal fin slightly emarginate. Back and sides reddish olive; sides with numerous round light-coloured spots. Belly whitish powdered with reddish olive; paired fins and anal colourless; caudal immaculate. Pyloric appendages very long and wide.

"This is one of the smallest species of charr, both our specimens having the abdomen filled with mature ova."

It would be of no practical use to give a lengthy description of the specific differences which separates the charr from the rest of the *Salmonidæ*. The charr we are familiar with, as tenanting British waters, are as a rule resident in deep lakes. Yarrell, in his *History of British Fishes*, vol. ii., p. 125, tells us "The charr generally inhabit the deepest parts of those lakes, in which they are found, and afford but little amusement to the angler." The charr are very seldom known to wander into any of the streams, by which these lakes are either supplied or drained, except at the season of spawning, and their decided partiality for clear water and a hard bottom is then very conspicuous. The spawning season is in November and December.

I must ask my readers to forget for a short time the beautiful lake scenery we are all so justly proud of, to leave the haunts of the British charr (with which, if the reader is a disciple of the "gentle art," he is pretty sure to be familiar), and to visit with me, in imagination, its near relative, a dweller in the

* *Fario Lordii*, Nov. Sp., Gunther, Brit. Mus. Catalogue of Fishes, vol. vi., p. 148.

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wild regions of North-western America. Let us suppose ourselves to be entering the Fraser River, which, I need hardly say, is the principal navigable stream flowing through British Columbia; it heads from the Rocky Mountains, drains a large extent of country west of the Cascade Mountains, and empties into the Gulf of Georgia, about six miles north of the British and American boundary line, the 49th parallel of N. lat.; the entire length of the river may be roughly set down as 1000 miles.

A small steamer conveys us so far as New Westminster (which is the capital town of British Columbia), a small straggling place built on a steep wooded slope, about fifteen miles from the mouth of the Fraser River. Here we charter a canoe, and provide a stout crew of Indians, and if we start early, we may manage to reach Fort Langley by sundown. This so-called fort is a trading station belonging to the Hudson's Bay Company, whereat in salmon-time immense numbers of these lordly fish are salted and barrelled, to be eventually disposed of at the Sandwich Islands and San Francisco. Putting up cranberries also, at one time, formed a large item of the trade done at this station. The berries were bartered from the Indians, then headed into casks made at the fort, these casks were lastly filled with water, through a hole in the head bored for the purpose, and then plugged up. We sleep at Fort Langley, and paddle away again early in the morning. On either side of the stream (which in this, the month of August, is swift and turbulent), rise steep sharp-pointed hills, deeply cleft into ravines, and densely clothed with massive pine-trees, from the water's edge to the very topmost pinnacles of their craggy rocks. Here and there some tributary stream makes its way from amidst the trees, and, as we pass, little clusters of Indian lodges are revealed, resembling hillocks, but from which many columns of white smoke are stealing up through the trees, and but for such tell-tales we might have gone by the village fifty times, and have been none the wiser. Suddenly, as we round a sharp bend in the river, we come into a wide expanse of water, tranquil as a lake (these lake-like stretches of water are peculiarly characteristic of the scenery on the Lower Fraser) green grassy banks like verdant meadows extend for some distance from the water's edge to meet the bases of the hills, to be at last absorbed amidst their timbered slopes. These banks are favourite camping-grounds for the fishing Indians, and we can make out, as we paddle slowly past, little fleets of canoes, laying bottom uppermost on the grass, whilst behind them are lodges of all sizes: many camp-fires are burning brightly, and round about them groups of dingy savages loll lazily or squat on their heels. A-head of us are four canoes, each of

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them manned by two nearly nude savages, the one paddling is seated in the stern, the other, standing in the bow, is armed with a spear seventy feet in length. These Indians are sturgeon-spearing—sturgeon five hundred, and sometimes as much as seven hundred weight, are speared and landed with these frail canoes, that the slightest inequality of balance would upset in a moment. We land in the evening on the "Sumass spit," a large sand-bank at the junction of the Sumass and Fraser Rivers. Here we find a regular Indian town, not very large as regards the number of its houses, but each house contains from nine to twelve families. The houses are built like sheds, with cedar planks, a small part of the interior is apportioned to each family, who sit or lie on the bare ground round the fire, every family has its own fire, and the smoke from the whole of them finds its way out as best it can. A stockade about twelve feet high, constructed of small trees and stout poles, encircles the village; this defence is pierced with small apertures, through which arrows or bullets, if need be, can be fired at an enemy. About three miles higher up the river lives another tribe, we shall not see their village, because it is situated inside a small island, and, thus craftily hidden from sight, any one going up or down the river, would not know of its existence. The owners, the Chilukweyuk Indians, are dire enemies of the Sumass tribe, hence the latter, being the weaker, need a stockade to prevent their foes from pouncing upon them unexpectedly. These Indians live in a great measure upon white fish (*Coregonus quadrilateralis*) and salmon, fresh and sun-dried.

We have fifty miles more to accomplish ere we reach Fort Hope, our destination. The river above Sumass gets swifter in its course, rapids are more numerous and difficult to ascend, and what is most astounding, heaps of drift timber, each heap containing many thousands of immense trees, are piled up at nearly every bend, or wherever rocks, a point of land, or a sand-bank, has offered any obstruction to their onward course. These trees are washed down by the floods, which commence in May, and are at their highest during June and July, at which time the sun rapidly melts the snow from off the hills. If one did not previously know that the river rises quite forty feet during the summer freshets, it would be a puzzle to conceive how such gigantic trees could be piled one upon top of another; as the canoe glides along beneath their shadow, it is precisely like looking up at a cliff composed of huge trees. Two living things only are to be seen on this chaos of wood; one of these, the dipper (*Cinctus Americanus*) hunts busily on the submerged stumps for aquatic insects and larvæ, sometimes quite under water, at others only half immersed; whilst the

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other, the "store keeper" squirrel (*Tamias quadrivittatus*) scampers along from tree to tree, chattering, whistling, and scolding, as if in angry remonstrance at so impudent an intrusion into its solitudes. It is ticklish work getting up some of the rapids; paddles are of no avail, and the canoe has to be propelled with light poles (poling a canoe up a swift rapid is a feat I have never seen a white man perform with the same skill as an Indian, not even the oldest and most skilful voyageurs belonging to the Hudson's Bay Company are equal to the red-skins; the art of holding the canoe with the pole, and whilst propelling her against the current, preventing its sweeping her round, is an art Indians, and only Indians, know how to manage) the slightest slip and over we go, with the water running like a mill-race, rocks, boulders, and snags everywhere, and eddies, and whirlpools strong enough to suck down a boat; why, a man would not have the slightest chance of saving himself from drowning, even if he could swim like a beaver; but somehow the red-men get us through in safety. Now and then we pass beneath a rocky cliff, the splintery points of which knock the water into spray as it hurries on its way; then coaxing the frothy current into clefts and hollows, whirls it round in countless eddies. Here in these dark retreats salmon love to linger, as they toil on against every obstacle in search of some gravelly stream, wherein to make a nest and bury their eggs; and we may count these noble fish by the thousand, and then fail to arrive at a fair estimate of the numbers which every year ascend the Fraser and its tributaries. Stages suspended by ropes of twisted bark dangle over these gloomy whirlpools, frail are they in construction, being simply light poles tied clumsily together, one shudders even to look at the fearless savages, as kneeling or sitting on their heels they ply a small round net affixed to the end of a long handle, and one by one land goodly salmon on the treacherous platform. It is no easy feat to lift a heavy fish, flapping and struggling in the full vigour of superfluous health, on to a stage swinging in mid-air, or to knock it senseless with a single blow when it is there; and yet these untutored men manage to do it, every day and all day long. To fall from off the stage must be certain death, and yet they are compelled by hard necessity thus to imperil life and limb in order to obtain food, on which to exist during the biting cold of a six months' winter.

We need not linger to describe all our different camping-places, but we will pass them by as offering little worthy of particular notice. Fort Hope, our destination, is visible a-head, perched upon a bluff some height above the river. The scenery is grand and massive beyond description; lofty

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mountains, some of them crowned with perpetual snow, completely shut the river in on both sides. A dense impenetrable forest of pine-trees seem to rise from out the water, and in a series of green slopes end only at the sky-line. But this mass of dark green is so broken, divided, and grouped, if I may so express it, by craggy masses of rock, deep ravines, and narrow valleys, through which streams rattle noisily, that all idea of monotony vanishes, and on every side is a magnificent natural picture, wherein are all the elements requisite to make a landscape beautiful, but on such a scale of immensity, that it fairly staggers one to gaze upon it. The river sweeps past Fort Hope with great velocity, then making a sudden bend to the right, is suddenly lost amidst the jutting points of land and the dense foliage of the forest.

Fort Hope is but a small place, consisting of the Hudson's Bay trade post, some scattered log houses, and a kind of street facing the water, made up of stores, groggeries, billiard saloons, and barber's shops. This town, since the period of which I am writing (being the head of steamer navigation) has grown to be a place of some importance, because one of the routes to Cariboo is *viâ* Fort Hope and Lytton. A steamer in old days did occasionally come up to Fort Hope at certain periods of the year, in order to take away the furs collected there during the year, and at the same time to bring goods for barter with Indians, which goods were destined for the supply of the frontier trading posts.

We are now near the home of our new charr, and I shall continue this imaginary journey, because it will the better enable me to describe the character of the river in which the fish lives, and the kind of country through which the stream flows, matters of importance, as showing how the charr of British Columbia differs in habit and habitat from its better known British brethren.

The distance to our fishing-ground is rather too great to walk comfortably, and the hills are steep, so we will mount our mustangs, and ride. Our route is along a flat at first, covered with shingle and large rounded boulders, which were brought here, in all probability, on the shoulders of the ice king, for in no other way could masses of rock, differing entirely from the rocks comprising the encircling mountains have been transported from a distance. Water power could never have rolled them; their weights must be calculated by tons, not pounds. The flat we are traversing was, most likely, the bed of an ancient lake. The best evidence obtainable respecting the age of these vast accumulations of water-worn stones is at best but very imperfect. Whether this huge continent has been depressed in the mass, or whether the

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upheaval in the centre has greatly exceeded that along its margins are speculations for geologists to decide.

These terrace formations, as they are styled, must strike the most obtuse traveller as being unlike anything he has seen before in other parts of the world. There is hardly a valley between the Rocky Mountains and the Pacific coast lower than 4000 feet above the sea in which these shingle terraces are not met with. Two miles across the shingle, which is but sparsely covered with timber, brings us to a beautiful stream, the Qua-que-alla, clear as crystal, and cold as ice. It has a swift rocky course, and as we look into the glass-like water, brigades of salmon (*Salmo lycaodon*) are seen toiling on, all with their heads up stream, literally crowding one another against the rocks and banks, the bright scarlet stripe marking the sides of every fish; the worn noses and large ulcerous wounds that have eaten holes into the living fish, tell their own tales of hardships, difficulties, and privations, endured in obeying an instinct ever prompting them to deposit their eggs as high up in the mountain streams as they can get. Neither can we be blind to the fact that another purpose is fulfilled by the bountiful hand of God, thus directing myriads of fish to quit the sea, and enter rivers intersecting the interior of a continent or an island. This obedience to an unalterable law is a simple means by which heat-yielding materials, and meat requiring sunshine only to cure it (salmon sun-dried will keep sound for years), are floated, free of all freight, to the dwellings of the aborigines who live far inland, and have to endure a rigorous winter and six months snow.

It is not at all overstating the fact to say, that four out of every six of these salmon we are watching, will die as they struggle onwards, and drift back again in rotting masses, towards the ocean from whence they came.

We only follow this stream for a short distance to reach its junction with a second stream, up the course of which we ride by following a narrow trail. Where the forest is a little open we can look upwards through the trees and discern the water-shed of the Cascade Mountains. The waters of the eastern side find their way into the Columbia, whilst these on the west flow into the Fraser. The hill we are ascending is steep, and the river tumbles from rock to rock with tremendous force; a louder roar than we have been listening to, directs us to a waterfall, where the river plunges over a vertical wall of rock, and puts an effectual stop to the salmon's further ascent (bear this fact in mind).

We by-and-by reach a kind of plateau, where the water has a slower course; now we will tether our mustangs, put our fishing-gear into working order, and commence work.

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The flies we must use are small, and of bright, gaudy colours. My first cast results only in a rise; my second is attended with better success—a fine speckled trout, the Oregon-brook trout (*Fario stellatus*) lies flapping on the grass. The next throw is into a comparatively still pool; with a gentle splash a small fish seizes the fly, and finds itself suddenly in the hands of a naturalist; I examine it carefully, and discover that I have a charr; more than this, it was a female fish, and she was full of eggs, others were soon taken; but in all the roe and milts were near to maturity, the largest charr did not exceed six inches in length, and there could be no doubt the fish were adult, and fully grown. I had frequently fished in the lakes on Vancouver's Island, as well as in other lakes and streams (I may mention the Sumass, Chilukweyuk, and Sweltza, as examples; these are mountain lakes, with streams flowing out from them), at lower levels along the spurs of this, the Cascade range of mountains; but in no single instance did I ever catch a charr.

The three lakes I have named fulfil every condition of the Cumberland, Swiss, and other lakes in which our charr (*Salmo salvelinus*) are usually taken, and one would have naturally supposed that if charr were to be found at all, they would have been in localities similar to those they favour and frequent in other countries. Not so, however; here is the only place (as far as my experience goes) where charr are to be obtained in British Columbia. The first thing which occurs to us as being unusual as regards this charr is, that there is no lake, nor even still water, near to where it resides, and not far above the spot on which we are standing, is the source of the river (about 7000 feet above the sea level), owing its origin to the melting snows, of course the water is at all times intensely cold. In the second place, we have tracked the river courses from the sea, and it is quite clear this tiny charr could never have come from the lower part of the river; it must have quitted its egg near to where I caught it, and have lived there to a mature age, and in its turn is now ready to deposit eggs for the production of another family. Even supposing this small and delicate charr risked a plunge over the cascade we peeped at, and survived the tumble, it is hardly conceivable that it would escape the thousand and one dangers which would beset it; and if it did, by no possibility could it ever return again to this part of the river. In the third place, the habit of leaving the lakes at the spawning time common to all our charr (according to Yarrell) can never be indulged in by this British Columbian species, because it is completely imprisoned in a few miles of river. The barrier on one side is a waterfall; on the other the source of the stream.

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The stomachs of all the charr I opened were crammed with the remains of winged insects, and in a few of them I observed portions of the wings, together with other parts of the larger dragon-flies (*Eshna*), an insect that in size nearly equalled its devourer. I did not see any remains of aquatic larvæ intermixed with the other contents of the stomach, hence I am disposed to think these charr during the summer take the greater part of their food on the surface of the water. They are the most greedy little gluttons conceivable, I could see them dash at my flies two or three at a time, fighting and struggling to get the first chance to seize it.

The British Columbian charr is a particularly handsome little fish. The body is more slender than is that of the trout, and in colour olive-green, blushed with pink; the sides are densely covered with minute white spots, as if the fish had been sprinkled with whitewash; all the fins are of a pinkish hue, whilst the fish is alive, but turn to a dingy white immediately after death. The lower jaw being a little shorter than the upper, gives the head and snout (if I may use the word for want of a better) a snubby appearance. As the eggs of the female fish were nearly mature, there can be but little, if any, doubt that these charr spawn in August, although I had no opportunity to watch them as to their modes of depositing the eggs; and, singular to say, I never obtained a male fish. It is a somewhat remarkable difference, as regards the *Salmonidæ* of North-western America, when compared in habits with our own, that the former spawn in summer and early in the autumn, whereas our salmon generally deposit their eggs in December. But then we must not forget that during the summer the North-western rivers are at their highest, from the enormous inflow of water caused by the rapid melting of the snow, and also that the temperature of the water is never, in the hottest weather, more than a degree or two above the freezing point. If the salmon did not ascend the rivers during the flood time, they could not leap over the falls, or twist their way against the rapids, that everywhere occur to intercept their progress towards the spawning grounds. What are obstructions only when the rivers are high, become impassable barriers when the waters are at their lowest level.

There is another curious feature in the habits of North-western American salmon, one is at once struck with, which is, salmon never take a bait of any kind after quitting the sea; whereas their near relatives, the charr, trout, and salmon-trout, greedily take anything offered to them. My own opinion is, that the salmon in North-western rivers never feed after they abandon the salt water until they either perish or again reach the ocean, and I say, without fear of contradiction, that four

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out of every six salmon die which ascend the river for the purpose of spawning in its tributaries. So vast, during the winter months, is the accumulation of dead salmon in the small streams, that to live anywhere near to them is next to impossible. Rotting fish hang from every spray that dips into the water; rotting fish lodge in every eddy, and jam against the irregularities of the rocks and boulders; rotting fish lie stranded on every sand-spit; and rotting fish are day and night drifting onwards towards the sea. Why such a waste of valuable food is permitted by the all-wise God who bountifully sent it, no one can tell; but that it is intended to serve some wise and useful purpose, although to us inscrutable, is indisputable.

To return to our little charr, it is equally puzzling to me to account for the presence of this member of the *Salmonidæ* in a mountain stream, shut in betwixt two barriers, and, as far as I know, it is not to be found in any other part of British Columbia. I am almost afraid to venture a suggestion, lest some geologist pounce down upon me. It is disagreeable, to say the least of it, to find oneself tumbled over, and sent floundering amidst the fragments of a pet theory, by some person who happens to be more learned in matters geological. I have my own opinions, however, and I mean to state them, and if I am snuffed out and utterly extinguished, so to speak, then so be it; there must be a right side and a wrong side to this question as there is to every other, and if I am groping my way along the latter, why the sooner somebody comes to the rescue the better.

I cannot help thinking this isolated charr might possibly have lived in a lake at some remote period, the bottom of which, now high and dry, we rode across when we left Fort Hope. Upheaval of the land drained the lake of its water, and as the mountains were tilted up higher and higher, a few charr might have either followed up the course of this stream, then a tributary to the lake, or they may have been lifted up bodily by a sudden convulsion, such as caused the cliff of rock over which the stream now finds its way, and constitutes an impassable barrier to the ascent or descent of fish. The other charr, after the lake was drained, perished, it may be, suddenly; or if they escaped, have given place, during the course of ages, to some stronger race of fishes "in the struggle for existence." Only in this way can I account for so singular a case of isolation as shown us in this British Columbian charr. Bearing upon, and in some degree, too, confirmatory of this theory, is another fact. Near by this stream wherein the charr live, rhododendrons grow, and in no other part of the Cascade Mountains were these plants discovered. How, then, can we account for this? Here we find a group of flowering shrubs completely islanded, if I may so express it, on a small spot of

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ground in the very midst of a vast mountain-range. I can see no other way to solve the problem save that of admitting that some geological change has so modified and altered the general conditions requisite for the growth of this plant in the surrounding district, as to cause its extinction, whereas the small spot of land on which it thrives remains unchanged.

Perhaps I had better stop my theorizing, lest I get inextricably entangled. "Fools rush where angels fear to tread," says the adage. Dr. Gunther for some time imagined the specimens of this charr, which I brought home to the British Museum, to be the young of one of the species of salmon common to the rivers of British Columbia; and it was not until he examined them carefully, and discovered the fish were females containing fully-matured eggs, did he decide they were charr, and the smallest known species. In compliment to the discoverer, Dr. Gunther has named the new charr *Fario Lordii*.

I have given briefly a sketch of the general features of the Fraser River, the stream in which I caught the charr, and of the district through which it flows. How far my speculations as regards this fish's isolated position may accord with the opinions of those more conversant with the changes which have from time to time altered the earth's surface than I am, I do not know; of the charr itself I have not deemed it necessary to say more than was sufficient to put any reader in possession of its most prominent characteristics. Minute descriptions of structural peculiarities, by which it was known to be a species new to science, would prove anything but amusing, and of no practical value to any but the scientific icthyologist. My end was to place its habits, and the singularity of its position, in a pleasant guise, for I fully believe the general reader, though looking upon a fish as only a fish, feels a pleasure in knowing what it does, and how and where it lives in far away lands. Whether or not I have succeeded in my endeavour my reader must decide.

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