THE

INTELLECTUAL OBSERVER:

REVIEW OF NATURAL HISTORY,

MICROSCOPIC RESEARCH,

AND

RECREATIVE SCIENCE.

VOLUME II.

ILLUSTRATED WITH PLATES IN COLOURS AND TINTS, AND NUMEROUS ENGRAVINGS ON WOOD.

LONDON:
GROOMBRIDGE AND SONS,
PATERNOSTER ROW.
Sm MDCCCLXIII.

HARRILD, PRINTER, LONDON.

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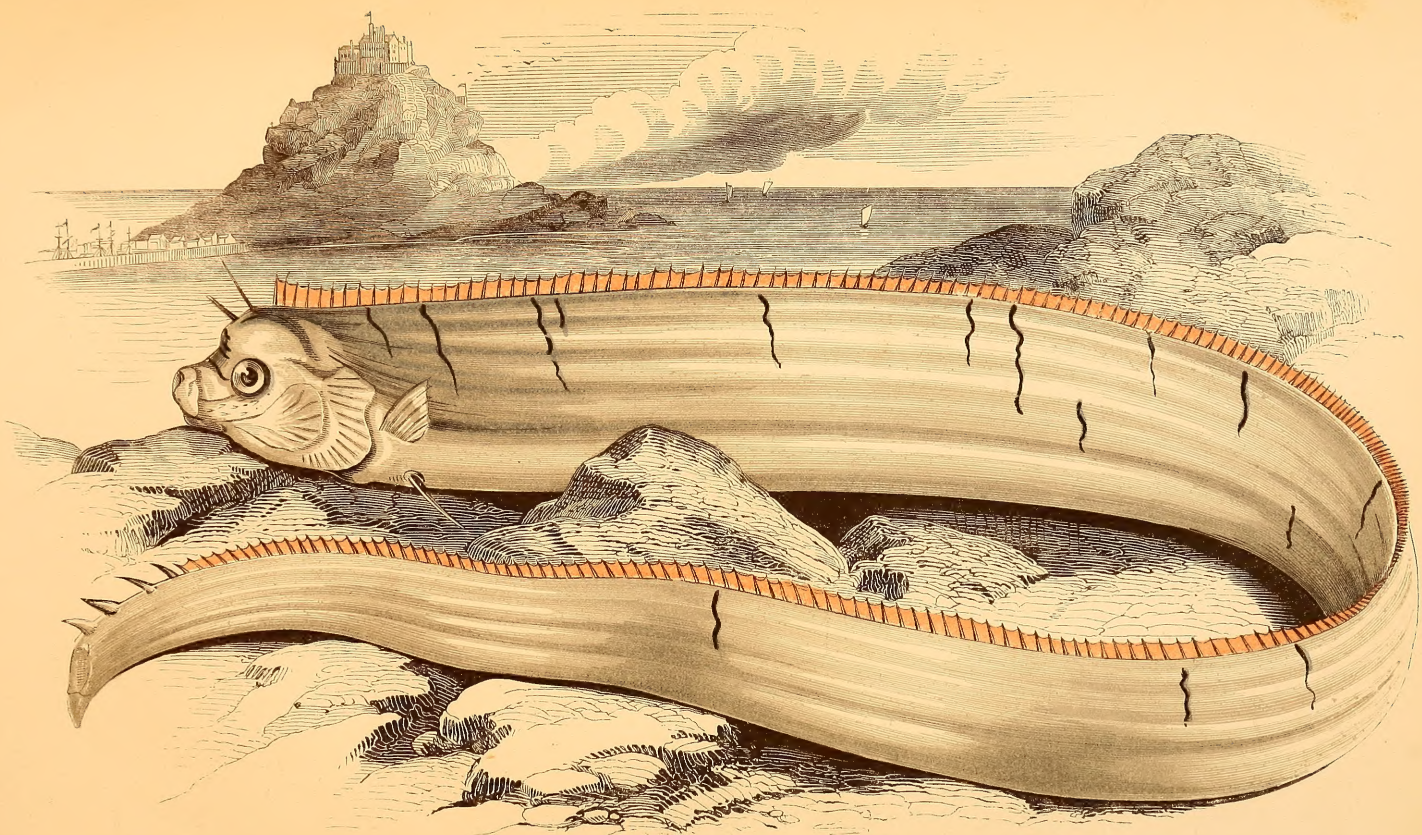


Banks's Oarfish.

THE INTELLECTUAL OBSERVER.

AUGUST, 1862.

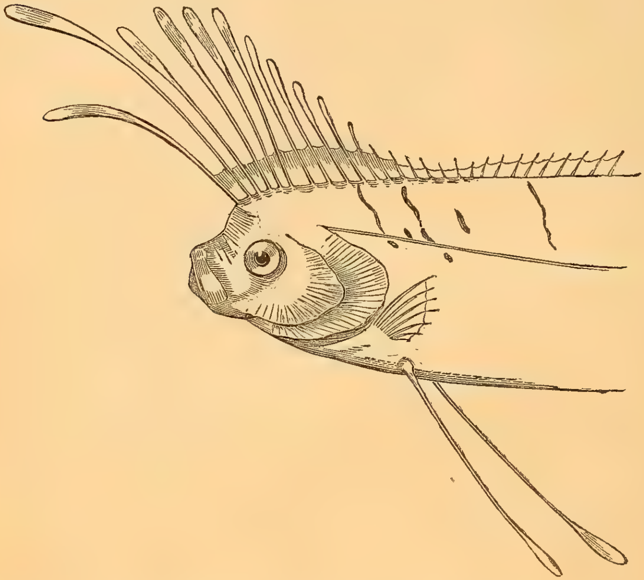
RIBBAND FISHES OF THE GENUS GYMNETRUS.

BY JONATHAN COUCH, F.L.S.

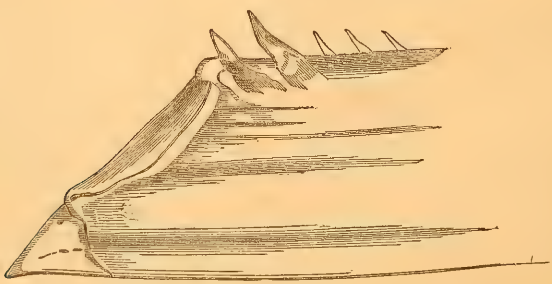
The habits of that family of Ribband or Band fishes called Gymnetrus are so little known that their history for the most part, is confined to the knowledge of the places where they have been taken, and the circumstances attending the capture. Yet there is reason to believe that they are widely distributed in the Ocean; for while the greater number of instances in which they have been obtained have been in the north of Europe, one at least is believed to have occurred in the East Indies, one in New Zealand, and another among the islands of Bermuda, of the particulars of which we intend to give a more minute account.

The earliest reference we have of a fish of this kind as being obtained in Britain, is quoted from the *Annual Register* by Albany Hancock, Esq. and Dr. Embleton, as having occurred about the year 1759; but it was not described by any scientific naturalist, and we might have entertained doubts concerning the species, and even the genus, but for the mention of a circumstance attending it which has since accompanied the capture of every example, and which, therefore, while it forms a character, permits a doubt to continue with regard to the exact form of some of its parts. It became easily broken and mutilated when handled, as was the case also with the next specimen of which we have any account. This was left dead by the tide near the little town of Newlyn, close to Penzance in Cornwall, in February 1788; the date of which is to be particularly noted, since there appear to have been repeated mistakes concerning it. The occurrence of this example, which was then believed to have been its earliest instance in Britain, excited considerable attention at the time; and of it I possess a coloured drawing, which was presented to me by Mr. Chirgwin, near whose house the fish was found, and who expressed his belief that it was the authentic original from which all the other figures that have been circulated were copied.

This last circumstance must be a mistake, as we shall see; but in itself his figure is a fair representation of the actual appearance of the specimen as it then existed, with, perhaps, the exception that the jaws are unnaturally drawn out; and at the



bottom of the drawing is the following inscription:—"This is a drawing of a fish that came on shore at Newlyn on Saturday the 23rd of February, 1788. Its length without the tail (which



it wanted) was $8\frac{1}{2}$ feet, its extreme breadth $10\frac{1}{2}$ inches, and its thickness but $2\frac{3}{4}$ inches.—M. Wright *fect.*" The artist has supplied the deficiency of a tail by something which bears a resemblance to the same part in the common sea-bream—but without actually joining it to the body; and a deficiency also occurs at the head, where the crest or plume is represented by two long rays only that are bent forward, and each one tipped with a membranous expansion not much unlike the termination of a peacock's feather, but of a red colour, as are all the fins. The ventral fins are formed, each of a single ray, with its fan-like expansion, and reaching to about the middle of the body. The acknowledged imperfection of portions of this fish appears to have been deemed a sufficient warrant for the exercise of the imagination in persons who had not seen the original, but who undertook to form a likeness according to what they supposed it ought to be. Such must have been the case as regards a figure in the possession of the late William Rashleigh, Esq., F.R.S., etc., by whom I was permitted to take a copy of it; and which requires to be particularly noticed, as it was that from which Mr. Yarrell's figure was derived in the first and second edition of his *History of British Fishes.* In this case, the two rays which naturally rise from the forehead, and are so represented in Mr. Chirgwin's figure, are transferred to the throat, and thus the ventral fins are represented with double their usual number of rays, a mistake which is rectified in the last edition of Mr. Yarrell's work.

That Mr. Chirgwin, as above referred to, was in error when he supposed that no other drawing but his own was taken from the actual specimen at Newlyn appears from the fact that there exists in the library of the British Museum, bound up in a quarto copy of Pennant's work on the *Natural History England*, formerly in the possession of Sir Joseph Banks, a figure of this same fish, but which differs in several particulars from Mr. Chirgwin's drawing. In this the jaws are reduced to their proper position, but the rays on the top of the head are without their membranous expansion, and the ventral fins are broken short, which defects appear to be sufficient proofs that the figures in Pennant's volume were really copied from nature, but somewhat later than that of Mr. Chirgwin. The remarkable liability to injury in this fish, from rough handling, will explain the difference thus observed. Block's great work on fishes contains a likeness of what that author supposed to have been this Cornish fish, but his description of it appears to be scarcely intelligible. Some account of it, with a figure, was sent to him by Mr. John Hawkins, who had travelled on the Continent as a naturalist, but chiefly in pursuit of botany; but this gentleman appears to have sent also a small specimen of what both of them supposed to be the same species, but which had been taken in the East Indies, and what the Prussian naturalist is able to say on the subject is derived from a combination of these distinct and even diverse materials, with some confusion perhaps arising from not having well understood the information afforded by his Cornish friend. A claim has been made for two other examples of this fish as having also been taken in Cornwall—one in the year 1791, and the other in 1796; but after close inquiry I have found no ground for altering the belief that such was not the fact in either case; and in the last named instance it seems probable that the capture of Banks's oarfish at Filey Bay in Yorkshire, at that date, has led to the mistake; an opinion also countenanced by Dr. J. E. Gray of the British Museum, who communicated a satisfactory paper on this subject to the Zoological Society. As the published account of this last-named specimen gives a particular description of its appearance, we extract it more at large. It was thirteen feet and a half in length, rather more than a foot in depth, and not more than three inches in thickness. The skin was smooth and of a silver hue, it had no tail, and its fins were the colour of those of the roach or perch. The following notes are added from a private hand:—"The head seven inches long; eye, one inch and three-eighths in diameter; no scales, but very small protuberances, silvered over like the surface of a herring. These run the whole length in stripes, alternate with others that are bare and of a light colour. The dorsal fin runs the whole way from the head to the other end, and is red like that of a roach or perch: branchial rays six; dorsal fin with two hundred and ninety, and thirteen rays; pectoral fin with twelve, ventral one; no anal; no teeth, a soft tongue; the face and inside of the mouth black; anus, four feet nine inches from the head; iris a silver white."

Another example of this fish, which attracted much attention, was caught by some fishermen at Cullercoats in Yorkshire on the 26th of March, 1849, and fortunately came into the hands of Mr. Hancock and Dr. Embleton, who published a particular account of it in the *Annals and Magazine of Natural History* for July in that year. The fish was first seen at about six miles from land in water of the depth of from twenty to thirty fathoms. When first seen it was lying on its side on the surface, but as the fishermen approached it it became erect and came towards them with a gentle lateral undulating motion, with its crest and a small portion of its head above water. When struck with a staff it made off with a vigorous and vertical undulating motion, and quickly disappeared. In a short time it again came within reach, lying on its side, but when laid hold of with a hook it tore itself away, but was lifted into the boat at last by two young men placing their arms round it. It lived for some time after being taken on board, but there cannot be a doubt that when discovered it was in dying circumstances; and in every instance yet known it is clear that these fish have been driven from their usual haunts by disease, these haunts being in some of the deeper and more secluded caverns of the ocean, beyond the reach of human sight. In shallower water, and with less protection from the rage of storm, their fragile structure would expose them perpetually to destruction; for in the present instance the rude handling of rough visitors was found to have injured it greatly, in addition to what it had undergone in its immediate capture.

The length of this fish was twelve feet three inches, the greatest depth eleven inches and a quarter; the body exceedingly compressed; in its general form resembling a double-edged sword-blade; four longitudinal flattened ridges, each rather more than an inch broad, extended from head to tail above the lateral line, the uppermost, which was the longest, running forward almost to the eye. The dorsal fin extended from immediately behind the upper and posterior end of the curved frontal profile to within three inches of the tail. The anterior part of this fin was more prominent than the rest, with twelve rays, which, when the fish was taken, are said to have been twelve or fourteen inches in length, and each furnished with a membranous expansion on its posterior edge, increasing in width upwards, something like a peacock's feather. The first ray was a rather strong spine arising within the frontal curve; the three next very slender, and much closer together than the rest; the next equally slender with the preceding, but rather further apart; the three or four after this nearly as strong as the first, while the rest diminished in strength and length, and became uniform with the more level rays of the dorsal fin. Exclusive of the crest, there were two hundred and sixty-eight rays in the dorsal fin. The fishermen said that this fin was without colour when caught, but it had a red tinge along the border when examined by the gentlemen who described it. Each ventral fin had a very strong spine, with a limited motion, and at first their colour was a bright red. It will be observed that the number of rays in the dorsal fin differed rather considerably from those which were counted in the example obtained in Filey Bay; but this variation offers no difficulty in regard to the sameness of the species, since it is generally found that where the fin-rays in fishes are very numerous, they are rarely alike in number in different individuals. It is only when they are few that their number affords a character to be depended on.

This fish, obtained at Cullercoats, of which we have given a very much abridged description, was conveyed to London for the purpose of being exhibited; and it was there that, in company with Mr. Yarrell, I was favoured with a private examination of it; by which opportunity I was enabled to obtain the figure which accompanies this paper, and some notes which will enable us the better to understand some further particulars of its peculiarities. It is to be observed that the figure given in Sir John Richardson's (second) supplement to Mr. Yarrell's *History of British Fishes,* is represented, especially as regards the crest or plume on the top of the head, as it is said to have been seen at first by the fishermen, and not as when it was examined by the gentlemen who described it; but we prefer to represent it as it actually appeared when examined by ourselves in London.

On comparing the fish as exhibited with the figures represented in the great work on fishes by Cuvier, an adequate likeness did not show itself in any of them. The mouth appeared arched above, the mystache conspicuous, angle of the mouth depressed. The front ray of the fin on the forhead admitted of very little motion, but projected firmly forward; but this and all behind it were broken short, and no one of the fishermen who were present at this examination would affirm that the rays were at first bordered by a membrane through their whole length. A membrane united the rays for less than half their length, but beyond this it seemed uncertain. By joining the piece of the pectoral fin that had been broken off, this fin was shown to have the first rays longest, and consequently that it tapered towards the extremity. The tail portion of the body was remarkable, and therefore has required to be exhibited separately. The dorsal fin ended a very little short of it; and from thence the outline sloped downward, the lower portion forming an angle two or three inches behind a perpendicular line drawn from the upper. The exact internal structure of this part could scarcely be known without dissection; but from a fixed point of bone above there passed a firm bony curve, with the concavity towards the body, to the fixed point below; and from one to the other was stretched a thin substance resembling membrane, which appeared to represent something that might act as a fin, at least for the purpose of guiding or assisting its progress. A curiosity in the inward structure of this fish was observed in the convolution of the intestine, which passed backward close to the end of the body, and then returned to the vent that was much nearer to the head.

It is clear that this fish is an inhabitant of the northern seas, where it grows to a greater length than we have already mentioned; for since the date given above an example was obtained about five miles north of Wick, in Scotland, that measured more sixteen feet. But there is much difference of opinion among naturalists as regards the distinction of species of several of the examples which have been met with. Dr. J. E. Gray has expressed his belief, "from a comparison of the various descriptions and figures given by English observers and those given by Ascanius, Brunnich, and Lindroth, that there is only a single species yet found in the North Sea, and that this species comes as far south as the coast of Cornwall;" while, on the other hand, Dr. Gunther, who is engaged in arranging the fishes preserved in the British Museum, expresses his opinion that five separate species have been found in the seas of Europe. Without attempting to decide where doctors differ so widely, I will add an account of a fish which may be of the same species, and certainly is of the same genus, which ran itself on shore on Hamilton Island, one of the Bermudan group, and of which, besides the notes published in the *Zoologist* for 1860, I was furnished with pen-and-ink sketches and measurements taken at the time by an officer of the royal navy. The contradictions which appear in the descriptions of this example by gentlemen who cannot be suspected of a wish to deceive, will afford a lesson how far we should implicitly accept the information conveyed by those who possess no knowledge in the science of natural history. This unfortunate fish encountered the usual fate of its race in suffering violence sufficient to destroy its symmetry, even at the first; the fears of its captors being excited by the belief that they had met with a sample of the far-famed serpent of the ocean, the existence of which has been so strenuously denied.

The effect may be imagined when we are informed that this supposed reptile was attacked with large forks, which were lying near at hand, for collecting sea-weed, by which it was "unfortunately much mauled" before it was secured. Its length was sixteen feet seven inches, and the general proportions much like those of Banks's oarfish, which the profile of the head also much resembles. The crest, or plume on the head is, in an American figure, given in *Harper's Weekly Paper*, represented as separate from the more level dorsal, but in others it is not so; and, says Captain Hawtaigne, in the *Zoologist*, this crest was formed of a series of eight long thin spines of a bright red colour, which followed each other at about the interval of an inch: the longest ray, which was in the middle, was two feet seven inches long, and flattened at the end like the blade of an oar. Mr. Jones, however, who more closely examined this fish, and better understood its nature, informs us that the number of rays in this crest was "ten or eleven, from two to three feet in extent." And my other account represents them as exactly ten, the longest three feet in length, and united by a membrane for more than half their length. In the American figure the dorsal fin runs to near the extremity of the body, of a bright scarlet colour, the pectoral much injured, but with twelve rays. In all these descriptions there is nothing to lead us to suppose that this example was other than the usually described Banks's oarfish, except that Mr. Jones says that what remained of the right ventral fin was "composed of two consistent bony rays," which would be decisive of an hitherto unknown species, and even of an aberrant genus. A sketch referred to gives only a single ray to this fin, but in the American drawing there is the appearance of two. It is probable, however, that neither of these unscientific persons were aware of the interest attached to the question whether these rays were one or two, and until this is settled the exact nature of this fish must remain uncertain.

MOSS PARASITES,

BY THE REV. MILES JOSEPH BERKELEY, M.A., F.L.S.

ALMOST every one is acquainted with the rhymes which speak of the parasite upon parasite with which some members of the insect world are infested, and a similar legend would equally hold good with respect to other branches of the animal kingdom. Nor are vegetables less subject to become the prey of other vegetables. The mistletoe and broomrape, after they have done their worst by their victims, are in their turn infested with fungi, and the fungi themselves are obliged to submit to the attacks of other more minute species, though not exactly *ad infinitum*. Even lichens in their more arid form, subject as they are at times to months of drought and the direct rays of a burning sun, are not without their peculiar parasites, constituted to endure the same abrupt changes from continued damp to almost perfect dryness as themselves. Nor are the vascular cryptogams, such as ferns, mosses, and liverworts without their own especial enemies, though these are fewer in number perhaps than in other organized beings. Mosses, for example, besides affording a nidus for the development of such fungi as the pretty scarlet *Peziza axillaris*, which perhaps is only a false parasite, have one or two species which are developed in their substance, as *Septoria thecicola*, Berk. and Broome, and *Sphæria emperigonia*, Auerswald. The former of these was found on the ripe capsules of *Polytrichum piliferum* at Aberdeen, by Dr. Dickie, and the latter in Germany by Herr Auerswald, on the rose-like male inflorescence of *Polytrichum commune*, specimens of which are published by Rabenhorst in his German Fungi. Different as they are in structure, as will appear from the accompanying figures, there is good reason to believe that they are merely different conditions of one and the same species, for nothing is more common than for fungi to exhibit two forms of fruit on the same or on different plants, after the fashion of

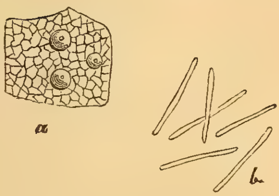


FIG. 1.—*Septoria thecicola*, Berk. and Broome.

a. Perithecia, magnified.
b. Spores, highly magnified.

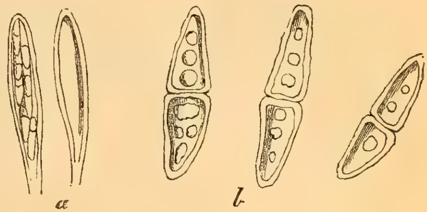


FIG. 2.—*Sphæria emperigonia*, Auerswald.

a. Asci, magnified.
b. Spores, highly magnified.

monoicous or dioicous Phœnogams, a fact long since suspected by Fries, and now proved to demonstration by the brothers Tulasne.

Besides these pigmies of the vegetable kindom there are some higher Fungi peculiar to mosses, or indifferent as to their nutriment, whose spawn or mycelium runs over their leaves and quickly effects their destruction.

For example, nothing is more common than to find mossy sticks in our woods covered with delicate snow-white patches consisting of threads far more slender than those of a spider's-web. These patches soon extend to the mosses, which presently become discoloured, and ultimately fade altogether. This enemy when fully developed is found to be *Corticium arachnoideum*, one of those fungi, which at a later period form little solid pellets which live through the winter, and are ready on returning spring to attack the tender shoots of another year's growth.

Another fungus still more destructive to mosses can scarcely have escaped the notice of those who are accustomed to greet Nature in all her phases. In calcareous districts, especially the Oolitic, where the stone fences are capped with a kind of mortar consisting almost entirely of comminuted oolite, which has been crushed down upon the roads, and adapted admirably for the development of many a moss, nothing is more common than to see the pretty tufts, which rejoice the artist's eye with their warm tints when lighted up by a sunbeam, more or less completely marred by large white mouldy patches, which soon run into decay. A close inspection shows that here again we have the mycelium of a fungus at work, though of a very different kind from that just mentioned. At first, indeed, nothing but the cotton-web is visible, but this soon becomes partially tinted with salmon colour, and then studded with little pale scarlet specks, which are the cysts or perithecia of a *Nectria,* which from its peculiar habit has been called *Nectria muscivora.* This species is found on the Continent as well as in this country, and appears in M. Desmazières *Cryptogames du Nord de la France* as *Sphœria bryophila,* having been found by him about the old fortifications of his neighbouring city, Lille. This little enemy is of the greater importance, and more worthy of being mentioned here, because it is no less active in destroying mosses under cultivation than in the open air. I have seen it at work in a little conservatory devoted to these beautiful and interesting vegetables; and it very soon proves fatal if the gardener is not careful to remove it with a feather or camel's-hair pencil, as fast as it appears.

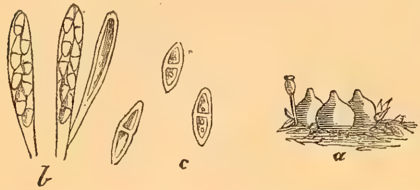


FIG. 3.—*Nectria muscivora,* Berk. and Broome.

a. Perithecia, magnified.
b. Asci with sporidia, magnified.
c. Sporidia, highly magnified, natural size $\frac{1}{1000}$ inch long.

I observed a few days since another moss parasite in a very peculiar position, which deserves record, as much on account of its curious habit, as because it forms an addition to our list of fungi which prey upon mosses.

The oolitic stepping stones which run along the ancient causeway leading from the site of Fotheringay Castle across the valley of Nene, produce, where they are not worn by the feet, a large quantity of that variety of *Orthotrichum cupulatum* which has a smooth veil, mixed with *Schistidium apocarpum,* and one or two other mosses. The capsules of the different species of *Orthotrichum,* as is well known, are just a year from their first growth in coming to perfection, and perhaps partly on account of their comparatively short fruit-stalk, and partly from the tenacity of the fruit-stalk itself, are more persistent than in most mosses, so that the plant at the present moment presents the capsules which were ripened last year, those that have just come to perfection and the rudiments of the crop which is to be matured early next summer. The teeth which surround the mouth of the capsule are sixteen in number, and when dry spread out more or less, but are not recurved as in several other species. I was surprised, however, to find in many of the old capsules, that the teeth were horizontal and applied by their edges to each other, exactly as when they were still within their lid, and just after the fashion of that arrangement of the unopened petals or sepals of phœnogams which is known by the name of valvular æstivation. When immersed in water no change took place in their position, and the teeth seemed permanently glued together. This, of course, excited attention, and on opening one of the capsules it appeared that the mass of spores was infested by a little pink *Fusisporium*, whose slightly gelatinous spores had been the means of closing the orifice of the capsules, and preventing the dispersion of the spores. I did not indeed always find the mould within the capsule, its proper season being probably over, but on washing the surface of the united teeth, I was always able to obtain a quantity of the spores of the fungus, which from their peculiar form were not likely to be mistaken.

It is very possible that this little parasite may be extremely common, but I believe that it has not been observed before, and its discovery affords one among the many proofs that, even in the most unpromising situations, there is always some novelty to be found or some interesting fact to be ascertained if there is an eye to mark it.

The characters of the little parasite are not striking, and its specific distinction must rest partly on its peculiar habits, for the spores scarcely differ from those of one or two other species. Its characters such as they are may be given as follows:—

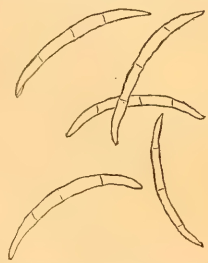


FIG. 4.—*Fusisporium incarcerans*, Berk.

Spores, highly magnified.

Fusisporium incarcerans, Berk. pallide roseum intra sporangium muscorum vel in peristomio nidulans, sporis arcuatis tenuibus triseptatis.

The spores are about 1-416th of an inch long, but, as is very often the case with fungi, are by no means uniform in size.

IS THE GIRAFFE PROVIDED WITH MORE THAN TWO HORNS?

BY T. SPENCER COBBOLD, M.D., F.L.S.

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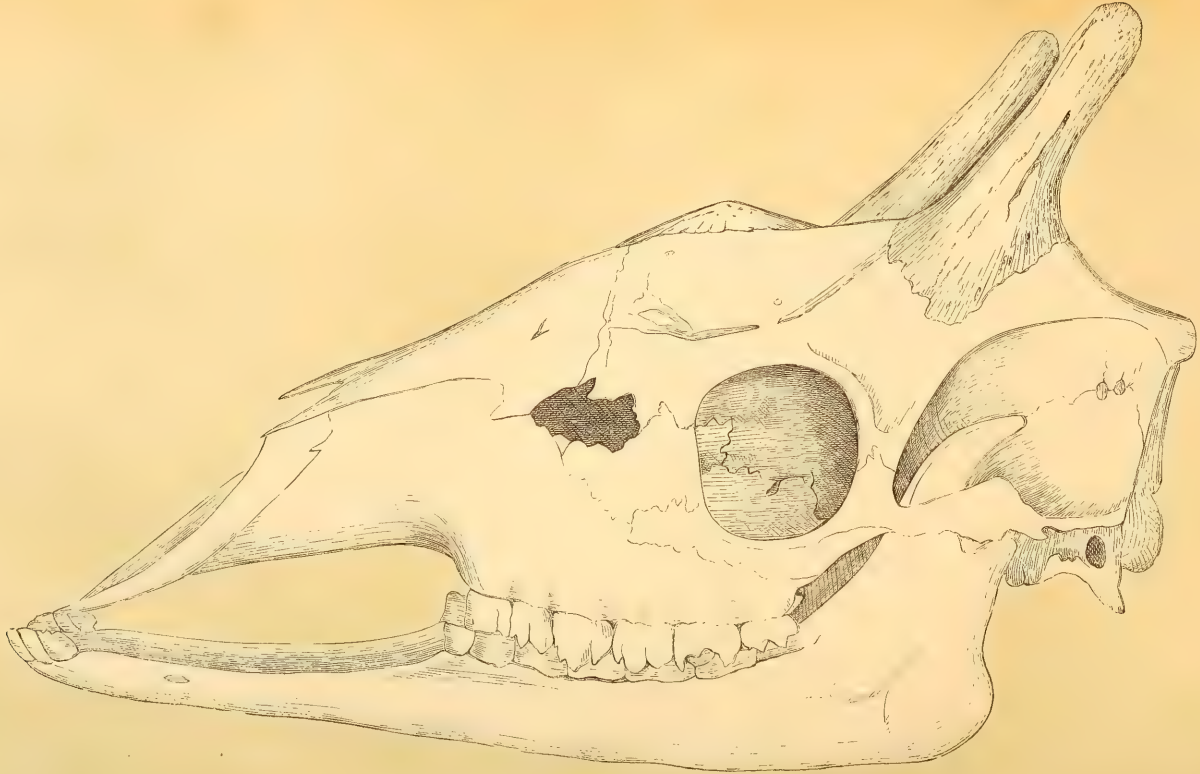
In the first of a course of public lectures "On the Structure, Habits, and Affinities of the Herbivorous Mammalia" which I had the honour of delivering at the Royal Institution of Great Britain, Albemarle Street, during the summer of 1860, I ventured to answer the above proposed question affirmatively. I say "ventured," because I was aware that in doing so I should be recording an opinion directly at variance with the published views of one to whose elaborate and long-continued researches the progress of anatomical and zoological science is deeply indebted. In the present case, however, we have to deal with a simple matter of fact, and I therefore proceed in the following pages to explain the grounds on which, in contradistinction to the statements of Professor Owen, it may be truthfully affirmed that there are three horns, or "pseudo-ceratophorous epiphyses," projecting from the skull of the adult male giraffe.

The veteran traveller, Dr. Edouard Rüppell, who, according to recent information, is still in the enjoyment of good health, and living in the city of Frankfort, was the first to declare unequivocally that a third horn existed in the full-grown male. In his trustworthy and admirable *Reise im Nordlichen Afrika*, published in the year 1828, he observes that "the horns constitute the principal generic character, they being formed by distinct bones united to the frontals and parietals by a very obvious suture, and exhibiting throughout the same structure as the other bones. In both sexes one of these abnormal bones is situated on each branch of the coronal suture, and the male possesses an additional one, placed more anteriorly, and occupying the middle of the frontal suture." Not having the original work by me at the present time, I quote the above translation from an excellent article in the *English Cyclopædia*, where a rough woodcut is also given, copied from Rüppell, representing the third horn in profile. In the *Atlas zu der Reise*, etc., the plates are beautifully executed, and from repeated examinations and comparisons, I am convinced of their accuracy in all respects. Though less developed and conspicuous, the mesial prominence is precisely like the two posterior epiphysial horns, and all of them are distinct from the true osseous elements of the cranium.

This early statement of Rüppell appears to have received the unqualified support of Baron Georges Cuvier, and so far



Skull of a young [illegible], shewing the [illegible]

as I am aware, no anatomist found occasion to doubt its correctness before Professor Owen, who, from the examination of crania preserved in the Museum of the Royal College of Surgeons, Lincoln's Inn, was led to believe Rüppell's views to be erroneous. In his otherwise valuable memoir, modestly entitled "Notes on the Anatomy of the Nubian Giraffe," published in the second volume of the *Zoological Society's Transactions*, at page 217, he says: "In regard to the existence of horns in the two sexes, we find a few examples among both deer and antelopes, which thus resemble the giraffe. The horns of the giraffe possess, however, certain characters which are peculiar to themselves; the basis of the horn, for example, is articulated by synchondrosis to the frontal and parietal bones, and thus constitutes an epiphysis rather than an apophysis of the cranium. A broad, obtuse, osseous eminence in the middle of the forehead has been described as a third horn, and has been stated to be similarly articulated to the frontal bone, at least in the male Nubian giraffe, and to be the only instance of a horn developed in the mesial line of the cranium, and over a cranial suture in the mammiferous class." Cuvier says: "Au milieu du chanfrein est un tubercle ou une troisième corne plus large et beaucoup plus courte, mais également articulée par suture." J. B. Fischer describes the third articulated horn as peculiar to the male giraffe. To this sentence Professor Owen also appends a foot-note, wherein he observes: "The figure of the skull which illustrates the account of the Nubian giraffe in the *Atlas zu Rüppell's Reise im Nordlichen Afrika*, pl. ix. p. 23, represents indeed this third tubercle as distinct and articulated by suture with the cranium; but in the original cranium, from which the original figure is taken, and which I have examined in the Frankfort Museum, I could not perceive any evidence of the existence of such a suture; the mesial protuberance had not been detached from an epiphysial articular surface, but had been sawn off in order to be preserved in the stuffed animal." Further on, at p. 235, whilst instituting a comparison between the Cape and Nubian varieties of the giraffe, Professor Owen adds: "In the adult male Cape giraffe, the only appearance of the distinctness of the anterior protuberance is due to some irregular vascular grooves at the circumference of its base; but similar grooves are also visible in the skull of the female; and a section of the skull, taken through the middle of the frontal protuberance in the male, shows that it is formed by the thickening and elevation of the anterior extremities of the frontal, and the contiguous extremities of the nasal bones. In the male Nubian giraffes, which had attained nearly two-thirds of their full stature, the posterior horns, like other bony epiphyses, were less firmly attached to the skull than they were in the full grown Cape giraffes, and they became detached from the frontal and parietal bones after a short maceration. Now if the anterior protuberance had been formed by a similar separate ossification, this would undoubtedly have been demonstrated in a similar manner; it, however, consisted only of a partial elevation of the frontal and nasal bones, as in the adult Cape giraffe."

The very argument which is here adduced by Professor Owen to prove the absence of the third horn, is precisely the one which I shall presently bring forward to show that the mesial epiphysis exists; but in the meantime I may observe that the Professor's convictions as to the certitude of his views are elsewhere more strongly expressed. Thus in his excellent article "Giraffe," in Mr. T. Brande's *Dictionary of Science, Literature, and Art*, at page 514, speaking of this animal, he observes: "Up to a very recent period, we find it described as having callosities on the knees and over the sternum like the camel, and as a kind of lusus with three horns, of which one, being articulated over a suture in the middle line of the forehead, seemed to take away from the chimerical nature of the unicorn by indicating a transition to that heraldic monster. The truth is, however, that the giraffe possesses neither those callosities nor this median articulated horn."

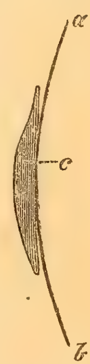
Having thus fairly stated the grounds on which the absence of a third horn is denied by our highest authority in vertebrate anatomy, I now proceed to record the evidence and experience which enable me to vindicate the originally received opinion, as expressed by Rüppell, and to throw light upon a question which should now, at once and for ever, be set at rest. In this persuasion, let it be observed, I do not stand absolutely alone; for, as I shall afterwards show, the independent *Osteologische Bemerkungen* of Dr. George Jaëger, as recorded by him in the twenty-sixth volume of the *Acta Acad. C. L. C. Nat. Cur.*, part i. section 3, for 1855, prove that distinguished anatomist to have been led to a similar conclusion:—

1. In the young giraffe which died last year at the Zoological Society's Gardens, Regent's Park, there was only a slight thickening of the subdermal periosteal tissues immediately above the central frontal eminence; but it was sufficiently thickened to allow of detachment by dissection; and I have preserved the separated portion in a dried state. This young male giraffe was only about six weeks old.

2. In another young male giraffe which died at the Zoological Society's Gardens on the 2nd of December, 1859, the fibrous sub-integumentary aponeurosis was still more markedly thickened; but there was as yet no development of a gristly cartilaginous tissue within its substance. This giraffe was born

on the 6th of July, 1859, and was therefore about five months old. I have given an account of the accidental circumstances which led to its death, together with the anatomical peculiarities it presented, in a paper entitled "Contributions to the Anatomy of the Giraffe," published in the *Zoological Society's Proceedings* for February 14th, 1860.

3. In an immature male giraffe which died at Edinburgh during the severe winter of 1854, I found the frontal aponeurotic thickening much more marked, forming on the dried skull a distinct fibrous mass, which presented an appearance in profile such as I have here represented in the accompanying diagram; the letters *a b* indicating the border of the fronto-nasal eminence, and *c* the fibrous mass. I subsequently detached this fibro-cartilaginous matrix for separate preservation and examination, but it was, I believe, swept away with other museum debris, by an assistant who had no knowledge of its value. After removal, it was perfectly transparent, and free from osseous deposit. The giraffe in question belonged to Wombwell's travelling menagerie, and was represented to me as being about eighteen months old. Having, at the outset, devoted three weeks to its dissection, and renewed my examinations of the various organs at subsequent intervals, I may, for further particulars respecting its anatomy, death, etc., refer to my several memoirs in the *Edinburgh Physiological Society's Reports* for 1854, the *Edinburgh New Philosophical Journal* for 1856, and more particularly to the June number of the *Annals of Natural History* for 1854.



4. When engaged during the autumn of 1856 in writing the article "Ruminantia" for the *Supplement* to Dr. Todd's *Cyclopædia of Anatomy and Physiology;* I took occasion to visit the Museum of Trinity College, Dublin, expressly with the view of examining the adult cranium of a fine male giraffe, which I understood to be preserved there. As a result of this inspection I subsequently wrote as follows:—"Through the kindness of Dr. Ball we have examined the skeleton of a male giraffe which died at the Dublin Zoological Society's Gardens, and which is now preserved in Dr. Harrison's anatomical museum. In this individual the central cranial eminence is not smooth as in our specimen (above referred to); on the contrary, it is particularly rough, owing to the deposition of osseous nodules which bear a marked resemblance to the irregular bony laminæ prolonged from the attenuated margins of the bases of the true horns. If these rough prominences could be shown to be separable by maceration, we might with good reason infer the

rudimentary existence of a third horn." This fine male formerly belonged to the London Zoological Society, and was bred in the Society's Gardens, Regent's Park. I have noted the peculiar cause of its death, in the paper already referred to, in the *Zoological Society's Proceedings* for 1860.

5. After completing the article above mentioned, I visited the museum of the Royal College of Surgeons, Lincoln's Inn; and having, through the ever-ready kindness of the late Professor Quekett, had an opportunity of inspecting the giraffine crania there preserved, I was in time to append a footnote to "Ruminantia" to this effect: "The osseous nodules noticed in the Dublin specimen not only exist in one of these crania, but they could be partly raised from the subjacent bone by the easy insertion of the finger-nail under the margin." Since the year 1856 I have repeatedly examined these crania, and have no shadow of doubt as to the existence of an ossified synchondrosis which has united the third horn to the frontal eminence.

6. The distinctness between the third horn and the frontal eminence was still more significant in the skull of an adult giraffe which died at the Zoological Society's Gardens several years back; but in this case also there was union by synchondrosial ossification. I examined the cranium in 1857, before the skeleton was finally cleaned and sent away, and have since been informed that it is preserved in a museum at Bristol.

7. The most cogent evidence, however, which I can adduce, is that derivable from the skull of a young male, whose cranium is here represented in profile, and whose entire skeleton may now be seen, set up and preserved, in the Derby Museum at Liverpool. This skeleton was formerly in the possession of Mr. Gerrard, the accomplished taxidermist at the British Museum, and I am indebted to his son for the loan of a carefully-executed drawing which I have here sketched in a reduced form, and caused to be copied in a tinted plate. In this instance, as I am distinctly and unequivocally informed by several gentleman connected with the British Museum, who have examined the skull, *the third horn became readily detached by maceration,* it was for a considerable time separately preserved, and presented all the ordinary characteristics of the two posterior horns, of whose epiphysial character no one entertains the slightest doubt. The third horn, or central pseudo-ceratophorous epiphysis, has since been glued on to its original position, and may now be seen *in situ,* as a standing proof of the correctness of Rüppell's original persuasion.

8. In the Museum of the University of Tübingen there is also preserved a similar skeleton of a young male giraffe, in which—according to verbal information kindly communicated to me by Dr. Gunther, of the British Museum, who is familiar

with the specimen—the third horn was equally well marked and separated by maceration.

9. Lastly, I adduce additional conclusive evidence from Dr. George Jaeger's *Bemerkungen uber die Hörner und Epiphysen*, etc., as recorded in the twenty-sixth volume of the *Acta* already referred to; and I beg to call particular attention to this extract, which I translate from a footnote appended to the memoir in question; the italics are mine. The author says: "In the skull of a young male in the collection at Munich, whose horns are scarcely two inches long, and likewise separated, there is, in the place of the third central horn, a rather strongly-marked elevation of the frontal bone, but no trace of an epiphysis. In the skull (nineteen inches long) of a male received a short time ago from the north of Africa, through Dr. Heuglin, which skull we believe to be mature, the suture of the hind horns is still perceptible, but the serrated borders are almost firmly united to the frontal and parietal bones. *The mesial horn, however, is still quite separated by the epiphysial cartilage from the frontal and nasal bones,* whose sutures are not yet obliterated, as also obtains in the other cranial bones. The anterior margin of the central horn-bone projects about one inch over the posterior limit of the nasal bone. From thence the anterior part of the horn rises to the tip, forming a very gradual slope, while the posterior inclination is comparatively steep and short. It results from this that the central horn unites with the bones much later than the hinder horns, which are common to both sexes."

After such evidence, it is scarcely reasonable to regard the point under consideration as still an open question. Had Professor Owen chanced to have examined the crania of younger males, he would undoubtedly have confirmed Rüppell and Cuvier in all essential particulars. The old skull at Frankfort, the skeleton at Dublin, and the cranium in the Hunterian collection, all seem at first sight to lend their support to his view, because the synchondrosial ossification has in all of these cases firmly welded the third horn to the subjacent fronto-nasal eminence; but even in some of these specimens a minute inspection indicates at the margins the original distinctness of the several osseous elements. The skull at Munich represents an example where the intervening fibro-cartilage has not yet commenced ossification, although it appears to be just on the point of doing so. The crania of young males preserved at Tübingen and Liverpool show the separable but distinctly-osseous third horn in a less completely developed condition; and the three young male giraffes dissected by myself severally displayed yet earlier stages, where the periosteal aponeurotic matrix in which the third horn would have been developed had become more and more thickened, according to the relative increase of age. These being the facts of the case, I have no hesitation, for my own part, in asserting that every adult male giraffe is certainly possessed of three distinct horns, or, to speak in the more precise zoological phraseology which I have elsewhere adopted, this ruminating herbivore possesses three cranial "pseudo-ceratophorous epiphyses permanently invested by a hairy integument."

THE MINSTRELS OF THE SUMMER.

BY SHIRLEY HIBBERD.

It is one of the consolations of having to live within the hearing of the tolling of the hour by the clock of St. Paul's that all the summer minstrels are to be heard in the garden. Though only three miles distant, as the crow flies, from the General Post Office, Stoke Newington is annually visited by the nightingale, cuckoo, flycatcher, blackcap, garden warbler, whitethroat, grasshopper warbler, redstart, and some few other nomadic minstrels of less fame. Every spring it occurs to me that it would be an interesting contribution to natural history if we could have lists of all the birds visiting and nesting in the immediate vicinity of our great towns and cities, and as the plants peculiar to numerous suburban districts have been carefully registered, we might hope some day for similar catalogues of birds classified as to their localities, with especial reference to the nearness of their haunts to populous places. In the pages of *Rustic Adornments*, I called the attention of Londoners to the fact that at Stoke Newington the nightingale was always to be heard in its season, and in consequence of that intimation there have been numerous parties formed to visit the reservoirs in Lordship Road, where, in the secluded shrubberies, this and other warblers breed in perfect security. Though during the period of twenty years' experience in connection with the nightingale in this locality, buildings have increased to an extent which would be saddening were it not true that men are better than trees, the nightingales have not only not left it, but this year they literally abound, and since the 22nd of April I have commonly heard three and four at a time singing in rivalry among the trees surrounding my own garden. So with the cuckoo, its merry, inspiriting note may be heard resounding from every point of the compass, and wrens and blackcaps are almost as numerous as sparrows. This, I imagine, is to be attributed in some measure to our increasing regard for the protection of small birds; people are beginning to appreciate birds as proper adjuncts of rural scenery, and the destructive propensities of the untaught are kept in check by proprietors who value birds in trees more than birds in cages.

The supposed ornithological poverty of suburban districts is mainly attributable to the infrequency of a habit of observation among the residents. People who believe that no more select feathered visitants than sparrows ever do them the honour of a call should adopt an agreeable method of putting the matter to the test. Choose a time between the 1st of May and the 20th of June, and to secure the best day let it be the 1st of June, and on that day renounce the solicitations of Morpheus. In other words, sit up all night, walk about the garden, read a play of Euripides in a room overlooking the woodiest prospect you have, and take care to keep the window open. I confess that I set apart many nights during that period to enjoy perfect stillness, broken only by the barking of dogs, the crowing of cocks, and the singing of feathered minstrels. With a cup of good coffee, and Virgil's *Georgics*, or a readable edition of Columella, better still the Psalms of David, it is like adding a year to one's life, so intense is the enjoyment of the coolness, the greenness, the music, and the whispers of the wind. From 8 till 11 P.M. the concert is kept up with unflagging vigour by thrushes, blackbirds, wrens, blackcaps, and nightingales, the cuckoo adds his bass accompaniment or chorus. I have just seen the sun rise after one of these nocturnal vigils, and I feel fresh: the dew is wet on my beard; I feel elastic, and should like to walk up a breezy hill, had I not noted a few passages in books that I have turned over, and to which I propose making reference. I have heard the muttering of crickets and beetles in the privet hedge, seen roosting thrushes change their places, heard a quarrel between two sparrows cowering under a ledge of timber on the roof of a shed, and counted the voices of nine species of birds between midnight and 2 A.M. Within one hour from 11.30 P.M. to 12.30 A.M. I heard the cuckoo, nightingale, thrush, woodlark, reed-wren, whitethroat, willow-wren. Soon after 1 A.M. I heard, in addition to the foregoing, the chaffinch, the wren, and the chiffchaff, and after two o'clock there was such a general mingling of voices that it was possible only to distinguish the thrush, cuckoo, chaffinch, and robin, whose utterances are so distinct as to be at all times unmistakeable. Far away on the borders of the New Forest, and among the crowded slopes of Herefordshire and Hertfordshire, I have at night heard the golden oriole, the ring-ousel, the water-ousel, and the grey wagtail; the last to be seen as well as heard during moonlight at the midnight hour, but none of these, so far as I know, visit the gardens near London.

The music of birds has a different effect to music of every other kind, and it may be that the associations of vegetable luxuriance and the enjoyment of a refreshing out-door temperature assist the charm and are properly parts of it. Gassendi gives a curious reason for preferring the music of birds to that of instruments, and describes the effect of the latter on the mind—"Præhabebat porro vocibus humanis, instrumentisque harmonicis, musicam illam avium." Certainly with a western prospect, consisting of broken campaign sward terminating in a background of copse and tall elms, when the sun darts his first horizontal beams across it, and with a scarlet thorn to perfume the air and a thrush or nightingale in song overhead, the pleasure is as great as can be borne, and is enough to make one satisfied that our summer grows by successive increments, for if it were to burst upon us all at once it would be too much for ordinary powers of endurance.

It has been frequently remarked that song birds generally haunt the dwellings of man. This is particularly the case in Britain, though it is a mistake to allege that the birds of the tropical wilderness are deficient of musical powers, and in the tropics, especially of America, the richest bird-music is heard in districts where man is at most a sojourner, and has never chosen a site for a village or encampment. It may be that song birds like human society, as it is certain the robin, blackbird, and thrush do; and it may also happen that food and conveniences for building are more plentiful on the skirts of towns and villages than in deep forests and great open wastes. But this association has not been without its effect on literature; and when I have heard some of those wild Scottish and Irish airs that remain to us of the music of the past, I have often thought they were borrowed from the songs of birds; and I should suppose the modulations of the robin, the nightingale, and the song thrush, would furnish ready-made compositions, needing only to be copied, for the use of the mellowest human voices, and for any class of soft-toned wind instruments. Gardener's *Music of Nature* I have never seen, but have always understood that it is a reduction to musical scale of the songs of our best birds. Kircher, in his *Universal Harmony* (vol. i. chap. 14), attempted a reduction of the nightingale's song, and with much better success than Bechstein's reduction to words consisting of zi and zo endlessly repeated. The very thought of wedding such music to words, as I believe was done by the old Scottish and Irish minstrels, suggests the question, What do the birds themselves mean? for these exquisite utterances have a meaning, we may be sure, and are not far away from parallels to the hymns and ballads we sing ourselves. Every observer of birds must be familiar with their several call-notes to each other, their expressions of joy and alarm, from the blackbird's "chuck" when in possession of a snail, and "chirrall, chirrall," when suddenly alarmed, to the harsh "chink" of the robin when about to fight. As Plato called flowers the joy of plants, we must perhaps be content with equal vagueness of description in designating song the joy of birds. When the heart is merry we are wont to sing, and while the woods and gardens resound with a thousand melodious lays we can discover therein a new cause for thankfulness to the Father of all things, not only that we are made happy thereby, but that all the world brims with joy and speaks aloud its ecstasy in the voices of these timid, fluttering creatures.

The language of animals is not a new theme. Sir William Jones tells of a lutanist who, in a grove at Schiraz, competed with the nightingales who gathered round him on the branches, and in their endeavours to outdo the musician fell on the ground at his feet exhausted. In the thirty-fifth number of the *Quarterly Review* is an account of a man who had learnt the language of birds, and knew by the call of the mother where the nest was, how old the young were, and how many she had reared in the nest. But this is nothing to the story of Porphyry, in his delightfully gossiping book on abstinence. He says, vindicating the possession of reason by animals, "that which is vocally expressed by the tongue is reason, in whatever manner it be expressed, whether in a barbarous, or a Grecian, or canine, or a bovine mode; all other animals that are vocal participate of it." * * * * "This, for instance, is related of Melampus and Tyanæus, and others of the like kind, that they understood the speech of animals. It is related of Apollonius Tyanæus that once, when he was with his associates, a swallow happening to be present, and twittering, he said that the swallow indicated to other birds that an ass laden with corn had fallen down before the city, and that in consequence of the fall to the ass the corn was spread about on the ground. An associate of mine informed me that he once had a boy for a servant who understood the meaning of all kinds of birds, and who said that all of them were prophetic." (*De Abstinentia ab esu animalium,* lib. iii. 3.)

Thales and Tiresias are both represented to have understood the language of birds; and Plato, in his picture of the golden age, supposes men to have understood the language of birds and beasts. Cicero says the Arabians cultivated this knowledge; and Sigard, in the Scadinavian Mythology, acquires the gift by eating the flesh of a serpent.

It is an old dispute, of which a book-lover never tires, whether the song of the nightingale be merry or sad. As Hartley Coleridge puts it, it is a poet's question :—

> "Oh, nightingale, what doth she ail,
> And is she sad or jolly ?"

But the naturalist must have an opinion, and his decision will be that it depends very much on the mood of the person hearing it. Such exquisitely tender, plaintive, and refined modulations as the nightingale pours forth for hours together, and generally at a time when other birds are sparing of their songs, will, of necessity, induce a feeling of agreeable sadness. No intensely wrought performance in any department of art causes mirth; the absorption of enjoyment is fatal to jollity, which catches at things as they flit over the surface of life, and cannot go deep without the certainty of being lost. Homer and Horace give us no opinions on the subject. The passsge in the *Helena* of Euripides, beginning at line 1191 of Potter's version, is decisive as to the opinion of this careful observer of nature :—

> "Thee, sweetest bird, most musical
> Of all that warble their melodious song
> The charmed woods among,
> Thee, tearful Nightingale, I call.
> Oh come, and from thy dark plumed throat
> Swell sadly sweet thy melancholy note
> Attempered to my voice of woe."

The beautiful thought of Isaac Walton is familiar to every reader; not so, perhaps, that in Sylvester's *Du Bartas,* beginning—

> "All this is nothing to the nightingale!
> Breathing so sweetly from a breast so small
> So many tunes."

Sophocles invariably represents the nightingale as sad, and, in common with the poets, addresses the bird in the feminine gender. How awfully touching is that passage in the *Agamemnon* of Æschylus, where the chorus describes the "frenzy of a mind possessed with wildest ravings," as

> ——— "Like the sweet bird
> That darkling pours her never-ceasing plaint."

And what reader of Sophocles will forget the wandering Œdipus, in his blindness and exile, led by his daughter to a land the name of which they knew not, where

> ——— "In the midst
> Thick fluttering nightingales their sweet notes tune."

Whose line is that—"Dulces variat Philomela querelas ?" It would be worth knowing, for it gives a new form to the discussion. Virgil comes near its spirit in the *Georgics* (IV. i. 511), "Qualis populeâ mœrens Philomela sub umbrâ," etc.,* beautifully rendered by Dryden—

——— "Her children gone,
The mother nightingale laments alone,
Whose nest some prying churl had found, and thence,
By stealth, convey'd th' unfeathered innocence,
But she supplies the night with mournful strains;
And melancholy music fills the plains."—(L. 741—7.)

Milton described the song as "most musical, most melancholy," yet, after all, these quotations go for nothing, except to show that, according to the mood of the mind is the nature of the impression, for the chorus in *Helena* is overwhelmed by anguish as the tragedy moves towards its climax. Virgil describes the song of a bird bereaved of its young, and Milton has it, in *Il Penseroso*, where every item of the furniture "some sad embroidery wears." So Æschylus, in the *Agamemnon*, makes amends for coupling the nightingale with images of woe—

"Ah me! Ah me! the nightingale's sweet lot!
A sweet existence that lamenteth not."

The nightingale is, in habit, one of the cheerfullest, as it is, perhaps, *the* most elegant of small birds. There is a tree in my garden on which a nightingale perches over my head a dozen times a day, while hunting for caterpillars and other dainties, and its sprightly action is unequalled for life and grace and spirit, coupled with a delicate shyness, most appropriate to such a marvellous songster. I often repeat to myself, as I enjoy the glorious concert, which, from the end of April to the end of June, rings out during the whole twenty-four hours, those lines of Gavin Douglas—

"To bete thare amouris of thare nychtis bale
The merle, the mavys, and the nychtingale,
With mirry notis myrthfully furth brist."

It is at night only that the thought of sadness would occur, and as the nightingale, until his mate has hatched the brood, sings at all hours, except just before and just after noon, it only needs to be heard in the daytime to prove that, intrinsically, the song is neither sad nor playful; it is deeply joyous, rich, sonorous, and enlivening, except during the gloom of a moonless night, when it rises above the sigh of the fitful gust, and issues out of darkness like weird music from a tomb.

Birds vary much as to the power of individuals and the effect of circumstances. The same bird will trill out a more spirited lay after a warm shower than during a cold, dry east wind. There are times when, for a few hours, or a whole

* Comment peuvent se rencontrer ensemble la nuit et l'ombre du peuplier.—*Heutiana*, xlv.

day, the feathered choristers seem animated by a passion of emulation, and pour forth such an exuberance of wild music, that is almost more than a sensitive mind can bear. Such a day was Tuesday, the 29th of April, when the gardens of Stoke Newington seemed to be peopled with all the songsters of the world, engaged in an international contest. Others, beside myself, observed it; it was a subject of conversation for days after. Amongst the number then noticeable was a thrush, who had a nest hard by in a thicket, and who, since early in February, had made the welkin ring from the dawn of day till long after evening twilight. That same evening one of my neighbours—hating the noise, I suppose—fired a gun, and that particular thrush has not been heard since. Whether he killed the thrush I cannot say, he is perhaps happy that he silenced it. *Requiescat in pace,* with no ghost of a thrush to warble reproaches on his grave.

Cowper has the credit of first honouring in verse the frequency of the nightingale's song by day. But Rapin had already noticed the fact—

> "Omnes implevit ramos
> Noctes atque dies."—Hort. *lib.* ii.

And Shakspere has actually misrepresented the case—

> "The nightingale, if she would sing by day,
> When every goose is cackling, would be thought
> No better a musician than a swan."—*Merchant of Venice,* act 1, sc. v.

The song, day or night, is doubtless the most delicious music that ever saluted mortal ears since the day when the angels sang "Glory to God in the Highest." Milton was the first to make it the music of Eden, where Eve relates her dream to Adam, and when we hear it now, we may all say—

> "Music of Paradise! which still is heard
> When the heart listens."

Tennyson has caught at the same idea in *In Memoriam,* in the invocation to the nightingale—

> "Wild bird, whose warble liquid sweet,
> Rings Eden through the budded quicks."

Keats's ode is as rich and tender as the fullest gush of this rare warbler's notes, and it has the truth of all his rustic images and scenes, especially where he describes it—

> "In some melodious plot
> Of beechen green and shadows numberless;"

for strange to say, if there be a beech within range of the bird's haunts, he will choose that for his retreat, and at the present moment a pair have nested in a beech within sight of my study window. I would help to hang a bird-catcher, amateur or professional, who would dare to molest them. I can only say more about the nightingale's song that the best description of it is in Conder's *Star in the East,* and that to account for its disappearance when its short season of love and song is over, Carew has a capital conceit—

> "Ask me no more, whither does haste
> The nightingale; when May is past.
> For in your sweet, dividing throat
> She winters, and keeps warm her note."

What a mystery is migration, and how much greater a mystery has it been made by that class of naturalists who persist in treating animals as if they were mere receptacles for food and vehicles of fur and feathers. The Marquis of Worcester's disquisition is worth reading for its quaintness, but the notions of Linnæus do discredit to that generally broad-minded philosopher, for the great master clung to the notion of swallows hybernating under the waters of ponds, and in Ellis's *Correspondence of Linnæus* are particulars of the experiments for any who would have a laugh at the great Swede. Stranger still that Gilbert White, most observant of observers, had a secret fancy for the hybernating theory, though well aware of the fact that the temperature of the blood of any of our summer birds is higher than that of man, or any other of the most active creatures. For a bird to hybernate, especially under water, is simply impossible. So energetic is the life of these little creatures that while they remain with us they scarcely sleep at all. You shall see swallows and swifts darting about till the last moment of twilight, and you shall see them again at half-past two next morning wheeling aloft and twittering as freshly as if they needed no rest, and so with the cuckoo and the warblers, the almost unbroken continuance of their song during the twenty-four hours round, is a proof of the energy of the circulation and all the vital processes. Their bones are hollow, they are themselves reservoirs of oxygen, and the flame of life burns more fiercely in their breasts than in any other class of animated creatures. Dr. Derham, in his *Physico-Philosophy,* notices two circumstances about migratory birds, first, that these *untaught, unthinking* creatures, should know the proper times for their passage, when to come and when to go; as also that some should come when others retire. Now to call them untaught and unthinking is to beg the question. In what revelation do we read that they are in either case such utter negatives? surely only in the revelation of human vanity. Experiments with which every tamer and *teacher* of birds is familiar, prove that their natural songs are acquired by the same process as we acquired a knowledge of A, B, C at school. As you pass along the side of a copse in July and August, you will hear hundreds of little birds recording the songs they are just learning of their parents, and the parents always sing till their young have learnt their lesson properly; and hence, though the nightingale usually sings less vehemently after he has found a mate, he does sing till August if the first brood has met with an accident, and the parents hatch out a second. White records the singing of the nightingale on the 1st of May, and Markwick on the 4th of July, and the latter adds, "last seen, the 29th of August." Take a young bird from the nest before it is old enough to have learnt of its parents, and it will learn any song or no song, just as circumstances influence it. I have a canary that was brought up to the nightingale's song, and sings it to perfection. He has since learnt the chirp of the sparrow, the warble of the wren, the harsh twirking of the blue-headed parakeet, and the graceful melody of a creaking wheelbarrow. Hen birds of almost any kind will sing nearly as well as cocks if well trained from the nest, and if singing is so much a matter of tuition, why should not flying be. Anywhere just now you may see the sparrows teaching their young to fly, and a pretty sight it is; the prettiest of the season. If they are taught to fly from a tree to the ground, and from the ground to a paling, why not over seas and continents in such cases as render long flight necessary? We are met here with the word "INSTINCT," which gives no account of motives, of caution in avoiding accidents, or of the almost supernatural powers of sight and wing which migratory birds possess. The swift will fly a mile in a minute, and in the course of a season traverses eight times the circumference of the globe in search of flies within the range of less than an acre of territory.

I remember a match of pigeon-flying between London and Amsterdam, in which the winning bird flew at the rate of two miles every three minutes, according to the timing of the competitors, who started and received the bird at the two extremes of its journey. Let those who cling to the unsatisfactory solution of instinct keep carriers three years, and fly them on scientific principles, and they will, at the end of that period, toss Dr. Derham's idea of "untaught, unthinking creatures" to its proper limbo among obsolete notions. There are three things noticeable in the migration of birds; first, that change of residence is desirable; secondly, that they know where to go, and thirdly, they know how to go by the safest and the shortest route. Egypt houses a vast number of our summer visitants. Why we cannot say, except that doubtless the food and climate suit them. Africa, indeed, is the winter home of the greater number of the British warblers; and why they come here we cannot say, except that, as before, the food and climate suit them. And what a blessing that our woods, and flowery leas, and gardens, are deemed worthy of a long stay, and of deep domestic joys by such happy, confident, and silver-throated creatures. The puzzle to naturalists is that they find their way over lakes, rivers, deserts, and seas, to the very spots that best suits them. I know a still more curious case, for when a boy I had given to me a pair of Guildhall pigeons, which I kept in a large cage of laths until they reared a pair of young ones. They then got out, owing to a rent in the laths, and made their way back to Guildhall, where, one of them having lost its tail, they were identified the same day by the friend who had scandalized the civic authorities in catching and sending them me. In this case the bump of locality must have been larger than that of philo-progenitiveness, and as the birds had never made that particular flight before, it was a greater puzzle than the passage of birds from Africa to England, or *vice versâ*, because these go in flocks, and there must be in every flock a certain number who have made the journey before, and can pilot the way for all the fledglings. Nor is it such a great undertaking, as it seems they rest on the rigging of ships, on headlands, and in places of seclusion, when stress of weather compels, and as the majority of migratory birds, especially those that traverse the Mediterranean, are insect eaters, they will probably find enough food to support them while on the wing, both by sea and land. The narrative by Mr. Thompson, in the *Annals of Natural History* for October, 1841, gives a list of twenty-seven birds which alighted or hovered about her Majesty's ship *Beacon*, during a voyage up the Mediterranean, in the month of April, and amongst them were the swallow, martin, willow-wren, quail, hoopoe, oriole, redstart, flycatcher, wheatear, and some of the minor raptores, When we see a sheep leave a parched herbage to rejoice in clover it does not surprise us, but we commend the creature for its good taste; the flight of a bird to a region adapted to its habits, when its hitherto home has ceased to be attractive, is but a similar process on a grander scale, and our wonder arises because of the distance, and the apparent frailty of the creature attempting it. But the poetry of the fact is heightened by granting reason and motive for the act, and wonder may stretch more wide her wings, and take flight with them through the mysterious darkness over pathless wilds, the more happy to be associated with roving intelligences that move according to a plan for mutual protection and guidance, than when resting in the thought that they know not how to go or where to go, but fly by blind destiny, the victims of erratic chance, like so many whiffs of gossamer scattered about by the winds. To see the swallows gathering at nightfall among the mists of autumn, though a common enough sight to country people, is one never to be forgotten as long as a man lives. To talk of magnifying the Creator, by ascribing all those movements to "unerring instinct," is to reduce Almighty wisdom to the cunning of an artist who has made a toy, and is half frantic that it dances when he pulls the strings. How much more consistent with all the plans and operations of nature which He has ordered, to believe that these wanderers have had given them a sufficient intelligence to rule their lives for good, and direct their appetites and passions for the preservation and increase of each particular race. When Natural Theology squeezes the mind out of a poor bird, it stoops almost as low as the bird-catcher who has drawn his net upon a sparrow, and who then twists its neck, because, in the first place, he delights in cruelty, and in the second place it is not the bird he wants. Pretty creatures, putting human wits to shame by your long journeys, without chart or compass, from one flowery land to another, how many risks have you to encounter, like the first Phœnician merchants, or the voyagers for the Golden Fleece, yet how much wiser than they in your unerring course and peaceful purpose, to carry happy voices into every chosen haunt.

INSECTS INJURIOUS TO THE ELM.

BY H. NOEL HUMPHREYS.

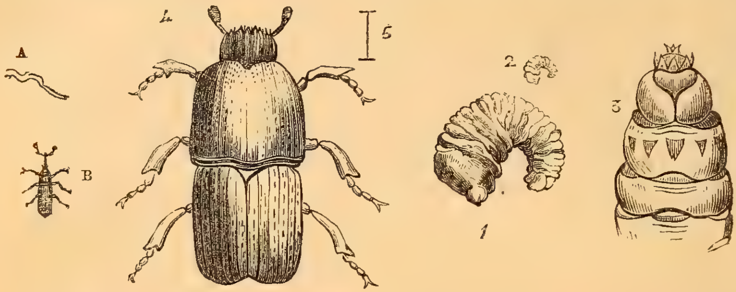
It has been asserted that of late years our native elm has exhibited less vigour in its growth, and that, in many instances, trees which might have been considered in the vigour of their age have been seized with sudden symptoms of decay, and have rapidly perished. Some have attributed the less flourishing state of this handsome and useful forest tree to the extensive system of drainage now going on, as the elm prefers a damp soil. Others have suggested different causes; some, and apparently with most show of reason, assigning it to the ravages of certain insects which burrow between the bark and the hard wood of the trunk, which is the most probable cause.

Taking this as the most likely cause of a certain amount of decay, the experiments of M. Robert, an eminent French botanist, merit careful consideration. Some years ago the trees of the Parisian Boulevards having shown symptoms of disease, M. Robert, whose experiments in tree diseases were already well known, was consulted on the subject. He attributed their diseased state principally to the ravages of the larva of a small beetle—Scolytus destructor, and with a view to the prevention of this cause, pared off portions of the bark in longitudinal strips, thus removing at once both the food and the protection of a great portion of the insect enemies. This measure was, however ineffectual, and M. Robert next proceeded to strip off the whole of the bark. This was considered by many a rash proceeding; but the event seems to prove that M. Robert was right, for entire colonies of insects were thus destroyed, and the bark, contrary to general expectation, is stated to have been perfectly reproduced. M. Robert, having apparently proved the efficacy of his method in cases where trees were attacked with scolytus, was called upon to apply his mode of cure to diseased trees in many parts of the French provinces, and also in Belgium; receiving various testimonial honours from many learned and scientific associations.

The severe method pursued by M. Robert may appear at a first glance extremely rash, especially on taking into consideration that the system of ringing only—that is, taking off a narrow strip of bark all round the trunk—is a method used for killing trees in forest clearings. Yet, we shall see, allowing his results to be indisputable, that M. Robert's process may be founded on sound botanical physiology. But let us first find the insect enemies of the elm, and having acquired a just idea of the exact nature of their ravages, consider whether the process of M. Robert be likely to prove efficacious for their destruction.

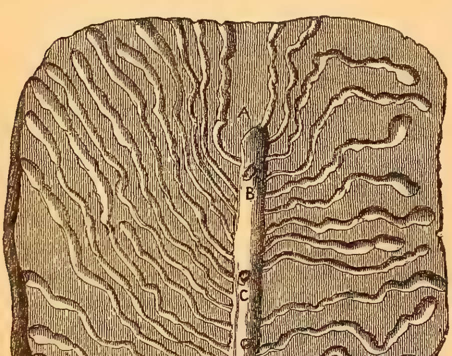
Among the most fatal of the tiny enemies of the elm, and others of our largest forest trees, is the Cossonus linearis, a terrible foe, for fresh specimens of which I am indebted to Mr. E. A. Smith of the British Museum. The figure at page 30 will convey a good idea of the insect in its perfect state. It is, however, in its larva state that its devastations are committed. The larva is, as may be conceived from the size of the perfect insect, very minute, and is a soft smooth grub totally devoid of legs, but it is furnished with considerable muscular power, and with powerful mandibles, with which it at the same time takes its food and perforates its miniature tunnel. This tiny creature does not only feed between the bark and the solid wood, either on the delicate liber or inner bark, or on the alburnum, that is to say, the last formed layer of wood, still in a soft state, but eats its way right into the heart of the tree through the sound, hard wood; and for these deeply internal ravages M. Robert's system offers no remedy. A colony of these creatures works upon the doomed tree, till it becomes perforated in all directions, and through every part of its vital tissues. The symptoms of disease soon show themselves; it loses the power to put forth its leaves; and, deprived of the result of their important functions, rapidly perishes.

Another enemy which, as being exceedingly numerous, is perhaps more fatal, is a small beetle known as Scolytus destructor, which is shown below. It is affirmed by some naturalists that this insect only appears upon a tree when a morbid or diseased



A. The tunnel of cossonus linearis.
B. Cossonus linearis.
1. Magnified larva of S. destructor.
2. Larva of S. destructor.
3. Greatly magnified head of S. destructor.
4. S. destructor magnified.
5. Size of S. destructor.

growth has already taken place; but I have found small numbers under the bark of apparently healthy trees. The first ravages probably induce that morbid growth which renders the multiplication of the insect more rapid, as softening the wood and bark, and rendering them more available as food. Scolytus destructor is one of a group of insects which the German naturalist, Ratzeburg, has minutely described in his *Forst Insecten* (forest insects), a great work which he produced at the request, and under the immediate patronage, of the Prussian government. He has figured in that volume many species of this genus and several allied genera, besides an immense number of other insects injurious to forest trees, exhibiting them, in many instances, in the larva, pupa, and perfect states, in order that foresters may recognize their enemies in all their stages.



No. 1.—Tracks of Scolyti on the wood of the elm.

The two engraved specimens of wood injured by the Scolytus and its congeners, will show the manner in which they eat their way between the bark and the main trunk. Their food being the *alburnam,* or soft white portions of newly formed wood, as before stated, which lies between the *liber* or inner bark, and the already hardened wood or *duramen.* The insect leaves about an equally deep track in both bark and wood; though, in general, if a piece of bark be broken off, the larva of the Scolytus will come away with it. The specimen of wood, No. 1, page 30, shows the tracks of a colony of Scolyti. The perfect insect or beetle has the power of perforating the bark, say at A; it then commences a tunnel, till at B it forms a deeper cavity, which some describe as a turning place to enable the female to effect her retreat, should she survive the act of depositing her ova. I have, however, found eggs deposited in such cavities which appear to succeed each at certain distances, and in which, as it appears to me, successive batches of eggs are placed. When the eggs are hatched the young larvæ depart to the right and left of this main channel, eating their way as they go. It will be seen that at their commencement these lateral channels are very narrow, the larvæ being still small; but, growing as they advance, the channel gradually widens, till at last it terminates, at its greatest degree of breadth, in a blunt *cul-de-sac.* In this extremity of the channel, the larva having attained its full growth, sinks into the dormant period of its existence, in which it undergoes its change to the perfect or winged state. This takes place with only the protection of a slight husk, which it constructs for itself, very inferior in structure to the elegantly formed case of the chrysalids of butterflies and moths. The larva gradually shortens and thickens, and the wings, legs, antennæ, and other members belonging to the perfect state gradually develop themselves within this imperfect pupa case. The beetle, when the full metamorphosis has taken place, eats, or rather bores it way through the bark, and emerges from the dark chambers in which the earlier stages of its existence have taken place, to the open daylight. Its daylight

No. 2.—A piece of elm wood showing the tracks of B. Chalcographus and B. Topographus.

existence, however, is a very short one, and the female, so soon as her instinct teaches her that the time has arrived for depositing her eggs, bores again through the thick bark for that purpose, voluntarily quitting the daylight for ever, as she frequently dies almost immediately after depositing her last batch of eggs in the dark tunnel, which thus serves at the same time for the tomb of the parent and the cradle of the progeny.*

The curiously branching tracks of insects of this class have in many cases suggested the name by which different species are distinguished—each having a peculiar method of progression, which, of course, leaves a track of corresponding character. For instance, the insect of the genus Bostrichus, the larvæ of which makes the little branching channels which look like lines engraved on metal, and are marked A in the engraving of injured wood, No. 2, has received the specific name of chalcographus, from a term founded on Greek words meaning "an engraver on brass." Another, the one whose larva makes the

* I have just received the following additional details respecting the habits of the Scolytus, and the fatal nature of its ravages. These interesting particulars are from a paper recently read before the Entomological Society, by one of the most careful and accurate observers among our English entomologists :—"When the first warmth of spring sets in the perfect insect makes its escape from beneath the bark, by eating its way out ; the female soon after selects a tree for the purpose of depositing her ova ; she commences her perforation always beneath a little projecting piece of bark, at the upper end of a crack; she bores onwards and upwards until on the surface of the alburnum, when she ascends direct. The tube thus formed is from two to three and a half inches in length, three-fourths of a line in diameter, and of equal size throughout, except at a short distance from its entrance, where a small cavity is usually found, sufficiently large to allow the perfect insect to turn ; on each side, in small crenules, she deposits her eggs as she advances. If the female insect live to effect her retreat, she closes the aperture by which she effected her entrance with some plastic material, to prevent the entrance of enemies ; the number of eggs is in proportion to the length of the tube—there are generally sixty to seventy. On bursting their shells the young larvæ immediately commence feeding on the last deposits of alburnum. They at first form parallel lines or tubes, which are seen gradually to enlarge and diverge, and are filled with exuviæ. Here they continue to feed during the summer, autumn, and winter (if mild) ; when full-grown they form a case, in which they change to the pupa state, and then, at the end of May, or the beginning of June, bore their way out through the substance of the bark. . . When the insect greatly abounds, it will perforate the bark of fresh hewn timber ; but I have never found one specimen in an elm whose juices were dried up. Therefore, irrespective of the cause of disease, it must be unanimously granted that an insect which can destroy *four square inches* of bark by detaching it from the alburnum, must prove highly destructive, and whilst permitted to remain must frustrate any attempt to restore health. When we find a tree dead, with terminal branches profuse and perfect, we certainly, under ordinary circumstances, should not say that tree had died from defective nutrition in the soil ; but that, from some cause or another, it had suddenly, as it were, come to an untimely end ; and such a tree we had in the Gardens (Royal Botanic). I watched it in its beauty, and in three years saw it cut down and carried away dead. But what a sight met our view on removing the bark—the surface of the trunk, as many gentlemen will remember, for I exhibited a piece of it three feet long before this Society (Entomological), was beautifully scored by the lateral tubes of the Scolytus larva, and we reckoned that this solitary tree gave birth to no less than the prodigious number of 280,000 perfect insects."

channels figured at B in No. 2, has been styled topographus, or "map maker," from a supposed resemblance in the channels to the lines indicating rivers, etc., on engraved maps. It is a rather larger insect than chalcographus, as shown by the larva tracks, which may easily be compared, as the traces of both are frequently found in the same tree. The channel of another larva of this class has somewhat the appearance of writing, to which it is indebted for its specific title autographus, while others have received equally characteristic names.

Mr. Westwood states that he has often found Hylisinus Fraxini in the elm, though its name would indicate that its ravages were confined to the ash. It is a small beetle, very similar in form to the S. destructor, but it is of lighter colour—the wing-cases being prettily variegated or clouded with a deeper tone. The larva of Hylisinus Fraxini closely resembles that of the genus Scolytus, and is found in a state of activity in the elm during the month of August. The larvæ of another little beetle, enemy of the elm, of the genus Hylargus, very closely resemble those of Scolytus.

We have hitherto described the enemies of the elm among the more minute representations of the beetle tribe. But the British giant of the race—the great stag-beetle, whose conspicuous size and form soon make him well known to the merest tyro among young entomologists—is also, in its larva stage, a formidable enemy of this devoted tree. The larva of this large insect is of proportionate size; and whenever it does attack a tree of this kind, which is fortunately of not frequent occurrence, as the insect is not very abundant, the dangerous nature of its inroads may be easily conceived, as it not only bores into the very heart of the wood, but also, with still more fatal effects, penetrates the main roots in a similar manner. A tree-enemy upon fully as large a scale, is the Cossus Ligniperda—the wood-boring Cossus. This is a large moth, one of the handsomest our British kinds; the caterpillar of which is large, and protected with strong scales, and also furnished with powerful mandibles, which enable it to eat its way into the core of the hardest woods. It prefers, however, the pear and the willow, but is frequently found in the elm and other large forest trees. The damage done by this powerful larva to the trees it attacks may be readily imagined, as it lives from two to three years in the tree before its transformation takes place; and at its full growth leaves a clear bore through the solid wood of from half an inch to three-quarters of an inch in diameter.

There are many interesting circumstances known regarding the habits of the Cossus Ligniperda; but the present paper has reached its extreme limits, which also prevents the description of many other insects injurious to the elm, both in its healthy and partially-decayed state.

Having examined the habits of certain xylophagous, or wood-eating insects, and having probably arrived at the conclusion that the ravages of the Scolytus and his congeners have a more direct connection with the decay of elm-trees than increased drainage, or any other cause, it is time to consider the seemingly dangerous method of cure proposed and practised by M. Robert, and to ascertain the principles upon which it must have been adopted, and upon the applicability of which its success must depend.

The sap, the basis of which is mere rain-water, that is to say water impregnated with carbonic acid, is taken up by the roots, and ascends between the solid wood and the bark, causing the formation of a coating of new wood all round the trunk, which coating, in its soft state, is termed alburnum. It is again through this alburnum that the surplus sap, vitiated by the functions it has performed, has to descend, eventually escaping through the spongeoles, or fine fibres of the roots, into the earth. Now, if the ascent of the nutritious moisture be impeded by the scoring of the Scolyti, or still worse, if, in its vitiated state, its descent be impeded, and its escape prevented, the most fatal consequences must necessarily ensue in some of the forms caused by the morbid retention of a poison. If, therefore, M. Robert can remove the bark, and with it the Scolyti, giving to the alburnum (relieved by his process from the further injury of its enemies) the opportunity of exerting its reparatory functions, which he asserts that it is able to do even when deprived of its natural protection, the external bark, which, he assumes, it is able to restore, then M. Robert appears to have hit upon a mode of cure which, under favourable circumstances, may prove successful. It is, of course, necessary that in removing the bark care be taken to spare in every way the alburnum. My neighbour Dr. Evans informs me that a goat in his garden had eaten all the *bark* from the lower part of the trunk of a tree to which it was attached, but that not having seriously injured the *alburnum* the reparatory powers of that substance not only repaired its own injuries, but reclothed itself with a coating of bark. And thus it is seen, in "ringing" operations, pursued for the purposes of destroying trees, that the alburnum itself must be cut through, as well as the outer and inner bark, and then, no doubt, in the great majority of cases the tree invariably dies.

It may be stated, in support of M. Robert's theory, that the bark is, speaking by analogy, the *bone*, rather the *skin* of the tree, and bone, as is well known, is the result of a kind of organic action which has to an unusual extent the power of reproduction. A singular link between the forms of vegetable and animal bone, if one may be permitted the use of such fanciful terms, is to be found in Crustaceæ. The bone of the lobster, for instance, unlike that of the higher forms of animal life, is entirely external, that is to say, what would be the internal spine, etc., in a fish or a quadruped is the *shell* of the lobster. This external casing of bone is not only capable of renewing itself in case of injury, but does so naturally every year, the creature shedding its external bone to allow of the annual growth of the body, which it clothes and protects. The inner coating, analogous to the liber and alburnum of the tree, having not only an inherent power of protection when deprived for a time of their usual external covering, but having also the power of re-clothing themselves with a new one of the same kind, suited in dimension to the increased size of the body. So that we need not be altogether surprised at the reported success of M. Robert in doing for the tree that which the lobster does once a year for itself. It may be added that there is even a "tree lobster," as one may term it, which also does for itself that which M. Robert pretends to do for diseased oaks or elms; that tree, is the well-known oriental plane, which sheds its old bark every year, a circumstance which may partly account for its retaining its health in the very heart of smoky towns, where other trees perish, probably from the clogging of the pores of the bark, and so stopping that necessary expiration which trees carry on by them as well as the leaves. Just as in the human being, the pores of the skin allow of a continuous expiratory action supplemental to that of the lungs. The process of M. Robert, then, may *possibly*, should it be found practicable, be effectual, in permanently checking the ravages of the Scolytus family; but it cannot touch the inroads of the Cossonus, and cannot repair such damages as that effected by the larva of the stag-beetle and the Cossus Ligniperda.

I should add, in conclusion, that I have just received a letter from a botanical physiologist who has entered into direct correspondence with M. Robert, and who, after that correspondence (as before) is decidedly of opinion that the *procédé Robert,* as the French would say, is certain to be fatal to any tree upon which it is fairly put to the test. A series of careful experiments can alone decide the question; and if judiciously carried out, would, no doubt, lead to the elucidation of many facts with which we are at present but imperfectly acquainted.*

* The question raised in this paper is of great interest as a matter of vegetable physiology; but whatever may be the result of further experiments, we cannot endorse the *bone* theory.—Ed.

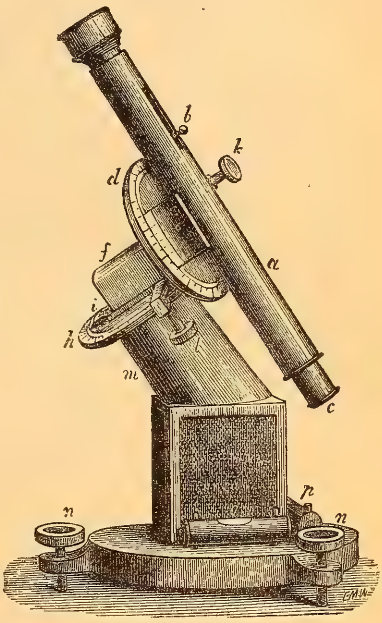
STAR FINDING.

There are few more delightful occupations than paying telescopic visits to the hundreds of beautiful objects which the heavens present, and which are accessible to the possessors of very moderate optical means. A beginner need not be discouraged by the difficulty incidental to the nature of the pursuit. Let him commence with such a work as Mrs. Ward's elegant *Telescope Teachings*,* and he will find himself insensibly prepared for the consideration of more complicated problems, and the prosecution of investigations of a more elaborate kind. Many interesting stars require instruments of considerable magnitude and power, but Mrs. Ward has shown much that may be accomplished with a two-inch glass; and Mr. Webb has furnished a valuable guide to all the principal astronomical wonders that can be reached by objectives up to double that size.† The names of the principal stars in our hemisphere may be learnt from maps, globes, or the excellent planisphere published by Smith in the Strand; but as the constellations are among the most bungling contrivances of human ingenuity, it is by no means an easy task to trace their imaginary boundaries in the sky, or to know exactly where to point the telescope to the less conspicuous members of their bewildering groups. In the papers for which our readers are indebted to Mr. Webb, very simple directions are given for finding, at a specified date the objects which he describes, but, inasmuch as the whole celestial framework appears to revolve about our earth, and each month —each hour—presents a different aspect of the firmament to our gaze, it is very desirable to possess accurate and scientific means adapted to any time, by which, if the weather permits, the object we wish to examine may be infallibly found. Such an aid the professional astronomer possesses in the equatorial, and several opticians have produced equatorial stands adapted for portable telescopes of moderate size. They are, however, from their price beyond the reach of many students, and even if they were cheaper and less cumbersome, they would not answer all the purposes that can be served by a small instrument readily carried from one room to another, or to any part of a garden or field from which a good view can be obtained, and the adjustment of which can be readily made. Such an instrument has been produced by Messrs. Horne and Thornthwaite, and since we first alluded to it in the

* *Telescope Teachings; a Sketch of Astronomical Discovery, containing a Special Notice of Objects coming within the Range of a Small Telescope.* By the Hon. Mrs. Ward. Groombridge and Sons.

† *Celestial Objects for Common Telescopes.* By the Rev. T. C. Webb, Incumbent of Hardwick, Herefordshire. Longmans.

"Notes and Memoranda" of our May number, we have given it repeated trials, and have likewise obtained an excellent report of its merits from a practical astronomer, to whose care we consigned it for several weeks. It consists of a steady bed, shown in the annexed sketch, furnished with two spirit-levels and three adjusting screws. The polar support, *m*, has the slope required by the latitude of the place in which it is to be used, and being fixed by the makers at the right angle, becomes free from error and always ready for work. *a* is the telescope, rotating on an axis and carrying the index *e* to any point of the declination circle *d*; *h* is the hour circle, and *i* its index, moving with the telescope and giving the right ascension in hours and degrees.



If the student has a convenient place commanding a sufficient sky view, he can if he pleases fix the instrument upon a pillar after having adjusted it according to the directions given in an excellent paper issued with it, but in many cases it will be convenient to preserve its portability, and then it must be brought to the right position each time it is employed. If required merely as a finder it will be sufficient to set the two circles for the right ascension, and declination of the pole star as given in the *Nautical Almanack*, or any other ephemeris; the polar support should then be approximately pointed to the star, and the bed accurately levelled by the adjusting screws. If this is properly done a very trifling movement will bring the star into the centre of the field marked by the cross wires, and the instrument will be ready for use. In this way we obtained good results as a finder, and for measurements of position sufficiently near the mark to distinguish and ascertain the name of any star not easily confounded with its near neighbours. This mode of proceeding has certain obvious advantages, but every possessor of the instrument should accustom himself to use it from one particular situation where he has obtained a good meridian line, and can adjust it so as to work with the greatest accuracy of which it is susceptible. The method of doing this is clearly explained in Messrs. Horne and Thornthwaite's paper of directions, and many of our readers will remember the information furnished by Mr. Burder in the articles published in *Recreative Science* on a portable equatorial.

The student will gladly avail himself of this instrument (1) to find stars, or other objects he wants to look at; (2) to discover the name of any star by determining its exact position, and then ascertaining from an almanack or chart what body it must have been to have occupied such a position at such a time; (3) to obtain the time within a few seconds by watching the transit of any star convenient for such a purpose. It also possesses a high educational value, affording to teachers the means of giving their pupils an initiation into many processes of practical astronomy that ought not to be neglected in any civilized school.

The construction of the star-finder displays considerable skill. To render such an instrument generally useful, it was necessary to make it handy, cheap, and not easily deranged, and in these several particulars Messrs. Horne and Thornthwaite have succeeded extremely well. The telescope, although small, is of excellent quality, giving a good view of Jupiter's moons, and clearly showing ϵ Lyra as a double star, on a bright summer's night. The movements are smooth and steady, the graduation accurate, and every part firm and strong. Thus the student will find it an excellent aid to his fascinating pursuit.

DE LA RIVE ON THE AURORA BOREALIS.*

M. DE LA RIVE conceives that two general facts relating to the aurora are established: 1st, "the coincidence between the appearance of the Boreal and the Austral Auroras: 2nd, that auroras are atmospheric phenomena which take place within the limits of the atmosphere, but not beyond it." He seeks to show that the positive electricity carried to high regions of the atmosphere by vapours from tropical seas, and which the trade winds accumulate near the polar regions, acts by induction on the negative electricity with which the earth is charged. There results, he says, "a condensation of contrary electricities in those portions of the earth and the atmosphere which are nearest each other, and in consequence a neutralization in the

* *Comptes Rendus*, June 9, 1862, p. 1171. A similar account is given in the *Archives des Sciences* (Genève), No. 54, and accompanied with a drawing of the apparatus.

neighbourhood of the poles, which takes place under the form of more or less frequent discharges as soon as their tension has reached a limit which cannot be maintained. These discharges ought to take place simultaneously at both poles, since, as the conducting power of the earth is perfect, its electrical tension ought to be sensibly the same, with some slight differences arising solely from accidental variations in the stratum of air interposed between the two electricities. There are thus upon the earth during the appearance of the auroras two currents proceeding from the poles to the equator; but if the discharge only takes place at one pole—the southern for example—there is no longer in the northern hemisphere a current directed from north to south, but a weaker current directed from south to north. This change gives an eastern declination to the compass-needle instead of the western declination which occurs when the boreal discharge takes place and the current is directed from north to south."

"It is known that auroras are accompanied by more or less intense currents in telegraphic wires. Mr. Walker in England, and Mr. Loomis in America, have made them the subjects of special study, and they have found that they vary constantly not only in intensity but likewise in direction, coming alternately from north to south, and from south to north. If we remember that the currents propagated by telegraphic wires are derivative currents gathered by means of large metallic plates sunk in the moist soil, it will appear that these plates are not slow to polarize themselves under the chemical action of the current which they transmit, and that they ought to determine in the wire which unites them an inverse current as soon as that which occasioned their polarization ceases or diminshes its force; and all observers know that the auroras exhibit a very variable and perpetually oscillating light."

"The change which occurs in one terrestrial current when the discharge passes from one pole to another—from the north to the south, for example—determines also a change in the direction of the currents of the telegraphic wires, which in that case flow from south to north, instead of from north to south; but the new current is much weaker than the old one, except when it unites with the secondary currents arising from the plates."

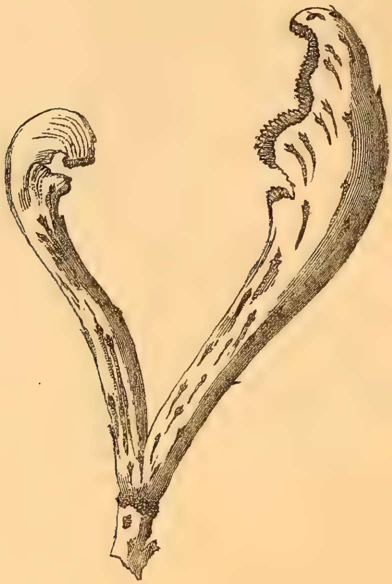
"There is, however, a great difference in the results obtained when, instead of observing the currents collected by telegraphic wires, we study the perturbations of the magnetic needle which accompany auroral manifestations, as in the latter case there are neither electrodes nor secondary currents, but only one direct action of the principal current. This current may vary in intensity, but it must always operate in the same way (*même* *sens*) while the discharge takes place at the same pole, whether it be strong or weak, and it will not change its character until the discharge nearly ceases at the nearest pole, in order to operate almost exclusively at the other; whilst by reason of the effect of secondary polarities a change in intensity suffices to produce a change of direction in the currents of telegraphic wires. This difference is strikingly shown by comparing the graphic representations of purturbations in the magnetic needle observed by Mr. Balfour Stewart at Kew, during the auroras of the 2nd September, 1859, with the results of Mr. Walker's observations of the currents exhibited by telegraph wires at the same time. I have succeeded in experimentally verifying these observations by transmitting the discharge of a Ruhmkorff's coil through rarefied air, placing in the circuit some water holding a little salt in solution, and in which two plates of metal were immersed. As soon as the principal current was weakened or stopped the inverse current was exhibited by the plates."

"In order to reproduce all the details of the natural phenomena, I caused an apparatus to be constructed composed of a sphere of wood about ten inches in diameter, which represented the earth, and carried at each pole a bar of soft iron about two inches long, and about one inch in diameter. Each bar rested on a vertical cylinder of soft iron to which it was united, and thus the sphere was supported. So arranged, the sphere had a horizontal axis terminating in two appendages of soft iron which could be magnetized by bringing the two cylinders on which they rested in contact with the poles of an electro-magnet, or by surrounding the cylinders with coils of wire traversed by electric currents. Each of the iron bars was surrounded by a glass cylinder (*manchon*) between five and six inches in diameter, and about seven inches long, and in which it occupied an axial position projecting into the middle of the glass. The two vessels were hermetically sealed by two metallic caps, one of which was traversed by the iron bar, while the other carried a metal ring upon two arms, the centre of the ring coinciding with the end of the iron bar, and having its plane perpendicular to the axis of one bar. The diameter of the ring is a little less than that of the glass. Stopcocks were conveniently placed to allow of a vacuum being formed in the glass vessels, and any kind of gas introduced.

"To use this apparatus, the wooden ball is covered with two strong bands of bibulous paper, one occupying its equator and the other crossing it from pole to pole, and making contact with the two bars of iron. On this last band, pieces of copper about one or two-thirds of an inch square are fixed at equal intervals with copper tacks that penetrate the wood. All the copper squares are arranged in the same meridian. Between two of the squares a metallic communication is established with the thread of a galvanometer placed about twelve yards off, so that its needle shall not be directly influenced by the electro-magnet. Having thus arranged the apparatus, the paper bands are moistened with salt and water, and the equatorial band is connected with the negative electrode of a Ruhmkorff's coil, which has its positive electrode brought into communication, by means of a bifurcated wire, with the two metallic rings which are inside the glass vessels, and in highly rarefied air. The discharge is soon seen as a luminous jet between the rings and the extremity of the iron bar, sometimes in one vessel, sometimes in the other, but rarely in both at once, although both are placed under apparently the same circumstances."

"As soon as the soft iron is magnetized, the jet spreads and forms an arc round the central wire, animated by a rotary movement, the direction of which depends on the character of the magnetization. It is evident that it depends also on the direction of the discharge, but we have supposed this direction constant, and resembling that of nature, that is to say, directed from the circumference towards the centre. It is important to notice that if the air be not too rarefied, a moment is observed in which, when the iron bars are magnetized, the rotation begins, and the jet not only expands into an arc, but darts brilliant rays that remain quite distinct from each other, and turn round with greater or less velocity like the spokes of a wheel. In this we see an exact representation of what occurs in the aurora borealis, when the luminous arcs being all impressed with a movement of rotation from west to east, dart luminous jets in the higher regions of the atmosphere. These jets do not occur unless the iron is magnetized, and they may be stopped if the air is highly rarefied, by introducing a vaporizable liquid, such as a drop of water. It is impossible to produce them if the discharge, instead of being directed, as in nature, from the circumference to the centre, passes in an opposite direction."

M. de la Rive adds, that on examining the galvanometer with which the two wires previously mentioned are in communication, a secondary current will be indicated, its character and direction being determined by whether the discharge takes place at one pole or the other; and he states that he can imitate the disturbances which the magnetic needle experiences when the auroras occur.



CURIOUS ILLUSTRATION OF VEGETABLE MORPHOLOGY.

It is not uncommon for natural objects to assume somewhat extraordinary forms, but perhaps few are more curious than the one which I have endeavoured to represent in the accompanying sketch. This singular freak of nature was shown to me at the house of some friends with whom I have been recently staying, and was cut from an ash-tree in a wood near Reculver, in Kent. The branch suddenly assumes a flattened form, and shortly after separates into two branches, which bear at first sight a curious resemblance to the antlers of a stag. Buds appear at short intervals, some of them with an approach to regularity in their arrangement, others in clusters. The two arms, after division, are not exactly in the same plane, the small one being slightly foreshortened when the large one is in full view. My drawing, though somewhat rough, is, I believe, accurate, being made from a pencil sketch and description which I took from the object itself. I neglected at the time to take the actual measurements, but the length of the large arm is scarcely less than eighteen inches. As an example of the curious in nature you may possibly deem it worthy of a notice in the Intellectual Observer.

Robert Gausby.

THE NEW METAL THALLIUM.

On the 19th June Mr. Crookes read a paper on the new metal thallium, before the Royal Society, and on the 25th of the same month M. Lamy made a similar communication to the French Academy. It is from these sources that we are able to lay before our readers the following particulars:—In March 1861, Mr. Crookes announced that a brilliant green line, exhibited by some selenium residues, in the spectroscope method of analysis, was an intimation of the existence of a new element. In the following May he gave a further account of his discovery, and named it *thallium* from our Greek θαλλος, on account of its coloured line resembling the hue of vigorous vegetation. M. Lamy, who was not aware of Mr. Crookes's investigations, made a subsequent but independent discovery of the same green ray, which he noticed in the spectrum of a specimen of selenium extracted by M. F. Kuhlmann from the refuse of chambers in which sulphuric acid had been prepared by the combustion of pyrites. Both chemists set to work to isolate the new metal; Mr. Crookes operating with crude sulphur distilled from Spanish pyrites, and containing thallium to the extent of one or two grains in the pound; while M. Lamy used the selenium previously mentioned, from which he obtained salts of thallium that gave up that metal by voltaic action. Mr. Crookes's process will be found in the *Chemical News*, July 5th. In substance it consists in dissolving the metals out of crude sulphur or pyrites by strong hydrochloric acid, to which nitric acid is gradually added. The solution is evaporated to drive off the nitric acid, and a little sulphuric added if required. It is necessary to stop the evaporation before the solution becomes pasty. It is then diluted, gently heated, filtered, rendered alkaline with carbonate of soda, treated with an excess of cyanide of potassium free from sulphide of potassium, heated once more, and filtered again. It is in the solution left after these processes that the thallium remains, which is precipitated by sulphuretted hydrogen. If cadmium and mercury are present, warm dilute sulphuric acid will remove the former, and the sulphides of thallium and mercury are separable by dilute nitric acid, which dissolves the first, and leaves the last. The nitric acid solution is evaporated to dryness, the residue dissolved in hot sulphuric acid, and the thallium precipitated by a piece of pure zinc. Thus obtained, the new metal looks first like a deep brown powder, which soon changes to a heavy black granular precipitate, to which fusion in hydrogen gives a coherent form.

Thallium bears a strong physical resemblance to lead. Its specific gravity is about 12, that of lead being 11·36. Mr. Crookes says it is not so blue as lead, and M. Lamy describes it as less white than silver, and resembling aluminium in hue. A fresh cut surface has a brilliant lustre, which tarnishes quicker than lead. It is soft enough to be scratched with the nail, and very malleable, but possessed of little tenacity. It readily marks paper, leaving a trace "with yellow reflexions." M. Lamy also states that it becomes yellowish if rubbed with a hard substance, a change which he attributes to oxydation. It is so sensitive in the spectroscope that the last named authority affirms that it may be discovered in one fifty millionth of a gramme of one of its compounds. Mr. Crookes describes two oxides of thallium, and thinks that a third is probably formed. To one he ascribes basic properties, and we presume it is that which is formed when the metal tarnishes, and which M. Lamy states to be alkaline, with an odour like that of potash. The next oxide, containing more oxygen, Mr. Crookes names thallic acid, which may be obtained in a crystalline form.

Iodine, bromine, sulphur, and phosphorus can unite with the new metal, and it combines with sulphuric, carbonic, chromic, phosphoric, and other acids.

M. Lamy exhibited to the French Academy an ingot of thallium weighing fourteen grammes, obtained by a Bunsen battery from chlorides which he formed by chemical means. The new metal is far from rare, and is very likely to be extracted in sufficient quantities to serve some economic use. Its spectroscope properties are highly important. In the words of Mr. Crookes, "The green line of the thallium spectrum appears to be unaccompanied by any line or band in other parts of the spectrum. A flame of sufficient temperature to bring the orange line of lithium into view produces no addition to the one thallium line; and an application of telescopic power strong enough to separate the two sodium lines a considerable distance apart, still shows the thallium line single. I consider, therefore, that I am justified in stating that thallium produces the simplest spectrum of any known element. Theoretical inquiries into the cause of the spectrum lines, and their relation to other constants of an element may be facilitated when we know a metal which gives rise to luminous vibrations of only one degree of refrangibility. The remarkable simplicity of the thallium spectrum offers a strong contrast to the complicated spectra given by mercury, bismuth, and lead, the metals to which it has most chemical resemblance."

ARTIFICIAL HALOS.

Everyone who has used an air-pump has noticed the clouds of vapour which form in the receiver after a few strokes of the piston, and which arise from the air yielding up a portion of its moisture as the pressure is diminished. If these vapours are viewed by light transmitted from a candle, prismatic colours will appear; but to insure a distinct and fine halo Mr. Slack recommends the following plan: Place a large receiver on the principal plate of an air-pump, and a small one, holding about a quarter as much as the former, on the smaller plate. Turn the stopcock so that when the pumps are worked the small receiver only shall be exhausted, the large one remaining full. When a vacuum has been made, place a taper on one side of the large receiver, and stand on the other, keeping the eye on a level with its light, and suffering no other illumination in the room. Now, suddenly turn the stopcock so that a portion of the air from the large receiver shall rush to the exhausted smaller one. At this moment a splendid halo will appear, and it is an interesting and by no means an easy task to notice the exact order in which the colours are exhibited. The average decision arrived at in one set of experiments was as follows: A yellow light seemed to rush from a circumference to a centre, forming a luminous disk, which passed instantly to a red-orange hue, and then to a brilliant emerald-green. At this point the green central disk appeared to expand outwardly and take the form of an external ring, the centre resuming an orange tint. The changes in the phenomenon are exceedingly rapid, and their duration so infinitesimal that it is impossible to note and describe all the chrcmatic effects, among which some rich purple rings will be observed, before the luminous circles disappear. Thoss who wish to perform the experiment with an air-pump that has only a single plate should connect its receiver by a pipe and stopcock with a larger closed vessel full of air, and then proceed in the manner described. A large amount of light is injurious to the results, as it overpowers the coloured rays. If the experiment were performed on a large scale it would probably be effective in a lecture-room.

Under ordinary circumstances there is enough moisture in the air to give rise to pleasing effects; but they will become more striking if a few drops of water are sprinkled on the inner surface of the large receiver. It is also interesting to notice the variations that occur if alcohol or liquid ammonia be substituted for the water. In the latter case, the clouds formed are denser and less evanescent.

RESULTS OF METEOROLOGICAL OBSERVATIONS MADE AT THE KEW OBSERVATORY.

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

1862. 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 P.M.; and 5 P.M. respectively. Proportion of Sky clouded.	Direction of Wind.	Rain, read at 9·30 A.M.
	inches.	°	°		inch.	°	°	°			inches.
April 1	29·854	46·9	43·5	·89	·298	53·2	41·2	12·0	10, 10, 10	SW by W, SW by S, SSW.	·063
„ 2	29·629	48·0	49·9	1·00	·372	54·9	49·4	5·5	10, 10, 10	SSW, S by W, S.	·027
„ 3	29·672	49·6	43·6	·81	·299	58·3	48·1	10·2	3, 7, 4	SW by W, WSW, WSW.	·268
„ 4	30·074	44·4	39·6	·84	·260	53·2	45·0	8 2	10, 9, 6	N, W, —	·000
„ 5	30·000	45·2	45·0	·99	·314	54·3	44·2	10·1	8, 10, 10	S by W, SSW, SW by S.	·000
„ 6	...	...	...	...	...	54·5	49·4	5·1	...	...	·038
„ 7	30·171	44·5	45·4	1·00	·319	51·5	47·6	3·9	10, 10, 10	NNE, NNE, N.	·262
„ 8	30·237	40·3	40·5	1·00	·269	46·0	42 6	3·4	10, 10, 10	NE by N, NE by N, ENE.	·005
„ 9	30·048	40·5	41·1	1·00	·275	47·0	41·1	5·9	10 10, 10	NNE, N, N by W.	·780
„ 10	29·946	43·1	43·0	1·00	·293	51·5	42·3	9·2	10, 10, 10	NW, NE by E, N.	·670
„ 11	30·173	36·9	33·6	·89	·211	45·0	41·1	3·9	10, 10, 10	NE, NE, N by E.	·004
„ 12	30·253	34·4	18·6	·57	·123	42·2	30·7	11·5	2, 7, 4	N by E, N by W, NW.	·002
„ 13	...	...	...	...	...	43·8	29·1	14·7	...	...	·000
„ 14	30·098	37·8	24·8	·63	·154	45·2	29·2	16·0	6, 10, 10	NW by W, WNW, NW by W.	·000
„ 15	30·128	38·3	30·8	·75	·185	46·1	33·6	12·5	10, 7, 7	NE, NNE, NE by N.	·000
„ 16	30·080	42·7	34·5	·75	·218	49·8	29·0	20·8	8, 10, 10	W by S, WSW, SW by W.	·000
„ 17	29·855	46·4	31·4	·59	·195	54·7	44·1	10·6	2, 7, 3	NW, WSW, W.	·000
„ 18	...	...	...	...	...	55·4	41·8	13·6	...	...	·035
„ 19	29·822	49·6	44·8	·85	·312	56·1	48·0	8·1	9, 10, 9	SW, SW, SW.	·000
„ 20	...	...	...	...	...	58·9	50·1	8·8	...	...	·004
„ 21	29·973	53·3	46·5	·79	·331	61·1	45·7	15·4	6, 9, 9	SW by W, SW, SW by S.	·000
„ 22	29·628	50·8	43·6	·78	·299	59·5	46·3	13·2	9, 10, 4	SW by S, SW by S, SSW.	·000
„ 23	29·756	50·7	38·1	·65	·247	58·9	46·7	12·2	7, 6, 6	WSW, WSW, W.	·096
„ 24	29·967	53·7	41·6	·66	·279	61·6	44·3	17·3	8, 3, 3	SSE, S by E, S by E.	·020
„ 25	29·838	61·0	53·6	·78	·422	70 5	45·6	24·9	9, 9, 2	SSW, SW, SW.	·060
„ 26	29·886	57·4	50·4	·79	·378	64·8	51·2	13·6	10, 7, 8	SE by S, WSW, WSW.	·229
„ 27	...	...	...	...	...	62·4	42·8	19·6	...	...	·012
„ 28	30·150	57·7	45·4	·66	·319	65·7	41·4	24·3	2, 3, 1	E by S, —, NNW.	·000
„ 29	30·243	55·0	41·0	·62	·274	62·9	39·1	23·8	0, 0, 0	E by S, E, E.	·000
„ 30	30·028	58·6	43·8	·60	·302	66·3	44·9	21·4	0, 0, 2	SE by S, NE by E, E.	·000
Monthly Means.	29·980	47·5	40·5	·80	·278			12·7	...	...	2·575

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

APRIL 1862.

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																																
A. M.	1	7	23	16	3	4	16	5	11	12	8	12	17	4	4	4	1	18	9	14	16	4	5	18	12	4	2	4	3	3	13	9·1
	2	8	21	16	7	4	19	4	9	10	5	13	15	4	5	4	2	18	8	12	13	5	7	18	11	2	5	4	2	2	16	9·0
	3	8	22	10	5	4	19	4	14	9	3	14	14	4	5	4	1	16	7	11	13	4	8	16	7	2	3	2	3	3	10	8·2
	4	9	24	9	3	6	19	3	13	12	4	12	13	6	5	5	4	15	7	15	11	5	6	17	7	1	5	4	1	2	11	8·5
	5	8	26	5	5	5	23	0	13	12	5	13	11	6	7	5	3	15	7	16	11	11	8	19	7	3	7	4	1	3	9	8·9
	6	8	27	5	4	6	21	2	15	15	4	16	14	7	4	5	2	14	7	17	11	8	13	18	4	2	6	4	2	5	11	9·2
	7	6	25	10	6	9	23	6	19	15	3	19	19	7	3	5	4	11	9	15	12	8	14	18	6	3	5	3	1	8	19	10·4
	8	14	32	8	8	8	24	9	15	17	4	20	22	12	9	9	5	20	11	20	13	14	19	19	10	3	5	5	2	10	18	12·8
	9	17	27	7	9	12	19	11	17	18	4	21	23	14	8	11	7	20	12	19	14	15	25	19	13	3	3	5	3	13	20	13·6
	10	18	28	8	7	15	21	11	16	13	4	21	20	14	12	17	11	17	15	21	17	16	21	24	15	6	7	6	3	17	17	14·6
	11	12	26	10	8	21	22	8	15	15	3	22	16	17	13	17	13	15	15	28	17	14	26	20	17	7	9	7	4	20	21	15·3
	12	16	27	10	7	24	19	7	16	17	3	22	16	19	15	20	19	15	20	25	19	12	24	22	21	7	18	11	7	20	25	16·8
P. M.	1	18	27	11	5	25	18	9	16	14	6	24	14	17	14	17	18	17	17	25	16	13	25	27	21	8	19	9	5	25	24	16·8
	2	24	26	10	6	25	16	8	15	14	4	27	14	19	13	19	20	14	18	26	18	13	27	27	21	7	19	10	6	26	26	17·3
	3	24	24	14	7	23	16	9	16	12	2	25	13	19	11	17	21	15	21	24	18	17	27	26	20	8	18	8	4	28	27	17·1
	4	26	22	13	5	23	19	8	15	9	2	26	14	20	11	17	21	15	24	25	16	16	26	24	17	9	15	6	6	26	18	16·5
	5	23	23	7	4	24	15	10	15	10	3	25	14	19	11	15	20	17	22	30	17	16	27	26	17	14	14	7	4	28	17	16·5
	6	27	22	9	2	22	16	9	14	3	5	25	10	12	9	12	20	14	21	25	16	14	24	22	11	12	12	5	6	27	15	14·7
	7	26	20	9	1	18	14	9	16	10	6	20	5	10	6	8	20	14	18	25	12	10	23	18	6	10	8	2	4	25	11	12·8
	8	26	23	5	2	20	10	10	13	12	9	26	5	5	5	2	20	9	19	25	8	9	22	14	7	10	7	2	8	25	12	12·3
	9	24	25	6	2	18	9	9	13	10	12	23	4	6	5	3	19	10	16	21	10	7	20	10	4	6	8	3	2	25	15	11·5
	10	26	25	3	2	20	7	11	15	9	11	15	2	11	5	5	19	7	15	22	14	7	20	7	5	6	7	4	1	18	12	11·0
	11	24	30	5	1	22	7	11	13	7	10	18	4	12	3	5	22	9	14	21	9	10	19	9	4	6	6	5	3	18	10	11·2
	12	19	34	4	3	17	6	9	10	9	16	20	3	8	4	3	18	5	15	19	5	7	16	11	5	4	5	3	1	15	8	10·1
Total Daily Movement.		418	609	210	112	375	398	182	344	284	136	479	302	272	187	229	310	340	347	501	326	255	452	449	268	143	213	123	82	392	385	12·7

RESULTS OF METEOROLOGICAL OBSERVATIONS MADE AT THE KEW OBSERVATORY.

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

1862. 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 P.M., and 5 P.M., respectively. Proportion of Sky clouded.	Direction of Wind.	Rain—read at 9.30 A.M.
	inches.	°	°		inch.	°	°	°			inches.
May 1	29·936	62·3	53·7	·75	·423	72·1	51·0	21·1	10, 1, 1	S, SSW, S by W.	·032
„ 2	30·193	51·4	42·1	·73	·428	59·3	50·6	8·7	9, 2, 1	W, N, N.	·018
„ 3	30·067	42·7	41·0	·94	·274	49·5	40·2	9·3	10, 10, 10	ENE, E, E by N.	·005
„ 4	...	...	...	...	...	71·5	44·9	26·6	...	... ...	·000
„ 5	29·961	62·8	52·9	·72	.412	71·2	44·9	26·3	8, 4, 1	WSW, SSE, S by E.	·128
„ 6	30·010	65·1	53·8	·69	.425	74·8	54·9	19·9	9, 8, 6	N by E, NNW, NW by W.	·008
„ 7	29·748	52·3	51·1	·96	.387	63·6	54·5	9·1	8, 10, 10	WNW, SW by W, SW.	·756
„ 8	29·904	53·6	46·2	·78	.328	61·4	48·5	12·9	7, 7, 9	SW, SSW, SSW.	·727
„ 9	29·612	48·5	46·8	·94	.334	58·5	47·2	11·3	8, 10, 8	SW, SW, SW by S.	·620
„ 10	29·618	49·8	43·9	·82	·303	60·1	48·6	11·5	10, 8, 5	WSW, SW by W,—.	·183
„ 11	...	...	...	...	...	57·5	47·7	9·8	...	... ...	·148
„ 12	29·610	51·1	42·0	·73	·283	57·2	46·4	10·8	8, 10, 9	N, —, E by S.	
„ 13	29·891	48·6	40·9	·77	·273	58·1	45·4	12·7	10, 9, 7	NE by N, NNE, N.	·000
„ 14	29·867	47·0	42·0	·84	·283	53·7	39·6	14·1	8, 10, 10	NE, ENE, NE.	·000
„ 15	29·879	44·3	44·2	1·00	·306	53·7	44·5	9·2	10, 10, 10	NNE, N, N by W	·150
„ 16	29·898	52·6	50·9	·94	·385	61·5	47·0	14·5	10, 10, 3	NNW, NW, W.	·456
„ 17	30·132	60·1	47·6	·65	·344	69·2	45·5	23·7	0, 7, 7	WSW, W, NW,	·000
„ 18	...	...	...	...	...	72·6	47·6	25·0	...	... ...	·000
„ 19	30·015	62·9	56·1	·80	·459	75·3	47·8	27·5	0, —, 7	W by S,—, S	·000
„ 20	29·716	55·9	44·1	·67	·305	65·3	47·4	17·9	8, 9, 6	S by E, SW by S, SW by W.	·000
„ 21	29·493	43·3	39·7	·88	·261	57·3	46·3	11·0	10, 10, 10	SSW, W, WSW,	·011
„ 22	29·770	51·4	34·6	·56	·219	60·2	39·6	20·6	7, 6, 9	W, W, W.	·200
„ 23	29·761	53·7	52·3	·95	·404	63·6	49·5	14·1	10, 10, 10	SW, SW by S, SSW.	·016
„ 24	29·949	54·2	45·7	·75	·322	63·4	51·1	12·3	10, 10, 10	W by S, SW by W, SW by S.	·013
„ 25	...	...	...	...	...	61·3	45·6	15·7	...	... ...	·000
„ 26	30·074	57·0	42·5	·61	·288	64·3	43·1	21·2	6, 7, 4	W, WSW, SW.	·000
„ 27	29·880	53·9	52·7	·96	·400	61·3	51·7	9·6	10, 9, 10	SW, SW by S, W.	·090
„ 28	29·886	57·4	55·5	·94	·450	66·0	54·5	11·5	10, 10, 10	SW, WSW, SW.	·038
„ 29	29·795	60·0	55·3	·85	·447	68·5	55·6	12·9	6, 9, 10	ENE, SE by E, E.	·020
„ 30	29·445	57·3	55·7	·95	·453	65·7	57·2	8·5	10, 9, 10	E by N, SSE, SSE.	·030
„ 31	29·937	55·3	49·9	·83	·372	63·9	54·4	9·5	10, 10, 9	W by N, W by S, W by N.	·126
Monthly Means.	29·854	53·9	47·5	·82	·349			15·1			3·775

HOURLY MOVEMENT OF THE WIND (IN MILES) AS RECORDED BY ROBINSON'S ANEMOMETER—MAY 1862.

Day.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Hour. 12																
A.M. 1	8	16	12	20		6	13	16	1	17	8	5	7	5	12	7
2	4	13	13	20		8	6	17	2	12	5	2	8	7	13	8
3	6	12	9	18		5	3	12	3	13	7	2	7	7	15	4
4	6	13	7	22		7	6	12	1	13	8	3	6	5	16	6
5	9	12	9	18		6	7	17	2	14	6	3	12	4	14	5
6	4	12	10	17		3	3	13	7	14	4	1	11	9	13	5
7	2	11	10	20		2	10	15	7	17	7	1	14	10	17	7
8	7	11	20	20		6	5	23	5	14	9	2	15	13	18	6
9	8	14	21	15		3	7	22	10	13	8	2	17	15	22	7
10	11	14	23	15		3	8	25	12	15	8	4	16	15	20	7
11	5	14	22	15	7	4	4	22	13	13	9	5	15	15	15	6
12	7	13	26	10	7	6	4	24	21	20	12	6	15	18	15	6
P.M. 1	10	10	27	17	11	8	7	27	26	15	9	2	13	17	13	5
2	16	11	30		13	6	15	25	23	15	12	1	11	16	13	9
3	19	14	30		15	3	14	25	24	12	12	1	14	14	15	9
4	17	11	32		17	7	13	22	23	11	12	3	15	13	14	8
5	16	10	31		15	9	18	18	18	14	11	5	16	14	12	9
6	12	11	30		10	10	18	15	15	13	9	7	16	16	10	9
7	12	9	30		10	12	17	10	15	12	6	3	13	14	14	6
8	11	10	35		8	10	10	8	15	8	4	2	14	16	17	5
9	12	9	32		7	13	13	7	12	7	5	8	10	14	14	3
10	10	7	32	118	12	9	12	7	18	8	5	9	8	11	11	5
11	14	11	31		14	8	18	5	15	8	4	6	11	12	10	5
12	13	13	22		8	12	15	2	15	7	4	7	7	10	5	5
Total Daily Movement.	239	281	544	499		166	246	389	303	305	184	90	291	290	338	152

Day.	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	Hourly Means.
Hour. 12																
A.M. 1	5	3	1	1	9	6	13	11	5	4	10	9	5		8	8·4
2	3	1	0	2	8	5	13	9	5	3	9	10	4			7·5
3	5	0	1	1	5	7	18	7	7	3	11	12	5	18		7·7
4	5	1	1	3	10	8	15	11	5	2	11	12	5			7·9
5	5	0	1	2	9	12	22	9	6	4	14	10	5	67	71	8·5
6	2	1	0	2	6	10	20	8	7	4	10	8	4			7·4
7	3	2	1	2	10	15	20	8	9	5	14	11	4	20		9·4
8	5	3	1	5	11	16	22	10	12	5	15	9	6	25		11·0
9	1	2	1	6	13	20	20	10	10	8	16	10	5	17	12	11·2
10	3	3	3	12	11	17	20	9	9	11	15	11	7	13	10	11·7
11	5	3	5	16	5	21	20	10	10	10	17	10	7	[illegible]	8	11·2
12	6	4	3	17	17	19	23	10	10	11	18	11	10	9	8	12·5
P.M. 1	4	5	5	18	13	18	23	11	11	10	18	10	13	[illegible]	9	12·8
2	3	4	6	21	12	20	22	12	10	14	15	7	13	11	9	13·2
3	5	5	4	23	11	19	19	11	8	13	15	5	17	13	6	13·2
4	5	4	9	21	10	16	19	11	9	15	15	5	14	13	7	13·0
5	5	7	7	20	20	14	24	12	8	11	13	8	21		4	13·4
6	5	3	11	20	10	16	17	13	7	9	14	10	20		5	12·4
7	5	4	7	14	14	14	18	10	4	10	13	11	22		4	11·5
8	3	3	5	13	9	13	15	5	3	7	10	11	26	77	1	10·0
9	4	2	4	9	12	8	10	7	2	6	9	8	21		3	9·3
10	3	1	3	13	12	14	12	7	2	7	10	7	18		6	9·6
11	2	1	3	13	8	13	12	6	3	10	13	7			4	9·5
12	5	1	0	13	4	12	16	6	4	10	7	5	73	9	4	8·3
Total Daily Movement.	97	63	82	267	249	333	433	223	166	192	312	217	645		179	9·7

RESULTS OF METEOROLOGICAL OBSERVATIONS MADE AT THE KEW OBSERVATORY.

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

1862. 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 P.M., and 5 P.M., respectively. Proportion of Sky clouded.	Direction of Wind.	Rain—read at 9·30 A.M.
	inches.	°	°		inch.	°	°	°			inches.
June 1	...	...	...	...	...	67·4	50·8	16·6	...	... ...	·003
,, 2	30·043	57·5	48·6	·74	·356	72·0	47·0	25·0	0, 1, 7	W by N, W by N, W.	·000
,, 3	30·019	54·1	51·3	·91	·390	63·7	54·5	9·2	9, 10, 9	SSW, SW, SSW.	·000
,, 4	30·112	57·9	44·7	·64	·311	68·0	45·9	22·1	4, 3, 1	WSW, SSW, S by E.	·015
,, 5	29·719	50·7	47·3	·89	·340	61·9	47·2	14·7	9, 10, 10	SW, W by S, SW by S.	·000
,, 6	29·638	56·2	53·5	·91	·420	64·8	53·5	11·3	6, 10, 10	S by W, S by W, S by W.	·302
,, 7	29·763	57·8	46·4	·68	·330	66·7	36·6	30·1	3, 3, 10	SW, SW by S, SW by S.	·026
,, 8	...	...	...	...	...	65·9	51·2	14·7	...	... ...	·056
,, 9	29·973	53·2	44·7	·75	·311	61·9	44·2	17·7	6, 7, 3	SW by W, WSW, SW.	·047
,, 10	29·894	52·3	41·4	·69	·277	63·0	42·1	20·9	6, 10, 10	S, SSE, S by E.	·098
,, 11	29·377	54·8	49·9	·85	·372	64·6	50·7	13·9	3, 9, 5	SSE, S by E, S by W.	·070
,, 12	29·293	50·8	51·8	1·00	·397	60·1	52·0	8·1	10, 10, 10	SE by S, S by E, S.	·213
,, 13	29·564	51·4	50·0	·95	·373	62·5	52·2	10·3	8, 9, 7	SW, SW by S, SW by S.	·445
,, 14	29·658	49·5	51·3	1·00	·390	60·1	49·9	10·2	8, 8, 10	SW, SSW, S by W.	·076
,, 15	...	...	...	...	...	63·8	45·3	18·5	...	... ...	·408
,, 16	29·976	51·2	46·3	·85	·329	64·6	49·6	15·0	7, 9, 10	WNW, NW, —.	·246
,, 17	30·009	56·0	46·9	·73	·336	65·7	47·8	17·9	5, 10, 10	WSW, W, NW by W.	·040
,, 18	29·969	50·8	43·8	·79	·302	61·5	50·3	11·2	3, 9, 8	N by E, N, N by W.	·093
,, 19	30·050	52·3	42·5	·71	·288	61·4	48·4	13·0	9, 10, 10	NW, WNW, SW,	·047
,, 20	29·900	49·9	44·3	·82	·307	58·4	50·2	8·2	7, 10 10	NW by W, WNW, W.	·037
,, 21	29·756	52·2	46·1	·81	·326	60·4	50·5	9·9	10, 10, 10	W by S, SW, W.	·000
,, 22	...	...	...	...	...	60·3	51·9	8·4	...	... ...	·001
,, 23	29·872	54·4	44·9	·72	·313	65·4	52·8	12·6	10, 6, 3	SW by S, NNW, NW by W.	·076
,, 24	29·928	57·1	51·5	·83	·393	68·0	47·8	20·2	10, 9, 8	WSW, SW, NW by W.	·000
,, 25	30·135	53·5	47·4	·81	·341	63·3	49·8	13·5	10, 10, 7	NW by N, NNE, NE.	·000
,, 26	30·003	57·4	49·6	·77	·368	67·4	50·4	17·0	8, 8, 10	W, NW, W by S.	·000
,, 27	29·769	51·1	40·1	·69	265	67·3	51·7	15·6	9, 10, 7	W by S, W by S, W.	·000
,, 28	29·905	52·6	43·4	·73	·297	61·9	44·6	17·3	7, 8, 8	NW, WSW, NW.	·010
,, 29	...	...	...	...	...	64·0	43·8	20·2	...	... ...	·000
,, 30	29·910	53·7	39·2	·61	·257	64·3	53·3	11·0	8, 7, 3	NW by N, NW, W.	·057
Monthly Means.	29·850	53·5	46·7	·80	·336			15·1			2·366

HOURLY MOVEMENT OF THE WIND (IN MILES) AS RECORDED BY ROBINSON'S ANEMOMETER.—June 1862.

Day. / Hour. 12		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.
A. M.	1	2	2	7	7	7	5	27	11	5	6	14	17	21	16	7	3	2	7	5	5	5	9	7	5	2	2	4	9	5	9	7·8
	2	3	6	7	8	4	4	24	11	2	5	14	17	20	18	7	5	3	8	7	12	6	10	11	6	5	3	5	8	6	11	8·5
	3	3	6	7	7	4	7	24	7	3	4	15	16	18	14	9	3	3	5	7	10	5	9	8	9	5	4	4	10	5	9	8·0
	4	4	4	5	6	2	10	24	6	2	3	14	14	18	15	10	2	2	7	6	6	7	9	10	5	7	4	3	7	3	10	7·5
	5	8	5	6	5	1	10	23	8	5	3	15	13	20	17	9	2	2	10	5	8	8	11	10	5	6	6	3	8	6	9	8·2
	6	10	4	4	6	2	10	21	7	5	5	18	16	22	15	11	4	4	15	5	9	9	14	10	7	10	6	7	8	3	6	9·1
	7	12	3	6	6	3	13	22	9	6	3	13	19	23	16	14	2	4	15	5	12	11	14	13	6	12	7	9	12	5	9	10·1
	8	13	3	7	9	7	15	24	11	8	5	17	18	22	17	15	7	5	20	9	14	10	16	12	7	12	5	12	15	6	10	11·7
	9	14	2	10	8	10	19	25	16	7	9	22	17	23	15	18	6	8	20	13	13	12	15	13	10	15	7	12	14	7	14	13·1
	10	13	3	10	10	10	18	25	17	7	11	18	20	24	12	12	6	5	20	10	15	15	17	12	10	11	10	13	13	7	13	12·9
	11	16	3	14	12	6	18	30	22	10	15	18	18	28	13	17	3	7	20	10	13	14	13	14	10	10	10	15	14	11	13	13·9
	12	14	3	18	13	4	22	28	24	7	13	21	20	35	11	16	7	8	20	8	11	13	15	9	10	13	12	17	13	10	13	14·3
P. M.	1	12	3	19	15	11	25	28	27	8	14	21	22	32	14	13	3	10	19	9	13	11	13	10	13	13	11	11	15	12	15	14·8
	2	13	4	20	13	16	21	30	23	9	14	20	23	31	12	12	13	10	19	7	11	12	12	8	10	11	10	13	16	10	14	14·6
	3	13	7	17	13	16	25	29	13	13	17	22	23	29	12	11	11	10	19	8	9	11	12	9	9	13	13	17	16	10	13	14·7
	4	13	3	17	14	15	27	27	13	15	15	26	22	28	16	7	16	8	13	8	7	11	13	7	11	8	12	17	18	15	11	14·4
	5	15	7	20	20	9	29	26	17	13	14	24	25	22	12	5	7	10	17	4	10	3	12	9	11	8	12	17	14	18	11	14·0
	6	15	8	12	17	6	31	20	17	12	8	23	20	20	10	11	6	7	13	8	7	6	13	7	9	7	8	13	10	13	10	12·2
	7	12	5	11	15	2	32	19	13	10	7	23	23	25	12	3	9	13	11	3	9	6	11	2	10	4	7	13	8	15	11	11·5
	8	13	7	12	9	3	25	18	8	7	8	18	29	21	10	6	5	7	9	10	8	8	11	1	5	1	6	7	8	14	7	10·0
	9	9	6	12	7	2	33	15	7	7	5	15	27	20	9	7	3	3	6	5	7	7	8	2	10	1	6	7	3	13	8	9·0
	10	4	7	6	10	4	34	12	7	6	10	14	24	19	7	5	2	5	3	7	10	6	10	5	10	2	5	6	3	12	7	8·7
	11	7	7	12	12	5	34	11	7	6	13	17	27	17	7	5	1	8	3	7	9	9	12	5	7	5	8	7	4	13	7	9·7
	12	2	6	8	5	5	25	12	6	6	10	16	23	18	8	4	1	7	3	4	8	9	9	5	3	4	6	6	2	10	6	7·9
Total Daily Movement.		240	114	267	247	154	492	544	307	179	217	441	493	556	308	234	127	151	302	170	236	214	288	199	198	185	180	238	248	229	246	11·1

TRANSIT OF THE SHADOW OF TITAN—DOUBLE STARS—THE MOON—OCCULTATIONS.

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

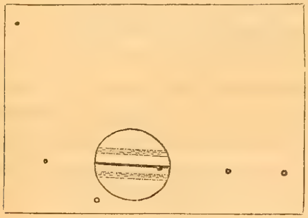
TRANSIT OF THE SHADOW OF TITAN.

A TOTAL eclipse of the sun to the inhabitants of the earth of course infers the passage of the shadow of the moon over the face of our globe. In consequence, however, of our comparative nearness to the sun, and the resulting breadth of his disc, the cone which this shadow forms tapers so rapidly that its point frequently fails to reach the earth: in annular eclipses it falls short of it; and even in the largest total ones it is but of small dimensions, its section at right angles to the axis seldom attaining a breadth of 180 miles, though it may be greatly drawn out in length if it falls among the shadows cast by the rising or setting sun. The case is very different with the projection of the shadows of the satellites of Jupiter and Saturn. The sun's diameter is so much lessened to them from their greater distance, that the cone of shadow is always prolonged far beyond the surface of the primary, and a dark spot is formed there every time that a solar eclipse takes place; and while the shadow of our satellite upon the earth would be barely visible from the nearest planets with powerful telescopes, and from the remoter ones would be quite imperceptible, the corresponding phenomenon in the system of Jupiter, and, as it now appears, in that of Saturn also as far as the largest satellite is concerned, is sufficiently conspicuous to be witnessed by us with comparative ease.

In the case of Jupiter, these shadow-spots have been familiarly known, since Campani, the celebrated Italian maker of refractors of long focus, first observed one in 1658;* but as regards Saturn, they have been hitherto little noticed. This has been owing in part to the exceeding distance and minuteness of the object; for it is certainly something extraordinary to contemplate the effect of a solar eclipse at a distance never less, often much more, than 760 millions of miles; but it is quite as much due to the different arrangement of that planet's system. The general plane of the orbits of Jupiter's satellites differs so little from that of his own path, that the shadow of three of the satellites invariably, and that of the fourth for the most part, falls on his globe once in every revolution, and every "new moon" there brings a total solar eclipse; but the inclination of the whole system of Saturn to the plane of his orbit is

* *Cycle of Celestial Objects*, I. 171. Arago erroneously gives the discovery to Cassini I. in 1664.

so great, that, excepting about the time when the ring presents its edge to the sun—once in fifteen years—the apparent paths of the more distant satellites are ellipses open enough to carry them and their shadows clear above and below the ball, while the specks cast by the nearer ones would be imperceptibly minute. Consequently, the records of such phenomena are very few, and will naturally relate to the shadow of Titan, the 6th (reckoned outwards) and largest satellite, whose diameter, about three-fourths of a second, according to Struve, considerably surpasses that of the others. Sir W. Herschel was the first to perceive a transit of this shadow, 1789, Nov. 2, and notwithstanding his gigantic instrumental means, he does not appear to have repeated the observation. 1833, May 7, Gruithuisen, who had been watching the ring from March 27 with a 4-inch Frauenhofer achromatic, and had found the knots of light gradually decrease, and at length disappear together with it, says, "I saw, almost in the position where Schröter placed his two knots in the eastern, now not visible, ansa, two satellites, of which the nearest cast its shadow close upon the shadow of the ring, which I at first was inclined to hold as the shadow of a knot in the ring. I saw besides, at a greater distance, the 6th and 7th satellites, to the W. of the former ones." This last expression seems not very intelligible; however, there can be little doubt from his aperture that he mistook the names of these two latter; and as little, that it was Titan whose shadow he saw. 1848, Sept. 20, Schwabe, the great observer of the sun, says that he perceived with the same kind of instrument, upon the very narrow line of the shadow of the ring, between the centre and the W. limb of Saturn, an excessively minute black point; but he does not refer it to the shadow of a satellite; and possibly this, and even Gruithuisen's observation, may have related to one of those curious irregularities in the shadow of the ring which have been remarked by Schröter, Lassell, and De la Rue. If so, Herschel's observation must have stood alone till the present year, for Dawes sought in vain to recover the phenomenon at the last disappearance of the ring in 1848 and 1849. During the present season, however, several persons, led on, as was fitting, by that most clear-sighted and accurate observer, have been more successful. He saw it first, April 15th, with his magnificent $8\frac{1}{4}$-inch Alvan Clark achromatic. Mr. Lockyer, of Wimbledon, caught the next transit on May 1st. The following one, on May 17th, was witnessed by several observers, and as I was fortunate enough to be one of the number, I have thought that a brief account of its appearance might not be without some interest. I had entirely lost sight of Dawes's announcement of the transit for that evening, and turned my telescope on Saturn, solely with a view of ascertaining whether any trace of the ansæ might still be perceptible; they had, however, entirely vanished, leaving only a narrow black band, where the ring presented its unenlightened side to the eye. On this band I instantly perceived a spot, which a moment's reflection convinced me must be the shadow of Titan, then preceding at a short distance the N. pole of Saturn; at first I imagined that it projected on each side, like a knot in a black thread; but a little consideration—especially as at the time I had a mistaken impression as to the breadth of the ring—showed that this would give it an exorbitant magnitude, and I speedily satisfied myself, as far as the light of $5\frac{1}{2}$ inches of aperture, and an atmosphere not particularly favourable, would permit, that it stood out only from the N. edge, along which I watched its progress from about $\frac{1}{5}$ to $\frac{1}{3}$ of its path across the ball. Four satellites were unquestionably visible; it was doubtful whether a small object at a short distance *sp*, was Japetus, or a star; probably the latter. Two belts were readily made out. The following diagram will give a general idea of the phenomenon, but it will be borne in mind that it has no pretension to accuracy.



The unexpected size of the shadow on April 15th was noticed by Dawes, and it is very singular that this strange anomaly, detected some time back in the system of Jupiter (see INTELLECTUAL OBSERVER, No. III. p. 232), should thus seem to be repeated in that of Saturn. The same observer was highly successful in watching the transit of May 17th, and on the 25th he was probably the first to witness an immersion of Titan into the shadow of Saturn.

The subsequent transits on June 2nd and 18th were invisible from the state of the atmosphere, at least in many places, and I am not aware that any account of them has appeared.

DOUBLE STARS.

The evenings are now beginning to close in, and our time for study is proportionally extending. Wega, the lovely gem of the zenith, must be postponed, from her inconvenient elevation; but we shall use her as a *pointer* to other objects. We will draw a long line from Arcturus, our *pointer* of last month, towards the E., sloping somewhat downwards, and a shorter line from Wega to the S., tending towards the W. These two lines will intersect each other at right angles near a 2nd mag.

star, which though not a brilliant object, takes the first rank in a dull neighbourhood. This is *Al Râi,* alias *Ras-al-hangue,* in the head of the large though inconspicuous constellation *Ophiuchus,* whose legs reach below the serpent which he is carrying, a long way towards the S. horizon. A few degrees W. and slightly N. of this star, is a much smaller one, *Ras-al-Gjâthi,* marking the head of *Hercules,* another widely extended constellation in an unaccountably undignified posture, kneeling on one knee with his feet uppermost. The heads of these two singular figures thus awkwardly "laid together" for thousands of years, ought to be familiar to the student as guides in a neighbourhood barren to the eye, but full of telescopic interest; the head of Hercules itself giving us a grand object;—

24. *α Herculis. Ras-al Gjâthi.* 4″·5. 118°·7. $3\frac{1}{2}$ and $5\frac{1}{2}$. Orange and emerald or bluish-green; *intense cærulea,* according to Struve. Sir W. Herschel considered that the principal star was variable from 3 to 4 mag. in $60\frac{1}{4}$ days: Struve has not confirmed it, but has seen the companion sometimes 5, at others 7 mag. Argelander, who doubts this, fixes the period of the large star at 66·4 days; Baxendell at 88·5 days. This "lovely object," as Smyth calls it, "one of the finest in the heavens," though looking so much like a system, has not as yet been proved to be in motion. A power of 80 will draw it out and show its colours in a good glass, though of course it will gain in beauty by magnifying.

25. *δ Herculis.* 25″·9. 173°·9 (1830·71). 24″·5. 175°·1 (1839·62). 4 and $8\frac{1}{2}$. Greenish white and grape-red. Struve during 7 years marked the companion "albacinerea." I thought it bluish-green in 1850. Fletcher made them yellow and red, 1851·67; Dembowski, yellow and blue, 1854, 1855; white and blue, 1855, 1856. This is probably a binary system, and if so, is a fair instance of a very remarkable fact, which, however, does not depend upon such slender proof as this single example, but is evident in other cases and ways, that *the brightness of stars is,* at least in many cases, *no indication of their real distance.* Here we have an $8\frac{1}{2}$ mag. star in all probability as near to us as its very much larger companion. This conclusion once admitted—and how it can be resisted, it is difficult to see—very remarkable consequences follow; speculations, however ingenious and beautiful, which assume anything like a general distribution of stars throughout space according to apparent magnitude, fall away of themselves; and but for the modern improvement in instruments, which renders the determination of parallax no longer impossible, we should be left in entire uncertainty as to the real marshalling of the starry host; and even that "longior scala astronomorum," as Kepler calls it, while it confirms the overthrow of all arrangements based

on apparent brightness, is applicable, from the extreme minuteness of the measures required, and their rapid decrease and disappearance with increasing distance, to so few cases, that we still feel bewildered as at the entrance of a mighty labyrinth; so very few are the known points, the unknown, practically infinite.

To find δ, run a line N. from *a*, which will strike it at 10° distance; it will be the first conspicuous star in that direction, and, though not large, the brightest in a considerable region.

26. δ *Serpentis.* 2″·8. 196°·2. 3 and 5. Bright-white and bluish-white; under the very best vision, both bluish. Dembowski gives yellow tints, probably from his telescope. Motion is suspected in this very fine pair, which may be found by drawing a line through the two stars called *Yed* (see No. 15) towards the right, and bending it a little upwards; this will pass, at some distance, through three stars, of the 3rd, 2nd, and 3rd mags. the centre one, which is by far the brightest, is *a Serpentis;* the furthest is our object, δ.

27. κ *Herculis.* 31″·4. 9°·7. 5½ and 7. Pale-yellow and reddish-yellow. Probably stationary. To find it, run a line through the "two heads," *a Ophiuchi* and *a Herculis,* and bend it a little upwards; at a considerable distance it will strike upon β *Herculis,* 3 mag., the brightest star in a wide region; a little *s p* from β lies a smaller star, γ, in the *unbent* line through the "two heads." Another line through β and γ, bent a little upwards, falls upon several minute stars close together, rather further from γ than γ is from β: κ is the most to the W. of these. It is also nearly in a line from γ Herculis to δ Serpentis (No. 26).

28. 53 *Ophiuchi.* 41″·3. 192°·5. 6 and 8. Greyish and pale blue. This beautiful object, which seems only optical, is rather minute for the naked eye in twilight, but it is not difficult to find, as it lies due *s* of *a,* only 3° distant; the space between *a Ophiuchi* and *a Herculis* being about 5½°.

The *number* by which this and other stars are designated, is that assigned by Flamsteed, and denotes the place in his catalogue, in the order, not of brightness, but of Right Ascension.

Before it sinks too far towards the horizon, we had better turn to—

29. 12 *Canum Venaticorum. Cor Caroli.* 19″·8. 227°. 2½ and 6½. Flushed white and pale lilac, 1837·4. There is some doubt about these tints. Herschel II. says, in 1830 or 1831, "with all attention, I could perceive no contrast of colours in the two stars." His father calls them white, inclining to red; Struve, in 1830, made them white; Sestini, in 1844·5, yellow and blue; Smyth, again in 1850·5, full white

and very pale; in 1855, pale reddish-white and lilac; Dembowski, in 1856, white and pale olive-blue. I found them, about 1850·5, with a $3\frac{7}{10}$-inch object-glass, white or a little yellowish and tawny or lilac; 1862·2, with $5\frac{1}{2}$ inches, the same colours, but with very little contrast; $6\frac{1}{2}$ seemed rather orange-tawny, but became bluish when its light was materially reduced by the passage of a thin cloud illuminated by the Moon. These variations are probably due to instrumental and personal differences; but as this may not be the case in some other pairs, an instance like the present deserves to be studied, with a view of deciding between real and apparent changes of colour.

This fine pair has been relatively fixed for 57 years, but has a common proper motion. It is easily pointed out, in the middle of a vacant space below the Great Bear's tail, by a long line from Polaris through Alioth, or ε Ursæ Majoris, the 5th star of that constellation, counting from right to left.

For a reason the reverse of the last, we will take a fine object in *Cassiopea* before it attains an inconvenient altitude. This constellation, "the Lady in her Chair," is generally known from its resemblance to the letter W, the top being towards the Pole; the student will find it about the beginning of August in the evening, bearing N.E., at some distsnce to the right of the Pole Star, but at a somewhat lower elevation.

30. η *Cassiopeæ.* 9″·8. 87°·8 (1830·91). 7″·7. 108°·3 (1854·17). 4 and $7\frac{1}{2}$. Dull white and lilac. Herschel II. and South gave red and green. Sestini, yellow and orange; Struve, *flava* and *purpurea*: so Fletcher. Smyth calls this a "superb physical object," with a period of about 700 years, and a considerable proper motion of nearly 2″ in R.A., and $\frac{1}{2}$″ in Declination annually. Eyre Powell reduces the period to 181 years. We have here a striking instance of the fact referred to under No. 25, *the equal distance from our eye of stars of very different magnitude.* It is readily found by learning the letters of the five conspicuous stars, which, beginning at the right-hand end of the W, and reckoning backwards, are β, α, γ, δ, ϵ. Our object is nearly in a line between α and γ, nearer to α. Smyth could see it with two inches of aperture.

THE MOON.

The surface of our satellite is at once a very easy and a very interesting object of telescopic research. As not merely the general arrangements of its lighter and darker portions, but even the greater irregularities of its "terminator," or boundary of light and darkness, are visible to the naked eye, it is evident that the smallest telescope will suffice to give us some curious information; while instruments of moderate size, such as are now becoming both cheap and common, will bring out details enough to occupy, in their close study and careful delineation, the leisure hours of many a long year. This branch of astronomy will be found peculiarly within the reach of the numerous class of amateurs whose telescopes are furnished neither with micrometers nor clockwork motions; and it is one in which they may do good service, provided only the judgment of the eye is good in estimating proportions, and the hand fairly practised in the most desirable acquirement of drawing. This latter is, indeed, an acquirement—accomplishment, in the ordinary sense, seems too trivial a name for it—of more value than the inexperienced may be aware of; for it is found that the habit of representing what is seen reacts upon the mode of seeing, and the accuracy of the hand increases the discrimination of the eye, so that a practised draughtsman distinguishes more, especially in a complex object, than one ignorant of design, even with a naturally keener sight. The micrometer is by no means so necessary in this pursuit as in the observation of double stars, since, however desirable it may be to fix the principal points in a lunar survey by actual measurement, the details may be quite as well filled in by hand; while, should a micrometer be employed, the trouble of arranging an artificial illumination is avoided. Schröter employed, in his numerous delineations, a contrivance called a "projection machine," which consisted merely of a white surface, divided by parallel lines into numerous small squares, placed at a convenient distance from the eye, and exposed to a suitable illumination. His telescope being of the Newtonian construction, this surface was supported by a bar fixed perpendicularly to the tube at its mouth, and thus he was enabled to view at the same time any lunar region with the right eye in the eye-piece, and the divided surface with the left eye, unaided, across the open end of the telescope, so that, by means of a paper similarly divided into squares, he could make drawings with greater accuracy than could be attained by the eye alone, though inferior to that resulting from the use of the micrometer. This method of projecting the image on a divided scale (whence the name of the apparatus) is now found useful for microscopic purposes: it would be difficult to attach it to an achromatic telescope; and if measurement is desired, the object might be more conveniently attained by inserting in the focus of the eye-piece a little divided glass scale, which may be obtained of Messrs. Horne and Thornthwaite, 121, Newgate Street; or the photographic image of a scale, which I had tried by a friend some time ago with a very fair prospect of success, and which has since, I understand, been advertised for sale. However, a practised eye, capable of estimating pretty sharply multiples or fractions of any assumed distance, as well as *bearings* or angles of position, will leave little to be desired by an amateur in this matter, as our details are relatively fixed, and in subsequent comparisons it is easy to leave a margin for the differences of eyes, or of the same eye at various times, without the risk of mistakes in identification.

The intention of the papers, of which this is the commencement, will be to point out to such of our readers as may feel disposed to take up this interesting pursuit, some of the most remarkable features of the moon, more especially with the hope that those who possess sufficient optical means and leisure may be induced to study them and delineate them with care, and thus assist in accumulating a body of evidence which may, by ultimate comparison, be found to possess much value. Notwithstanding the worthy labours of our predecessors, there is plenty of room here for the diligent co-operation of many eyes and hands. Schröter's exemplary fidelity in observing and recording was not well seconded by his pencil: his designs are coarse and rough, and contain little of the finer details. Russell's lunar globe and maps are beautiful and ingenious, but not accurate enough to possess much value as standards of reference: a globe of the moon *in relief*, by the same observer, may be seen at the South Kensington Museum, but, unlike the marvellous production of Madame Witte described in Herschel's *Outlines*, can only be regarded as a curiosity. Lohrmann's accurate and ugly "sections" comprise, like the views of Schröter, only a portion of the moon. The continuation of his work by Schmidt, the present Director of the Athens Observatory, if completed, seems to be unknown in this country. Beer and Mädler's great map speaks for itself as a noble production of industry and skill, and, especially as illustrated by the corresponding two volumes entitled *Der Mond* [The Moon], makes the nearest approach to a complete Selenography; yet the little attention I have been able to give has convinced me—and my opinion is fully borne out by that of a very diligent observer, Mr. Birt,—that, in some regions, at least, the minuter details are less carefully entered than might have been expected from the general style of the work. The drawings and models of Nasmyth are of very limited extent, and the promised publication of Dr. D'Orsan has not yet appeared. On the whole, we are quite justified in saying, that after all that previous observers have done, there are many desiderata in the state of our lunar knowledge. It is pleasant to be able to add, that the deficiency is, in a great measure, such as may be supplied by amateur observation. Not only are the general outlines satisfactorily settled, but many of the minuter configurations. The details which are wanted are chiefly such as are calculated to throw light upon the mode of formation of the surface, upon the existence of continued eruptive action, and upon the presence or absence of atmospheric variations indicated by illusory appearances of change. An attempt will be made, in a future paper, to point out the conditions under which such investigations may be attended with success.

OCCULTATIONS.

These, during the present month, are few. The moon, as viewed from Greenwich, makes a near approach to 39 Ophiuchi, 6 mag. on the 5th, at 9h. 4m.; to δ Arietis, $4\frac{1}{2}$ mag. on the 16th, at 10h. 34m.; A^1 Tauri, $4\frac{1}{2}$ mag. immerges, Aug. 17th, 11h. 26m., and reappears at 12h. 18m., followed by A^2, 6 mag., at 11h. 38m. and 12h. 35m. respectively. These two stars lie a little *s f* from the Pleiades, in the direction of Aldebaran.

PROCEEDINGS OF LEARNED SOCIETIES.

BY W. B. TEGETMEIER.

GEOLOGICAL SOCIETY.—*June* 18.

Raised Beaches of Scotland.—In reference to a paper of Mr. Geikie, an account of which appeared in the Intellectual Observer, vol. I. page 319, Mr. W. Carruthers made a communication in which he stated that in the section of clay, sand, and gravel near Leith, described by Mr. Geikie as part of a raised beach elevated since the period of the Roman occupation, not only have mediæval pottery and tobacco-pipes been found as described by Mr. Geikie, but a mediæval jar has been met with in the sand beneath. The so-called "Roman" pottery was stated by Mr. Carruthers to be of mediæval age, on the independent authority of Messrs. Birch and Franks of the British Museum; and he believes that the beds in question are mainly of late and artificial formation; he does not, however, argue from this that there is no evidence of a late upheaval of the central part of Scotland.

On the Sudden Destruction of Fishes in the Sea.—The formation of deposits containing the remains of fish in vast numbers was illustrated in a very interesting manner by Sir William Denison, Governor of Madras, who, in a letter read before the Society, stated that when steaming between Mangalore and Cananore, on the west coast of India, he found that for some time after the south-west monsoon the sea was offensive with dead fish, killed by the great mass of fresh water poured into the sea during the season of the monsoon.

CHEMICAL SOCIETY.—*June* 26.

Artificial Production of Organic Compounds from Boghead Naphtha.—At the last meeting of the Chemical Society Mr. Greville Williams, F.R.S., read a paper, in which he stated that he had succeeded in obtaining the iodides of several alcohol radicals from Boghead naphtha. When we consider the almost infinite variety of metamorphoses which these iodides may be made to undergo, it is evident that an almost inexhaustible mine of research has thus been opened. Acids, alcohols, ethers, aldehydes, alkaloids, etc., may now be produced from Boghead naphtha almost to infinity. Mr. Williams has already procured the iodides of amyle, œnanthyle, capryle, and pelargonyle; he has also obtained the new alkaloids œnanthylamine and pelargonamine.

ENTOMOLOGICAL SOCIETY.—*July* 8.

The red-letter day of every London entomologist is that one on which Mr. Wilson Saunders of Reigate invites the members and a select number of scientific men to meet the President and Council of the Entomological Society. The day is always commenced by an excursion to some neighbouring district; the locality selected this year being Betchworth Park, Deepdene, and Brockham. The day was one of the most brilliant of this uncertain summer, and enabled the visitor to enjoy to the utmost the beauty of the Wealden district, that has been so appropriately named the Garden of England.

It could be wished, but is hardly to be expected, that each of these scientific explorations should be rewarded by the discovery of some new species. Though not so fortunate on this occasion, the members were gratified by the capture of several rare and interesting insects, among which may be mentioned *Myrmidonia Haworthii*, one of the rarest of the Staphylinidæ, also *Calomicrus circumfusus*, which was found in tolerable abundance on the furze, and *Ilobates propinqua*. At Mr. Bennett's, at Brockham, the members had the pleasure of seeing several young emeus, about three months old, reared in this country. These birds may be said to have been successfully acclimatized by Mr. Bennett. The particular species is the Dromius irroratus.

On the return to Reigate, the members assembled at the New Hall—an elegant and convenient building, erected for scientific and literary meetings—and there partook of a sumptuous repast. After dinner, Mr. Saunders made some observations on the exact scientific value of entomological collections, stating that study of the habits and mode of life of an insect was necessary to render collecting of any real value; that collectors were not necessarily entomologists; and that collections, however great, were only the means to, and not the end of, entomological science. He also stated that the internal anatomy of insects was almost entirely neglected in this country, and that the field was open to thousands of investigators, each of whom could do good service to the cause of science. Speeches were also made by Mr. Smith and Mr. Dunning, president and secretary of the Society; Dr. Gray, General Sir John Hearsey, who has shown that devotion and service to science, is compatible with the most active discharge of arduous military duties; Dr. Wallace, to whom we are indebted for the living specimens of the birds of paradise, and several other gentlemen.

ASTRONOMICAL SOCIETY.

Mr. T. W. Burr exhibited and described a new eye-piece for telescopes, which had recently been constructed for him by Messrs. Horne and Thornthwaite of Newgate Street. It is an improvement on the form of eye-piece much used in microscopes, and known as the "Kellner," or "Orthoscopic," which consists of a double convex lens for field-glass, and a meniscus for eye-glass. This combination requires no stop, and gives a much larger field than a Huyghenian eye-piece of the same power. The alteration made in the new form, which has been named the "Aplanatic," consists in replacing the meniscus by a plano-convex *achromatic* eye-glass, made up of a double convex crown lens and a plano-concave flint one, similar to one of the pairs of a microscope objective. This preserves the advantage of the large and flat field with better definition and freedom from colour than the "Kellner," and is equally applicable to both microscopes and telescopes.

Mr. Burr stated that he had, during several months past, compared an "aplanatic" eye-piece, giving a power on his telescope of 125, with a Huyghenian of 123, and found that upon the sun and moon the field was one-third larger, taking in nearly, or sometimes quite, the whole disc of those luminaries, while the increased light rendered the eye-piece most valuable in observations of the planets, nebulæ, and double stars.

In the discussion which ensued, Mr. Pritchard remarked that he thought it unwise to depart from the Huyghenian form, which was theoretically and practically perfect, but Mr. Burr replied that the practical difference in definition and colour of the new form was so slight that the increased field and light rendered the experiment worthy of trial, and that all improvement would be stopped if we refused to depart from an established construction. Mr. Carrington also stated that he had found the "Kellner" eye-piece in constant use in Germany, especially on comet seekers, where it was much valued for its large field, and that he thought the proposed modification now shown very likely to be an improvement, as nearly effecting a perfect balancing of chromatic aberration.

ROYAL INSTITUTION.

Gas Glass Furnaces.—At the last Friday evening meeting of the Members of the Royal Institution, Professor Faraday delivered a lecture, explanatory of the construction and mode of action of Mr. Siemen's gas glass furnaces. In these furnaces the gaseous fuel is produced by the combustion of coal in a limited amount of air; the products of the combustion which takes place at the lower part of the furnace having to pass a layer of unignited coal are decomposed; the carbonic acid is reduced to a state of carbonic oxide by taking up an additional quantity of carbon; various gaseous hydrocarbons are also liberated by the heat acting on the coal, and by the introduction of water into the burning fuel steam is produced, which is decomposed by the heated carbon yielding carbonic oxide and hydrogen. The mixed gaseous fuel thus produced passes off from this furnace; it consists of the nitrogen derived from the air; this constitutes about one third of its bulk, and is a useless ingredient as possessing no calorific power whatever; the remaining two consist of a somewhat varying admixture of hydrogen, carbonic oxide, and gaseous hydrocarbons. This gaseous fuel is allowed to ascend a vertical tube, and may be conveyed to any required distance before it is mingled with air and allowed to burn. Such is the general principle of the action. In the furnaces of Mr. Siemen there are, however, certain contrivances, termed by him regenerators, by the aid of which the heat produced is encouraged in its distribution, so that but little of it escapes being utilized. Hence the economy of fuel is estimated, practically, at one half.

The explanation of the value of this process depends on the calorific or heat-giving power of the substances burnt. One part of carbon, if perfectly oxidized, unites with two and two-thirds of oxygen to form carbonic acid CO_2, and evolves sufficient heat to raise the temperature of 8000 parts of water one degree centigrade. If it burns in a limited supply of oxygen so as to produce carbonic oxide, the CO, the amount of heat evolved, would only raise the temperature of 2473 parts of water one degree; but when this amount of carbonic oxide is allowed to burn in a fresh access of air, it evolves the remaining units of heat (viz. 5607) required to make up the 8000 produced by the perfect combustion of carbon.

The calorific power of the hydrogen is very high—being 34,000 as compared with carbon 8000, and that of the hydrocarbon produced may be taken in round numbers at over 12,000; hence the heating power of the whole mixed gaseous fuel is equal to that of an equal weight of carbon; and as it is capable of being applied so much more advantageously, owing to its gaseous form, its practical value is in reality much greater.

GLEANINGS FROM THE INTERNATIONAL EXHIBITION.

Production of Alcohol and other Organic Substances by Synthesis.—In an obscure corner of a case in the French department may be found a bottle of alcohol, differing in no respect from that obtained by the usual process of fermentation, except in its mode of origin, it having been formed synthetically. The credit of the exceedingly interesting discovery of the possibility of forming this and analagous compounds, that have so long been regarded as belonging exclusively to organic chemistry, is due to M. Berthelot, who ascertained that when olefiant gas (C_4H_4) is agitated for a long time with many thousand concussions with sulphuric acid (SO_3,HO), that sulphethylic acid is produced as indicated by the following formula:—$C_4H_4 + 2(HO,SO_3) = C_4H_5O,SO_3,HO,SO_3$. When sulphethylic acid is heated with water, alcohol distils over, and sulphuric acid remains behind. In connection with the artificial productions of alcohol, M. Berthelot's researches on the formation of acetylene are very important, as tending still further to break down the distinction between organic and inorganic chemistry. Acetylene is one of the most permanent of the hydrocarbons; its composition is expressed by the formula C_4H_2. It is produced by the action of the induced electric spark, or by the aid of heat from olefiant gas, and is also developed by the action of heat on the hydrocarbons benzole and naphthaline. Berthelot has succeeded in preparing acetylene by the direct union of its elements, carbon and hydrogen. The carbon is first purified by the action of chlorine at a high temperature. This removes sulphur and metallic impurities in the form of volatile chlorides. The carbon thus obtained in a perfectly pure state may be submitted to the action of hydrogen, aided by the highest temperature that it is possible to obtain, but no union will take place. In the like manner the inductive spark is equally powerless to effect their union. If, however, an electric arc is caused to pass between two charcoal poles or electrodes surrounded by an atmosphere of hydrogen, union takes place as soon as the spark commences to pass. Acetylene being produced, and its production continued as long as the electric arc is maintained, the acetylene produced around the poles may be carried away by a current of hydrogen, and condensed by passing through an ammoniacal solution of protochloride of copper. In this manner it is easy to obtain large quantities of acetylene, which is readily liberated in a free state by the action of hydrochloric acid. Acetylene is very important, as it presents a basis from which other bodies may be obtained; thus Berthelot has demonstrated that by the simple addition of hydrogen it can be changed into olefiant gas, and that from olefiant gas alcohol can be formed, from alcohol ether, and thus the commencement be made of a chain of compounds, all of which have been hitherto regarded as belonging exclusively to the domain of organic chemistry.

Ancient Egyptian Jewellery.—In the gallery of the Turkish court there is a case of ancient Egyptian jewellery, taken from an

Egyptian tomb, the date of 1900 years B.C., the time of the patriarch Abraham. The collection comprises earrings, necklaces, seal rings, and amulets; the workmanship of which is of the most beautiful description. The most interesting object in this case, however, is a model of what was termed the Boat of Death, in which is represented the carrying away of the soul of the departed. A small silver image of the deceased queen is placed in the boat, and the rowers sit on either side. [In cases near this there are beautiful specimens of extremely delicate modern filagree ornaments, both gold and silver, from Nubia. It is interesting to contrast this work with that executed by the same race nearly 4000 years ago.]

Rapid Growth of Vegetables in High Latitudes.—In a valuable treatise on the vegetable productions of Norway, which has been published by Dr. Mueller, in connection with the Norwegian department of the Exhibition, some extraordinary facts are related respecting the influence of the long duration of light, during the summer months, on the growth of vegetables in the higher latitudes in Norway. At seventy degrees N. it was found that ordinary peas grew at the rate of three and a half English inches in twenty-four hours for many days in summer, and that some of the cereals also grew as much as two and a half inches in the same time. Not only is the rapidity of growth affected by the constant presence of light, but those vegetable secretions which owe their existence to the influence of actinic force on the leaves, are also produced in far greater quantity than in more southern climates; hence the colouring matter and pigment cells are found in much greater quantity, and the tint of the coloured parts of vegetables is consequently deeper. The same remark applies to the flavouring and odoriferous matters, so that the fruits of the north of Norway, though not equal in saccharine properties, are far more intense in flavour than those of the south.

Utilization of Waste Tin Plate.—The utilization of waste products is now a subject attracting much attention. Among the more remarkable of these processes we may specially direct notice to that shown by Kuhn, in the Austrian court, by which the tin from the useless scraps of tinned iron plate is obtained in a pure form. It is stated by the discoverer that the labour of four men can produce yearly from perfectly valueless tin cuttings three hundred weight of pure tin, with a large proportion of malleable iron and other products.

Disintegrated Black Lead.—The chemically-disintegrated graphite of Mr. Brodie is a subject of great interest, as it affords a ready means of obtaining a chemically pure black lead, that by mechanical pressure can be aggregated into a solid mass, and employed for those purposes for which the best and most expensive plumbago has hitherto alone been applicable. The outline of the process may be thus stated: the impure plumbago is mingled with chlorate of potash, and then acted upon by a mixture of nitric and sulphuric acids; these not only give rise to the evolution of gaseous chlorine compounds, but also dissolve up and remove many of the impurities. The plumbago, thus obtained in a pure form, is washed and heated, the result of the combined mechanical and chemical action of these operations is, that the plumbago is so perfectly disintegrated as to be formed into light floculi, which are capable of being blown away by the slightest current of air. In this condition they are readily condensed into solid blocks by pressure.

PHOSPHORIZED COPPER AND BRASS.—The peculiar effects of the presence of small portions of phosphorus on the properties of metallic copper have been studied carefully by Mr. Parkes, who has taken out a patent for the application of phosphorus to the improvement of the working properties of metallic copper. Phosphorized copper, as it is termed, possesses an extreme degree of malleability and may be forged readily even when heated to redness; it is so ductile that it is capable of being drawn out into tubes which can be flattened in various directions, or even tied into close knots without showing any evidence of cracking; these tubes are made, in the first instance, by casting them of a large size, and the diameter is then reduced by drawing them in the same manner as wire. The extreme ductility of phosphorized copper is shown by the production of a long tube with a bore as fine as a needle, which has been reduced down by drawing from a nine inch casting. Brass manufactured from phosphorized copper also retains many of its valuable properties.

INSECT-DESTROYING POWDER.—The exact nature of the preparation so well known as the Persian insecticide powder, has not been generally known. It is produced by the *Pyrethrum roseum caucasicum*, a composite flower growing wild in the Caucasus. The central or tubular florets of the disc are alone employed, and when ground furnish the powder known in commerce. The plant belongs to the same genus as the common feverfew of our hedgerows; several species of Pyrethrum the natives of England and other temperate climates; and it would be interesting to ascertain whether those florets possess the same destructive influence on insect life. Specimens of the plant and its flowers in the various stages of manufacture, are shown in the Austrian and in the Russian courts.

NOTES AND MEMORANDA.

TOBACCO SMOKING AND ANGINA PECTORIS.—In a communication to the French Academy on the 9th of June, M. Beau connects the practice of tobacco-smoking with that very painful and dangerous disorder, angina pectoris. In one case a gentleman of sixty passed the greater part of one day in smoking, and during a month he suffered violent palpitations at night, accompanied by oppression and shooting pains in the shoulders. On leaving off smoking, the symptoms disappeared. Three months afterwards he betook himself again to tobacco, and brought back the complaint, which finally left him when the narcotic weed was definitively abandoned. In the second case a physician about fifty smoked cigarettes all his spare time, his digestion was bad, and he suffered nightly attacks of angina. He gave up smoking, and the disease subsided, but sitting in a room filled with tobacco smoke was enough to cause a return of the pains on the following night. In the third instance a physician of thirty-five smoked as he went his rounds in the country, and for a long time suffered loss of appetite. One morning, while smoking upon an empty stomach, he was seized with frightful pains in the region of the heart with constriction of the chest. He could neither walk nor speak, his pulse became insensible, his hands cold. The attack lasted half an hour. By M. Beau's advice he left off smoking, promising to let him know if the disorder returned, which does not appear to have been the case. In a fourth instance a young Spaniard continually smoked cigarettes. His appetite vanished and his digestion became difficult. One evening, while smoking, he felt a sudden and violent pain in the chest, as if he had been squeezed in a vice, and his pulse became insensible. The attack lasted ten minutes, and being frightened he consented to forego smoking, and suffered no more. In a fifth case a physician was subject, while a smoker, to constriction of the thorax and neuralgic pains. In a sixth case a merchant suffered similar attacks, but stuck to his cigar, and his disease. In a seventh a hearty man of seventy-five smoked desperately to get rid of his cares, and had three attacks of angina, the last of which killed him. An eighth illustration was afforded by a smoking diplomatist who died suddenly under similar influence. M. Beau observes that M. Bernard produced in various animals a disorder resembling *angina pectoris*, by introducing nicotine into the thorax. He adds, that for tobacco-smoking to produce this disease the practice must be in excess, the individual endowed with a peculiar susceptibility, and likewise suffer from some debilitating circumstance, such as grief, fatigue, or indigestion. Then he considers that the system cannot expel the matter absorbed from the tobacco, and nicotine can accumulate sufficiently to exert a poisonous action on the heart.

The Ova of Entomostraca.—Dr. Baird described in former numbers of the *Annals of Natural History* some new species of entomostraca obtained from mud brought in a dry state from the neighbourhood of Jerusalem, and which he placed in pure water, and allowed to stand during the spring and summer. He obtained six species, and the individuals of two or three species increased rapidly as the weather became warmer. He now adverts to the extraordinary way in which the ova of these creatures can resist continued drought, and mentions his success in rearing specimens from dry mud brought from the neighbourhood of Port Elizabeth, Cape Colony: they afforded several new species.

New Group of Parasitic Crustacea.—Dr. Fritz Müller describes parasites of crabs, to which he gives the name *Rhizocephala* (root-headed). He says: "The head of these apparent worms, which is inserted into the body of the host, emits roots like those of plants—hollow tubes, which, being much ramified, cling round its intestines, and their brood holds a middle place between that of the Lerneæ and the Cirrepedes." The parasite of the Porcellana he calls *Lernæodiscus Porcellanæ*, and that of the Hermit Crab, *Sacculina purpurea*. Further details will be found in *Wiegmann's Archiv*, 1862, or *Annals Nat. Hist.* for June.

Nervous System of Polyzoa.—The *Bulletin Universel* (No. liv. p. 179) gives the following account, taken from the *Archiv fur Naturgeschichte* (1860, p. 312), of the "Colonial Nervous System," as Dr. Fritz Müller calls it, of the Polyzoa. "Among those animals which live united in an intimate family or colonial life, such as the bryozoa or polyzoa, we often witness movements either of individuals or of the entire family, and which are evidently voluntary, but resulting less from the volition of individuals than from an impulse of an superior order, appearing to emanate from the entire family. Dr. Fritz Müller, at Desterro, has observed among the Pedicellina, that when individuals have been violently torn away, their peduncles remain adherent to the family, and continue their movements through whole days. In another species he noticed energetic movements of peduncles only bearing individuals in the condition of buds. Considering the relatively high organization of the polyzoa, he was led to believe that, in addition to an individual nervous system, they also possessed a colonial one belonging to the whole family, and presiding over its movements. The discovery in the sea of Santa Catharina of an exceedingly transparent *Serialiaria*, has enabled him to confirm this view. These polyzoa form trichotomously ramified colonies, having the branches laden with individuals. These branches are permeated by a nervous trunk, which swells out at the origin of each branch into a basal ganglion. This nervous trunk is in intimate relation with a nervous plexus which sends branches to a basal ganglion of each individual, and which consequently establishes a communication between the colonial and the individual nerve systems."

Test for Oxygenized Water.—M. Schönbein finds iodized starch, to which has been added a little acetate of lead, and a little acetic or nitric acid, the most sensitive test for oxygenized water. Peroxide of lead is formed, and this substance evolves the blue colour in the iodized starch, especially in the presence of free acids. Water containing a three millionth part of oxygenized water gives a sensible blue colour with this reagent.—*Archives des Sciences.*

Production of Nitrate of Ammonia by Air and Water.—M. Schönbein has shown that nitrate of ammonia is formed at the expense of air and water, during the slow combination of phosphorus ; he has likewise proved that this salt is present in metoric waters, and has thence concluded that its formation must be due to a very general cause. He now announces that this cause is found in the simple fact of the volatilization of water in free air, and he cites many experiments which confirm this belief. The process which succeeds the best is to cause water to fall drop by drop in a metallic vessel heated above 100° C., without, however, reaching the point at which the liquid passes into the spheroidal state. By holding a cold flask above the vapours which are produced, he condenses enough water to recognize the presence of nitric acid and ammonia. M. Schönbein has remarked that the quantity of nitrate of ammonia condensed with the vapour of the water is very variable, sometimes almost *nil*, and he is disposed, in the absence of any positive determination, to attribute these variations to changes of temperature. It is not, however, necessary that the water should boil, as the salt is produced during all evaporation, and its presence may be shown in the water that remains after a portion has been evaporated. A sheet of filtering paper dipped in pure water, and dried in the air, becomes impregnated with sufficient nitrate of ammonia to be distinguished in the water with which the paper is washed, and it can be discovered in linen that has been washed and hung up to dry. In all these cases the production of nitric acid may be rendered more evident by adding to the water which is evaporated a little potash, to fix the acid. Wet sand dried in the air becomes impregnated with nitrate of ammonia." The editor of the *Archives des Sciences*, from which the above account is taken, regrets that M. Schönbein did not ascertain whether the salt was produced by evaporation of water in a limited quantity of air, as, if so, the objection to the conclusiveness of his investigations, arising from the possible wide diffusion of the salt, and its mere condensation, under the circumstances he mentions, might be removed.

Shell of the Cuttle Fish.—In our third number we called the attention of microscopists to the beautiful character of the shell of the cuttle fish as a polarized object, and we indicated the way in which its structure should be examined. We have since received from Mr. Baker of Holborn an exquisitely prepared slide, containing a thin section of the shell, showing the floors and the corrugated sheets of crystalline carbonate of lime by which they are supported, and separated, so as to make the shell at once firm and light.

New Polariscope Object.—Pleasing results may be obtained with the Platinocyanide of ammonia, a very striking salt, exhibiting the phenomenon of dichroism. It is red in one view, and green in another. With the polariscope the beauty depends on the condition of the crystals. A few experiments will show what is required.

The Comet of 1861.—We learn from *Cosmos* that the astronomers at Pulkova saw this object as late as the 1st of May, after which the nights became too bright to permit their following its course. Towards the end of May, the light in the sky was so strong at midnight that they were able to read in a room facing the north.

Markings on Diatoms.—On this interminable controversy the President of the Hull Microphilosophical Society, George Norman, Esq., remarks that, " after duly considering the cellular or areolar theory, that such structures, though at first view appearing cellular, yet after more careful study and observation, are evidently granular, the granules being in some species isolated and round, in others more closely crowded and compressed, causing an appearance of hexagonal cellulation."

Paradisea Papuana.

THE INTELLECTUAL OBSERVER.

SEPTEMBER, 1862.

BIRDS OF PARADISE.

BY T. W. WOOD, F.Z.S.

THOSE exquisitely beautiful creatures, the Birds of Paradise, have long attracted attention among the stuffed specimens in our museums, and now, through the energy and enthusiasm of Mr. Alfred R. Wallace, the public can make the acquaintance of one of the finest species in a living state. I am also personally indebted to that gentleman's kindness in allowing me to make copious use of his papers on the subject.

Describing more particularly the Great Bird of Paradise, *Paradisea apoda*, he tells us that no one can traverse the forests of Aru, without hearing "a loud, harsh, and oft-repeated cry, wawk, wawk, wok, wok, wok." This is the note of the Paradisea, constituting his morning and even song, and frequently sounded throughout the day. So far from being, as was once supposed, a very rare bird, Mr. Wallace assures us it is plentiful all over Aru, and is, in fact, a common species. It is, however, most frequently met with in a young and immature state, and our enterprizing traveller shot more than a dozen in that condition before he even saw a perfect male. It is in the loftier trees that the full grown males live, flying from branch to branch and from tree to tree in constant activity; but keeping a wary eye on all intruders, and being so tenacious of life as not to fall an easy prey before the naturalist's or the sportsman's gun. Before sunrise the Great Bird of Paradise is on the wing, seeking his food, but, unlike many other fruit-eaters, he is moderate in his appetite, and preserves his activity through the day, instead of following their example of gorging until repletion produces torpor, and compels repose. Such being the character of this interesting denizen of the dense and secluded forests, we look for a corresponding development in physical organization, and are not surprised to learn that—

"On examining a freshly killed bird, we see the great muscular strength of the legs and wings, and find the skin to be remarkably thick and tough, and the skull, as well as the bones all very hard and strong. The whole neck is lined with a thick muscular fat, exactly similar to that of the Cephalopterus ornatus, in the same position, and probably serving in both cases to nourish the highly developed plumage of the adjacent parts. This causes the throat to appear externally very wide, and as if swollen, which displays to great advantage the dense, scaly, metallic plumage. The flesh, as might be expected, is dry, tasteless, and very tough—to be eaten only in necessity. By far the greater number of birds I have opened have had their stomachs full of fruit, and this seems to be their usual and favourite food. At times, however, they seek after insects, principally Orthoptera; and I have found one of the largest of the Phasmidæ almost entire in the stomach of a full plumaged bird."*

The natives of Aru only obtain these birds during the East monsoon, and hence invented theories of their migration which do not correspond with the fact. It is—

"About April, when the change from the west to the east monsoon occurs, the Paradiseas begin to show the ornamental side feathers, and in May and June they have mostly arrived at their full perfection. This is probably the season of pairing. They are in a state of excitement and incessant activity, and the males assemble together to exercise, dress, and display their magnificent plumage. For this purpose they prefer certain lofty, large leaved forest trees (which at this time have no fruit), and on these, early in the morning, from ten to twenty full-plumaged birds assemble, as the natives express it, 'to play and dance.' They open their wings, stretch out their necks, shake their bodies and keep the long golden plumes opened and vibrating—constantly changing their positions, flying across and across each other from branch to branch, and appearing proud of their activity and beauty. The long, downy, golden feathers are, however, displayed in a manner which has, I believe, been hitherto quite unknown, but in which alone the bird can be seen to full advantage, and claim our admiration as the most beautiful of all the beautiful winged forms which adorn the earth. Instead of hanging down on each side of the bird, and being almost confounded with the tail (as I believe always hitherto represented, and as they are, in fact, carried during repose and flight), they are erected *vertically*, over the back from under and behind the wing, and then opened and spread out in a fan-like mass, completely overshadowing the whole bird. The effect of this is inexpressibly beautiful. The long ungainly legs are no longer a deformity, as the bird crouches upon them, the dark brown body and wings form but a central support to the splendour above, from which more brilliant colours would distract our attention; while the pale yellow head, swelling throat of rich metallic green, and bright golden eye, give vivacity and life to the whole figure. Above, rise the intensely shining, orange-coloured plumes, richly marked with a stripe of

* *Annals of Natural History*, 1857.

deep red, and opening out with the most perfect regularity into broad, waving feathers of airy down; every filament which terminates them distinct, yet waving and curving and closing upon each other with the vibratory motion the bird gives them; while the two immensely long filaments of the tail hang in graceful curves below."

After mentioning the manner in which the natives procure this bird by building a small inartificial looking hut in the tree while the birds are absent, and shooting them with arrows when a sufficient number have arrived, by concealing themselves in the hut, Mr. Wallace continues:—

"Of the geographical distribution of the Bird of Paradise many erroneous statements have been published. Its supposed migration have by some been extended to Banda, by others to Ceram and all the eastern islands of the Molucca group. These statements are, however, totally without foundation, the species being strictly confined to the New Guinea and the Aru Islands, and even to a limited portion of each of those countries. Aru consists of a very large central island, and some hundreds of smaller ones scattered around it at various distances, many being of large size and covered with dense and lofty forests; yet on not one of these is the Paradisea ever found (although many of them are much nearer New Guinea), being limited to the large island, and even to the central portions of that island, never appearing on the sea coast, nor in the swampy forests which in many places reach some miles inward. With regard to its distribution in New Guinea, the Macassar traders assured me it was not found there at all; for, although they obtain quantities of 'Burong mati' (the Malay name), from most of the places they visit on the west coast of New Guinea, they are all of another kind, being the Paradisea papuana, a smaller and more delicate, but less brilliantly coloured species. On inquiry I found that they did not trade eastward of Cape Buro (135° E). Lesson, I believe, found the larger species in the southern peninsula of New Guinea, and an intelligent Ceramese trader I met at Aru assured me that, in places he had visited more eastward than the range of the Macassar traders, the same kind was found as at Aru. It is therefore clear that the Paradisea apoda is confined to the southern peninsula of New Guinea and the Aru islands, while the Paradisea papuana inhabits only the northern peninsula, with one or two of the islands (most probably) near its northern extremity."

The birds now living in perfect health at the Zoological Society's Gardens are two males of Paradisea papuana. Their habits in the aviary remind one very strongly of a jay or jackdaw, being very restless and prying in their disposition, often clinging to the perpendicular parts of their cage wherever there is a hold for their feet, and even hanging suspended under a branch like a titmouse. When on the ground, their mode of progression is by hopping; and their call consists of a series of very loud but pleasingly varied notes. Not only are these notes varied in themselves, but they are also differently arranged at different times; the birds, however, possess two or three distinct series, which are more frequently repeated than the others. Mr. Wallace says that their note differs much from that of the wild birds, the latter terminating their series with a single low note, whereas the former often finish with a kind of gobble repeated twice. One of their notes uttered occasionally is exceedingly like the caw of a rook or jackdaw, but less harsh; another resembles the word "Jacob." These birds display their long plumes generally in the forenoon after a bath, and when their toilet is thoroughly completed; the body then assumes a position almost erect, the feet clinging to the perch very tightly, otherwise the bird would fall backwards; the wings are raised, fully extended and widely separated from the body; the bird is seen to shake the whole body, at the same time expanding the lovely ornamental feathers, the uppermost and shortest of which are elevated the most, their ends hanging over in a most graceful manner. At each side of the plume the brilliant, shining orange colour is seen extending to more than half its length, and gradually fading all round into the pure white in a most exquisite manner, a strip of the richest red-brown, almost black in its depth of colour, running through the orange colour to about one quarter the length of the plume—the wings have a slight flapping movement during this display, and the tail with its two long bare shafts are thrust forwards under the perch.

While the birds are thus showing themselves to the greatest advantage they suddenly commence jumping and turning themselves about on the perch in a very excited manner, uttering at the same moment a series of screams, louder and more piercing than any of their ordinary notes. The two birds are almost sure to "show off" both at the same time, and a careful observer may notice that the pupil of the eye is continually contracting and dilating. The bill is of a light greyish-blue colour, and has an opaque appearance; the iris is pale greenish-yellow; feet lead colour; of course none of these colours are seen in the preserved skin, but the colours of the feathers may be retained in all their intensity by excluding the light as much as possible.

As is well known, there are several other species belonging to this group of birds, almost each one possessing something quite unique in the manner of its ornamentation; the Semeioptera Wallacii, for instance (named after our intrepid traveller and discovered by him), possesses two long thin whitish feathers growing from amongst the lesser wing coverts; this gem was found in the Island of Batchian, one of the Moluccas, and the natives spoke of another and finer black species with longer plumes, but Mr. Wallace, after many inquiries and much fruitless exertion, was obliged to leave without ever seeing a specimen.

The following is extracted from a paper recently read by Mr. Wallace at a meeting of the Zoological Society of London:

"Nature seems to have taken every precaution that these, her choicest treasures, may not lose value by being too easily obtained. First we find an open, harbourless, inhospitable coast, exposed to the full swell of the Pacific Ocean; next a rugged and mountainous country, covered with dense forests, offering, in its swamps, precipices, and serrated ridges, an almost impassable barrier to the central regions; and, lastly, a race of the most savage and ruthless character in the very lowest stage of civilization. In such a country and among such a people are found these wonderful productions of nature. In those trackless wilds do they display that exquisite beauty and that marvellous development of plumage, calculated to excite admiration and astonishment among the most civilized and most intellectual races of man. A feather is itself a wonderful and beautiful thing. A bird clothed with feathers is almost necessarily a beautiful creature. How much then must we wonder at and admire the modification of simple feathers into the rigid, polished, wavy ribbands which adorn P. Rubra, the mass of airy plumes in P. apoda, the tufts and wires of Seleucides alba, or the golden buds borne upon airy stems that spring from the tail of Cicinnurus regia, while gems and polished metals can alone compare with the tints that adorn the breast of P. sexsetacea and Astrapia nigra and the immensely developed shoulder plumes of Epimachus magnus."

A DREDGING EXCURSION.

BY D. WALKER, M.D., F.L.S., CORR. MEM. Z.S., ETC.

Living on a sandy seaboard where there are few rocks and little shingle, I have often been disappointed in my search along the shore for specimens of marine natural history. Many fruitless hours have been spent with such meagre results, that I have frequently returned home murmuring at the circumstances which placed me in a locality so destitute of a luxurious marine fauna. My opportunities for dredging are few and scattered; all however are eagerly taken advantage of, and with a hope that some readers similarly situated may follow my example, and receive some pleasure from the perusal of a few reminiscences of my last dredging excursion, I jot them down, adding, as they occur to me, such practical hints and details—needful, but not dry—as may enable others most advantageously to pursue this healthful and fascinating study.

With most shore-dredgers and amateurs, the greatest depth at which they can dredge with ease will be about ten or fifteen fathoms, so that any observations that I may make must be understood as referring to such an expedition. One preliminary remark as to companions: as a rule, not more than two or three should form the party, exclusive of the boatmen; and it would be as well, perhaps, if you go on a rough day, that none were subject to sea-sickness, which would certainly mar your pleasure, if it did not take away your profit. A fine day should, if possible, be chosen, with a clear sky and a good breeze. Then time your starting so as to go three hours before low water, and return with the flood, eight or nine hours being sufficient for the most ardent zoologist on this coast. Our destination is the north-west lightship, off the mouth of the estuary of the Dee; so having secured a good boat, efficient boatmen, and everything necessary for our purpose, we will start if you please from New Brighton pier, and get as soon as possible into the Channel, hauling our wind as needful, and keeping near the buoys unless we wish to run ignominiously aground on a sandbank. With a good wind we shall generally reach the dredging ground at low water, passing on our way flocks of ducks and plenty of gulls, at which the sportsman may try his hand if he please.

If the wind be not too high, or the swell too great, we may have put out a towing-net—a bag made of bunting or canvas, eight to ten inches wide, and twelve to fourteen inches deep, attached to an iron ring, and towed astern by means of a line fastened to a triplet cord. This net skims the surface of the sea, frequently catching beautiful specimens of Acalephs. They will seem to the uninitiated hardly worthy of notice, appearing as they do like lumps of almost transparent jelly lying in the corners of the net; but in their own element they will amply repay observation and attention. If these be placed at once in a glass jar of water, by inserting the bag into the jar the movements of the *ciliæ* will be beautifully seen. They are not likely to injure the hands of those who touch them, having this advantage over their foreign relatives, which have more than once given me a rather severe attack of *whitlow*. As you closely look at these gelatinous creatures you will notice that they may be divided into two sets; one set, *Cydippe*, have long thread-like appendages, which are absent in the others. These (*Beröe*) are oval and hollow, furnished with eight longitudinal radii, which pass from the small end to near the margin of the large extremity. These lines have each a *single* series of short ciliæ or hair-like appendages, which move with great celerity and gracefulness in a wave passing from the top to the margin. The iridescence and play of colours displayed when these beautiful creatures move through the water is beyond the imagination of those who have never witnessed it. In the Polar Seas I have seen the surface of the ocean covered with quantities of the *Beröe ovata,* and other Acalephs, which form a principal part of the food of the whale. The specimens of *Cydippe pileus* which we have obtained are not so large as the *Beröe.* They are somewhat globular, and have, besides the long thread-like organs, a *double* series of ciliæ attached to each of the eight longitudinal radii. The long threads you will find are moveable according to the will of the animal, and are retractile, and are also furnished with ciliæ. The average size of the *Cydippe* is about five lines and a half by four lines.

We are now on the scene of our operations, and the helm is put up, bringing the boat to the wind. As she drifts, the dredge is brought to the stern and let go to windward. Twice the quantity of line required by the depth of water is payed out, made fast to a belaying-pin, and the remainder coiled up in the bottom of the boat, the end being fastened to the mast for safety. While we discuss the provisions which provident dredgers supply, and which you will by this time feel the need of, three hours being supposed to have elapsed since leaving the shore—I will give you an idea of what operations are going on at the bottom of the sea. And first to describe the dredge in its simplest form, as others, however needful on stony bouldery shores, would be quite out of place here. Our dredge, then, consists of a framework of iron and a net or bag. The frame is made with moveable joints, to fold and carry in the hand, and is from eighteen to twenty inches long, and from seven to ten wide. The edges of the two long pieces are made broad for scraping; the cross pieces are merely for the handles of the dredge, and have two swivel joints, so that a sideway motion as well as the ordinary forward and backward one, is obtained, which is useful in case of the dredge fouling stones, etc. The two handles end in two rings, through which the dredging-rope is passed and made fast. Care should be taken that the knots are not made in what sailors call "a lubberly manner," or it is very likely that they may slip, and the dredge be left at the bottom of the sea, to be triumphed over by the inhabitants as one of "our failures." The bag of our dredge is made of tolerably thick line, woven into a net, the meshes not very large, and it is fastened to holes in the scraping side of the framework. The dredging-rope should be sufficiently strong to anchor the boat in smooth water; though, of course, if there be much way on her, that could not be expected. This strength is requisite in case of the dredge fouling, when it is needful to let out some of the spare line and relieve the strain while the boat is being brought round. The dredge then capsizes, and can be hauled up.

A good deal of judgment is required for the regulation of the line: if too long, the dredge will be in danger of getting fast; if too short, it will only skim the bottom. If the bottom be sandy or muddy, the boat must have pretty good way on her or the dredge will bury itself. If rocky, or composed of boulders, shorten the line, or the strain will break it: but experience is the only teacher; and the feel of the line soon tells whether the dredge be properly bumping or scraping the bottom. Before lowering the dredge a weight is to be fastened on the line, a fathom or two from the handles, in order to keep the strain as near as possible on the plane of the bottom.

Sweeping thus along, whatever comes in the way of the dredge is draughted into it, the water escaping through the meshes, and leaving the live desiderata and dead shells in the inside. It is often advisable, especially in dredging over hard and pebbly ground, to have a lining-net inside the dredge-net. This should be made of bunting, and will often secure rare shells, such as *Mangelia, Scalaria,* etc., which would otherwise have escaped with the rush of water. When a sufficient distance has been traversed, or the straining of the rope seems to render it desirable, the boat is brought to, the dredge and its contents hauled on board and capsized into a sieve of quarter of an inch mesh, or, as we are amateurs, a basket, which will answer our purpose just as well.

And now begins our real work. "What," cries Mr. Delicate Faintheart, "do you call it delightful and fascinating to poke about in that dirty black mass of mud and stones? If that be the only way to secure specimens for aquarium or microscope, I beg to decline having anything to do with either," and our fastidious friend returns to his sandwiches: we laugh at him, and set to work all the more vigorously. In the basket we find a portentous mass of dirt, stones, crabs, sea-urchins, oyster shells, etc.; at once we pounce on them, and our one companion becomes quite excited as he fumbles among the mud, having come across a crab, and finding, when he has worked the mud off his shell covering, that he has discovered the rarer species of *Hyas*. *Hyas coarctatus,* or the contracted spider crab, his carapace, or shell, is in form somewhat between a fiddle and a lyre; the first pair of legs half as long again as the body. He is the largest yet met with there, his carapace measuring 1·7 inches by 1·1 inches. Put him into water and you will see that those dirty-looking things upon the back are beautiful zoophytes. I have met with this species in Greenland. Crawling over the surface of the stones and mud, I see a long-legged spider crab, with a very small back; no other *Stenorynchus* having been found here, you may be pretty sure he is *S. phalangium;* the second pair of legs in this crab are almost four times the length of the body, all the legs and the back are covered with hairs, and frequently pieces of seaweed and small sponges; it moves very sluggishly, and dies in a very short time if kept out of water. Presently my friend catches hold of a ray protruding from the mud, and dexterously disentangling it, it proves to be *Ophiocoma rosula*, the common brittle star; the five comparted disk is covered with spines, and in this case is white, spotted with red, the rays are banded with amber, while one is of a dark blue with roseate spines. Take care how you touch him, for if you handle him much he will, in the most spiteful manner, break off his rays and throw them at you in disgust. These are very common, their arms appearing at almost every one of the meshes of the dredge. Now, however, the motion of the boat begins to tell us that we have got into a chopping sea, and, turning towards my dainty friend of the sandwiches, we see that he has resigned himself to his fate. Considerably sobered by this affecting sight, my remaining companion resumes his search in the basket, but finding that a stooping posture is not agreeable in the sea-way, he most reluctantly joins his companion in tribulation.

Not being particularly susceptible to these weaknesses, I call the boatman to my aid, and pick away alone in my glory. On yielding to the enemy, my friend has dropped his last prize, a beautiful *Pecten opercularis*, well worth preserving; for beside the pleasure of seeing the valves open and display the gem-like eyes which fringe the mantle, the surface of the shell is covered with corallines of exquisite delicacy—*Plumularia*, *Sertularia*, and other equally interesting organisms. Another dead valve has a little group of the angular stems of the *Laomedea geniculata*, with their red, jelly-like extremities, which, when placed in water, expand and show themselves to be campanulate alternate glassy celled polypes, with many tentacles attached to each. Ha! there is a crab trying to walk up the side of the basket and get away, take care of him, he is new to this district—that is a *Portunus marmoreus*, or marbled swimming crab. See his hind legs, how they terminate in broad, swimming plates, finely ciliated, enabling this cleanser to scuttle about in a very active manner; his back is marbled with the most beautiful varied patterns, the arched lines on the carapace are covered with deep blue points, while each region into which it is divided has apparently its own shade of brown, buff, and red. If the foreclaws be examined with a lens, the exquisite sculpture will be seen, the four keels notched and toothed with fine indentations, and the one sharp tooth at the inner angle of the wrist; his brethren, *P. puber* and *P. depurator*, are now scarcely so common on this coast, having been partially replaced by a colony of *Portumus marmoreus*. Here is another crab, with brownish-green legs, dull red abdomen, and dark green back; a sulkylooking fellow, who tries to escape by awkwardly shambling, as if he wanted to skulk away and watch you at the same time; that first pair of legs is armed with remarkably strong thumbs and fingers, as you will find to your cost if you come within range of their operations, that is *Carcinus mœnas.*

Now my friend has recovered from his sickness, and by no means disheartened, returns to the grubbing, evoking from the mud a beautiful urchin, all covered with spines; it proves to be the *Echinus Flemingii,* a rare species, and not the common sea-urchin, as at first we supposed. Another dive into the basket brings out a single ray, what is it? Part of a sand star; and on looking closely we find a disk with four rays, to which the former one evidently once belonged, but he has parted with it under the pressure of circumstances, as he was jammed in between two stones, from which perilous position you have just rescued him and prevented further mutilation. Examine him with your pocket lens, and you will see thirty or forty imbricated plates covering the rays; examine also the small spines on their sides, and count the teeth in the frill, at the base of each ray, where it comes off from the disk. Another star also emerges from the basket, a much smaller species; these two are *Ophiolepis texturata* and *O. albida.* But the boatman has also been at work putting everything alive into the glass jar beside him, and all at once we hear a knock, knock, tap, tap, against the side of the jar. Looking in we see a large *Buccinum* moving most mysteriously over everything, so we turn the shell round and find that it is tenanted by a Hermit crab. *Pagurus Bernhardus* has made it her home, and is now inspecting the new locality in which she finds herself, her long claws go clacking against and over all impediments, the shell bobbing along after. Look how she works those organs attached to her head, feeling here, and listening there, as she stands still and gazes out with those large goggle eyes. Give this crab a piece of mussel and watch those internal and smaller antennæ how they move whilst feeding; the jaw-feet, or pedipalps, shovelling the food up, creating a constant current towards the mouth, and making the water turbid with the sand attached to the mussel shell. Having disposed of that dainty, a change of residence is deemed advisable. See how cautiously she feels over that empty shell with her long claws, the eyes staring intensely the whole time, till satisfied with the proposed new tenement, the body is carefully drawn out of the old shell, and with great dexterity whisked into the new one, as if she were afraid that some one would attack her from behind at this advantageous moment. Another plunge brings up a twelve-rayed sun star, with his rich scarlet disk, the rays white and tipped with red near the extremity; put a small specimen into, and watch how soon it fastens itself to, the jar, and begins to crawl with the thousand suckers it protrudes from rays and disk—this is *Solaster papposa.*

Here is a *Trochus,* or "top," with his roughly granulated whorls beautifully marked and sculptured, its pointed spire and finely turned lip. There are one or two rarer *Mangelia* and a *Triton* crawling along the bottom of the basket. But see, the boatman is just throwing a handful of mussels overboard, and when we stop him, he abandons his occupation in contempt at the idea of our being such fools as to come this distance to pick mussels. Well, "all is not gold that glitters," and *vice versâ.* Turning to the despised mussels, we find something sticking to the shells, and, as we touch it with the nail, we perceive that we have some nice specimens of *Flustra* with parasitic *Cellularia,* and other interesting varieties of the Polyzoa. Now look attentively at that stone, see those two slugs—one dirty grey and one with red tipped tentacles; these are both specimens of Nudibranchs. Put them into the jar, you will see the former expand its beautiful barred or ringed gills, and close to the eye you will see two beautiful toothed horns, that is a *Doris;* the other is much rarer *Eolis rufabranchialis;* we shall soon most likely encounter a white *Eolis.* Here is another bunch of mussels, each fastened by his thread-like byssus to a small stone, and all tied together, sociably enjoying each others' society. Crack one with a hammer, and lo! a very tiny Pea crab (rejoicing, like other little people, in a long and important name, *Pinnotheres pisum*) looks out of his shell; he is beautifully blotched with brown patches on a yellow or orange ground. The old superstition was, that Nature had not given the mussel eyes, so he made a compact with our little friend similar to that which the blind man is said to have made with the lame, according to our schoolboy tradition.

While we have been sorting this basket, the boatmen have had their shank-trawl overboard, which is a net twelve feet by ten, fastened to two "trawl heads" as they are called, which I may explain, for the information of the uninitiated, to be semicircular flat bands of iron attached to the extremities of a wooden beam, which extends for the whole length of the net, the lower mouth of which is weighted by a chain wolded round with old rope. As the net sweeps along the bottom, the upper mouth kept open by the trawl heads and beam, the fish, rudely roused from their repose by the chain, rush into it as their nearest place of safety, and suffer the consequences of their rashness. All hands are called to haul the net on deck; quantities of plaice, *Platessa vulgaris,* and soles, *Solea vulgaris,* are floundering about, but look! what a beautiful fish we have here, the Gemmeous Dragonet, *Callionymus lyra;* admire its different shades of yellow, and the sapphirine stripes which cover its body and head; look at the black tail-fin, and the finely arched first ray of the fin on its back. Here is the spotted Goby, *Gobius minutus,* if you turn him over you will see under his throat the disk by which he can attach himself to rocks and stones; put him anywhere, he will live a long time out of water. Here is the "stingfish,"—get him over the side as soon possible, touch him not, or you will find some of the poison oozing out from each of his hairy hollow spines transferred into your blood. There is a fine specimen of the male "masked crab," *Corystes Cassivellaunus;* look at those long graceful arms, and observe the mask on his carapace when you have washed him; watch how he twirls and brushes those elegant antennæ, just as a modern dandy does his moustache.

There, hopping about in a very lively style, are some long, transparent, shrimp-like animals, their bodies beautifully banded with dotted rings of golden amber, and each leg at the joints similarly ornamented; how their antennæ move about as they are put into the water; those triplet antennæ with brown bases, the ends like a whip, these are *Squillæ.* Close to them are numbers of *Crangons,* "common shrimp," and *Pandalus,* or "Esop prawns;" how unlike those yellow and red animals which are such agreeable adjuncts to our tea-table; admire the notched keel of those "Esops," and their up-turned points; you had better put them by themselves, else they will be eaten up by so many crabs. Here, hidden under a stone, is a specimen of the "spotted gunnell," with a long, ribbon-like body, which writhes away under the stones, it is spotted along its upper side with brown dots, the dorsal fin extending almost the whole length of the body, the anal for two-thirds. That broad, ungainly-looking crab, stalking about on those shells, is the "angular crab," *Gonoplax angulatas;* his eyes are set, as you see, on remarkably long stalks, and mark the groove along which they lie when not in use; what an awk-ward companion he must be with those enormously long arms! Here are quantities of the common "cross fish," *Uraster rubens;* turn them over before you throw them away, you may find some interesting bivalves sticking in their suckers. See there is one with a fine glassy, almost transparent shell, *Syndosmya alba;* it is worth looking at at home: there is also a specimen of that apparently shelless mollusc, *Philline aperta,* a fine specimen for dissection. But here is something we have not seen before: into the jar with him at once, and watch him; the head seems as large as the body, with large staring eyes at the side, the neck considerably contracted, the body with two wing-like appendages which wave through the water, enabling the little creature to swim; out of its head grow ten arms, eight of which have small cups or suckers on the inner side, and two larger ones which only have cups at their extremities, how delicately the whole body is painted over with spots; touch him, and at once the clear water becomes black with the cuttle-fish ink, for that is the *Sepiola atlantica.*

Pick up that mouse-like animal—its back is covered with a kind of down, out of which sprout spines of different length, coloured with all the hues of the rainbow, the score or so of bristles exhibiting every imaginable brilliant metallic tint. When you go home put one of those hairs under a microscope, and see how nature has provided a hard sheath into which these weapons are retracted, so that the soft parts of the animal can receive no injury; pluck some of the down off the back, and you will expose a double set of large scales attached to the alternate segments of the animal; that is the hairy sea-mouse, *Aphrodite hispida.* Here is another Annelid, a *Nereis,* which boasts of a distinct head, eyes, and mouth, and wriggles about by means of the tentacles issuing from its many feet. Look at this dirty, leathery tube fastening to a large stone, place it in the water, and in about five or ten minutes, if you look again, you will see such a rainbow frill, such a circle of plumes surrounding the opening! that is a *Sabella,* and those are its branchiæ or breathing organs; that central elongated disk acts as an operculum, and although funnel-shaped is not pervious, but is one of the tentacles purposely enlarged to plug up the aperture of the tube when the animal retreats within. To the same stone adheres very tenaciously a small shell, which on a close examination you will find to consist of eight plates, overlapping each other at their edge and joined together by a leathery mantle; get it off the stone with your nail, and, holding it in your hand for a minute, you will see the plates separate, and the extremities come close together, till what was a flat surface has become almost a ball; in the jar, however, it soon fastens itself to the side, where you may see the muscular foot, the expansion and contraction of which form the locomotive power of the animal, that is a *Chiton, Ch. cinereus,* admirable for the beautiful moulding on his back. Here is a white *Eolis,* with gills arranged on each side, the tentacles not retractile. There is a good sized globular shell with four or five whorls, nicely dotted with brown streaks on a greyish-yellow ground; drop him into the jar that you may view the large foot with a large, broad lobe in front, so broad, indeed, as to conceal the head, close to the lobe you will perceive the tentacles sprouting out, this is a carnivorous mollusc, *Natica monilifera.* In the bottom of the basket you may find what is called "an elephant's tooth," *Dentalium entalis;* notice the shell, it is tubular, slightly curved and tapering from end to end, with an opening at each extremity, one very small; the other, through which it is intended the animal's body should protrude, is proportionately larger; the head in the middle of the body is surrounded by gills; this mollusc is a sand-borer, and feeds on minute marine animals. Almost hidden from our view is a small crustacean belonging to the sessile-eyed division of the family; watch how it scuttles along on its side when it reaches its native element, using its swimming feet so constantly and so rapidly, as to suggest the idea of their being worked by a small private steam-engine; if you examine the antennæ of this creature, you will see two small secondary feelers sprouting from the upper pair, the lower pair having no such appendages; glance at that broad hand, with its finger so admirably adapted for nipping, and view the structure of the swimming plates and tail so delicately fringed with ciliæ, that is a *Gammarus*, *G. sabini*. Near him lies *Galathea squamifera*, a stalk-eyed crustacean, with pointed notched rostrum, and long fore feet, its abdomen and swimming tail, neatly tucked away out of sight, completely concealing from our view the spawn which would soon form *Zoeæ*, and ultimately crabs.

And now, our jars being tolerably well filled, we turn homewards, rather tired, we must confess, but anticipating with no little eagerness the work that remains for us on our arrival there. Many a day may be pleasantly and usefully employed in examining, classifying, and identifying our specimens, and dissecting those whose organizations we desire to study more carefully.

THE SUNFISH AS A HOST.

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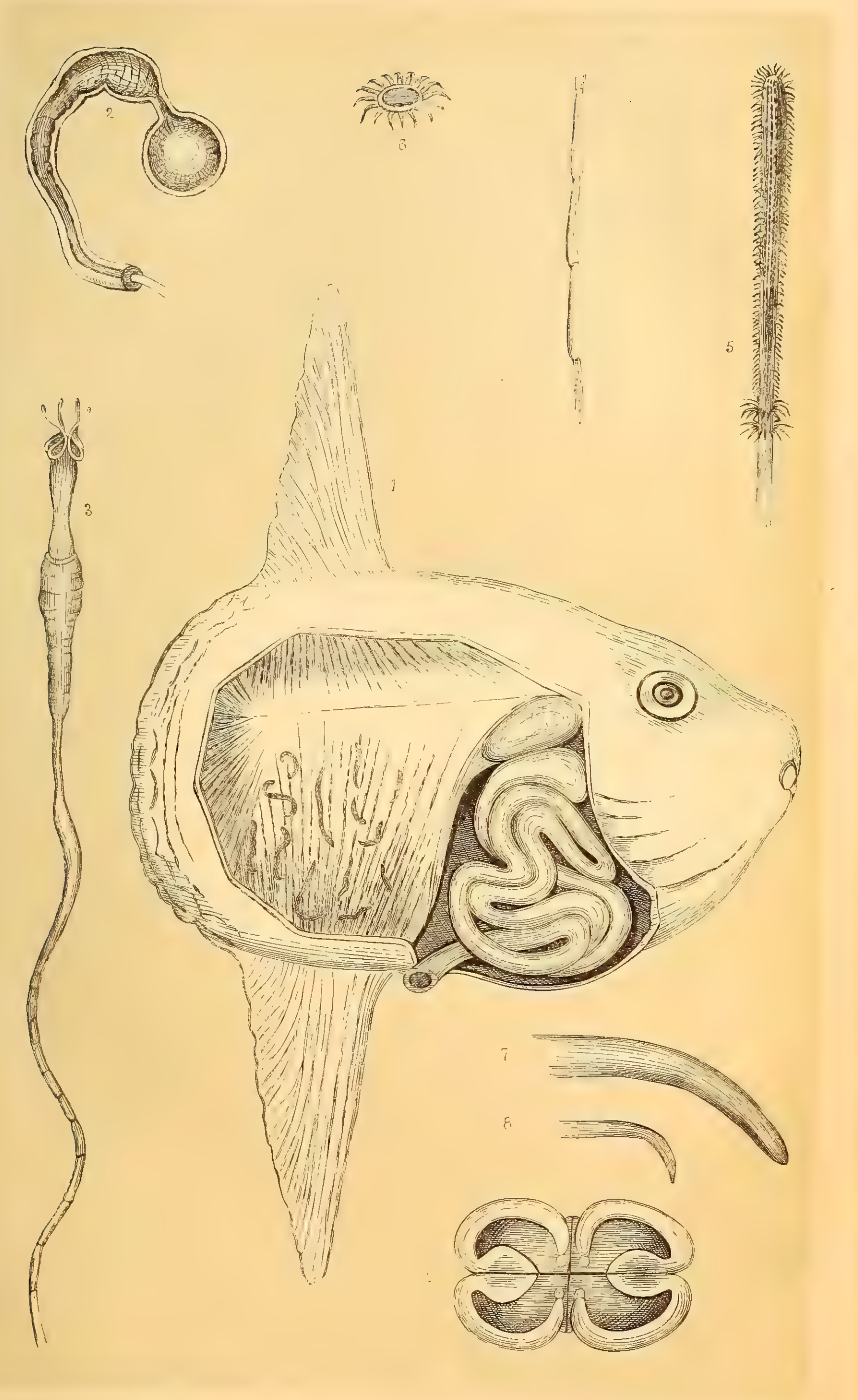
Some credit is due to those of our continental brethren who have devised a set of simple terms calculated to express the relations subsisting between different forms of animal life, both as regards the species themselves and the various phases of being known to occur in one and the same individual. The Danish naturalist Steenstrup first suggested the convenient titles of "nurse," "grandnurse," and so forth, in reference to "parents" producing non-sexual broods of larval flukes by the now well understood process of internal budding; and, in like manner, Von Siebold, and other German parasitologists, fittingly applied the term "host" to any animal actually infested with, or liable to be attacked by parasites, because it thus, as it were, entertains within its own body the presence of these singular creatures. In their view, the question as to whether the company of entozoa be acceptable or not to the "host" in no way prevents the invaders being recognized as guests, whilst in most cases they are sumptuously entertained, although they be not welcome. The organization of the entozoa admirably adapts them for a temporary residence within the body of the selected "host;" so much so, indeed, that from their peculiar organization, one might fairly argue their legitimate title to such an abode; yet, at the same time, it must be admitted that the means of entry at their command, as well as the instincts they exhibit in their mode of gaining access, do but epitomize the instincts of the genuine burglar. In few cases, if in any, can it be shown that the presence of animal parasites confers positive good to the "host;" but in numerous instances it is certain that they cause incalculable mischief. This was sufficiently shown in our paper on *Fasciola hepatica*, in the first volume of the INTELLECTUAL OBSERVER, and the subject has since been further elucidated by Professor James Beart Simonds, in his instructive memoir on the *Nature, Cause, Treatment, and Prevention of the Rot in Sheep*.

If the mere variety of parasites formed an accurate criterion of the hospitality, so to speak, of any given "host," the species here selected for the purpose of illustration might certainly be regarded as a very liberal individual; but it often happens that an animal liable to harbour only one or two forms of entozoa is more copiously infested by those few particular kinds than another animal which is liable to be infested by a much greater variety of parasitic guests. The short sunfish (*Orthagoriscus mola* of Schneider, and *Tetradon mola* of Linnæus) is believed to be infested by nine species of helminths, three of which are usually attached to the gills, while a fourth adheres to the surface of the body. All of the latter, though ecto-parasitic in their habits, are true flukes belonging to the genera Distoma and Tristoma, and cannot therefore be removed from the entozoa properly so called. In the present communication we propose to treat only of one of the above-mentioned "guests," selecting for this purpose a species which belongs to the great tapeworm family. We are aware that to some persons the study of this group of animals appears to be peculiarly uninviting; but in our own experience, based upon a prolonged contemplation of their structure, habits, and development, we can testify to the rare instruction and pleasure which such a research is calculated to afford.

Notwithstanding the light which experimental investigation has lately thrown upon the subject, the tapeworms are still regarded by many as individual animals, possessed of long jointed bodies, whereas the organism usually called a tapeworm—like that, for example, shown at fig. 3 in the accompanying tinted plate—is not one individual animal, but in reality a series of individuals associated together so as to form a long band resembling an ordinary measuring tape, the likeness to the latter gaining strength by the circumstance of the band being jointed, or transversely marked at tolerably regular intervals. Every tapeworm is, in point of fact, a colony of creatures arranged in single file, and in the more technical nomenclature of helminthology is termed the "strobila." As we have recently taken occasion to remark elsewhere, the tapeworm, or "strobila," is usually composed of several hundred joints, each segment representing a single member of the colony, and to this latter we apply the term "proglottis." Those individual "proglottides" which are nearest to the lower end, or so called tail of the ordinary tapeworm, are sexually mature; moreover, they are hermaphroditic, that is, they are provided with both male and female reproductive organs. Those feebly developed joints, which form the so-called neck of the worm, are imperfect or immature individuals, whilst the little head is neither more nor less than a single joint or proglottis, curiously modified and furnished with an apparatus by which the strobila or colony is securely anchored to the interior of the infested "host."

It is necessary that the above-mentioned facts be borne in mind, otherwise the true relation of the parts of the strobila or tapeworm to be presently described will be entirely lost sight of; and it becomes the more necessary to insist on these distinctions in cases where, as in the present, the application of our zoological nomenclature seems to lend countenance to the popular and erroneous notion that the strobila is, after all, only one zoological individual. So far as tapeworms are concerned our specific distinctions for the most part depend upon the characters presented by the so-called head of the worm; but this head is, as we have seen, the primary individual of the colony. It might be supposed that although the head of one kind of tapeworm-colony differed from that of another kind, yet the joints or members of the colony might display similar characters in different strobila, and so be after all the same creatures, although their so-called heads were different. Such a notion, however—which at one time was practically supported by Von Siebold himself when he denied the hitherto recognized specific distinctions of five well marked tapeworms (*Band und Blasenwürmer*, p. 98 *et seq.*)—is contra-indicated by numerous facts; for even the joints themselves exhibit co-ordinating structures, which are found to be invariable in the different tapeworm colonies.

The more complex the characters of any particular class of animals, the greater the confusion introduced into the writings



etrarhynchus re

of those who in earlier times directed their attention to the group. A glance at the literature of tapeworms renders this truth especially significant. Some investigators, indeed, spare themselves a vast deal of trouble by altogether ignoring the labours of previous writers; but deprecating this mode of procedure, we have always considered it due to antecedent observers to express some recognition of their researches, even in those instances where recent discovery has demonstrated the fallacy of their facts and theories. In this view, therefore, we offer a synonomy of the tapeworm, or strobila under consideration, which we take to be as follows :—

Gymnorhynchus reptans, Rudolphi, Bremser, Blainville, Nordmann, Dujardin.

Gymnorhynchus horridus, John Goodsir.

Acanthorhynchus reptans, Diesing.

Bothryorhynchus continuus, Van Lidth de Jeude.

Bothryocephalus patulus, Leuckart.

Anthocephalus elongatus, Rudolphi, Nitzsch, Nordmann, Drummond, Dujardin.

Anthocephalus macrourus, Bremser.

Floriceps saccatus, Cuvier.

Floriceps elongatus, Blainville.

Scolex gigas, Cuvier.

Here it will be seen that we have the same tapeworm described by twelve authors under ten different titles, whilst not less than seven of these authorities have considered the animal as referable to two separate species; moreover, as if to render "confusion worse confounded," several of them have adorned their descriptions with extremely inaccurate figures. Systematists and others who have not been fortunate enough to examine the species for themselves have naturally placed great store by the various representations given by Cuvier, Rudolphi, Bremser, Leuckart, and others; and thus the figure of one author is taken to represent a different species from that given by another, and a new name has been applied accordingly. Had the distinguished Professor J. P. Van Beneden, of the Catholic University of Louvain, chanced to have stumbled on this species, his skilful pencil would not have failed to have added another exact picture to the beautiful series of figures which illustrate his *Recherches sur la faune littorale de Belgique*, and he would thus have dissipated many doubts as to the identity of the species. For our own part, we have not hesitated to expose the accumulated errors which have crept into helminthological literature; and while offering an accurate illustration drawn to nature, we at the same time take leave to observe that this tapeworm should both in the first and last instances have been described under the appropriate genus Tetrarhynchus, established by Rudolphi at a very early date. At the risk, therefore, of appearing inconsistent, we believe it to be in the interest of science to place the worm under this genus, whilst we retain the specific title "reptans" as fitly expressing its groping habits.

If attention be now directed to the accompanying plate, a correct understanding of the organization of this remarkable Cestode will be greatly facilitated. Fig. 1 represents a very juvenile example of Orthagoriscus, which was taken by fishermen off Anstruther, on the Fifeshire coast, on the 6th of September, 1856. Several full-grown individuals had been captured in the same neighbourhood some weeks previous, one very large example being subsequently anatomized by the professor of anatomy at the Edinburgh University. The small fish here drawn gave the following dimensions: length from snout to tail, eighteen inches; between tips of dorsal and anal fins, twenty-six inches; greatest depth of the body, twelve inches; length of pectoral fins, two inches and a half; width of gill aperture, one inch; consequently it will be perceived that our illustration represents the animal reduced to about one-sixth the natural size. Having placed our fish on its left side, a considerable portion of the integument was removed so as to expose the great lateral muscular mass of the right side, and more particularly also the abdominal viscera which are here retained *in sitû*. At the upper border of the ventral cavity the liver is shown resting, as it were, upon the stomach, the latter being insensibly continued into the uniformly thick intestine; and the gut, after making five or six distinct sigmoidal flexures, terminates in front of the anal fin by a patent orifice. The surface of the liver was scarred by numerous worm-tracks, a few of the Entozoa still remaining within its substance, while larger and more vigorous specimens were groping their way among the lateral muscles, each worm being surrounded by a smooth and stoutish capsule. Portions only of these investing sheaths are seen in the accompanying drawing, it having been impossible, in the dissection, to expose any one of the parasites in its entirety. Several of them were afterwards dissected out and dropt into a tumbler of sea water, when, to our astonishment —for the fish had been dead about a week, and had been cast aside as refuse by the salesman of whom it was purchased— they moved about actively. On being further deprived of their investing capsules, the proboscidiform tentacula attached to the so-called head, were protruded and retracted in an irregular alternating manner. These movements continued until the third day following, when, muscular irritability having well nigh ceased, they were plunged into alcohol for future use and preservation. Some of the worms removed were from fifteen to twenty inches in length, but they were imperfect individuals. On a previous occasion, from the liver of a full-grown Orthagoriscus—for the opportunity of examining which we were indebted to Professor Goodsir—we obtained several examples fully double this length. Even these were incomplete specimens; and it is impossible to calculate accurately the length any given worm may attain, because they are usually rolled together in inextricable confusion; moreover, the sheaths are much longer than the worms themselves, being, as it were, left behind in the tissues of the "host" wherever the parasites may have wandered. There are thus found permanent indications of the erratic movements of the "guests," and were it possible in an adult sunfish to unravel the entire sheath of a single *Tetrarhynchus reptans,* we should probably find the capsule—representing, be it remembered, the entire life-wanderings of the tapeworm thus far—at least one hundred feet long. In this case, of course, we assume the worm to have entered the fish while the latter was quite young. Whatever reflections such phenomena are calculated to excite, one certainly sees no reason to envy the piscine "host" thus destined to have its muscles and viscera tunnelled in all directions by an uninvited Tetrarhynch.

Several questions here naturally suggest themselves, such as:—What is the object of this perpetual tunnelling? Does the boring really cause suffering to the host? Do the parasites ever make their escape from the body of the fish? To some of these queries we believe ourselves capable of giving a satisfactory answer; but before doing so, it is necessary that we should complete our account of the organization of this worm. In this view, therefore, we have to remark that fig. 2 is a slightly enlarged, but otherwise exact, copy of the upper end of the Tetrarhynchus enclosed within its transparent capsule. The rounded extremity is not merely the so-called head, but it embraces also the neck and its subcervical enlargement—all these three distinct parts being represented in their unfolded condition in fig. 3. In the latter drawing, the numeral is placed opposite the constricted portion of the hour-glass-shaped neck. Immediately below this enlargement is a still more attenuated portion corresponding with the narrow neck-like constriction shown in fig. 2. The swellings below this, again, are identical in the two figures, but in the lower illustration the body of the worm is more drawn out. The so-called head in fig. 3 displays four proboscidiform tentacula—hence the generic title employed—and also four cephalic lobes, each of which is furnished with a sucking disk. In fig. 9, at the bottom of the plate, we have given an enlarged view of this so-called head, seen from above. The four proboscides are retracted within sheathing-tubes, the orifices of the latter being closed by four papillæform elevations, symmetrically disposed near the centre. It will also be further seen that the sucking disks coalesce on either side, so that the four cephalic lobes are rather to be regarded as two auriculate appendages, deeply cleft transversely in the middle line. In form they strangely resemble, as it were, a pair of cloven hoofs placed heel to heel. The four proboscides are club-shaped, each being furnished with a complicated armature of hooks, arranged in circular rows. The latter, though scarcely visible to the naked eye, present a formidable appearance when magnified. This is shown in fig. 5, where one of them is enlarged twenty diameters. Very difficult was it found to ascertain the precise number of hooks, but after careful and oft-repeated examinations, we satisfied ourselves that each circle consisted of sixteen hooks (fig. 6), whilst there appeared to be fully one hundred of these rows on each proboscis. Each tentaculum, therefore, was calculated to carry about 1600 hooks, which would give us altogether a total of more than 6000 of these little instruments on a single tapeworm. The majority of the hooks displayed a tolerably uniform length and thickness when compared with each other, but the two lowermost circles near the base of each proboscis were two or three times the size of any of the others. Fig. 7 represents one of the large hooks, with its somewhat blunted extremity directed obliquely downwards; and fig. 8 shows one of the numerous small hooks having the end more curved, pointed, and retroverted. Both these figures are from hooks magnified about 250 diameters. The body of the Tetrarhynchus is distinctly segmented; the joints gradually acquiring greater conspicuity the further we recede from the so-called head. This character is partly exhibited in the lower half of fig. 3, but a few well-marked articulations from the posterior region of the body are faithfully illustrated at fig. 4. Lastly, it is particularly worthy of remark, that none of the segments display the slightest indication of the presence of reproductive organs, such as we should undoubtedly have discovered if the tapeworm or its joints had been fully developed and matured. The explanation of this will appear in the sequel.

Reverting to the questions previously mooted, we may observe, that the object of the tunnelling process appears to be two-fold: first, in order that the animal may constantly obtain fresh nutriment, and secondly, because the creature is impelled by instinct to seek out another "residence," which it can only gain by being transferred to a separate "host." The tapeworm not being supplied with any mouth or digestive organs, acquires nutriment by imbibition through the general surface of the body; and the reason why it needs transference to another "host," arises out of the circumstance that the joints cannot become mature until the parasite finds its way into the alimentary canal of the "host" it is ultimately destined to occupy. It is a curious example of an animal perpetually striving to perform an act which cannot be accomplished by its own unaided powers, for our Tetrarhynchus must wait until a shark or other large fish attack and devour the sun-fish before it can gain access to the stomach and intestines of the final "host." Although the mature condition of the joints or proglottides of *Tetrarhynchus reptans* at present remain unknown, it is quite certain that, no matter how long the immature strobila remains within the sunfish, it cannot attain sexual maturity until it is transferred in the manner pointed out. This law in the development of tapeworms appears to be universal, and as such was, we believe, first recognised by Von Siebold. Another and more familiar illustration of its application is seen in the development of the *Cysticercus fasciolaris* in the liver of the mouse. It is not uncommon, in old mice especially, to find this cysticercus developed into a strobila or tapeworm several inches in length, whilst it is still coiled within the liver, but if the joints be examined, none of them will be found to contain reproductive organs, or even indications of them; as soon, however, as the cat—the final "host" of the parasite—swallows the mouse, the cysticercal condition of the immature tapeworm immediately disappears, and fresh joints are formed, which become sexually mature; in this state the strobila is recognised under the title of *Tænia crassicollis*. In regard to the question as to whether the boring of the young tapeworms through the flesh and viscera of the first "host" gives pain or otherwise, we cannot of course speak with absolute certainty, but from the slowness of the process and the extreme minuteness of the boring apparatus, we think it very doubtful if the presence of the parasites is even felt at all. When, however, there are many of them, and they have by their complex and long-continued movements injured the secreting structure of the liver, we think they give pain indirectly, as it were, by causing the decay of that organ and the consequent enfeebling of the vital powers of the "host." It is at such a time that the sunfish would be easily overcome by its natural enemies, and the piscine life would thus be sacrificed for the advantage of the long-imprisoned guests. The Tetrarhynchi are passively transferred into the alimentary canal of their final "host," and, so far as our observations extend, we know of no instance where the young tapeworms escape by themselves from the body of the first "host" before they complete their final development.

HONEY, ITS ORIGIN AND ADULTERATION.*

BY W. W. STODDART.

Honey is so familiar an object, and so well known to the youngest child, that it has become quite a household word. It has had its praises from every author and poet, from the sacred writers to the present day; and yet it is very surprising how little mention is made in any chemical or botanical work of the changes that take place in its elimination, of its origin, or even of its composition. Like the foreigner who consulted Johnson's Dictionary, the more he searched the more he was puzzled. Fownes, Turner, Gregory, and Stockhardt simply state that the solid crystalline portion of honey is grape-sugar, but say nothing of the liquid. Johnston in the first volume of *Chemistry of Common Life,* says "Honey is formed or deposited naturally in the nectaries of flowers, and is extracted therefrom by the bees. When allowed to stand for some time, it separates into a white solid sugar, consisting of white crystals, and a thick semifluid syrup. Both the *solid and liquid sugars have the same general properties.* The solid sugar of honey is identical with the sugar of the grape."

Dr. Hassall, in the article on honey, in his *Food Adulterations,* after quoting the above, says that the regularly-formed crystals, myriads of which are present in honey, are *identical in form with cane-sugar.* Such is the drift of the whole information that can be gathered respecting the composition of honey.

On dissecting the honey bee, we find the proboscis continued into a beautiful ligula or tongue. It is a flexile organ, covered with circlets of very minute hairs. The ligula of the honey bee differs from that of the other divisions of the bee family (the Andrænidæ) both in shape and microscopic appearance. It is probable that the bee uses the ligula, by inserting it in the nectar, which would be plentifully collected by means of the hairs before-mentioned. These hairs very likely answer a somewhat similar purpose to the teeth of the molluscan tongue. At the base of the proboscis commences the œsophagus, which, after passing through the thorax, terminates in an expanded sac, termed the honeybag. This is an elastic glandular organ, placed before the entrance to the true stomach. Into this sac the saccharine fluid enters after being swallowed. Should, however, any more solid substance be present, it is forwarded into the true stomach for trituration by the numerous

* The author read a paper on this subject before the Bristol Miscroscopical Society.

teeth with which it is furnished. The honey gland also secretes a peculiar acid to be mentioned presently. The bee retains the fluid portion in the honey sac till the proper time should arrive for deposition in the cell of the honeycomb.

Before describing the floral fluid and its transition into honey, it will perhaps be better to briefly describe the appearance under the microscope of the different sugars that are connected with the present subject. These are of three distinct kinds.

Cane-sugar (sucrose) $C_{12}H_{11}O_{11}$, Grape-sugar (glucose) $C_{12}H_{12}O_{12}2HO$, and Manna-sugar (mellitose) $C_{24}H_{24}O_{24},4HO$. A fourth kind (fructose) is mentioned by some authors, but requires more confirmation before it can be regarded as a distinct sugar.

Cane-sugar is the well-known crystalline substance usually procured from the cane, but is found occurring in beetroot, Indian corn, the lotus bean, and many other vegetables and fruits. When pure, cane-sugar forms very fine oblique rhomboidal prisms, with dihedral summits. When crystallized on slides for the microscope, it always has a tendency to form flat bold crystals, which usually are so connected one with another as to cause a mass, which, when large, is commonly called sugar candy. Cane-sugar, when in contact with vegetable acids, has always a strong disposition to change into the second kind of sugar mentioned (grape-sugar). So much is this the case that the author has never yet found cane-sugar in a natural state unaccompanied by traces of grape-sugar.

Grape-sugar (glucose) is the sweet substance found in the grape, dried raisins, diabetic urine, and wherever cane-sugar has been formed. Besides differing with chemical re-agents, grape-sugar has not the slightest resemblance under the microscope to that from the cane. It crystallizes generally both from water and alcohol in tufts, which consist of lamellæ radiating from a centre. The author has slides in which glucose has crystallized in perfectly regular six-sided prisms, but these instances are very rare. When a solution is hastily evaporated, the crystals are beautifully dendritic. Glucose is formed in plants by the addition of three equivalents of water to one of sucrose, which change is caused by the continued increase of warmth, action of acids, or a principle called diastase, or all combined. For sugar being an organic body, like all such in the living tissues is constantly undergoing changes.

The third variety to be mentioned is manna or mushroom-sugar (mellitose). It is formed always during the fermentation of cane, or grape-sugars. In old honey it exists in much greater proportion than in new. It crystallizes in long four-sided prisms. Mellitose differs from sucrose and glucose, in being nearly incapable of fermentation, and is by these means obtained from honey for examination. A very remarkable fact is that manna-sugar occurs in many of our seaweeds, as Fucus vesiculosus, Halidrys siliquosa, Laminaria saccharina, etc. The latter contains as much as twelve per cent. It may be detected also in the dandelion and celery plants.

All the sugars are splendid objects for the polariscope. A very beautiful method of exhibiting manna-sugar is by fusing a little on a glass slip over a spirit-lamp, and when cooling, touching three or four spots with the point of a needle, when circular crystals will form, showing the purest and most exquisite colours, rivalling the similar and well-known salicine slides.

At the base of the corolla of a flower, on the thalamus, is a part termed by botanists "The Disk." It is that portion which intervenes between the stamens and the pistil. It is composed of bodies usually in the shape of scales or glands. When examined at the proper season, they are seen to abound in a thick, sweet fluid, which, since the days of Aristotle and Virgil, has rejoiced in the name of "nectar." On this account the fruit yielding it received formerly the name of "nectary." Even in the present day those organs are the subject of much misapprehension. Linnæus and his followers gave the term nectary to any gland or organ for whose office they could not otherwise account.

The plants which furnish the greatest quantity of nectar, and therefore most liked by the bees, generally excrete it from the disk of the flower.

On many plants, however, as the ranunculus and fritillaria, a small glandular organ occurs at the base of each petal, and in which also nectar is enclosed, though not in such profusion as in the disk before alluded to.

As will presently be shown, this nectar is a simple solution of cane-sugar formed from the amylaceous sap of the flower and elaborated for the nutrition of stamens and pistil. What the bees find in the flowers is the surplus left when these organs have been supplied. The author examined every flower he could collect at the early season of the year (April and May) and found sugar in them all, whether furnished with disks, or nectariferous glands, or not; and came to the conclusion that sugar is necessary to the male reproductive organs of the flower, as it is in them chiefly to be found, the so-called nectariferous body merely serving the purpose of a reservoir.

M. L. Bravais, in a paper published in *Ann. des Sciences*, 2nd ser. vol. xviii. pp. 152, is of this opinion, and says :—The nectar-bearing parts occur rarely on the pistil or calyx, but generally on some part of the andræceum, always accompanying the discharge of the pollen. He divides the stamen into four parts, which, reckoning from below upwards, are—1, the stalk, 2, nectary, 3, anther, 4, the limb, and makes out the nectary to be a filament carrying either secreting hairs, or glands, or a nectariferous horn. The author was unable to make out this subdivision satisfactorily.

The plants which in England are most attractive to bees are:—

Mignonette.	Rosemary.	Gooseberry.
Currant.	Lime.	Lemon Thyme.
Hazel.	Berberry.	Heath.
Wallflower.	Buckwheat.	Turnip.
Hollyhock.	Clover.	Winter Aconite.
Raspberry.	Willow.	Osier.
Broom.	Furze.	Borage, etc.

On examining an immature blossom of a wallflower, the vessels will be filled with an amylaceous fluid, which gives a distinct blue with iodine. After the lapse of from twenty-four to forty-eight hours, the flower having become much more expanded, and the stamens more mature, the fluid on being again tested will have a sweet taste, and give a dirty bluish-brown instead of a blue with iodine.

On cutting out the disks of several ripe specimens of wallflower, the author obtained a syrupy, clear, colourless fluid. This was mixed with a small quantity of distilled water, treated with lime and carbonic acid in the usual way, and filtered. The filtrate was then concentrated, and allowed to crystallize spontaneously on a glass slip. The result was a beautiful regular crop of crystals of cane-sugar, agreeing in their goniometrical measurements with that substance.

As the flower became more mature, the saccharine fluid was acted upon by the vegetable acids more and more, until at length when the ovary being fertilized, and the flower dead, a last examination showed the saccharine residue on the withered disk to be nearly all grape-sugar, almost incapable of being fairly crystallized.

The bee visiting the flowers when in their prime, inserts its ligula into the blossom, and laps up the greater portion of the liquid sugar, which after passing through the œsophagus is deposited in the honey sac. It here comes in contact with the secreting glands, which emit an acid which the author's experiments showed to be identical with formic acid. This it is which doubtless causes the peculiar tingling sensation at the back of the throat when much honey has been swallowed, and which is more perceptible to some than others. The bee after its arrival at the hive empties the contents of the honey sac into the comb, where it remains until the store of honey is taken. When separated from the comb, the purest honey is a clear, thick liquid, which after standing becomes thicker, till at length it "sets," as it is technically called. A small bit of this placed under a quarter of an inch objective, shows that this is owing to the grape-sugar (which has gradually been forming at the expense of the cane) crystallizing out in extremely thin, regular six-sided prisms. All the cane-sugar is retained in the liquid portion of the honey. This crystallization proceeds as the whole of the cane-sugar becomes converted into grape. When this takes place, so great is the proportion of crystals that the honey is said to "candy," and is not considered so good from the presence of acetic acid, which is produced by the grape-sugar, which in its turn undergoes a change through the agency of fermentation.

The honey crystals are not identical, as Dr. Hassall says, with those of cane-sugar. Although they greatly resemble the *summits* of regular prisms of the latter, yet the angles do not measure the same. Besides, cane-sugar always enlarges the sides instead of the summits, which are very much narrowed.

On more closely examining a slide containing a bit of old honey, besides the prisms will be seen small bundles of crystals. These are the manna-sugar. They remain after honey has been fermented, and may thus be separated. With these, small round or oval bodies will also be noticed spread over the field of the microscope, and are the pollen globules, showing in a beautiful manner from what flower the honey was collected. Of course they vary with every locality; but it is worthy of remark that a bee will only visit the same species of flower at the same journey; for the examination of a great number of bees will show that two kinds of pollen are never found on the same insect, although they may be very different on another working on the same flower bed. A single bee with all its industry, energy, and innumerable journies it has to perform, will not collect more than a tea-spoonful of honey in a single season, and yet the total weight of honey taken from a single hive is often from sixty to one hundred pounds. A very profitable lesson of what great results may arise from persevering and associated labour!

The evidence on which the author relied for the presence of formic acid was by distilling the honey and receiving the distillate in an alkaline solution. The resulting solution, after decomposition by an acid and evaporation, afforded all the usual reactions, and readily reduced the salts of silver.

The foregoing facts, therefore, clearly show that—

First. Honey is derived simply from a solution of cane-sugar identical in every respect with that from the sugar-cane.

Secondly. That it afterwards receives the addition of a small quantity of formic acid from the glands of the bee.

Thirdly. That the cane-sugar afterwards becomes gradually altered into grape-sugar by common chemical composition.

The flavour is of course quite accidental, and dependent on the aroma of the flowers the bees have visited.

For the purpose of illustrating the lamentable manner in which so useful an article as honey is frequently adulterated, the author exhibited four examples, all purchased in Bristol.

No. 1 was adulterated with cheap arrowroot and common brown sugar. The starch granules were easily detected under the microscope. The crystals of brown sugar were in considerable quantity, accompanied with the disgusting acarus, alive and in all stages of growth. It was remarked that in this and several other specimens the cane-sugar crystals present in the honey had no resemblance to the engravings in Dr. Hassall's work, nor in Dr. Lankester's *Half Hours with the Microscope*. Here the sugar had always the appearance of sugar-candy, or else flattened prisms, but totally distinct from the genuine honey crystals.

No. 2 had been lowered with brown sugar only, and in every respect resembled No. 1, minus the starch granules.

No. 3 was adulterated with pipeclay and turmeric. The peculiar cell structure demonstrated the presence of turmeric. The clay was easily separated by washing. The author exhibited a good sized button of pipeclay, which he had obtained in this manner.

No. 4 was adulterated with plaster of Paris and brown sugar. In this instance the gypsum was procured in the same manner as the pipeclay of No. 3. The usual chemical tests—barium and oxalic acid, proved its composition.

With all these honeys a considerable quantity of water must have been added, for they continued in a liquid state throughout the winter, without the slightest appearance of setting.

THE ORIGIN AND TRANSFORMATION OF ANIMALS.

During the years 1855 and 1856 M. Quatrefages published a series of articles in the *Revue des Deux-Mondes*, which he has now elaborated into a book entitled *Métamorphose de l'Homme et des Animaux;* and as this work deals in a succinct and agreeable form with questions of great interest, we propose in this paper to give an account of the principal results which are set forth in its pages. In distinct opposition to the school of Heterogenists—represented in France by M. Pouchet and in England by Dr. Grant—M. Quatrefages adheres to the maxim of the illustrious Harvey, *Omne vivum ex ovo*—"Every living being from an egg;" and all the cases of eggless production he treats as phenomena of individual growth, assembling the entire group under the new-fangled and not very happy designation of *Geneagenesis*, or the "Generation of Generations." "Every living being," he says, "and consequently every animal, comes from a germ. With the organization of this germ commences a series of transformations, general or partial, rapid or slow, and which only terminate with its life." All animals likewise undergo transformations, which, considered radically, "are due to the same cause, and are effected by the same methods." The germs or first rudiments of living things may be referred to three types. Animals multiply by eggs and by buds, which are either permanent or "caducous."* The egg method may be regarded as "fundamental, and the distinction between oviparous and viviparous species, although still admitted in scientific phraseology, is in reality only nominal. Baër, in discovering the egg of the mammalia, M. Coste, in demonstrating that this egg possesses the same parts as the egg of birds, have established this fact, which has been put out of doubt by the profound researches of those two naturalists and by the admirable labours of English and German physiologists, Barry, Bernhardt, Bischoff, Wharton Jones, Valentin, Wagner, etc. It is now plainly demonstrated that the mammalia, including man himself, spring, like birds and reptiles, from veritable eggs."

Here the question arises, What is an egg? M. Quatrefages answers, "Three spheres enclosed one in the other and contained in a transparent membrane, constitute the germ." The egg may differ in accessories, but "we always find in the vitelline membrane the vitellus, or yolk, enveloping the *germinative vesicle of Purkinye*, which itself includes the *germinating spot* of Wagner. The precise functions of each of these spheres is far from being determined, but it is at least certain that the vitellus is especially composed of organizable and nutritive materials. In certain animals its alimentary provision is considerable: a small part suffices for the constitution of the new creature, which nourishes itself and grows at the expense of the rest." The fish, for example, comes out of the egg completely formed, and gradually assimilates the matter which his stomach has enclosed. Among the viviparous animals the vitellus is very small, and the embryo is nourished by materials obtained elsewhere. The oviparous creatures *lay* their eggs, the vivipa-

* This term is borrowed from the botanists. In Professor Henslow's valuable *Dictionary of Botanical Terms* we read "caducous (*caducus*, ready to fall) when a part falls off very early compared with other parts with which it is associated. Thus the sepals of many poppies fall as soon as the flower begins to expand." Caducous germs fall for the purpose of development.

rous retain them for internal development; but birds, worms, reptiles, and men, all are *hatched.*

The viviparous, and many of the oviparous tribes, resemble their parents as soon as they have passed the fœtal stage. The marsupial animals, such as the kangaroo, forming no real exception, as the seclusion of their young in the pouch is only a second act of gestation. In other species—all of them oviparous —the offspring, at the moment of leaving the egg, differs completely from both its father and its mother. It may possess organs which they have not, and be destitute of organs with which they are furnished, so that changes and metamorphoses are required to bring it back to the original type. M. Quatrefages proposes to restrict the term *transformation* to the designation of those changes which the germ experiences in becoming an embryo, or which it undergoes while still enclosed in the egg. *Metamorphosis,* in like manner, designates changes altering the character of the creature, and, occurring after it has left the egg, or been hatched. *Geneagenisis* refers to the changes which "affect the generations themselves."

In discussing the transformations of the egg, M. Quatrefages refers particularly to his own observations of the Serpula and Teredo. After the laying of their ova, the eggs, whether fecundated or not, exhibit an internal commotion; "a mysterious force agitates the yolk; granulations accumulate now at one point and now at another," so that the shadowy mass changes its aspect every moment. M. Quatrefages considers that similar changes take place in the eggs of higher animals although they may be slower, and more difficult to trace. In the Serpula and Teredo eggs the agitation causes the "Purkinje vesicle" and the "spot of Wagner"—to disappear. If the eggs have not been fecundated, the movements become accelerated and irregular, and, finally, decomposition ensues. All through the animal kingdom the male element appears to excite and regulate the germinating force. In the eggs of the creatures named, a little nipple appears on the surface of the altered yolk, from which one or two transparent globules are expelled, the use of which is unknown.

This occurs whether the eggs have been fertilized or not. If fertilized, the expulsion of the globules is succeeded, "whether it be in the mammalia or the serpulæ," by a short period of repose. When activity recommences constrictions become visible, and the yolk assumes a mulberry aspect. The details of the process varyin different animals, "but in all, the consequence of the phenomenon is the formation of a primitive organized layer which envelopes the yolk, and is called the *blastoderm.* As soon as organization begins, it assumes distinctive characters; "the germ becomes the embryo, and from its origin reveals the fundamental characteristics of the group of which the new creature will form a part."

We must refer the reader to M. Quatrefages' agreeable volume for further details on this branch of the subject, and pass to the consideration of a few points in the development of the egg of the mammalia. Here our author tells us the heart soon makes its appearance, accompanied by arteries and veins, and soon after it the nervous system, the digestive tube appearing more late. This order of succession is directed by the method of nutrition, and it is inverted among the invertebrata, where the digestive apparatus precedes the circulatory. In watching the process of transformation, "every day, every hour, the scene changes, and this instability effects essential as well as necessary parts, etc. . . . Here cavities partition themselves into distinct chambers, or extend themselves into canals; and these, in their turn, are filled up and converted into ligaments; films are rolled up into tubes; isolated parts solder themselves together into continuous organs, or uniform masses divide themselves and form several organs. At the same time, relations and proportions change each instant. Parts which had been almost comfounded, separate and become strangers; others, which had been separated, approach and contract intimate union. Organs with temporary functions, grow, increase rapidly, acquire an enormous size, and then become atrophied, and disappear. Others stop at a given moment, while all grows around them. They retain their place, and will be found in the adult, where they have no other apparent part than to bear witness to a state of things which no longer exists."

Having got out of the egg and been born, the young mammal experiences *transformations*,* the proportions of the several parts altering at each stage, that of puberty being highly interesting and important. MM. Andral and Gavarret state that at an early age boys and girls respire with equal vigour. Before puberty M. Quatrefages calls them neither males nor females, but neuters. "But as soon," he says, "as the sexes are characterized, the respiration of the young man exhibits a redoubled and rapidly augmenting activity, while in the young girl and young woman this function remains stationary. About the age of thirty the former burns† about one hundred and seventy or a hundred and eighty-six grains of carbon in an hour. Subsequently, when the progress of age, and its accompanying transformation, cause the two sexes to approach by effacing their more salient characteristics, the respiratory activity of the

* M. Quatrefages entitles the chapter from which these remarks are taken "Transformations des Mammifères hors de l'œuf." Thus he does not follow the nomenclature which he recommends, and according to which these changes would be metamorphoses.

† The non-chemical reader may be reminded that respiration is a process of combustion.

woman comes nearer to that of the man, but without reaching so high a limit."

From transformation we pass naturally to metamorphosis, and we find that the larva of an insect or crustacean may be regarded as an embryo with an independent life, which obtains its own food instead of being nourished by its mother, and which undergoes before our eyes transformations analogous to those which the young of viviparous creatures experience inside the maternal organism. A proximate cause of metamorphosis may be found in the small amount of organizable material supplied by the yolk of the eggs of creatures which exhibit its peculiar phenomena. In common language, the more imperfect the condition in which the egg turns out its inhabitant, the more extensive the changes which the creature must afterwards undergo. M. Quatrefages observes that, compared with the eggs of certain molluscs, those of insects are enormous. Thus, the egg of the *Cossus ligniperda*, which Mr. Noel Humphreys discoursed of in our last number, is about "thirty thousand times bigger than the egg of a teredo." We cannot therefore be surprised that from the former there emerges a caterpillar or animal of a complicated construction, while the ovum of the teredo yields only a simple creature, "a homogeneous pulp, in which a digestive tube is vaguely discerned. The first has to fabricate certain organs, but its chief work is to develope and and modify those which it possesses, while the last has everything to acquire." In contemplating the changes which we can observe in the lower vertebrates or molluscs we are insensibly led to the philosophy of the case. If we observe the gills and tail of the tadpole disappear, we must, as M. Quatrefages says, exclaim, "Here are organs that become atrophied or dwindle." If we compare the abdomen of a young crab with that of the adult animal, we conceive the idea of "arrested development," and if we observe the Lernea* having its limbs, which first acted as oars, changed into a kind of anchor to fasten it to its prey, we cannot but admire the way in which nature appropriates an existing organ to a novel use, and we find the idea of "transformation." In these and similar transitions there is nothing violent, but all goes on in measured order and progression. In our author's words, "the gills of the tadpole do not fall off to make room for lungs; the tail is not detached, because the legs are ready. No; as the one pushes on its growth, with bones, muscles, nerves, and vessels, the other diminishes in all its parts. Molecule by molecule the one is absorbed; molecule by molecule the other is built up." The moults of crabs and other crustacea do not prove exceptions to this rule, for although the actual change of the hard integu-

* Described by Mr. Brady, in our July number.]

ment appears sudden, the internal processes which lead to it have been gradually carried on. Among insects the larva prepares the materials which the chrysalis will require; it has, so to speak, stored up in a magazine the materials necessary for its transformation.

We now come to the class of facts which M. Quatrefages groups together under one term, "Geneagenesis." As our readers will probably know, those vexatious inhabitants of the greenhouse or garden, the plant-lice, or *Aphides*, produce a series of offspring without the conjunction of two sexes, and in this mode of proceeding, Bonnet discovered unexpected facts. "He found that all through the fine weather the aphides reproduce their race, if isolated, but when the temperature falls, these animals, returning to ordinary conditions, propagate by eggs which demand the conjoint action of a father and a mother. These eggs pass the winter glued to the branches of the trees on which the colony dwelt that was destroyed by the cold. When they are hatched in spring they yield *viviparous* individuals only; in the autumn males and females appear, and from this moment *oviparous* generation recommences its work." It would have been impossible to place these curious incidents in their true position if Trembley and others had not observed that polyps and similar animals of simple structure can propagate like vegetables by buds. It was also necessary that Chamisso should make his discovery that the Salpæ produce their offspring in the strange fashion which he characterized as the "alternation of generations;" and here we cannot do better than borrow M. Quatrefages' description of a salpa, for the benefit of those to whom this interesting inhabitant of our seas is unknown. He says: "Salpæ are marine molluscs of a very queer shape, which it is difficult to describe. We may, however, figure one as an irregular crystal cylinder, perfectly transparent, in the interior of which is suspended a proportionably small mass of opaque lively coloured matter, called the *nucleus*. This is formed by the junction of the principal *viscera*. The cylinder represents the mantle and the shell of ordinary molluscs, and it is pierced towards each extremity. The water necessary for its respiration enters at one of these apertures and is expelled from the other, thanks to the contractions of the mantle; and making its exit with rapidity, it pushes the animal in an opposite direction, so that the creature swims solely by means of its respiratory movements." For a long while the attention of naturalists was drawn to these objects, "whose phosphorescence was remarkable even among the fiery waves of the intertropical ocean," and they sometimes discovered them in an isolated condition, and sometimes in chains. It was Chamisso who explained this riddle. He saw that the Salpæ were androgynous (bisexual) and viviparous; that they came into the world in the shape that they preserved all their lives; and that, strange to say, a solitary mother only brought forth infants united in colonies, and these in their turn engendered only solitary individuals. It followed from this that a Salpa never resembled its mother or its son, but always its grandfather or its grandson." Upon this curious state of things, M. Quatrefages remarks that "metamorphosis here influences generations and not individuals, and matters proceed as if the caterpillar, instead of becoming transformed, gave birth to complete butterflies, which in their turn reproduced the caterpillars."

It is, in fact, a case of the alternation of generations, the precise nature of the process being left for Krohn, Huxley, Leuckhart, and Vogt to elucidate. Before completing this curious story, let us follow M. Quatrefages, and advert to a similar set of incidents in the domestic manners of the Medusæ, or jelly-fish. "For more than a century," as he tells us, zoologists had admitted among the other great divisions of the subkingdom of the Radiata, the class of Acalepha, or medusa (sea nettles, jelly-fish), and that of polyps. This distinction seemed more than justified, as differences between the two groups were detected, more profound, and more numerous than those which separate the reptiles from the birds. There was in fact no resemblance in external aspect or internal organization. The jelly-fish, or Medusæ, for example, are free swimmers, and mostly solitary; while only a few polyps enjoy a crawling motion, nearly all are fixed, and most of them live in colonies. Notwithstanding these and other differences, the two classes approximated as their history became known. "The medusa lays eggs, well characterized by the existence of three concentric spheres, of which we have already spoken. These eggs transform themselves into larvæ, which at first differ little from those of the Serpula or the Teredo. Their oval and apparently homogeneous bodies are covered with vibratory cilia, and exhibit a small depression in front. They swim for some time with vivacity, like the infusoria, which they resemble sufficiently to deceive any one whose observations were restricted. This first phase of the life of a Medusa lasts about eight and forty hours. The movements then grow slower, the young larvæ seem fatigued, and by the aid of the little depression attach themselves to some solid body. Henceforth the wanderer vegetates in one spot—a thick mucous which it secretes forms a large disk that fixes it firmly.* The young Medusa changes its shape as well as its mode of life. It elongates rapidly. Its

* In a note M. Quatrefages says that he has reproduced the opinion of Sars, although he thinks it probable that the so-called mucous is a veritable expansion of the sarcode.

pedicle grows narrower, and its free extremity swells out in a club form. Soon an opening appears in the middle of this extremity, and an internal cavity is seen. Four little nipples spring from the margin, and grow into arms, while others are not slow to appear, and elongate in their turn. The infusory of yesterday is changed into a polyp." In this state it exhibits the properties and ways of the polyp group, multiplying by buds and by *stoles*,* from which new polyps arise. The formation thus produced resembles "horns widely expanded, but short, and having their margins garnished with twenty or thirty slender and moveable filaments." M. Quatrefages compares this mode of growth to the proceedings of a strawberry plant, and thus continues the story. "The Medusa lives some time under this form, until at last, one horn acquires three or four times the length of its companions, and at the same time becomes cylindrical. A circular depression then forms near the crown of tentacles, others follow at regular intervals towards the pedicle, which is never reached. The body thus becomes circled with ten to fourteen rings." After undergoing development, these rings are successively detached, and swim away. They are in fact medusoids, and gradually assume the true medusa form. These remarkable steps are again compared by M. Quatrefages to an imaginary case in the insect world. Suppose, for example, "a butterfly laid an egg, that from this egg there came an earthworm, which changed into a caterpillar, from which other caterpillars grew like branches. Suppose, then, that each caterpillar retained its head, but suffered its body to be transformed into a chrysalis; that the body was then constricted at intervals, and that it gradually appeared to be composed of butterflies piled one on the top of another; that the head subsequently fell off, and the butterflies flew away and gradually assumed their full proportions and perfect forms." This certainly would be an incredible narration, but transfer the incidents from the insect world to the jelly-fish, and it is pretty much what actually takes place.

The interpretation of this class of facts renders it necessary to bear in mind the words *larva*, *chrysalis*, and *perfect insect*, and to remember the conditions which they indicate. Turning to the classes of animals undergoing the peculiar changes which we have traced, M. Quatrefages proposes to adopt the nomenclature of Van Beneden, and to "call *scolex* the animalcule which emerges from the egg of a medusa, or any other species following the same method of reproduction. Extending the

* "Stole (*stolo, a shoot*), a lax trailing branch given off at the summit of the root, and taking root at intervals, whence fresh buds are developed."—Henslow, *Dictionary of Botanical Terms*. Zoologists borrow this term to describe an analogous process in certain animals.

meaning assigned by Sars to the term *strobila,* it will designate every compound being which proceeds from a scolex, and which is destined to produce isolated individuals. Lastly, borrowing from Dujardin an expression which he employs in a similar sense, *proglottis* will designate the individuals springing from a strobila, and which complete themselves by the acquisition of reproductive organs, and thus close the cycle of development." Between the primitive *scolex* and the *strobila* several generations may, as we have seen, be intercalated, and in this case our author calls the first scolex *proto-scolex,* the second *deuto-scolex,* and so on, signifying first, second, etc. by Greek words.

In the medusa, we saw that "each egg which it laid, produced not a single medusa, as a butterfly's egg yields a single butterfly, but a great number of individuals. Secondly, this reproduction took place in an indirect or mediate way; for between two generations of medusa, several generations of very different creatures were produced by budding. To speak in a still more general way, it is a case of *multiple generation* by the aid of a *single germ.* It is that which I have endeavoured to express by the word *geneagenesis,* which is applicable to every method of reproduction that exhibits this characteristic feature." The common polyp multiplies by buds, and also by eggs; but when it lays eggs it dies. Thus from the polyp egg comes a single individual, a *scolex,* capable of producing others like itself, which can bud in their turn and repeat the process, and which end, like the original stem animal, in acquiring sexual attributes. "It is as if there came from the egg of a butterfly, an animal having the appearance of a perfect insect, but destitute of reproductive organs, although able to give rise by budding to individuals like itself, and which, together with itself, would ultimately acquire the attributes of a father and mother." In such instances geneagenesis is reduced to its simplest elements, each scolex transforms itself into a proglottis, and the strobila stage does not appear.

Among the ascidians, of which the Salpa may be taken as an example, "the scolex transforms itself directly into a proglottis which in its turn produces a whole generation of individuals like itself. . . . . In this case, to follow our comparison, it is as if the butterfly's egg produced a caterpillar which arrived at a perfect state, and afterwards from the butterfly coming from the primitive egg, other butterflies had sprung, of which it was neither the father nor the mother, but only the parent." With the plant-lice we arrive at further complications. "The egg laid in autumn engenders a scolex having the character of a nymph or pupa. During the spring this nymph does not lay eggs, but forms *buds* which arise and organize themselves in the *interior* of its body, instead of making their appearance and developing themselves on the outside, as with the polyps and the medusæ. When the temperature falls, the normal reproductive apparatus shows itself in distinct individuals, and then we find males and females, that is to say, true *proglottis*." M. Quatrefages does not consider that the main facts demand any other interpretation, in consequence of Heiden's discovery that an aphis, after producing offspring all through the season *agamically*, or in a spinster state, ends in acquiring sexual characteristics. This he calls the *scolex* becoming a proglottis.*

With reference to the Salpa and its curious "alternation of generation," M. Quatrefages observes: "Thanks to Messrs. Krohn and Huxley, we now know that with the Salpæ there is not only an alternation in form and condition, but also in the method of reproduction. From their united labours, it appears that the *chained* Salpæ are at once males and females, and that they lay eggs from which the *isolated* Salpæ are produced. These last are neuters, and give rise, by internal budding, to chained Salpæ only. . . . Among the Salpæ it is as if the egg of a butterfly produced a caterpillar, from which sprung a chain of butterflies fastened together, and flying without power of separation."

The phenomena of geneagenesis are confined to the lower grades of the animated world: no vertebrate animal exhibits them, and they are rare amongst invertebrates of an elevated organization. Independent of the plant-lice, insects rarely furnish instances of this peculiar mode of multiplication, and M. Quatrefages tells us that among the superior annulated animals, or those possessing articulated feet, it is only found among insects and crustaceans. "Moreover, among these latter we have no other example than that afforded by the Daphina; at least nothing of the kind has yet been noticed in the myriopods, spiders, and cirrhipedes.†

Among the worms, or inferior annulated animals, it is commonly found, and M. Quatrefages regards *fissiparity* or multiplication by division as belonging to this system of reproduction. He observes, with special reference to Nais, Nemertes, and other worms, "During many generations the individuals produced by this method are neuters like their parent; at length, under conditions which are not known, the sexes appear, and the species is propagated afresh by means of eggs." He adds, that no mollusc, properly so called, adopts this mode of propagation, but that among the *molluscoida* (or mollusc-like creatures) geneagenesis seems to be the rule.

* Detailed information concerning this subject will be found in Mr. Huxley's paper on the *Organic Reproduction and Morphology of the Aphis. Linn. Trans.* 1858.

† The Scolopendra, or "Hundred Legs," common in gardens, is a myriopod; the acorn barnacle, so frequent on seaside rocks, is a cirrhipede.

We must refer the reader to the elegantly written work upon which this paper is founded, for details of the reproductive arrangements of the Radiata, and intestinal worms; suffice it to say, that among all the diversities which they present, the author traces the leading facts of his doctrine of geneagenesis, and feels justified in arriving at the conclusion that gemmiparous or budding reproduction is not able to perpetuate the species, but that after a given time the formation of true eggs becomes necessary. He rejects the Parthenogenesis, or Virgin-generation doctrine of Mr. Owen, and sees in all the cases to which such an explanation has been applied, illustrations of the methods we have explained. With the views of Dr. Carpenter he concurs, regarding oviparity or egg generation, as entirely distinct from gemmiparity or bud generation; the first demands the concurrence of two systems of organs, special and distinct; the second, as Dr. Carpenter expresses it, is a multiplication of cells by a process of continual growth. All reproduction that does not involve the formation of true eggs he regards as phenomena of budding, which in their turn are phenomena of growth, and as the manifestations of growth are limited, the budding process has its duration limited also, and can never perpetuate a race.

M. Quatrefages is of course aware of the difficulty of proving the intervention of a *father* in all cases of continuous reproduction in the insect world. As we have seen, the necessity for such an individual may be postponed for many generations, and some naturalists have thought it might be permanently dispensed with. It may be asked, Is the father a constant item in the natural arrangements for the preservation of species? Bernouilli, Treviranus, Suckow, and Burmeister had observed among several nocturnal moths, and Malpighi, Herold, Curtis, and Filippi had noticed among the silkworm moths, that females without any connection with the males of their species could lay fertile eggs, and M. Carlier has obtained three virgin generations of the *Liparis dispar*.

These observations seemed little favourable to the pretensions of the male sex, but subsequent discoveries reasserted its importance. M. Zierzon, curé of Carlsmark, in Silesia, a man whom M. Quatrefages describes as endowed with a rare faculty of observation, declared that while the Queen Bee preserved her virginity intact, she could only lay eggs that produced *males*. He admitted with Huber that the queen could receive on a single occasion enough of the fertilizing fluid to last for several years, but he contended that she could decide whether the egg which she laid should be acted upon by it or not. In the first case he said a female bee was the result, and in the latter a male. It appears that with bees the union of the two sexes can only occur during flight, so that cutting off the wings of a female bee, or a natural defect having the same result, will preclude her laying fecundated eggs. It also appears that if a married queen is exposed to a degree of cold capable of injuring the fecundating fluid, or if the communication is stopped between the vessel in which she retains it, and the canal through which the eggs are deposited, she only produces males *after* such an accident, although she had previously been producing bees of her own sex. In Germany, where bee culture occupies much attention, it seems that efforts to produce crosses between two races confirmed Zierzon's ideas. Thus when local bees were crossed with the Ligurian bee, the offspring resembled both parents so far as workers and queens were concerned, but the male progeny reproduced the maternal type in all its purity. Siebold and Leuckart undertook a scientific examination of the facts thus disclosed by Zierzon and Berlepsch, and the result of *post-mortem* examinations of married and unmarried queens, and of the eggs which they produced, showed that the curé of Carlsmark was right.

At this point of the argument the question arises whether the unimpregnated eggs are true eggs at all. To answer this M. Quatrefages has recourse to the labours of Mr. Huxley in reference to the reproduction of the aphides, and he observes, "in the three last chambers of the ovary of the *oviparous* aphis, figured by Huxley, we see the egg in its nascent conditions, represented only by an isolated vesicle of Purkinje, very small, but well characterized and already possessing the spot of Wagner. This vesicle grows in passing through the second chamber, but it is only in the third that it begins to surround itself with a vitellus, all the while leaving the germinating spot distinct and noticeable . . . . with the *viviparous* aphis, Huxley describes and figures these phenomena very differently. Here the last chamber of the ovary is filled with a pale homogeneous matter, in which are a dozen cells with opaque nuclei.* A portion of this matter is separated from the rest by a constriction of the walls of the chamber, which becomes more and more pronounced. . . . . Nothing here resembles the true "vesicle of Purkinje," or the true "spot of Wagner,"—"the fundamental elements of eggs properly so-called." Acting upon this view, M. Quatrefages considers the unfecundated eggs to be another form of *bud*, and he asks, "is their nature changed because, being destined for development outside the maternal bosom, they have received an envelope of greater or less solidity according to the protection against accidents which they are likely to require in the external world? . . . . But if these reproductive bodies are *buds* not *eggs*, it follows that

* "Dans laquelle sont comme noyées une douzaine de cellules à noyau opaque."

development without male intervention belongs to the phenomena which we have been studying, and that we have thus not *parthenogenesis* but *geneagenesis*."

Regarding no object as a veritable egg which does not possess the Purkinje vesicle, and the Wagner spot, M. Quatrefages considers that cases of parthenogenesis will be greatly diminished, but he is convinced they will not be entirely obliterated from the book of science. He admits, without, as he says, going as far as Huxley, Owen, and Lubbock, that there exist "intermediaries" between eggs and buds, but after all reservations, "parthenogesis is not in his eyes a constant fact." He admits that there exist "true females laying veritable eggs which develope themselves without male intervention in any way whatever;" but he thinks these phenomena are supposed to be much more frequent than is really the case, and that reproduction by females only, tends to exhaust itself, and that "always, the intervention of the male, recurring at a given moment, as a necessary element in the perpetuity of species, is evidently one of the great laws of nature." The father is thus "as necessary as the mother for the indefinite duration of species, and the point of departure for a cycle of generations is not only an egg, but a fertilized egg." *Parthenogenesis* is then "only a particular case of *geneagenesis*."

We cannot now follow M. Quatrefages through the vegetable kingdom in which he pursues his theme, but we may observe that philosophers, who require every step in an inductive process of reasoning to be strictly proved, will hesitate before they affirm with him that "a father and a mother—that is a male and a female—such is the origin of *every* living being." They will likewise prefer a frank confession of ignorance as to how and why the characteristics of individuals descend to their posterity, to the assertion that "an *essence* proper to the character of each being" is received from its ancestors and transmitted to its posterity. All, however, will allow that M. Quatrefages has produced an admirably written and learned work, which supplies the profoundest naturalist with deep matter for investigation and thought, while from the elegance of the language and the clearness of the style, it is admirably adapted for popular use.

CHEMICAL MANUFACTURES, AS ILLUSTRATED IN THE EXHIBITION OF 1862.

BY J. W. M'GAULEY.

It is probable that in no department of the Exhibition is the progress of Science more clearly demonstrated than in that which is devoted to chemical products. The various substances which are found there, and the different compounds, are so conveniently classified, and the specimens themselves are, in many cases, such beautiful objects, that a careful inspection of them is attended with both profit and pleasure. What can be more agreeable than the brilliantly white crystalline masses of sal-ammoniac, alum, etc., or more pleasing to the eye than the rich colours of the chromates and sulphates of copper, prussiates of potash, and many other salts. And if perfect crystallization, and either richness of colour or total freedom from it are to be considered as proofs of the purity and excellence of the products, what are shown on the present occasion must be admitted to be inferior to nothing that has ever before been exhibited. The illustrations of chemical manufactures presented to the student are particularly valuable, not only because he can examine them without fatigue or trouble, on account of their excellent arrangement, but because he will see collected together a variety of substances with which he could scarcely have been acquainted except by name. He will find also, in several instances, the different phases of important manufacturing processes placed before him, so that he can trace their progress from their earliest stages to their completion. No branches of industry have derived more benefit from science than those which depend on chemistry. Not only have long-established operations been extended by it, and augmented in usefulness through a greater economy of production, but altogether new ones have been originated and developed. The degree to which the cost of many useful matters has been diminished is truly surprising: not to mention acids, and alkaline salts, which, in our own time, were so much dearer than at present, there are a number of compounds, the prices of which bear no proportion to what they were at no distant period. Thus Prussian blue was originally two guineas a pound; it is now less than two shillings. Ultramarine, when made from lapis lazuli, was five guineas an ounce; what is just as useful may now be had for little more than a shilling a pound.

We propose to treat, on the present occasion, of the manufacture of mordants and dyes: but the subject is so extensive that we must confine ourselves to a comparatively limited view of it; and therefore we shall select for consideration only alum from the former, and madder, with its products, and the aniline colouring matters, from the latter.

Alum was well known to the ancients; it is mentioned by Pliny in his *Natural History*, but there is reason to believe that he did not restrict the word to the sense in which we understand it:—in his time sulphate of alumina, combined with more or less sulphate of iron, was also termed alum. From a very early period alum was used as a mordant, and also to render wood and cloth incombustible. It was obtained most abundantly, and of the best quality, from Egypt, and its name is probably an Egyptian word. Until the fifteenth century it was imported from the East, and was not made in England until the reign of Elizabeth. Our alum is essentially a double salt, one of its constituents being sulphate of alumina, and the other the sulphate of an alkali; and as there are three alkalis there are three corresponding alums. These are not, however, the only salts to which the name is given; every double salt constituted like an alum being considered such. Thus, in an alum, the sesquioxide of alumina may have been replaced by the sesquioxide of some other metal—as that of chromium, for example, or of iron; and in this way a great variety of alums may be produced; but each of them contains twenty-four atoms water. The alum in which alumina is replaced by oxide of iron, is used in Germany and other places as a mordant for logwood, galls, sumach, etc. Alum is found native, but almost all of the vast quantity which is used in dyeing, and for other industrial purposes, is artificial, being produced from alum stone or slate, schist or clay. Alum stone contains all the constituents of alum, but, in addition, certain impurities, which must be removed; schist contains only the alumina and sulphur; the latter must be oxidized, and an alkali must be added; clay requires the addition both of sulphur and an alkali. Alum stone is not abundant, but it yields alum by a comparatively simple process, and with a facility dependent on the proportions of its constituents. To obtain its alum, merely moistening it with water would suffice, but this is not the method adopted: in practice, sorted pieces of it are calcined, to deprive the free alumina present of its water, and thus destroy its affinity for the alum, with which it is in union. After which, they are exposed to the atmosphere, which causes them to fall into powder, and the alum is then dissolved out with water. The degree of heat to which the stone is raised, during calcination, is a matter of great importance; if this is too high, alum will not be formed; if too low, the result will not fall into powder.

Alum slate and shale are the most abundant sources of alum. Some of the alum shales, on being moistened with water, heat and fall into powder; but most of them require to be roasted. If the bituminous matter they contain is too little for this purpose, small coal, or some other combustible must be added. The roasting deprives any pyrites that is present of half its sulphur, which passes off, either free or as sulphurous acid, sulphuret of iron being formed. This sulphuret, by attracting oxygen, becomes sulphate, which, as the temperature rises, becomes peroxidated, and yields its acid to the alumina. If, in roasting the schist, the heat is allowed to become too great—and, when the mass is very large, this is very likely to be the case—the sulphuret of iron will form a slag with the earth, or too much sulphur will pass off, and, in either case, waste will occur; the more moderate the heat, within certain limits, the more abundant the alum product. After calcination the mass is so porous, that the air can circulate freely through it; to facilitate this, and also to remove the sulphate of alumina, water is sprinkled upon it. When all the alumina is obtained in solution as a sulphate, the liquid is concentrated by evaporation: and, on adding an alkali, alum precipitates as a crystalline powder, which is purified by washing with cold water, in which it is nearly insoluble: being then dissolved in just enough of water raised to the boiling point, the solution is run into casks with moveable staves. When the whole has cooled, the staves are taken asunder, and the alum appears to be a solid mass: but on making an aperture in it, the mother liquor flows out.

As the supply of shales is confined to certain localities, alum is manufactured also from clay. The difference of the process employed, in this case, consists in adding sulphuric acid after calcination, and removing the iron—generally as Prussian blue, with ferrocyanide of potassium; the alkali is applied in the usual way. When ammonia is used as the alkali, it is obtained from gas liquor. Ammonia alum has the advantage of precipitating from a less concentrated solution. Spence manufactures it on a very large scale, his products being, on an average, more than three hundred tons per week. He uses the carbonaceous shale of the coal-measures: and his process is so effective that instead of one ton of alum being made from sixty tons of oolitic shale, sixty-five tons of alum are made from fifty tons. He calcines in the ordinary manner, but with great care; and adds sulphuric acid to make up for the deficiency of that produced from the pyrites, introducing along with it the ammonia and its volatile salts contained in gas liquor, the fixed ammoniacal salt being subsequently liberated by lime. The precipitated alum powder is dissolved, not by boiling water, but by steam: and any basic alum (a subsulphate) subsides from the solution, which is crystallized in the usual way. The masses of alum, thus formed, weigh about three tons; one of them (No. 605) is exhibited.

Alum is used in a variety of ways, but chiefly as a mordant, on account of the affinity of its alumina for both colouring matters and vegetable fibre, between which it forms a bond of union. When applied to calico-printing, it is very important that it should be free from iron; and the chief use of the alkaline sulphate which it contains is to facilitate the separation of that metal, by rendering the aluminous compound so much more soluble as to allow the sulphate of iron to crystallize first, and be removed. When heated, ammonia alum loses first the whole of its alkali, and then the sulphuric acid passes off, pure alumina being left. The well-known superiority of Roman alum consists in its containing a considerable amount of cubic alum, which has a larger quantity of base than the octahedral; the extra alumina being held very feebly by the sulphuric acid, it is more easily detached as a mordant.

The use of alum has been in a great degree superseded by the employment of sulphate of alumina—incorrectly termed "concentrated alum." It is made from clay, contains but little alum, and is quite free from iron, that metal being easily and completely removed by ferrocyanide of potassium.

Madder is one of the most important substances used in dyeing, whether we consider the beauty, the variety, or the permanence of the colours it imparts; and it is specially deserving attention on account of the improvements which have been introduced into the mode of applying it. The plant from which it is derived is the *Rubia tinctorum* of Linnæus; and there is little doubt that its properties were as well known to the ancients as to ourselves. Other plants also, of the same genus, have been used for the same purpose. Thus, the *R. Manjista* has been employed in India from the earliest times for the production of the colour called *Turkey red:* and in the eastern parts of Europe the *R. Peregrina,* or *Alizari,* has long been used to obtain the same tint. Western Europe was, for many centuries, supplied with madder from Holland; but, on its being discovered that Dutch madder was incapable of producing all the colours which madder will give, it was imported from other places, and particularly from the south of France. Madder may be grown in England, but not economically. The *rubia tinctorum* is not an ornamental plant; its stem dies every year; but the root, which is the important part, is perennial. The Levant madder is the finest we receive; that of Avignon is next in quality. Cochineal imparts a richer tint than madder, but it is far more expensive. According to the mordants employed, madder produces every shade, from a pink to a deep red, and from a lilac to a black; and affords also varieties of orange and brown. It is not used in dyeing silk. The splendid colour termed Adrianople or Turkey red, is produced with it by a very complicated process, which is practised on a large scale in France, and is considered there an industry of the highest importance.

It was formerly supposed that madder contains only a red and a tawny colouring matter; but it has been ascertained that it includes two reds, termed respectively by their discoverer *alizarine* and *purpurine*. It contains other colouring matters also, including two that are resinous, with sugar, acids, etc. If an acid is added to the brown muddy liquor, which results on treating madder with boiling water, a complicated precipitate is thrown down. When boiling water will extract no more colouring matter from madder, it will give out a large additional quantity if acted on with an acid, then washed, and treated with caustic alkali; and a precipitate may be thrown down as before by means of an acid. Nothing will then remain but woody fibre. Alizarine, or *madder red*, is found among the substances precipitated by the acid. It is always present in the madder of commerce, but is not to be discovered in the roots when first taken out of the ground. The cells of the living plant contain only a transparent yellow juice, which becomes red by exposure to the atmosphere, and has been termed *Rubian*. It is believed to be identical with the bitter principle, and, by means of an acid, to be convertible into different dyeing substances. If madder is treated with cold water, and the liquid is allowed to stand in a warm place, it loses its bitterness and yellow tinge, and gelatinizes; it is then capable of producing the most brilliant colours. The whole tinctorial effect of madder is not developed until the process of dyeing, when the gradual heat first applied causes the required fermentation of the rubian.

If the gelatinized cold solution is treated with alcohol, and the alcoholic solution is evaporated, a further heating will sublime alizarine in long brilliant transparent orange-coloured crystals. Alizarine may be obtained also by heating madder itself; but the product will be rendered impure by an empyreumatic oil. Although alizarine is of a reddish-yellow colour, its compounds are a beautiful purple or violet hue. It is precipitated from their solutions by metallic salts, etc., if in combination with the fixed alkalies; but spontaneously by the escape of the ammonia, if in combination with that alkali. Alizarine is dissolved without change by boiling concentrated sulphuric acid, and is set free from the solution by the addition of water. It has a very strong affinity for alumina; but if, in dyeing with it, bases are present, they will enter into combination with it; if acids, they will combine with the mordants.

It affords very readily a brilliant red with alumina, and a black or purple with iron; and very little of it is sufficient to produce shades of great intensity. Madder itself, if used for the same purpose, would require a tedious and complicated process.

Purpurine, or *madder purple,* the other red colouring matter, resembles alizarine, from which it may be separated by a boiling solution of alum, and, after cooling, may be thrown down by excess of sulphuric or muriatic acid. It produces, with mordants, a more fiery red, and a more intense black, than alizarine; but the purple it gives has a very disagreeable reddish hue, and hence its name has not been well chosen. Its colours are not only inferior to those of alizarine, but less permanent.

The precipitate thrown down by an acid from infusions of madder, contains also *rubiacine* or *madder orange,* a yellow colouring matter which sublimes in yellow crystals. It may be conveniently obtained by digesting washed madder roots for sixteen hours in eight parts of water at 60°, and straining the liquid, which will then deposit small crystals. When these, after having been dried, are dissolved in boiling alcohol, crystals will separate on cooling, and must be washed with cold alcohol. Rubiacine, as also the two resinous colouring matters contained in madder, injure the beauty of the dyes obtained from it, giving to the red an orange, and to the purple a red tinge, and a yellowish hue to those parts of the cloth which should be white.

It is a curious circumstance that madder, to produce permanent colours, must contain a certain amount of lime, either naturally or from its having been added. Hence dilute sulphuric or muriatic acid, injures its dyeing powers, but they may be restored. Something, therefore, depends on the soil in which the madder is grown, or on the water used in dyeing with it; if these do not supply the required carbonate of lime, the effect produced will be imperfect. Lime water neutralizes the injurious effects of the pectic acid, rubiacine, and resinous matters, in the madder; but excess of it would combine with the alizarine. If, in dyeing, only the latter is used, the smallest quantity of lime would be mischievous, since it would prevent the combination of the dye with the mordants, which are weaker bases.

Many unsuccessful attempts having been made to improve the colouring properties of madder, it was at length discovered that by acting upon it with strong sulphuric acid, and then washing with water, a more powerful and brilliant dye might be obtained. It is believed that the acid decomposes the bitter principle, producing new quantities of colouring matter; and that it liberates colouring matter which was in combination, by rendering the earthy bases soluble, and therefore capable of removal. The subsequent addition of lime neutralizes the resinous colouring matters and other hurtful substances which the acid may have set free. When sulphuric acid is added to ground madder, all that is soluble in water can be extracted—including a large quantity of sugar, which is used for the manufacture of a spirit that pays for the whole process; since, though it is not drinkable, it answers well for varnishes. The dye stuff obtained in this way is termed *garancine;* it gives no colour to cold water; but, as it produces its whole dyeing effect at once, it is more powerful than the original madder; it affords brighter colours also, and does not stain the white parts of the cloth, which greatly simplifies the after-process. But, as the colours which it produces are less permanent, and do not so effectually, resist soap, etc., it cannot be so well employed for pink or purple. When the residue, after dyeing with madder, and the exhausted dye-liquor, are acted on with sulphuric acid, an inferior garancine, termed *garanceux,* is obtained; it will not give a good purple. The chief derivatives of madder, may be seen among the chemical products in the eastern annex.

But by far the most interesting manufacture connected with dyeing, is that which has for its object the production of colouring matters from coal-tar. The latter was long a reproach, both to the chemist and the economist, neither of whom, until within a recent period, applied it to any very useful purpose. It was generally consumed as fuel, the least profitable way in which it could be employed. Very valuable substances are however, now obtained from it, and among them *aniline,* which, with its compounds, has a special interest, on account of its capabilities as a source of colour, having been discovered long since the Exhibition of 1851. It is one of the bases discovered by Rungé, and was called by him *Kyanol,* but it has since been termed aniline, from the Indian name for one of the plants whence indigo, the substance from which it was first obtained, is procured. It may be had from a variety of sources, but most abundantly from coal-tar.

In the method of manufacture that is found most inexpensive and convenient, naphtha is first obtained by distillation of the tar; then benzole, by distillation of the naphtha, with certain precautions; nitro-benzole, by the addition of nitric acid to the benzole; and aniline from the nitro-benzole, by means of reducing agents. Two gallons of tar produce about ten grains of aniline. The various stages of this process are beautifully illustrated (No. 581) by the Messrs. Perkins, who exhibit also a mass of aniline purple, in the solid form, which is believed to have required for its production the tar from two thousand tons of coal; but it would impart a fine purple to one hundred miles of calico, the solution required for the purpose containing less than a grain of the salt to the gallon. Aniline may be obtained also from naphthaline; and thus a substance which was so long not only worthless but a cause of considerable inconvenience, may be made the source of a most valuable material. The method of obtaining it from benzole was discovered by Bechamp in 1856. Its most characteristic property is the blue colour which it strikes with the solution of bleaching powder, or of any alkaline hypochlorite; and this suggested its use as a means of producing colouring materials. It forms crystallizable salts analogous to those of the metals.

The aniline colouring matters are generally obtained from its sulphate, which is formed by the addition of dilute sulphuric acid, and, with gentle evaporation, separates as a salt. The sulphate of aniline having been dissolved in boiling alcohol, it crystallizes in colourless plates, which become red by exposure to the air. *Mauve* dye, or aniline violet, is obtained by precipitating the sulphate with bichromate of potash, and digesting the precipitate with coal-tar naphtha; then dissolving out the colouring matter with alcohol, and removing the alcohol by distillation. Cotton does not take the aniline colours as well as wool or silk; they may, however, be found to answer better with Indian cotton, which from some cause, yet unknown, is more easily dyed than that from other localities. Among the derivatives of aniline is *Rosaniline,* which is quite white until some acid is added. Its acetate, dissolved in water, constitutes the *magenta* dye. Some very splendid and valuable specimens of crystallized acetate of rosaniline, in the form of crowns, are shown at the Exhibition. There is also an aniline yellow, and an aniline blue; but, in general, the shades derived from aniline are those varying from pink to purple. No other dyeing material produces more beautiful or more permanent colours.

The present Exhibition affords abundant proofs of the perfection to which the dyer has brought his art, with the assistance of the chemist. That such valuable and beautiful compounds as the aniline dyes should be produced from so mean a substance as coal-tar, presents the most incontestable evidence of the aid which chemistry may furnish to the arts—an aid the more to be prized when, as in this instance, it consists in utilizing materials which may be obtained in abundance, and which are otherwise of but little value.

TASTE IN ART.

A visit to the Great Exhibition at Kensington must have suggested many interesting questions concerning taste in art, and they are not the less important because they are not new. The word art expresses one of the most complex ideas that civilization has evolved, and a perfect theory of art, like a perfect theory of society, is impossible, because analysis must fail to grasp the multiplicity of conditions under which the phenomena are produced. It is probable that certain relations between the structure of the eye and particular arrangements of form and colour, may ultimately enable a physical theory of beauty to be constructed, but this would not help us far on our road. Suppose, for example, that convenience of vision, and the physical comfort of the optical apparatus could be shown to be associated with certain forms and tints presented simultaneously, or in succession, we should still have to consider the more difficult relations of mental and moral association, in order that we might, out of an indefinite number of unobjectionable arrangements, bestow an artistic preference upon those which were best able to express, or stimulate emotion, and thought of an ideal kind. Imagining that we have to deal with an average eye and organization, we must condemn a disposition of colour which is painful, or wearisome, and we must likewise condemn forms, or arrangements of form, that suggest physical discomfort, or which are obviously inappropriate. Upon these principles it is not difficult to come to a wide and general agreement upon many elementary propositions. All people, for example, who are not sufferers from colour-blindness, admire sky-blue, and they can all be brought to disapprove of an inartistic treatment which should give the clear cerulean tint a muddy aspect, by the juxtaposition of a hostile hue. An equal facility for agreement exists with reference to simple harmonies, or discords of colour; but as soon as we approach more complicated problems we find that a prolonged education of the eye is necessary to enable the act of vision to be properly performed. Ask any child the form of objects seen in perspective, and the probability is that you will get an incorrect reply, founded not upon a real attempt to see, and a genuine explanation of what appears to be seen, but based upon wrong notions of the appearance it is supposed they ought to present. A few experiments with a round table, placed edgewise to the observer, and in various slopes, will convince any one how completely seeing is an art which has to be acquired, and show to how slight an extent the acquisition is usually made. If simple objects in easy positions are so little understood by children, or even by numbers of grown-up people, how much more must defect of vision prevent the appreciation of the beautiful curves that enter into the human form. From outline let us pass to colour, and those who have made no trials will be surprised to find how few persons can see all the tints of an ordinary landscape or street scene. One very noticeable deficiency in uneducated vision is not to see violets and purple-greys, and consequently, to be insensible not only to many of the chief beauties of natural objects, but also to be incapable of appreciating the best efforts of landscape art, The uneducated ear is contented with a few ballad cadences, not even elaborated into anything that can be called an air; the uncultivated eye is equally soon pleased with what is poor and bald, but as the uneducated ear is bewildered and pained by a strain of Beethoven harmony, the uncultivated eye is annoyed by a masterpiece of Turner, or an exquisite picture of Pyne, in which a highly complicated system of colour harmony its introduced.

Art criticisms are so often written by individuals who have not learnt to see, that they meet with little respect in this country. This is a misfortune, as we want methods of judging, and standards of excellence distinct from those which artists themselves set up. The tendency of a painter, for example, is to overrate technical skill and to underrate the human thought which a painting should express. He knows far better than the general public how difficult it is to perform certain manipulations, or imitate special effects. He is also well up in the ordinary rules of his craft, and quick at discerning errors or faults. On the other hand, he may have very low conceptions of the purposes of art. He may be ignorant of history and literature, or he may read the best authors with a dull perception of their meaning; he may look at scenery without the faculty of idealization; the events of life may go on around him; empires may crash, human passion, instinct, and reason may carry on their exciting conflicts, but he may see nothing, feel nothing, to translate into the language of his art. This shows that the mental faculty of seeing requires cultivation as well as the physical, and if criticism were not for the most part a bad penny-a-line sort of business, it would help the artist to create and the public to appreciate a nobler kind of work than we are accustomed to see. Some artists, like Mr. Creswick, establish and maintain a great reputation upon the principle of never seeing in nature more than the average of uncultivated people can understand; others, like Mr. Redgrave, appear to flourish by seeing a trifle less, for out of the thousands who looked upon his "Way through the Woods," in the Royal Academy exhibition of this year, we cannot imagine many to whom a woodland scene would have had so little to say.

In Eckermann's conversations with Goethe, the following passage occurs :—"Your excellency," said I, "made an excellent remark a little while ago, when you said that the Greeks turned to nature with their own greatness, and I think that we cannot be too deeply penetrated with this maxim." "Yes, my very good friend," said Goethe, "all depends upon this. One must *be* something in order to *do* something." In literature we do not forget this, for, excepting the ephemeral popularity of the trashy school of fast writers, our praise is given to those who *are* more as observers and knowers than ourselves. Artists, however, we treat less rationally, and are apt to over-value their mere technical skill. Rightly considered, this skill is the acquisition of a language in which something great and beautiful should be said, and he who possesses the language, but tells us nothing, is greatly to be condemned. Style in writing, or speaking, is something like the technical part of good painting, and it often covers deficiencies of thought. One who speaks in public with elegance of manner, choice of words, and flowing cadences, is sure to gain applause, even if there is nothing in what he says; except his audience are in earnest, and then the roughest utterance with point and pith in it will be preferred. This earnestness settles art questions as well as those of rhetoric or literature, and it is a maudlin frame of mind that induces people to be contented with a painting, or a sculpture, that leaves them emotionally and intellectually no wiser than they were before. The artist usually depreciates works in which there is a fine thought damaged by bad technical expression, and as we have said before, overrates works destitute of thought, but good in technicality. In this spirit very culpable pictures of Millais have been immensely praised, while his noble conception of Sir Isumbras was franticly abused because the knight bestrided a great rocking-horse fitter for the nursery than the field. The "Black Brunswicker" of this artist was perfection in satin and boots, but the man was as unlike a Black Brunswicker as could be. In fact he looked a creature far more likely to run away than to prove the stern hero determined neither to give nor take quarter, but to move on with iron determination towards inevitable death. Surely, if art is anything more than imitation, it is better to mount a rocking-horse with a great idea, than to make a mistake like this. This year Mr. Millais refutes the theories on which he used to act. He justifies the warmest hopes of those who saw the genius lurking under his most hideous efforts, and after the spectator had refreshed his memory by looking at the Nuns digging their grave at Kensington, and thus seen what could be accomplished by the force of ugliness, he could go to the Royal Academy and observe how the same artist could win higher triumphs in the "Ransom" and "Trust me," two noble pictures, unsurpassed in power, and violating no sound canons of taste.

Among the foreign pictures which the International Exhibition has brought before British eyes, probably the grandest is that in which M. Gallait depicts the terrible scene of the last honours paid to Counts Egmont and Horn. After recognizing the merits of the less painful and equally fine picture of Egmont's "Last Hours," Mr. Tom Taylor*—in a work which will prove a valuable aid to visitors whose opportunities are brief—thus succinctly describes the more terrible delineation (page 183.)

"Stronger still is the ghastly attractiveness of the next picture, where the bodies of Egmont and Horn, covered by a black velvet pall, and surmounted by their severed heads with the death sweat still damp on the brow and rigid hair, lie in the chapel of the Recollets, for the chiefs of the guilds and civic militia of Brussels to take a last look at those that should have been their leaders. The fact is historical, strange as it may seem. Either Philip hoped the sight would strike terror into the turbulent Low Country burghers, or, confident in his Brabanters and Spaniards, wished to show his contempt of the popular disaffection. In the figures of the guild-masters, M. Gallait has typified the past, in the elderly man, an associate of the headless chiefs in plans and pleasures, who, turns away, terror-stricken and trembling, from the horrid sight; the present, in the stalwart burgher down whose cheeks the tears are falling as he looks at the dead, the hopes of his order, the protectors of the Protestant, the free-handed and gracious Count of Lamoral, the stout captain of Graveling and St. Quentin; the future, in the young archer who exchanges a quick, fierce look of defiance with the Spaniards who stand near the bodies: the one a rough, haughty soldier—the hand of Spain; the other a civilian with polished, cruel face and thin white hand that caresses his dagger-hilt—the head that guides the hand."

This picture is very important in assisting us to arrive at a decision of the principles which should guide an artist in dealing with the repulsive and the ugly. If M. Gallait had invented the scene he would have stood condemned for a gross offence against good taste, in forcing the ghastly spectacle of two guillotined heads upon our view. To be sufficiently true to the nature of the incidents he could not soften down the horrible character of the objects, and thus follow Lessing's direction in "Laokoon," "that the truth of the repulsive in nature should be changed into the beauty of art." Having determined to paint such a subject at all, M. Gallait could only introduce the "beauty of art" as a relief to the

*_Handbook of Pictures in the International Exhibition._ By Tom Taylor. Bradbury and Evans.

repulsive facts that would not admit of the transmutation which the German critic required. The cold clammy heads in all the grim horrors of violent death will haunt us with their murderous tale; but the general tone of the picture shows that the mind of the artist lept beyond the scaffold, that he dwelt upon the grandeur of patriotic sacrifice, and saw, in a memorable execution, one of those incentives to heroism through which the liberty of his country was achieved. An Englishman should read Mottley's *History of the Netherlands,* and Newman's *Crimes of the House of Hapsburg* to understand the justification which a Belgian artist would feel in plunging into horrors so profound. We agree with Mr. Taylor in thinking the objections to this picture without reason, but the fact that in this case, the painter needs the justification of history, is sufficient to show how thoroughly the artist should be imbued with Lessing's maxim that "beauty is the highest law of plastic art."

There is another important picture open to adverse criticism upon a widely different ground. It is the "Roman Martyr" of Delaroche, which appears to divide the attention of the public with the far greater picture of "Marie-Antoinette going to the guillotine." In the last work, art criticism finds itself disarmed, although the Marie-Antoinette of the painter possesses grand attributes which certainly did not belong to the poor victim of that volcanic time, when the wrongs of centuries fairly boiled over in an excited and outraged land. In discussing the "Roman Martyr," we cannot do better than again have recourse to Mr. Taylor. It is the representation of "a maiden victim of the persecution of Diocletian, whose virgin body, floating in the Tiber, is revealed to those who seek it for interment by the aureole miraculously suspended above the pale face that looks serenely up to heaven from the green water." It is to the aureole that we object, on the ground that a physical miracle of this kind is not a legitimate subject for pictorial art. The general tone of the picture is real and natural; and this bit of supernatural, not conforming with the laws of the distribution of light, is an eyesore that mars the scene. It is a pretty legend that supernal powers hung their aureole over the dead Christian girl. A line of Tennyson would have made its light live for ever, but the paint brush should have been kept away—it is too gross a tool.

The selection of subjects is as important as their treatment, and we cannot excuse an artist in portraying horrors, because our disgust is mainly directed against those by whom they were committed. We acquit Gallait on the ground we have mentioned, but we condemn Gerôme for torturing our eyes with the brutalities of the Roman circus. If he had lived at the time when such a picture would have been the protest of reformers against the coarse cruelty of imperial savagery, he would have had his justification upon moral grounds; but why rake up disgusting materials, which time has benevolently buried? Better surely to see the beauty of the present, than the ugliness of the past.

In our own country the appreciation of the beautiful in art has wonderfully progressed within the last ten years, and although we should like to see public bodies sufficiently intelligent to create a demand for high class works adapted to galleries and halls, we rejoice at the domestic character which our best pictures assume. As a rule our artists endeavour to produce paintings calculated to adorn a home, and if in this effort the majority tend towards conventionality, tameness, and commonplace, occasionally varied by slap-dash violence, the fault lies more with society than with themselves. Few people will take the trouble to understand anything that requires study, and the same mental indolence which prevents thousands from mastering the elements of science, condemns them to perpetual childhood in respect to literature and art.

What direction French popular taste will take as the progress of industry enlarges the class of private buyers, may be somewhat difficult to tell, but there are evidences of a growing fondness for scenes of domestic and humble life. The battle pieces which their artists delineate with a skill that no others attain, are not natural results of national demand. Successive governments have seen their interest in demoralizing the people by an everlasting parade of the circumstances of war. In this way they have successfully touched a chord of national weakness, which we, who take the victories we are obliged to win, with Quaker-like quietness, can scarcely understand; but pictures like those of Edouard Frère and Henriette Brown show that our neighbours can see and enjoy aspects of life better worth contemplating than deeds of arms. As the people grow in intellectual and social importance their domestic incidents have more value in their own eyes; and though we laud the Belgians for their historical recollections, we praise the Norwegians still more for the thoroughly human and humanizing efforts in which Tidemand's pencil is engaged. Peasant life as shown in his pictures is a great thing in its way. It struggles with poverty, but is not ground down. It has its variety of thought and emotion—manly individuality, if not much female grace. Above all it has, for Englishmen, the attractions of foreign travel. You forget all about London, and seem inside the Norwegian hut. The pastor may be too tough and stolid to enter much into the grief of the receipients of the holy rites which he mechanically administers; we might like a greater charm of colour, or brilliancy of light, but Tidemand has successfully carried us with him and made us listen to his tale. We have as yet no such painter to deal in a spirit of equal earnestness with the phases of our village life. We are tired of the same children at the same school, with the same light streaming through the same casement, and falling upon the same deal boards; quite sick of peasant girls carrying pitchers, or gleaning, and polished up to the same degree of drawing-room correctness; and we want some one who can discover that working people are men and women, with hopes, fears, loves, hatreds, and aspirations, just like the more fortunate inhabitants of fashionable clothes. Historical pictures will not be much wanted now that society finds its good and evil determined, more by a multiplicity of unknown individual exertions, than by startling events; the classical gods and goddesses are used up, we have outgrown angels that look like celestial poultry, and would not be sorry if Mr. Frost's nymphs should be bound in perpetual ice. We want realities of to-day —not the less real because contemplated in their ideal aspect, and if we get them we care not from whence they come—whether Mr. Goodall brings us a stately pilgrim from sunburnt Egypt, or Mr. Millais finds his romance in the breakfast-room of a country squire. Let our artists, however, pay some attention to the meaning of what they are about. It is melancholy to find a big canvas by Mr. Ansdell pretending to illustrate Longfellow's "Excelsior." In that poem he ought to have known that the scenery is accessory and quite subsidiary to the moral which the author intended to convey. The "banner with the strange device," the mountain height, the struggling youth, and the voice which "fell like a falling star," are all in keeping in the magic verse, but Mr. Ansdell strives to give us a *caput mortuum* which does not make us care for the defunct traveller, and suggests no memories of Longfellow's rhyme. Another artist, Mr. Solomon, with far more cleverness, tells us in his motto exactly what he is *not* about. To illustrate the sentiment of the text, "Thou hast turned for me my mourning into dancing; thou hast put off my sackcloth and girded me with gladness," he depicts a family startled by the return of a member supposed to be no more. The mother, instead of "dancing" is likely to faint, the sisters, instead of being "girded with gladness," are scared out of their wits. A still worse offender in misunderstanding words, is Mr. Witherby, who takes the last verse of Tennyson's poem, commencing—

> "Break, break, break
> On my cold grey stones, oh sea,"

as the motto of a picture in which certain crags are made uncommonly hot in a sunset's reddening blaze. Our poets supply abundant themes; but unless they can supply the intelligence necessary to understand them, every new book they publish seems likely to lead the artist astray.

Our first-class landscape art is, on the whole, very good, but we have few painters who seem to have any appreciation of the variety of nature, and when a particular scene like Tintagel Castle is done into oil and water, many times a year, it is wearisome to find nobody entering into the spirit of the place, or able to discern the magic web of changing colour which, under favourable circumstances, the Cornish coast presents.

In painting we are escaping from the conventional system of the last generation. Dirty brown "old masters," as all smoky bits of canvas used to be called, no longer exert a despotic sway. Our artists are free to use their five senses, and what thinking faculty they possess. Painting is emancipated, and we may anticipate its advance. Sculpture is deeply indebted to Mr. Gibson for his tinted Venus, which, whatever may be its merits, is a contribution towards liberty in another field of art. The tinted statue question is too big to come in at the end of an article, but it is plain that the discussion which Mr. Gibson has provoked must assist in removing a mass of mere prejudice and cant. In other departments we want an emancipation movement too. Why, for example, should Minton's pottery halt between old notions and new? If some skilful maker of pots and platters in the middle ages did things that were ugly, as well as things that were fine, why must we suffer a descent of bad taste. It is because we admire Mr. Minton's ware that we care to point out its defects. We want to know why its grotesque should be ugly, when Cellini and the mediæval church builders have shown that the grotesque and the beautiful may be combined. Why should so much technical skill as this justly famous house has brought to bear upon its work be sometimes degraded into constructing great clumsy vases supported by miserable naked babies, with hydrocephalous heads, and distorted bodies, tied to their burdensome task with fetters of silk? We do not want monstrosities which require a Geoffroy St. Hilaire to elucidate, but demand from artists of all kinds that they shall exhibit to us "Beauty" as Akenside depicted her, "the lovely ministress of Truth and Good."

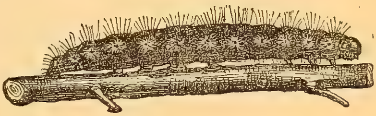
POISONOUS CATERPILLARS.

BY H. NOEL HUMPHREYS.

The caterpillars of several species of Moths, and also of Butterflies are provided with means of defence which are more or less venomous; but we seldom hear of fatal consequences arising from their venom, though many of the poisonous species are natives of Europe. This season, however, a boy, injured by the noxious hairs of the procession caterpillar subsequently died; and several persons in Belgium, have suffered serious illness in consequence of eating cherries gathered from trees infested by a caterpillar, the name of which is not given in the notice which furnished me with the information. Several kinds of our native caterpillars have the defensive power of emitting a fluid which produces considerable irritation of the skin; and in others, the hairs, when touched, produce an effect somewhat analogous to the sting of the nettle. Some children in my neighbourhood, attracted by the gay colours of the little caterpillar of the Gold-tailed Moth, endeavoured to rear a brood of them, in order to obtain fine specimens of the elegant White Moth. During the whole time (some weeks) that they were so engaged, the backs of their hands, and their faces also, were covered with red patches, which fortunately gave but little pain till rubbed or otherwise irritated. When the caterpillars went into the chrysalis stage, the red patches on the hands and faces of the young entomologists disappeared; but on obtaining some more caterpillars of the same kind, they again made their appearance. An experienced naturalist informs me that he once suffered a very sharp feverish attack while rearing a brood of these caterpillars; that the skin of the hands and face became painfully inflamed; that he suffered intense thirst, and was confined to his room for several days. The caterpillar of our largest and handsomest native butterfly, Papilio Machaon, popularly known as the Great Swallow-tail, is furnished with a fork-like tentacle on the neck, of a red colour, from which it is enabled to emit a strongly-scented fluid which is said to drive off its most dangerous enemies, the ichneumon flies; and when coming in contact with the human skin it produces an unpleasant though slight irritation. The small larva of Dicranura Vinula has a similar excrescence near the head, both points of which are furnished with many perforations, like the rose of a watering-pan, through which it can eject to some considerable distance a tiny shower of acrid fluid, which, if it fall in the eye, produces acute pain, and the effects are sometimes permanently injurious.

The injuries sustained from contact with the hairs of the procession caterpillar are, however, much more serious than those resulting from the more slightly venomous character of any of our native species; indeed they sometimes prove fatal, as before stated. As this caterpillar is very remarkable in other respects, I propose to give a short account of its general characteristics. It is in some years so numerous in many parts of France, that its devastations in the orchards, and even among forest trees, assume an alarming character; entire trees being so completely stripped of their leaves that they inevitably perish. In 1732, their ravages in the south-west of France were so extensive that the Parliament of Bordeaux issued an edict compelling the rustic population to clear the trees of caterpillars, under pain of severe penalties. There have been local enactments of similar character in England, but this is not the place to speak of them.

The Cnethocampa processionea,* or procession caterpillar, is in some seasons but too plentiful in many parts of France, as will have been perceived by my previous remarks, but the Forest of Bondy, and the Bois de Boulogne, near Paris, are mentioned by entomological collectors as places where it is found in most seasons. The caterpillar is about one inch and a half in length, and is grayish black, with tufts of brownish gray hairs. The engraving below will give a tolerable idea of its general appearance, even without the aid of colour.



The caterpillars of Cnethocampa processionea do not scatter almost as soon as they are hatched, as is common with most species, each individual seeking its food alone, but the whole brood remains together, as in some other gregarious kinds. Some of the gregarious caterpillars alluded to live in a large web, common to the whole brood; but each procession caterpillar, though living in society with the entire brood, weaves itself a more or less separate nest. These nests, generally attached to the trunks of trees, are made in compartments, but have only one general entrance. The mode in which the caterpillars go out to feed, following each other in a single line, is the peculiarity on which their name, procession caterpillar, is founded. Towards dusk, or when the sun is not shining

* This genus was included by Reaumur and his contemporary entomologists in the great division, Bombyx, which has been subdivided by more recent naturalists. The present distinctive generic title, Cnethocampa, is derived from the Greek word, κνηθω, to irritate, and καμπη, a caterpillar. The derivation of the specific name is obvious.

(says Reaumur, whose observations, in the last century, may be said to have laid the foundation of modern entomology), a single caterpillar goes out first, and, after some hesitation, appears to determine the line of route that is to be followed by the colony. He is succeeded by a second—a third then appears, and so on, till the whole colony is following the leader in single file; the line being sometimes thirty or forty feet long. As the food becomes exhausted in the neighbourhood of their nest, they select another centre for their foraging excursions, and establish another set of nests upon the trunk of some fresh tree well suited to their purpose. These nests are slight, but the nest, or rather cocoon, which they construct for the purpose of retiring to when about to enter the dormant state in which the change to the chrysalis, and then to the moth, takes place, is much more compact. The cocoons, being placed close together, slightly resemble in appearance the cells of humble-bees.

Each caterpillar seals up the opening to his cocoon, or cell, with his own hair, a portion of which loosens and falls off at this period of his existence. These chrysalis-houses are more dangerous to touch than the caterpillars themselves, for when the external web is broken or removed, the disturbed hairs at the opening of each cell are carried about by the slightest wind, and whenever they settle on the skin, a kind of irritation commences very similar to that caused by the sting of a nettle. The boy who recently died from this cause had been climbing a high tree in search of a bird's nest, and no doubt his chest had come in direct contact with a set of cocoons of this kind, for it was in the hands, face, and chest, especially the latter, that the chief seat of irritation, that could not be allayed, had established itself.

These poisonous hairs, however, which are so injurious to the human skin, do not appear (in spite of all that has been said upon the subject of their being a defence provided against their natural enemies) to be injurious to the birds that prey upon them, as the bodies of these caterpillars have been found in the stomachs of birds that have been shot, without seeming to have caused any internal injury, the stomach of the bird remaining in a healthy state. One of the handsomest of our European beetles, Calosoma Sycophanta, feeds upon the caterpillars of the pine-species, C. Pityocampa, following them among the branches of the pine, where it destroys vast numbers of them.

There are also caterpillars that feed upon them; these carnivorous caterpillars being termed by the French *vers assassins.* The procession caterpillar does not attempt to escape from his unnatural brother, but submits passively to his fate—fascinated, perhaps, in some way, like the bird that becomes paralyzed under the fixed gaze of certain snakes; or, like the antelope, who remains motionless when the roar of the lion has announced his fatal spring.* It need scarcely be added that the caterpillars that prey upon the processionists do not appear to sustain the slightest inconvenience from the poisonous hairs. But I must return to the immediate history of the procession caterpillar himself: he enters the chrysalis state about the middle of July, and the moth appears in August, when it lives but a few days, the female dying immediately after the deposition of her eggs. The hairs on the body of the perfect insect or moth are nearly as venomous as those of the caterpillar. The colour of the moth is gray, with brown transverse stripes, which are sometimes indistinct.

There is another species of this genus, Cnethocampe Pityocampa, which feeds almost exclusively upon the pine. The moth is very similar in appearance to C. processionea, being only distinguished by having three dark transverse stripes on the wings instead of two. Feeding on evergreens, the caterpillars of this species do not require and are not dependant upon the fresh foliage of the spring and summer. They are hatched about the middle of September, and as the cold weather approaches before they are full grown, they make a tolerably substantial nest in which to pass the winter in a dormant state. They awake from their hybernating sleep about the 31st of March. Sometimes they remain outside the nest a whole day or more before they venture forth in search of food, which, says Reaumur, "they must be in great want of after their six months of fasting." In fine weather they congregate on the outside of their winter nest on their return from feeding excursions, but bad weather drives them for shelter to its interior. The web, or silk, of which this nest is composed, was sent to Reaumur, in order that he might test its fitness to supersede the product of the silkworm. Experiments were tried, and seemingly with complete success, pretty-looking articles being woven from it, but they were found to have the inconvenient property of completely dissolving in hot water. Having attained their full growth, the caterpillars do not, like the allied species, form a series of adjoining cocoons, but bury themselves in the ground, to undergo separately their transformation to the chrysalis state. The habit of forming a single

* Dr. Livingstone, who was seized by a lion, declares that the terrible roar which accompanied the spring seemed to deprive him of all sense of pain, though his arm was dreadfully torn.

line of procession when they go forth in search of food is the same in this species as in the other, every sinuosity of route taken by the leader being followed by each caterpillar in the line, both in going forth and in returning.

The mass of absurd stories connected with these caterpillars, which Reaumur has curiously preserved, in the letters of his correspondents, appears now almost incredible. For instance, it was asserted, among other things, that they never arrived at a winged state, but laid eggs while in the caterpillar state!! Another absurd conviction of the uninstructed observers of that day was, that these caterpillars were the offspring of spiders, this extraordinary idea having arisen in consequence of spiders having been found in the nests. It is indeed now a well known fact that spiders frequently take possession of the deserted nests of the winter procession caterpillar, and this was sufficient to give rise to an assertion, which in those days was not put to the searching tests which such a statement would now have to undergo before being admitted among the facts of natural history, but was allowed to pass current, for the delight of wonder-mongers, an amiable race not yet entirely extinct. This ridiculous theory concerning the maternity of the procession caterpillar is to be found categorically stated, at considerable length, in the *Journal de Verdun*, for March 1734, page 165.

NEW PROCESS OF VINEGAR MAKING.

THE following important paper, by M. Pasteur,* has recently been read before the French Academy, and it will be found to present many points of industrial and scientific interest.

"I had the honour of bringing before the Academy in the month of February, the property possessed by mycoderms, especially those of wine and vinegar, of acting as agents for conveying the oxygen of the air to a crowd of organic substances, and thus lead to their combustion with a rapidity that is often surprising. The study of this property of mycoderms has led to a new method of manufacturing vinegar, which seems destined to practical application in this branch of industry. I sow the *mycoderma aceti*, or *fleur du vinaigre*, on the surface of a liquid formed of ordinary water containing two per cent. of its volume of alcohol, and one per cent. of acetic acid resulting from a previous operation. In addition to this, I add some ten thousandths of alkaline and earthy phosphates. The plant develops itself, and soon covers the entire surface of

* *Comptes Rendus*, 7th July, 1862, p. 28.

the liquid, not leaving a vacant spot. During this time the alcohol is acidified. While the operation is in full progress—when, for example, half the original alcohol is transformed into acetic acid—alcohol, or wine, or strong beer is added, day by day, in small quantities, and the process continued until the liquid is found to contain enough vinegar for commercial use. While the plant is able to excite acetification we add alcohol; and when its action begins to be exhausted, we leave it to complete the acetification of the alcohol still remaining in the liquid. The plant is then separated from the fluid, and on washing, it yields a slighly acid and azotized liquid, capable of ulterior use.

"The fermenting tub is then put to fresh work. It is indispensable not to suffer the plant to want alcohol, because in that case its oxygen-transporting faculty would exert itself partly on the vinegar, which it would transform into water and carbonic acid, and partly on those little understood volatile principles, the loss of which renders the vinegar flat and destitute of aroma. Moreover, if the plant is once turned away from its vinegar-making action, it will only employ it again with diminished energy. Another precaution, not less necessary, is not to excite too great a development of the plant, for its activity is then exalted without measure, and the acetic acid will be partially changed into carbonic acid and water, even while alcohol still remains in the liquid. A vessel of one square metre (about thirty-nine inches) surface, holding fifty to a hundred *litres* (say from ten to twenty gallons), will yield acetic acid equal to five or six *litres* of vinegar a day."

M. Pasteur recommends shallow wooden vessels, like the coolers used in brewing, to be employed in this process. They should be furnished with covers, with two small openings for the entrance of air. Two tubes of gutta-percha fixed to the bottom of the vessel, and pierced laterally with small holes, readily permit the introduction of fresh supplies of alcohol without disturbing the fungus film that forms on the surface. The presence of phosphates is necessary, as they furnish the mineral food of the plant, and if phosphate of ammonia be among them, the plant takes from its base the nitrogen it requires, so that complete acetification can be carried on in liquid containing a ten thousandth part of the phosphates of ammonia, potash, or magnesia.

Commenting on the advantages of this method, M. Pasteur states that two processes of vinegar making are now employed in France. One of these, called the Orleans process, is only applicable to wine. It is carried on in casks ranged horizontally, containing inferior *vin ordinaire,* and one-tenth of its bulk of vinegar. After about two months each cask begins to yield vinegar at the rate of about ten *litres* a week. In the second, or German method, the liquid to be acetified is allowed to trickle over shavings of beech wood contained in large barrels to which the air has access. This plan is rapid, but not applicable to wine, nor to beer in its natural state, and its product is of inferior quality, especially when derived from alcohols with a bad flavour. The wine-vinegar of Orleans in part owes its fine qualities to the presence of aromatic substances, which are carried off by the high temperature and the strong current of air which are permitted in the German method. There is, however, a singular inconvenience in the Orleans mode, which gives rise to myriads of the so-called vinegar eels.* These little creatures require air in order to live, and the film of the vinegar plant tends to deprive them of it. M. Pasteur says,—" My experiments have shown that acetification only takes place at the surface of the liquid in the thin film of mycoderma aceti that is incessantly renewed. Suppose this pellicle well formed, and the work of acetification actively proceeding, all the oxygen that arrives at the surface of the liquid is employed by the plant, and none is left for the eels. The latter finding themselves deprived of the possibility of respiration, and guided by one of those marvellous instincts of which all animals, in different degrees, offer us such singular examples, take refuge on the sides of the casks, where they form a thick white crawling mass." From this position they carry on war with the vinegar plants, often getting the upper hand, and forcing the latter downwards below the surface of the fluid, and thus more or less completely arresting the fermentation. In M. Pasteur's process the eels are not admitted, and as the acetification takes place at a low temperature, the aromatic elements are not destroyed. We believe the " Fleur du Vinaigre," or " Mother of Vinegar," although not presenting the same external appearance, is substantially identical with the solid leathery fungus that, under the name of the " Vinegar Plant," is often used by English families to induce the acetic fermentation in solutions of treacle and sugar.

* Anguillula aceti.

OPPOSITION OF MARS.—DOUBLE STARS.—OCCULTATIONS.—THE COMET.

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

OPPOSITION OF MARS.

A PLANET revolving round the sun in an orbit exterior to our own, and therefore, by the 3rd law of Kepler, with inferior speed, must necessarily be overtaken and passed by us from time to time, and these epochs will be attended with remarkable changes in the planet's apparent movements. So long as our own motion is such in point of direction and swiftness as not to give a false impression of the progress of the exterior planet, it will of course be seen to move, as we and all other planets really move, from W. to E., according to the order of the signs of the zodiac, or, in astronomical language, *direct;* but as soon as our position and velocity become such as to make appearances prevail over realities, our neighbour will first seem to slacken his speed, then to stand still, and ultimately, while we are in the act of passing him, to move backwards, or, astronomically speaking, to *retrograde;* as we leave him behind his reversed velocity will gradually decrease, till he again become stationary, to recover himself as it were, and afterwards starts afresh, and proceeds quietly on his own way. These phenomena are, of course, the same with those which may be noticed when a train passes an ordinary vehicle, or a steamer overtakes a sailing vessel. The precise position in which our neighbour is passed by us is called his *opposition,* because he is at that time exactly opposite to the Sun, and comes to the meridian at midnight; and being then, of course, at his least distance from us, this will be the most favourable opportunity for the study of his physical peculiarities under an enlarged diameter. Such is about to be the case with the planet Mars, whom our readers must have been for some time noticing as the most conspicuous as well as the most ruddy object in the Eastern sky. He becomes stationary on September 2, and from that time will rapidly increase in brilliancy as we are coming up to him, till, on October 5, we shall pass him by; after which date he will fall off in appearance and speed till, on November 7, he reaches the end of his retrogradation, becomes stationary, and subsequently proceeds in the ordinary direction till we begin to come round after him again, not, however, to overtake him till after two years and fifty days. Such is the general principle and aspect of these optical changes: but they are not invariable in their amount. They would be so, if the planetary orbits were of a circular form; but since they are elliptical, and the ellipses have no fixed position in space, but are subject to a continual variation in the direction of their longer axes, every succeeding opposition will take place under fresh relations, oscillating between the most favourable circumstances, when the Earth is in its *aphelion* or furthest from the Sun, and the planet nearest, in its *perihelion,* and the least favourable, in the reverse of these conditions. With regard to Mars, the difference is very considerable. His orbit is so elliptical, that when furthest he is distant from the Sun 158,754,000 miles, when nearest, only 131,656,000; so that his best opposition, so to speak, brings him more than 27,000,000 of miles nearer to us than his worst, from the form of his own orbit; while the excentricity of ours may increase or diminish this quantity by nearly 3,250,000 more. His apparent diameter of course varies in a corresponding proportion from little more than 13″ to upwards of 30″: at the coming epoch it will amount to 21″·8. The greatest expansion of disc will, in consequence of the mutual obliquity of the two orbits, take place on September 29; but the difference for a considerable time will not be material, as it will range above 20″ from September 5 till October 20; at the first of which dates there will be a slight phasis or defalcation from the perfect circle on the W., as at the latter on the E. limb. Had the opposition taken place between the aphelion of the Earth on July 1, and the perihelion of Mars on August 4, it would have been still more auspicious, and had those epochs coincided, as they nearly did in August 1719, the planet would have assumed unwonted magnitude and splendour; but the present is by no means an unfavourable opportunity, being little inferior to the opposition of 1830, which Beer and Madler found so advantageous for the delineation of his physical aspect. In another respect too it will be suitable for the observers of Europe, as the planet is a little N. of the equator; on some other occasions it has had such wide S. declination when we passed it as to be fairly visible only in equatorial or southern latitudes: in such a position, the most powerful telescope in our northern observatories would show it far less satisfactorily than a much smaller one upon the coming occasion. Such of our readers as are possessed of instruments of moderate capability will therefore prepare themselves for the examination of that fine ruddy disc, which, in its appearance of continents, and seas, and snowy poles, and atmospheric obscurations, as well as in its diurnal rotation and its change of seasons, presents so great and interesting a resemblance to our own globe. On these points a few remarks will be offered in a future paper.

P.S. August 15. A brief interruption last night in our wonderfully persistent cloudy veil exhibited the S. polar snows very distinctly, though of no great extent. There was much dark mottling on the disc, but no decided spot.

DOUBLE STARS.

We must now view the jewels in the hand of *Boötes*, which he has been lifting up for so many centuries above the end of the Great Bear's tail.

A little way *n f* from η, *Al Kâid* or *Benetnasch*, the last star of the tail, lie three small stars in a triangle, θ, ι, and κ *Boötis*, of which the two next *Al Kâid* are nearest together. These are ι, S, and κ, N. Each will repay the search.

31. ι *Boötis*. 37″·9. 33°·4. $4\frac{1}{2}$ and 8. Light yellow and dusky white, 1850·6. I thought the *comes* lilac about the same time. Sestini made it azure, 1844·5. This pretty object, which Struve thinks has a common proper motion, is rendered more interesting by the fact that the Czar's great telescope at Poulkowa, of $14\frac{3}{4}$ inches aperture, shows that the larger star is very closely double, consisting of two equal components, with a distance of only about 0″·3; so that we probably have a wonderful triple system here. Smyth, as might be expected from his inferior optical means, could only detect a slight elongation. A more beautiful object, however, is its neighbour—

32. κ *Boötis*. 12″·7. 238°·1. $5\frac{1}{2}$ and 8. Pale white and bluish. No satisfactory evidence of movement.

If we now carry a line from *Alioth*, ε *Ursæ Majoris* (the 5th star in succession, beginning with the Pointers), through our old friend *Mizar* (No. 1), and pass it on through the before-mentioned triangle forming the hand of Boötes, when it has reached nearly as far again as the distance from *Mizar* to the hand, it will fall upon a little close group, of which the brightest is—

33. 44 *Boötis*. 2″·9. 233°·8 (1830·82). 4″·1. 236°·2 (1847·45). 5 and 6. There has been much difference of opinion as to the colours. Smyth made them pale white and lucid grey, 1842·58; yellow and cerulean blue, 1850·5; pale yellow and dusky, 1856, which, he observes, agrees nearly with Struve's *subflava* and *subcœrulea* (1832·24). On the other hand, Sestini called them both orange, 1844·5; Fletcher, white and yellow, 1851; Miller, both white, 1853; Dembowski, yellow and ruddy orange or olive yellow, 1854, 1855; pale yellow and pale orange, 1856. I thought them yellow and ruddy or purplish, 1850·63, with an aperture of $3\frac{7}{10}$ inches. I regret to add that the almost unbroken veil of cloud which has obscured our summer skies, has, up to the present time, precluded me from re-examining this, and other similar objects, with my present much more powerful telescope. In another respect this is a very interesting pair, as there can be no doubt of its binary character, though as Smyth remarks, the case of its orbital motion is "beset with difficulties." It was so close in 1781 that it was recommended by Sir W. Herschel, together with 52

and 33 Orionis, neither exceeding 2″ in distance, as a test for a superior instrument; its movement during the present century has been such as to indicate, in Struve's opinion, a *sidereal occultation* between 1802 and 1819, when its distance was 1″·5, with the smaller star on the other side. The same observer thought it was approaching its greatest distance in 1835, when it measured 3″·17; but Secchi found it 4″·738, 1859·515. The ellipse in which it is moving is probably foreshortened almost into a straight line. Secchi, between 1855 and 1859, thought the brightness reversed, so that there may be a variation of light, which was also the opinionof Struve and Argelander.

Retracing our path a little from this object towards the hand of Boötes, but keeping somewhat below our guiding line, we find a very minute star, which the telescope expands into a beautiful pair—

34. 39 *Boötis.* 3″·8. 44°·7. 5½ and 6½. White and lilac. Some observers ascribe a bluish, some a ruddy tint, to the small star. Struve considered them to be probably moving, but Smyth and Secchi doubt this. I thought in 1850 that the difference in magnitude was less than that assigned by Smyth in 1839. Secchi gave them 6 and 6·5 in 1856; 6 and 6·2, 1857: perhaps there may be variable light here.

We now proceed to *Corona Borealis,* the *Northern Crown,* a beautiful little constellation, the principal part of which is well marked out by an ellipse of 4 and 6 mag. stars, among which is one of 2 mag. (a), lying in a line between *Arcturus* and δ *Herculis* (No. 25). A line drawn from *Arcturus* through ϵ (No. 19) and δ (No. 23) *Boötis,* bent a little to the left, will fall upon—

35. ζ *Coronæ.* 6″·1. 301°·2. 5 and 6. Flushed white and bluish green. This truly fine pair, notwithstanding its aspect, is very satisfactorily shown to be stationary, as far as our present evidence extends.

Our next object is found by a more complicated process. We draw a line from *Wega* to *a Coronæ:* this passes, at about three-fifths of the distance, a little above ζ *Herculis,* 3 mag., the brightest star in the vicinity. Another line from ζ *Herculis* to ζ *Coronæ* (our last object), at about one-fourth of the distance, falls upon—

36. ν^1 and ν^2 *Coronæ,* a noble 5 mag. pair of yellow stars, rather more than 6′ apart, to each of which an aperture of 5½ inches shows a minute attendant. A low power includes another star of about 6 mag., forming a splendid field. A little way (2°) p lies—

37. σ *Coronæ.* 1″·3. 107°·6 (1830·76). 2″·2. 176°·8 (1852·25). 6 and 6½. Creamy-white and smalt-blue. There is much discrepancy about the smaller star. South calls it "certainly not blue," and differing very little from the other, 1825; Struve, white, 1836·69; Dembowski, yellow, ashy, and doubtful blue, 1854 to 1857; Secchi, sometimes blue, sometimes

yellow, 1855 to 1857. I fancied it, with a $3\frac{7}{10}$ inch object-glass, at one time ruddy, at another bluish, from 1850 to 1855, apparently changing even while being looked at; a versatility of hue which I have remarked in other stars similarly circumstanced, and which may possibly depend upon unequal sensitiveness to colour in different conditions of the retina; during a short glimpse with $5\frac{1}{2}$ inches, 1862·57, the companion seemed bluish; at the same time I thought, as I had done in former years, that there was more than $\frac{1}{2}$ mag. of difference. Struve gave more than 1 mag. Secchi's discordances are considerable, ranging between $\frac{1}{2}$ and 2 mags. from 1855 to 1857; but the honesty of that excellent observer, in recording every temporary impression, must be allowed for. The binary character of this double star, sufficiently evident from the foregoing data, which indicated to Smyth a period of not less than 560 years, has been further confirmed by its continued movement, Secchi having found 2″·478 and 184°·77, 1857·711. The period, however, remains a puzzle. Hind has given 737 years; Eyre Powell, 240; Jacob, 195. "This is certainly," as the Admiral remarks in professional language, "more yawing than might have been looked for;" and we might still add Mädler's 608, and Klinkerfues' 420 years. This beautiful pair is converted into a triple group by the addition, in a far-reaching perspective, of a blue 11 mag. star, called 15 or 20 mag.* by South in 1825, and not perceptible to him with a power of more than 92 upon 5 inches of aperture, so that it may possibly be variable. The increase of its distance from 44″ in 1839, to upwards of 49″, according to Secchi and Mädler, in 1855, gives ocular proof of the proper motion of the other two, while its fixed position serves instead of a micrometer, to make their rotation sensible. In 1839 the angle between the directions of the two smaller stars was about 56°; a glance at their present position will show that it rather exceeds 90°. In this very interesting and unusual instance, angular progress is rendered distinctly perceptible to amateurs unprovided with the means of measurement, and much more satisfactorily so than by mere comparative estimates from the direction of motion through the field.

38. *η Coronæ.* 0″·8. 57°·2 (1832·63). 0″·5. 246°·8 (1852·43). White and golden-yellow. The period is stated by Smyth at about 44 years. Yvon Villarceau prefers 67, but Winnecke finds the observations best represented by 43. What a glorious idea is given to every thoughtful mind of the power of the Creator, and of the infinite variety of his creation, by this rapid revolution of these two magnificent suns! The object

* It must however be borne in mind that this observer calls the attendant of Aldebaran 20 mag., which Smyth rates 12, and which Dawes has seen with only $2\frac{3}{4}$ inches of aperture.

is perhaps somewhat difficult for a list like the present, but since it may now be seen elongated with a good $3\frac{3}{4}$ inch object-glass, and is beautifully divided with my $5\frac{1}{2}$ inches, it seems better not to omit so celebrated a test. Sir W. Herschel considered it, in 1781, as the most difficult but one of all his double stars; in 1832 Smyth could see a black division, but nothing more than an elongation, never even notched, from 1839 to 1852. Secchi could only doubtfully divide it with the splendid Roman achromatic in 1855; in 1859 this was my own case with a power of 460; but in 1860, when Dawes measured it at 0″·87, I succeeded in dividing it, and it is still widening, as I found it, on June 3 last, well separated with 275. There is little difficulty in finding it. A line from *α Coronæ* (see No. 35) to *δ Boötis* (No. 23), passes first through *β Coronæ,* 4 mag., and then, a little further on, falls upon *η*. The beginner will find it an excellent method to prepare the focus of the telescope by adjusting it as carefully as possible previously upon some of the closer pairs in the neighbourhood, as given in the foregoing list.

We now return to *Hercules,* where a line from *α* through *δ* (No. 25) carried more than as far again, points out *π*, 3 mag., the brightest of its vicinity, remarkable for its very fine deep yellow hue; immediately *f*, are two 4 mag. stars, the furthest of which, in a line towards *Wega,* is

39. *ρ Herculis.* 3″·7. 308°·9. 4 and $5\frac{1}{2}$. Bluish-white and pale emerald. This beautiful pair seems to be only optical. Smyth found it within the range of two inches of aperture.

λ Herculis, a single 4 mag. star, a little *nf δ*, is worth looking at for its colour, a deep, dull orange, with my old $3\frac{7}{10}$ inches, but which I now see somewhat like that of Antares, yellow encompassed by a scarlet glare. It is towards this part of the heavens, according to Sir W. Herschel and Argelander, that our Sun, with his whole attendant system, is being carried by "proper motion" through space.

40. 95 *Herculis*. 6″·1. 261°·8. $5\frac{1}{2}$ and 6. Light apple-green and cherry-red: a beautiful and curious instance of difference in colour between stars of very nearly equal magnitude. Secchi thinks the red the larger, the green the brighter of the two. Notwithstanding the complementary character of the tints, which might be thought to infer a connection, no motion has yet been detected. To find this charming object, we must have recourse to a fresh *pointer*, *Al Tair,* the *lucida* of the constellation *Aquila,* which we shall at once recognize as the brightest star in the S.E. heavens, standing just E. of the left-hand branch of the galaxy, between two 3 mag. attendants *γ n p* and *β s f*. A line from *δ Herculis* to *Al Tair* will pass, at a little more than one-fourth of its length, through a group of 5th mag. stars, of which the nearest to *δ* is our object.

If we look *s* from *a Ophiuchi,* a little *f,* we shall come upon *β Ophiuchi,* 3 mag., the brightest of its neighbourhood, lying from *a* as far again as the distance between the "two heads." *β* has *γ*, 4 mag., a little way *s f,* and *γ* is followed by a vertical line of three small stars, with a fourth nearly following the central one, but somewhat to the *s*. The central one of these three is—

41. 67 *Ophiuchi.* 54″·7. 143°·6. 4 and 8. Straw colour and purple. Wide, but a pleasing contrast in size and colour, in a fine field of minute stars.

The fourth star, nearly following the central one, is—

42. 70 *Ophiuchi* (often designated "*p*"). 5″·43. 136°·4 (1830·76). 6″·8. 119°·7 (1847·48). 4½ and 7. Topaz yellow and purplish. This is one of the most celebrated binary systems, and great trouble has been taken with it by many of the first observers. Mädler fancied its movements could not be reconciled with the law of gravity. Struve found that his Dorpat telescope gave smaller measures than his former ones, or than those of Sir J. Herschel, South, and Dawes. Jacob, after paying much attention to this object, is still dissatisfied, and suspects disturbance from a third invisible companion. Secchi, again, refers such discrepancies to errors of observation. In fact, where the quantities to be ascertained are so extremely minute, it is evident that there must be unavoidable differences arising not only from the imperfection of instruments, but from the diversity of eyes and judgments. The latter source of disagreement, known among astronomers by the term "personal equation," has a wide range of influence, and has been made the subject of considerable inquiry; since with the same micrometer some astronomers are known to measure distances very differently from others; and the judgment of the same eye seems liable to change; and all this requires to be allowed for in comparisons. But in such hair-splitting processes the general agreement which will be found to obtain between really good observers is much more remarkable than their occasional discordance. In the present instance there can be no question as to the existence or the shortness of the period; but it has been variously given between 112 years (Jacob) and 74 years (Encke). Smyth and Sir J. Herschel prefer about 80 years. Secchi's later measures, 1860·638, gave 6″·022 and 105°·46. The distance is, undoubtedly, again on the decrease. This pair acquires an extraordinary interest from the recent determination of its parallax—0″·169—by Krüger, Argelander's assistant at Bonn. This, of course, though he considers its limits of error to be only 0″·0103 *plus* or *minus,* is open to revision by other instruments; but adopting it as a basis till disproved, it will give us a distance which light could only traverse in 19¼ years,

and a mass of the larger star equal to $2\frac{3}{4}$ times that of our Sun. Well may we gaze upon such an object with astonishment and reverence !*

43. λ *Ophiuchi.* 1″· 351° ·2 (1834·48). 1″·2. 15°·5 (1853·25). 4 and 6. Yellowish-white and smalt-blue. This fine pair is unquestionably in orbital motion with a period, according to Hind, of about 96 years. Secchi's three measures give, at a mean, for 1857·5, 1″·35 and 20°·1. I divided it with an aperture of $3\frac{7}{10}$ inches and a power of 250 in 1856. It may be found by a line from *a Herculis* to the *n p* star of the two called *Yed* (see No. 15) at about two-thirds of the distance, and should be looked for soon, before it gets near the horizon.

We proceed to a grand object—

44. θ^1 and θ^2 *Serpentis.* 21″·6. 103°·9. $4\frac{1}{2}$ and 5. Pale yellow and golden-yellow. This is a superb pair, and one of the finest in its class, and it lies in a glorious field. The magnitude of θ^1 has been very differently rated, and it should be watched, as pretty certainly variable; for which its vicinity to θ^2 affords an unusually favourable opportunity. A line from 70 *Ophiuchi* to *Al Tair* will pass somewhat above this object, nearly in mid-distance. It lies in the vacant space between the two streams of the Galaxy, and not on the western edge of the eastern stream, where globes and maps usually, if not always, place it. This traditional misrepresentation of a very obvious and well-marked feature must have had its origin and continuance in that idle spirit of unhesitating copying to save trouble, which has been the cause of so much evil in many branches of research, but is especially inexcusable in such an instance as this. In many questions of history and archæology, reference to original documents may be very inconvenient, perhaps impracticable; but here nothing could have been more easy than that verification which no one seems to have thought it worth while to make.

A still more brilliant double star is—

45. a^2 and a^1 *Capricorni.* 6′ 13″·4. 291°·4. 3 and 4. Pale yellow and yellow; each with a faint attendant, that of a^2 (the larger star) being at some distance. There is a 5th most minute star 5″ from a^2, so delicate as to have been caught only once by Smyth in "little evanescent flashes," with an aperture of 5·9 inches. Sir J. Herschel has thought that it may pos-

* There seems to be some peculiarity, hitherto quite unexplained, about the light of this star. The rings which, under a high magnifying power, surround the spurious discs of stars, are commonly accounted for as the result of the "interference of light," on which supposition they would be an invariable phenomenon. Yet Sir J. Herschel says "the rings of this star seem to have something peculiar. They are thin, and extend farther than in general?" and in another place, "difficult, owing to the rings and appendages. N.B.—I always find this star difficult from the above cause."

sibly shine by reflected light; but the discovery of planetary systems in the starry heavens, though perhaps just waiting, as it were, at the door, has not yet broken upon us. No relative motion has hitherto been perceived in this grand object, which is double even to the naked eye, the finest of the few thus visible in the whole heavens. The components are, in fact, one-fifth of the Moon's diameter asunder, though they appear much closer;—an instance of the little dependance to be placed upon eye-estimates of distance when the objects compared are of dissimilar kinds. This leader of Capricornus is easily found, being the uppermost of two 3 mag. stars not far apart, and in a line sloping downwards a little to the left, coming to the meridian after *Al Tair*, but much lower in the sky, not higher than the February Sun, about 9h. P.M., during the second week in September.

OCCULTATIONS.

The following may be observed during the month:—September 2nd, 4 Sagittarii, 5 mag. immerges at 6h. 33m., emerges at 7h. 48m; 3rd, *o* Sagittarii, 4 mag., is occulted from 8h. 28h. to 9m. 41m.; π Sagittarii, 3 mag., from 11h. 46m. to 12h. 5m.; 5th, 9 Aquarii, 6 mag., from 10h. 9m. to 10h. 27m.; 8th, 16 Piscium, 6 mag., from 9h. 59m. to 11h. 11m.; 30th, 28 Sagittarii, 6 mag., from 6h. 45m. to 7h. 38m.; 30 Sagittarii, 6 mag., from 9h. 18m. to 9h. 38m.; 31 Sagittarii, 6 mag., from 9h. 42m. to 10h. 38m.

THE COMET.

This beautiful and tolerably conspicuous visitant, the second of the current year (whence in astronomical language it will be called Comet II. 1862), was discovered at Florence by MM. Pacinotho and Toussaint, July 22; after which date it gradually increased in visibility during its approach to both the Earth and Sun; its *perihelion* passage occurring on August 23, and its *perigee*, or closest proximity to the Earth, seven days later, its distance from us being then 32½ millions of miles, about one-third that of our distance from the Sun. Its subsequent course declines rapidly southwards through the N. part of Boötes, Corona Borealis, and Serpens, crossing the equator on September 5th, to disappear shortly afterwards beneath the W.S.W. horizon. It will therefore have already diminished before these pages can reach our readers, and they must lose no opportunity of studying its aspect, which at the present time (August 22) presents some interesting features, though nothing comparable to the fuller development of Donati's Comet, or the great one of July 1861; as far, however, as the "sector" adjacent to the nucleus is concerned, there is much resemblance to the comet of last year. The tail, which arises irregularly from only a part of the breadth of the coma, is short, as yet, in proportion to the brightness of the head. At present, no conclusion can be safely formed as to the period of this comet, whose orbit is said to have a slight resemblance to that of the year 770. Detailed observations, which have hitherto been but few, from the pertinaciously adverse condition of the sky, will be given in a future number.

HYDRAULIC ILLUSIONS.

BY W. B. TEGETMEIER.

Those visitors to the metropolis who accept Dr. Johnson's invitation, and take a walk down Fleet Street, may have noticed the small crowd of wondering gazers usually assembled around a shop window a few doors west of Temple Bar. The object of attraction being, not the exterior of the earthenware filters vended by the occupant, but a series of hydraulic contrivances and designs, the most attractive of which is a perpendicular glass tube, some six feet in length, up which is seen passing in endless and regular succession a series of bubbles of air, as unsubstantial and as interminable as the line of shadowy kings that passed before Macbeth.

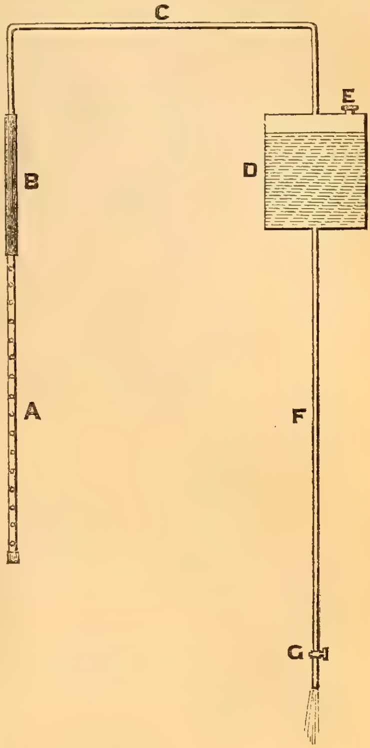
The mechanism by which this exceedingly effective and pretty contrivance is produced is entirely concealed; and as the occupant of the warehouse astutely declines to afford any information on the subject, the matter has remained for several years one of the unsolved enigmas of the town.

That the means adopted to produce the result are not generally known is evident from the fact, that the design has not been imitated, which, from its attractive character, would have been the case had the means by which it is effected been understood.

Scientific knowledge is not, however, the exclusive property of any one individual; and as Mr. Lipscomb has had for a very long period the benefit of this attractive advertisement, we have no hesitation in laying bare the concealed mystery, at the same time giving him every credit for the knowledge displayed and the ingenuity manifested in the contrivance.

The ascent of these bubbles is obviously produced by means of an apparatus known to chemists under the name of an aspirator, from its being employed to draw a current of air or gas through any tubes or vessels along which it may be required to flow.

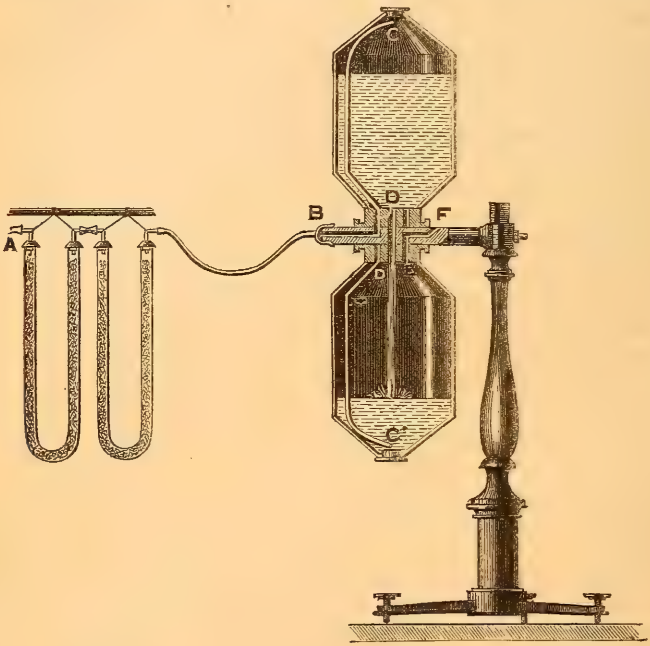
If our readers will look at the apparatus, in the Strand they may observe that the glass tube A, up which these bubbles ascend in apparently such a mysterious manner, is perfectly free and unattached below; this want of communication with any other portion of the apparatus rendering the action less easily comprehended. If, however, they look to the upper part of the glass tube they will find that it is enclosed in a metal tube B, and that from this a smaller tube C ascends to and passes along the ceiling of the shop. No other portion of apparatus is visible, and it is the extreme simplicity of the arrangement and the apparent want of any adequate cause that renders the whole so incomprehensible and attractive.



If we wish to understand how the effect is produced, we must imagine that the small tube C, after passing along the ceiling to a convenient locality, is made to descend and enter into a perfectly air-tight cistern D. This is furnished with an aperture E, for the purpose of filling it when required. The aperture is capable of being closed by a screw with a leather washer, that enables the opening to be shut in a perfectly air-tight manner. From the cistern descends a long tube F, having a stopcock at its lower extremity. No particular proportions are requisite except one which is absolutely indispensable, that is, that the length of the column of water in the cistern D and tube F should be greater than that in the glass tube A; and should this be filled with syrup or any liquid heavier than water, the difference must be proportionately greater.

Having described the apparatus, let us now explain its action. We will suppose the glass tube A, which is alone presented to the gaze of the public, to be filled with liquid. Water would answer, but as the object is to cause a slow ascent of the globes of air, a thicker liquid, such as clear syrup, would be preferable. Whatever may be the liquid employed it is prevented flowing out of the small aperture in the bottom of the tube by a valve opening upwards. This valve is contained in and concealed by the small metal cap placed on the lower end of the glass tube.

The cistern D is filled with water through the aperture E, which is then closed. On opening the small stopcock at the bottom of the tube F, the water will flow out, owing to the greater pressure in the longer tube F than in the shorter tube A. In order to supply the vacancy created in the cistern, the exter-



nal air will enter by the opening at the bottom of the glass tube and ascend in a regular series of bubbles through the liquid it contains. This action will continue as long as any water remains in the cistern, and may be renewed by replenishing it from time to time as may be requisite or desirable.

Such is the simple apparatus that has puzzled the wits of some thousands of spectators during a period of several years, and has tended to give greater notoriety and reputation to the warehouse in which it is placed than many more elaborate contrivances would have done.

The aspirator, as the contrivance is termed on which the action of this deception depends, has long been known to operative chemists, who not unfreqnently desire to draw a current of air or gas through a tube. For this purpose, however, a far superior instrument has been for some time in use in France; and as it appears to be quite unknown in this country, we have much pleasure in describing its structure and mode of action; its great advantage being that it is capable of being continued in operation during a very great length of time with the same supply of water. It consists of two reservoirs placed one above the other, and which are capable of being turned easily on the horizontal axis B F, which supports them. In the position shown in the figure the air is drawn in or aspired through the flexible tube ending at B, and is conveyed above the level of the water at C, into the upper vessel, replacing that which falls into the lower reservoir by the canal D D. The air in the lower vessel escapes by the tube E F as the water enters.

When all the liquid has fallen out of the upper reservoir it is evident that the action of the instrument ceases; but it is capable of being immediately renewed by simply turning the two reservoirs so as to bring the one filled with water uppermost, when, as they are constructed in a manner precisely identical, the liquid will again flow, and the aspiration of air proceed until the water has again flowed into the lower vessel, which may be then returned to its original position, and so on, the action continued indefinitely.

The engraving is taken from Jamin's *Cours de Physique de l'École Polytechnique* a work which, we may remark, in passing, is far superior to any class text-book of physics in our own language, and which ought to have been translated long since. In this cut the aspirator is represented as drawing air through two U tubes filled with pumice saturated with sulphuric acid, the object being to determine the amount of hydrometric moisture it contains.

GLEANINGS FROM THE INTERNATIONAL EXHIBITION.

MICROSCOPIC DIAMOND WRITING.—Within the last few days Mr. Webb has placed his apparatus for executing microscopic writing on glass amongst the philosophical instruments in the northern gallery. The instrument may be described as a long perpendicular rod or lever carrying at its lower end a pencil, which is traced over the original writing that is to be reproduced in miniature. The short arm of this lever is concealed in a box above, and acts upon a second lever, the arrangement being repeated until the motion, which originates with the hand below, is reproduced in the required degree of minuteness.

The extremity of the lever moving through this small space, carries a diamond point, which is pressed against a thin plate of glass, producing by its action a micrograph of the design over which the long arm of the lever is traced below. The apparatus is a modification on that originally designed by Mr. Peters, and produces effects which have not hitherto been obtained. As examples of its power of executing fine writing, it may be stated that the entire of the Lord's Prayer may be easily written in a space of the one 2500th of an inch, and the entire of the first chapter of St. John, containing 51 verses and 4137 letters have been written in less than the one thousandth of an inch, a degree of minuteness which would enable the whole Bible to be written in the space of two square inches. Notwithstanding their excessive minuteness, the letters are easily legible under a high magnifying power, each line being perfectly distinct. The instrument is equally applicable to the engraving of linear designs. Amongst those that have been engraved, and which are exhibited by Mr. Webb, may be mentioned a long geometrical spiral in the one 2000th of an inch, and a comic illustration of a joke of Captain Marryat's which can be covered by the point of a pin.

The true value of the instrument, however, is shown in its application to the purposes of microscopic science; it is capable of producing Nobert's microscopic tests in bands of lines numbering 100,000 to the inch, and micrometers with divisions rising to the one 4000th of an inch, which, when crossed, produce perfectly distinct and sharp angled squares, each of one-sixteenth millionth of an inch in size ($4000 \times 4000 = 16,000,000$).

As our notice may be the means of sending many to look at these astonishing results, it may save some trouble by stating, that having been introduced during the last few days, the micrograph will not be found in the catalogue, but its locality is readily ascertained as it is placed against one of the pillars of the northern gallery, on the railing overlooking the court below.

Analysis of New Minerals in the Exhibition: Dysodile.—In the Museum of Practical Geology, in Jermyn Street, will be found a large mineral mass labelled somewhat in the following style:—"Combustible matter from the banks of the river Mersey, north side of Tasmania." Specimens of the same substance are also to be seen in the Tasmanian Court of the International Exhibition, and it seems certain that this "combustible matter" is nearly identical with a rare mineral described as dysodile in Chapman's *Mineralogy*. It presents the appearance of a brownish-grey slate rather than that of any kind of fuel; yet it burns freely, though with a very offensive smell, when held in a flame. It has been employed in the locality of its occurrence instead of coal.

Examined with a magnifying lens of low power, the combustible constituent of dysodile is seen to be disseminated pretty uniformly through the mineral in the form of small flattened drops of a pale brownish-yellow colour, and marked with a few ridges radiating from the centre of each disc. When a piece of dysodile is crushed in a mortar, and the fragments warmed with strong hydrochloric acid, these discs float in the liquid and may be easily separated. They are nearly, if not quite insoluble in ether, alcohol and benzol, thus differing from solid paraffine; they require a high temperature to melt them; and have been found on analysis to contain, in addition to carbon and hydrogen, a small percentage of oxygen.

Dysodile, in its native state, can scarcely be termed a "combustible matter." By far the largest part of it is inorganic and incombustible, as the following analysis shows:—

Combustible matter	36·51
Water, etc.	2·30
Mineral matter or ash containing silica alumina, iron, soda, etc.	61·19
	100·00

ALBERTITE.—Under this name a beautiful, most lustrous, and intensely black substance is exhibited in the New Brunswick Court. Albertite presents the general appearance of a very excellent cannel-coal, and breaks with an extremely brilliant conchoidal vitreous fracture. Its jet black powder, when heated in an open vessel, melts, and then gives off great quantities of combustible vapours, leaving a light and bulky coke. But there is one point to be observed here of great interest—this coke is pure carbon, there being, in fact, practically speaking, *no ash* in Albertite, as the following result proves:—

1·55 grammes of Albertite left ·001 or 1 milligramme of ash.

This is equal to no more than ·0645 per cent., while we believe that no cannel-coal or anthracite hitherto analysed contains so little as 1·0 per cent. Among its volatile constituents Albertite contains mere traces of sulphur and nitrogen.

Together with the Albertite itself, specimens of oil produced by its destructive distillation in close vessels are also exhibited. They are admirably adapted for burning in paraffine lamps, affording a good light, having little or no disagreeable odour, and not forming, under any circumstances, an explosive vapour. In fact, a sample of the oil, when submitted to fractional distillation, did not commence to boil until the thermometer had risen to 338° Fahr., or 126° above the boiling point of water; while only half the oil had came over at 482° Fahr., one-seventh remaining in the retort when it had been raised to the boiling point of mercury.

The discovery of large sources of native mineral oil has caused the manufacture of Albertite oil to be discontinued. This is a circumstance to be regretted, as we are convinced that it far surpasses in its illuminating power, freedom from smell, and perfect safety in use, any hydrocarbon oil that has come under our notice.

We may mention, that the analysis of these two singular minerals has been made by Mr. A. Church, who is continuing the investigation of their composition and general properties.

FROG IN BLOCK OF COAL.—In the open court adjoining the eastern annex, is a tall block of coal from Russell's new Black Vein, in which has been excavated a square opening, wherein is placed a glass jar containing a living frog. The statement is not definitely made, but it is allowed to be inferred that the frog was discovered in the coal when the latter was excavated.

The accounts of living frogs being found enclosed in trees or blocks of recent formation are never found to bear the test of scientific scrutiny; the occurrence of a living animal of the most recent creation in a formation of such a degree of antiquity as the coal measures, is perfectly impossible. The animal should be turned over to some travelling show-van, containing mermaids and sea-serpents, its being shown in the International Exhibition is calculated to render the management of the scientific department the object of ridicule to all intelligent foreigners—in the name of the scientific men of this country we strongly protest against the continued exhibition of this ridiculous absurdity.

NOTES AND MEMORANDA.

Temperature of Snails.—M. J. B. Schnetzler has been experimenting on the temperature of the terrestrial mollusks, and has arrived at some interesting results, which are recorded in the *Bulletin Scientifique*. He began with the *Helix pomatia*, the large pale fawn-coloured snail, not uncommon in our lanes and woods, and which is considered fine eating by epicures abroad. In April, 1861, when the air temperature was 12°.1 Cent., a snail of this kind was a little warmer, 12°.5. In June, when the air was 23°.7, the thermometer, when covered with the snail's foot rose to 24°.7. A few days later, when the thermometer stood at 18°.7, it rose on being introduced into the snail shell, and brought as near the respiratory cavity as possible, to 20°. Irritating the muscles of the animal gave a further rise of .75°. In July a lively Helix pomatia, by mere contact of its foot, raised the thermometer 2½ centigrade degrees.* Half an hour later, the air rose one degree, but the snail remained the same. In September, after some snails had closed their shells for a month, a shower of rain came, and although they were kept in a room, they woke up, but their temperature did not exceed that of the surrounding air. In January he placed two snails in the open air, having removed their operculum. During the night the temperature fell to —2° Cent., but they were not injured; on a subsequent night, at —8°, they froze and died. Slugs have a lower temperature than snails. M. Schnetzler proposes to call these creatures "animals of variable temperature," in contradistinction to mammals and birds whose temperature is usually more equal, if we except the changes which hybernating mammalia undergo. Mollusks may become colder than the air, by evaporation from their skin, and Dutrochet found that frogs became noticeably warmer in air saturated with aqueous vapour, and, consequently, suspending their evaporation.

Cleaning Engravings.—Dr. Hayes, of Massachussetts, in the *Scientific American*, recommends old dirty engravings first to have any pencil marks removed with india-rubber or bread crumbs, then to have every spot saturated with solution of oxalic acid in the proportion of one ounce to a quarter of a pint of warm water. A few hours afterwards the engravings may be placed in a tub or foot-bath, being allowed to rest upon a piece of open cotton stuff, such as ladies used to employ for stiff petticoats before the return of hoops. This material, of suitable dimensions, should have two rods or sticks sewn to opposite edges. These sticks will hang over the sides of the vessel, and permit the prints to be withdrawn or moved without any risk of injury, and they should remain in soak with warm or cold water for twelve or twenty-four hours. When the prints no longer discolour the water on being agitated, the fluid should be withdrawn, and enough clean water added to cover them. Half a pound of chloride of lime should be made into a paste with

* A degree of Fahrenheit is equal to five-ninths of a degree of the Centigrade scale.

cold water, and stirred up with two quarts of water, and allowed to settle for six hours. Part of the clear solution should be added to the bath till the smell of chlorine is perceived, and the prints should be moved to facilitate the action. In very bad cases, one ounce of muriatic acid mixed with a pint of water may be added, and when the bleaching is effected, the prints should be well washed with fresh water and slowly dried.

M. Flourens on Wounds of the Brain.—The *Comptes Rendus* contains an account of experiments and observations by this distinguished surgeon, showing that wounds of the brain are easily cured. He cites several instances of human beings who have recovered from injuries involving loss of a portion of their brains, and adverts to his own proceedings in introducing leaden balls into the brains of rabbits and dogs. He made a hole in the skull with a trepan, cut through the *dura mater*, and made a slight incision into the brain itself, in which he placed the ball, which gradually sank into the cerebral substance, making a kind of fistula that cicatrized. If the ball was not too big, the whole thickness of the cerebrum or cerebellum might be traversed without being accompanied or followed by any bad symptom or disturbance of functions. He states that, in 1822, he removed one lobe from the brain of various animals, who recovered perfectly, and only lost the sight of the opposite side; and he adds, "but the most remarkable thing was when I removed the whole cerebrum, or both lobes. The animal deprived of his brain survived more than a year, but he had lost all his senses and intelligence, and was reduced to an automaton." In another instance he took away all the cerebellum, and this creature lived a year. It never regained regularity of movements. It was reduced to the condition of a drunken man.

Marriages of Consanguinity.—M. A. Sanson disputes the proposition that these connexions tend to deteriorate offspring, and he adduces many facts relative to breeding horses and other animals in England in support of his view. This paper has been referred to the commission appointed by the French Academy to "consider the effects of consanguineous marriages."

Refraction of Iodine Vapour.—M. F. P. Leroux states that when he employed a prism filled with the vapour of iodine, and "successively illuminated the slit of his collimator by the red and the violet-blue resulting from the dispersion of a pencil of solar rays by a flint-glass prism, he saw the red and the blue images in different places . . . which shows that the refrangibility of the red ray is greater than that of the blue ray in vapour of iodine."

Experiments in Solubility.—M. Girardin has ascertained that when a substance has several solvents, its solubility in a mixture of them is less than the mean of its solubility in each; thus if two saturated solutions in different liquids are mixed together a precipitation is the result.

The New Asteroid.—The 73rd planetoid, which Mr. Tuttle discovered in April, has been named *Clytie* by the American astronomers, after the daughter of Oceanis and Tethys.

Comet 1, 1862.—M. Radau states, in *Cosmos*, that this comet has so little light that it is not easily seen, and could not be detected on 15th July, in Vienna, when the moon was shining. He says: "The parabola which this comet describes does not resemble any cometary obrit we are acquainted with. It appeared suddenly, being at first visible to the naked eye, and moved rapidly towards the North Pole—circumstances which recal the behaviour of the great comet of last year." He then proceeds to show the great difference between the two, that of last year making its *sudden* appearance in the northern hemisphere only. Its orbit had, moreover, a very great inclination, while that of the present comet is very small. From the middle of June to the beginning of August, this comet moved in a direction opposite to the earth's motion, passing above us at the short distance of 4,000,000 of leagues on the 4th of July. It has traversed the plane of the ecliptic very near our orbit, but keeping before us. Taking for the basis of his calculations the elements computed by M. Sceling, M. Radau finds that it intersected the plane of our orbit on the 3rd of June, at 8h. 26m. mean Paris time; its distance being then 700,000 leagues, and less than 300,000 on the 5th of that month.

On the Rigidity of the Earth.—Professor Wm. Thompson shows that unless the earth were composed of very rigid materials, it would yield under the tide-generating forces exerted by the sun and moon, to such an extent as would sensibly diminish the actual phenomena of tides and of precession and mutation. The upper crust of the earth is possibly, on the whole, as rigid as glass, more probably less than more; but as a whole the earth must be far more rigid than glass, and probably more so than steel. Hence the interior must on the whole be more rigid, probably many times more rigid, than the upper crust. This calculation confirms the views of Mr. Hopkins, and is quite inconsistent with the hypothesis that the earth is a mass of melted matter enclosed in a thin solid shell. Mr. Hopkins has shown that this crust cannot be less than 800 miles thick. Professor Thompson considers that no thickness less than 2000 or 2500 miles would enable it to resist the tide-generating force of the sun and moon so as to leave the phenomena as they are actually found.—*Proc. Royal Soc.* No. 50.

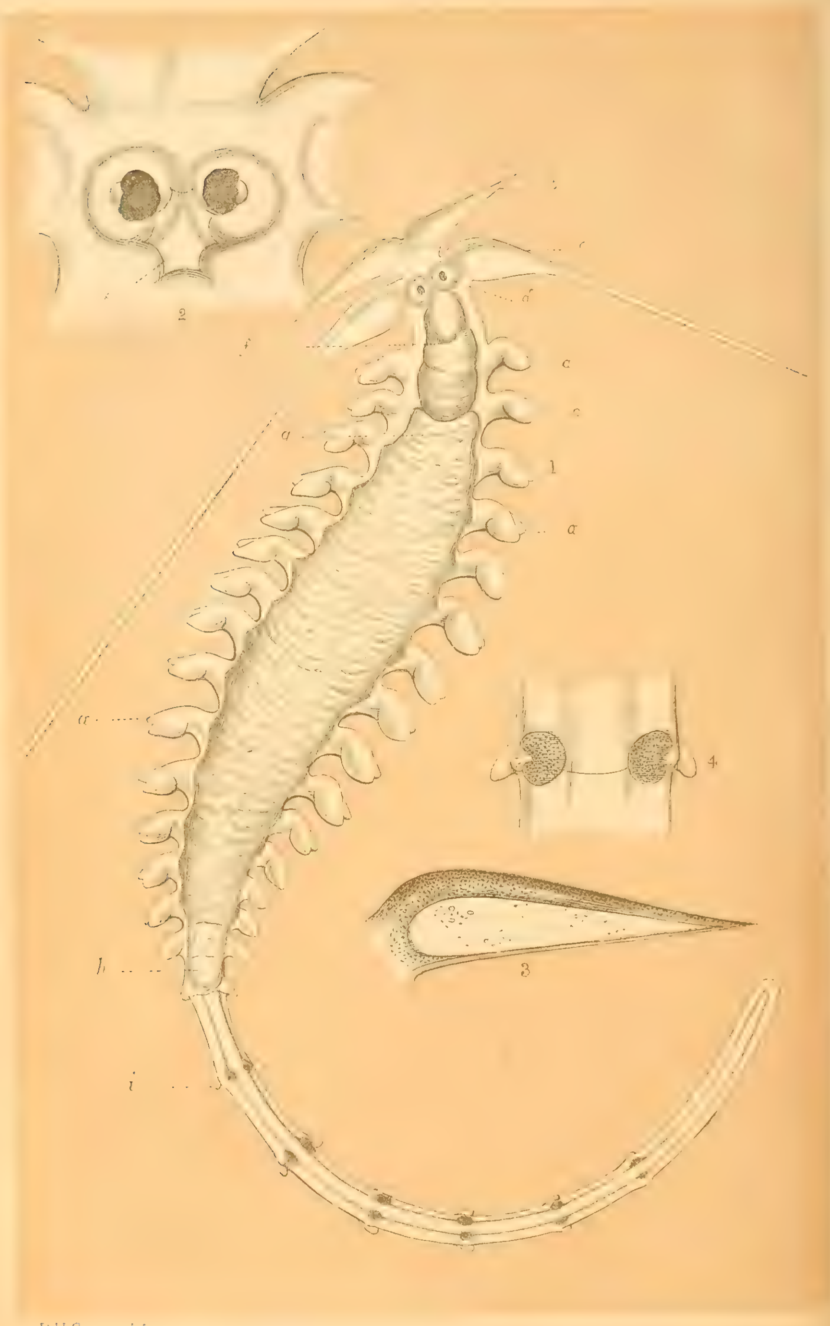
Distribution of Nerves.—In a paper communicated to the Royal Society Mr. Lionel Beale states: "The nerves distributed to the voluntary muscles of the frog do not terminate in free ends, but there is reason for believing that complete nervous circuits exist. In all cases, the fibres resulting from the division of the ordinary nerve fibres are so fine that many cannot be seen with a less magnifying power than 1000 diameters, and there is evidence of the existence of fibres which could only be demonstrated by employing a much higher magnifying power. It is by these very fine fibres alone, and their nuclei, that the tissues are influenced. The ordinary nerve fibres are only the cords which connect this extensive peripheral system." The author finds the same arrangement in the nerves of man and the higher mammals, and also in the invertebrata. He employs a highly refractive fluid, such as syrup or glycerine, in these investigations.—*Proc. Royal Soc.* No. 50.

Mechanism of the Human Voice.—By means of the laryngoscope, Mr. John Bishop has succeeded in watching the movements of the larynx during the utterance of vocal sounds. When the lower tones are made, the vocal cords vibrate through their whole length. As the pitch rises, the vibrating length diminishes, and the cords are pressed more closely together. In falsetto notes, it is only the extreme end of the cord that vibrates. Moreover, the vocal chords form a kind of valve, which is situated in a tube, and acts like a reed. Thus the organs of the voice perform the double office of reed and string.—*Proc. Royal Soc.* No. 50.

Mr. Lassell and the Moon.—At Malta, where Mr. Lassell has erected his magnificent 4-feet reflector, he observes the details of the moon with a sharpness and distinctness which he had never seen before. He states that, if a carpet the size of Lincoln's Inn Fields were laid upon its surface, he could tell whether it was round or square. He adds, in a letter to the President of the Royal Society, "I see nothing more than a repetition of the same volcanic texture—the same cold, crude, silent, and desolate character which smaller telescopes usually exhibit."

The Formation of Halos.—Sir John Herschel has devised an elegant mode of illustrating the action of minute refracting spheres. He mounts the spores of the common puff-ball in a film of oil between two pieces of glass. When these are held close to the eye, and a candle viewed through them, beautiful concentric halos appear.

Optical Experiment.—Mr. Slack calls attention to concentric circles of light, exquisitely marked by fine black intersecting lines, which may be seen by taking a stout glass tube, about one-eighth of an inch in diameter and six or eight inches long, holding it horizontally opposite the flame of a candle, and looking at the light through it. A piece of paper rolled round the tube shuts out all unnecessary illumination, and makes the phenomena more clear.



P.H.Gosse. del.

Tomopteris onisciformis.

THE INTELLECTUAL OBSERVER.

OCTOBER, 1862.

A SUMMER AFTERNOON BY THE SEA.

THE TOMOPTERIS.

BY PHILIP HENRY GOSSE, F.R.S.

During the summer months a naturalist on any part of the coast may have many opportunities of obtaining some of the rarer marine animals, and among them not a few of highly curious structure, or otherwise possessed of great interest, by collecting at the surface of the calm sea. Influences, which we can at present only conjecturally estimate, or which are altogether inappreciable to us, bring, at certain times and in certain conditions, perhaps electrical, of the sea or of the air above it, many forms of delicate animal life from the recesses in which they ordinarily conceal themselves to that stratum of the water which is in close proximity to the atmosphere. On a quiet day, when the surface has a glittering mirror-like smoothness, when the sun is shining, but a hazy veil slightly mitigates the fierceness of his heat, in the afternoon hours, if the observer will take a boat and pull gently about under the headlands, and into the tiny bays and inlets that are separated from each other by points of black rock, from which long draperies of wrack and oarweed and tangle hang down in the sleeping water, he may take many a curious form which, under a lens or on the stage of his microscope, will afford him both entertainment and instruction. The eye is not of much service in this mode of collecting; many of the desiderata are of minute or even microscopic dimensions, and most of the others are so transparent and colourless, that even when culled from the teeming bosom of the waters, and inclosed in a clear glass vase, they can be discerned by the eye only fitfully and with difficulty. A bag of fine muslin stretched on a hoop of wire fastened to the end of a staff some five feet long, is the best appliance for securing the prey. There should also be in the boat a large glass vessel—a confectioner's cylinder is very suitable—and two or three phials, such as those in which chemists keep sulphate of quinine. If the collector add a couple of glass tubes, respectively an eighth and a quarter of an inch in diameter, he will be set up.

As the boat is gently paddled along, making as little disturbance with the oars as possible, the operator standing in the bow, for the purpose of taking the water before the surface is broken, holds the bag so that the hoop shall cut the surface. After a few minutes he removes it from the water, and, turning it inside out within the large vase, allows the collected prey to float off into the vessel. Then raising this on his left hand to the level of his eye, he peers through the clear fluid, seeking to catch some movement other than that of the currents, or some flash of light from a reflecting body. The transparency of the water will most likely be dimmed, and his power of examination impeded, by a multitude of delicate filmy objects which he will in an instant see to be organic, but which, if he is a tyro, he will have difficulty in making out. These are the sloughs of Barnacles (*Balani*), the active creatures that inhabit strong conical fortresses of stone studding the rocks, and that ever thrust out and draw in a hand of many slender fingers, flexible-jointed, and fringed with an exquisite array of bristles. From time to time, the skin of this many-fingered hand is thrown off; and, as it remains entire, and every bristle is perfectly represented in the *exuviæ*, it is a very interesting object to examine, and to mount on a microscopic slide. These sloughs float by millions, and the collector having once satisfied his curiosity about them, will probably wish them somewhat less numerous or somewhat less obtrusive. However, he will soon learn to neglect them, and pursue his investigation in spite of their presence.

Perchance he detects a tiny bell of pure translucency, with a little clapper depending from its arch, and a series of strings of excessive tenacity attached to its margin. It shoots to and fro so rapidly, that he can scarcely keep it in sight; at length it takes an instant's respite, and he brings his dipping tube to bear on it, thus:—Before he inserts it, he claps his fore-finger tightly on the upper end, then plunging the other end into the vessel he brings it pretty close to the little bell he wishes to capture; then, for the briefest possible moment, he lifts his finger, the water rushes in at the lower end, carrying the prey with it; the finger is tightly clapped on again, and the contents of the tube are safely transferred to one of the smaller phials, isolated in pure water, and ready to be examined at leisure. He has caught one of the lovely little Naked-eyed Medusæ, a creature of exquisite grace and beauty.

I have some reason to think that in the darkness of the night more of such beautiful forms of life sport at the surface of the sea than even during the most auspicious day. The towing-net which, in the smooth seas of the tropics, the naturalist-voyager rigs out over the quarter of the ship, and leaves to gather what it may, rarely fails to yield to the morning's examination, as the result of the night's collection, a variety of creatures which are rarely or never seen by day. And I have occasionally been amply rewarded by taking my muslin bag-net down to the sea-side at nine or ten o'clock at night, and dipping at random as I stood on the lowest step of the quay stairs, or on some projecting rock, while the water flashed with bright phosphoric radiance at every movement.

Occasionally too, by carefully searching over the tiny basins in the rocks left full by the retired tide,—those most fascinating little pools which are fringed all round with floating filmy leaves of green or crimson, and tiny flexible shrubs with purple branches as fine as hair,—we may succeed in taking a prize. It was thus that a scientific friend a day or two ago obtained a very rare and otherwise interesting animal, which he kindly put into my hands.*

It was *Tomopteris onisciformis*. Ten years ago, when I was spending a summer at Ilfracombe, I met with it, in the way I have described above, dipping it with a muslin net from the open sea. Believing it to be new, I described and figured it under the name of *Johnstonella Catharina*.†

In this supposition I was mistaken; and soon afterwards Dr. John Edward Gray, of the British Museum, gave the following information concerning the animal, in a note in the *Annals and Mag. of Nat. Hist.* for August, 1853:—

"It appears to belong to the same genus as the animal described by Eschscholtz in the *Isis* (1825), p. 736, t. 5, f. 5, under the name of *Tomopteris onisciformis*, from the South Seas; and by MM. Quoy and Gaimard, in the *Voyage of the Astrolabe*, ii. p. 284, t. 21, f. 21, 24, under the name of *Briaræa scolopendra*, from the coast of Spain. Hermannsen has proposed to change the latter name to *Briaræa;* Harry Goodsir calls it *Briareus;* and Mr. R. Ball writes it *Bryarea*.‡ Eschscholtz, and Quoy and Gaimard regard it as a mollusk; the first referring it to the order *Heteropoda*, and the latter to the *Nudibranchiata*.

"Mr. Harry Goodsir, who found the animal abundant in the North Sea (*Ann. and Mag. Nat. Hist.* 1845, xvi. 163), observing the presence of 'cilia fringing the bifurcated poste-

* I call it rare, because through ten years' habitual searching of the sea on our south and south-west coasts, I have met with it so seldom. Dr. Carpenter however, finds it not uncommon on the western shores of Scotland.

† *Devonshire Coast*, p. 356, pl. xxv.

‡ Probably in ignorance of the allusion, which was to Briareus, the hundred handed giant of the old Greek theogony. If the name had been retainable, Mr. Goodsir's orthography would have been the more correct one—Βριάρεως.

riors of the lateral extremity of its body,' decided that it could not be a mollusk.

"Menke (*Zeitsch. für Malac.* 1844, 21) proposes to remove the genus to the Annelides; more recent authors have considered it as a Crustacean.

"Mr. Gosse at first sight thought it might be a Brachiopod crustacean, but thinks it has more affinity to the Annelides (p. 348), and refers it to that class in the Systematic Index.

"According to Eschscholtz, and Quoy and Gaimard, the South Sea specimens are very much smaller than those found in the Mediterranean; thus, *Tomopteris onisciformis* and *T. Scolopendra* are most probably distinct species. Mr. Gosse's *Johnstonella Catharina* is, no doubt, a synonym of the latter, since Mr. R. Ball records that *Bryarea scolopendra* has been taken in Dublin Bay by Dr. Corrigan." (*Proc. Brit. Assoc.* 1849, p. 72.)"

In addition I should state that Dr. Adolph Edouard Grube, in his excellent work *Die Familien der Anneliden* (Berlin, 1851), has included the genus, without question, among the Annelida; constituting a family and an order of it alone, which, with the curious caterpillar-like *Peripatus*, of the West Indies, of which he makes another order, he intercalates between the *Terebellacea*, and the *Lumbricina*. Dr. Grube includes but one species in the genus, quoting Quoy and Gaimard's *Briareus scolopendra* as a synonym of Eschscholtz's *T. onisciformis*.

The following is Grube's account of the family, with its technical characters:—*

"ANNELIDA.

"ORD. *Gymnocopa*. FAM. *Tomopteridea*.

"Body lengthened or worm-shaped, slender, with broad floats, often small or not well developed towards the hinder end. Segments not very numerous, not separated by bounding furrows.

"Head-lappets united behind with the mouth-segment; the former with short antennæ, the latter (hinder) with very long tentacular cirri, in which, as in the antennæ, a bristle-like part is set. Two eyes.

"Mouth directed downwards, unarmed, proboscis not observed.

"Lateral processes of the segments forming considerable floats, two-lapped, without bristles or needles.

"We know as yet but one genus, *Tomopteris*, with a single species, of which the external and internal structure has been thoroughly investigated by Busch. The body is amazingly

* Op. cit. p. 95.

transparent; the alimentary canal straight, without enlargements, vessels not perceptible; the blood colourless; the sexes separate; the eggs lie free in the abdominal cavity. The nature of certain rosette-shaped organs, found within at the base of the floats, Busch could not ascertain. The nervous cord in living specimens is difficult to detect, but in animals preserved in spirits I found its halves laid close side by side, scarcely forming ganglionic swellings, and the mouth ring narrow.

"GENUS *Tomopteris*, Esch.—*T. onisciformis*, Eschsch. *Isis*, 1825, p. 736, tab. v. fig. 5. Busch, *Müll. Arch.* 1847, p. 180, tab. vii. fig. 5. Grube, *Idem*, 1848, p. 456, tab. xvi. figs. 9—13. *Briareus scolopendra*, Quoy et Gaim. *Ann. des Sci. Nat.* x. p. 235, tab. vii. fig. 1."

As the creature under notice is not only one of great rarity, but also of more than usual elegance, I have thought that a figure drawn from the present specimen, and a description of its principal features, might prove not uninteresting to that large portion of the readers of the INTELLECTUAL OBSERVER who are at this season rifling the treasures of the sea among the secluded coves and smiling tide-pools of our rocky shores.

Fig. 1 in Frontispiece represents a male *Tomopteris onisciformis* when first taken, magnified six times; its natural dimensions during the vigour of health extending to about an inch and a half in length. Strange to say, it rapidly deteriorated in confinement; though transferred within an hour of its capture to a tumbler full of sea-water, it steadily diminished till, in the course of about four hours, it was not more than three-quarters of an inch long; and this, not by a contraction in length only, but by an uniform diminution of all its parts, so that the same form and proportions were maintained, but on a constantly lessening scale. Nor was this the only alteration perceptible; when my friend, a gentleman of science accustomed to accurate observation, captured it, the animal was so perfectly diaphanous that, when searching the pool, with his eye brought as close as possible to the surface, he caught sight of it only by the flashings and twinklings of light reflected from the rapidly-moving fins of its side-processes; and when he caught it by placing his hollowed hands, basin-wise, under the twinkling spot, and lifting out the water, he could see nothing of it either in his hands or in the bottle into which he poured the contents. So thoroughly was it transparent, and so exactly was the refrangibility of its body-tissues that of the circumambient water, that when he put the cork into the phial, and examined it, he actually could not discern the creature, and supposed that he had either failed to capture it, or else had lost it in pouring the water from his hands. Yet when, an hour afterwards, he brought it to me, the animal was distinctly visible, and could not be lost sight of, though still brilliantly transparent. And in the course of the three or four hours occupied in my observations, it became less and less hyaline, increasing in opacity as it decreased in size; till at length, when I put it into spirit for preservation, some five hours after capture, it was quite opaquely white, and scarcely above half an inch in length.

The body is slender, flattened, tapering to an attenuated tail of great length; much larger relatively in this individual than in my Ilfracombe specimens, the tail occupying nearly two-fifths of the entire length.* The lateral processes give an appearance of flatness to the body, greater than it really possesses; for when viewed sidewise, the trunk, independent of the fins, is about as deep as it is broad. The body is furnished with fifteen pairs of these lateral limbs (*a a*), which are manifestly analogous to the foot-processes in a *Nereis* or *Syllis*, but show no traces of the pencils of bristles so characteristic of the ordinary *Annelida*. Each foot divides at its tip into two thin expansions of delicate *sarcode* (transparent fleshy tissue), each of which assumes somewhat of a fan-shape, and is capable of being convoluted into an obliquely truncate cone. I could discern no appearance of external cilia. A transverse section of the foot-base would have an elliptical outline, whose longest diameter is vertical.†

These terminal expansions are used as fins, being waved in the water with great sprightliness and activity. They thus constitute a powerful locomotive apparatus, and may be instructively compared with the leaf-shaped swimming-fins attached to the upper surface of the feet in *Phyllodoce*.

The head is remarkable for its accessory organs.‡ These

* When this paper was written, I was not aware that the *Tomopteris* had been the subject of two valuable memoirs by Drs. Carpenter and Claparede, published in the *Linnean Transactions* for 1859 and 1860. Mr. Slack having very kindly sent me an abstract of the latter, I add in notes some particulars of structure which escaped my own observation.

These eminent naturalists find that the animal passes through a larval stage, which differs materially from the adult condition. They figure a larva, only ·04 inch in length, in which the tail is altogether wanting; there are but three pairs of fins, the antennæ, or first pair of head processes, *are much larger than in later life*, and the cirri, or second pair, show only a commenced development.

† Each of these processes, after the first five pairs, is furnished with two pairs of minute rosette-shaped organs, one pair placed near the base of the fin, the other on the terminal lobe-like expansions. The former are described as the external orifices of ciliated canals, which presently unite into one that runs along for some distance in the wall of the body, and then terminates in the body-cavity. These canals appear to admit the external sea-water to percolate into the cavity, which is then replenished with the products of digestion by exudation through the walls of the alimentary canal, and becomes a blood-like nutritive fluid.

‡ MM. Carpenter and Claparede describe on the dorsal surface of the head "a pair of ciliated epaulettes, which extend over the edges of the bilobed nervous ganglion. These, at a certain stage of development, are fringed with long cilia, both at their margin and at their base."

are two pairs, of which the anterior (*b*) may be considered antennæ, and the posterior (*c*) tentacular cirri; but these distinctions are perhaps somewhat arbitrary, and are rather convenient than precise. The antennæ (fig. 3) consist of a marginal portion, thick and cord-like, of granular tissue, of which the anterior is thicker than the posterior edge, and a thin clear membranous portion stretched across. The latter seems double, and to inclose a cavity filled with fluid; for I observed eddies of minute corpuscles, which were accelerated whenever they approached the cord-like margins.

The second pair, or cirri (*c*), have a similar structure, but the front cord is prolonged into a stiff straight seta of a length superior to that of the body and tail, which points obliquely backward, and is capable of but a very slight change of direction, by a contraction of the hinder part of its base. This pair is probably the seat of a delicate sense of touch.

Immediately between the bases of the cirri are seated the two eyes (*d*); each consisting of a distinct lens,* very convex, seated on a much larger mass of black pigment, and looking outward laterally, and the whole eye inclosed in, or resting on, a globose body of translucent tissue, probably a nervous ganglion, which is in contact with its fellow (see fig. 2). I did not remark any movement in the eyes.

Viewed from beneath, the cavity of the mouth is seen to open just under the eyes (*e*), the aperture being formed by an irregular corrugation of the surrounding flesh, forming lobes. In one of my Ilfracombe specimens, I was so fortunate as to see the protrusion of a thick œsophageal proboscis to some distance, of an ob-conic form, or somewhat trumpet-like, with a large four-sided orifice obliquely terminal. This observation was the more important, as such a protrusile œsophagus is eminently characteristic of the *Annelida,* and does not seem to have been seen in this animal by any other observer. In my recent specimen, the œsophagus (*f*), when withdrawn, reached to the second pair of fins, where, after a constriction, it expanded into an alimentary canal (*g*), having distinct corrugated walls, whose outline was commensurate with that of the body cavity, with a slight tendency to enter into the bases of each pair of fins. The cardiac extremity of this viscus, during my examination, was insensibly pushed forward, so as to inclose the termination of the œsophagus, but not changing the position or the appearance of the latter. It was manifestly empty.†

* MM. Carpenter and Claparede state (and quote the testimony of MM. Leuckhart and Pagenstecker to the same point), that the lens in each eye is double. It, however, appeared to me manifestly single.

† The alimentary canal in one specimen obtained by MM. Carpenter and Claparede contained fragments of a Beroe, which were kept in active motion by their own cilia.

The alimentary canal appeared to have a cloacal orifice, which, however, I did not distinctly define, between the fifteenth pair of fins (*h*), where I consider the tail to commence. This portion of the animal is nearly of the same diameter throughout, composed of nine segments, of which the bounding furrows *are* distinguishable, notwithstanding what Grube says to the contrary. The segments of the *trunk*, on the other hand, are only to be inferred. Each segment-furrow bears a pair of lateral processes. Of these, the earlier ones are not to be distinguished from the body-fins, which have been degenerating from about the middle pair backwards, except by still further degeneration; but as they approach the posterior extremity, they become more and more rudimentary, and can scarcely be discerned on the last one or two segments. The tail is perforated throughout by a viscus, which in most parts appeared simple, though with corrugated walls, but near the base was very manifestly composed of two cord-like portions, irregularly twisted together—a strange and unaccountable structure. The viscus inclosed at intervals two large oval air-bubbles, the effect of which, though accidental and unimportant, on the appearance of the animal, from the different refrangibility of the air, was very striking. More structurally interesting was the evidence of a circulatory fluid, surrounding and bathing both this viscus in the tail and the alimentary canal in the trunk; for at intervals there were seen groups of blood-corpuscles whirled to and fro and circling in irregular eddies, revealing the fact that the body-cavity is lined with a ciliated membrane. This fluid evidently bathed the whole interior of the body, and surrounded the alimentary canal, without the slightest trace of a dorsal vessel.

The walls of the body showed a texture composed of longitudinal fibres, very distinct.

Within the caudal cavity there was a series of organs of whose nature I am doubtful. At the points where the degenerated fin-processes originate on each side, there was a gland(?) shaped like a kidney-bean (*i*, and fig. 4), composed of pale brown granular matter, attached to the inner wall by a short stalk arising from the concavity, just as a bean is attached at the *hilum*. The texture and appearance of these bodies had so much resemblance to those of maturing ova (as in the *Rotifera*), that I should have concluded such to have been their solution, but for their isolated manner of attachment, and the absence of any viscus that I could identify with an ovary.*

* These glands are considered by MM. Carpenter and Claparede to be the *testes*; the form is probably inconstant, as they figure them of a very different shape. They found them filled with *spermatozoa*, which were furnished with *two* whip-like tails—"a common structure in the antherozoids of *algæ*, but rare, if not unique, among spermatozoa of animals."

The ova in the female are lodged in the general cavity of the body and tail.

Though to the unassisted eye the whole animal appeared to be destitute of colour, with the exception of the black eye-specks which are just discernible—the microscope shows that the skin is studded with minute scarlet dots, arranged somewhat sparsely in linear rows on the median line of the back, along the cirri, and irregularly scattered or grouped on the sides, fin-processes, and tail.

A few hours' captivity sufficed to deprive this delicate organism, before so agile and so vigorous, of motion and of life. It is strange that many of the low forms of animal life which swim freely in the open sea, are so excessively impatient of confinement, as to exhaust themselves even in what seems to be an ample supply of pure water. Many a tiny creature less than an inch in length, caught as it frolics in its abounding vivacity at the surface of the wide ocean, and transferred, without contact with anything firmer than its own pure element, to a bucket full of water, dies of utter exhaustion in a few hours. How and why is this ? It cannot be that the oxygen has been all taken up in so brief a time. It is as if a man shut up beneath the dome of St. Paul's should be found dead by daylight for want of air to breathe. Are the gills of an Anneloid or a Mollusk more *exigeant* than the lungs of a man ?

Explanation of the Illustration.—Fig. 1.—*Tomopteris onisciformis* magnified six diameters. *a*, the fins, or lateral processes ; *b*, antennæ ; *c*, tentacular cirri ; *d*, eyes ; *e*, aperture of mouth (in fig. 2) ; *f*, œsophagus ; *g*, alimentary canal ; *h*, cloaca (?); *i*, tail-processes, and contiguous glands. Fig. 2.—Inferior surface of the head, more highly magnified ; showing the insertion of the lens of the eye in the pigment mass ; and the aperture of the mouth (*e*). Fig. 3.—Antenna highly magnified. Fig. 4.—One of the joints of the tail, with the rudimentary fins, and the reniform glands.

PHOTOGRAPHIC DELINEATION OF MICROSCOPIC OBJECTS.

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

To be able to produce with rapidity and faithfulness representations of such objects and phenomena as are visible in the field of the microscope, is a matter of great importance to the labourer in almost every branch of natural science. Some observers are content to discard all adventitious aid, and to draw from the microscope in the same way as they would from an unmagnified object, relying for success on their own skill as draughtsmen. But though this method when well practised gives results, perhaps more spirited and life-like—more artistic in short—than any mere camera drawing can do; it is evident that the skill required is greater than can be brought to bear by the greater number of microscopists, and, moreover, in the best case it offers no unquestionable guarantee of faithfulness. To obviate these difficulties, to lighten the labour on the one hand, and to ensure perfect accuracy, at least of outline, on the other, the instruments in common use are the camera lucida of Wollaston and the steel disc of Sömmering. These are adapted to the eye-piece of the microscope, and by throwing the image down on to the table, so that its outline may be easily traced on a sheet of paper, they offer very great advantages. But even with these appliances, when the object to be drawn is very elaborate in its details, the labour involved is great, and in the case of living organisms their movements are a source of great perplexity, as an unlucky twitch of a limb may in a moment render useless the work perhaps of hours. Photography of course very early suggested itself as the remedy for all these hindrances, and a very encouraging amount of success attended the first attempts which were made in this direction. Mr. Shadbolt, many years ago, published in the *Microscopical Society's Journal* one or two very good photographs of microscopic objects, with an account of the process which he adopted, but it does not appear that any great practical results have followed so auspicious a beginning. For a long time, indeed, the cumbrousness of photographic appliances was a sufficient bar to any general use of them. In the midst of microscopic investigation, to have to busy oneself with preparing sensitive plates, and going through the whole processes of exposure, development, and fixing, was more than could be tolerated; but now that iodized plates can be kept always ready for use, and after exposure may be left any length of time for development, there is very little to be urged as to the *unhandiness* of the process, which is indeed exceedingly simple.

The body of the microscope being brought to the horizontal position must be inserted into the front of an ordinary portrait camera, from which the lens has been previously removed. In the absence of a special adapter, the aperture round the tube must be stuffed with some convenient material so as to exclude light. The image of the object is then to be accurately focussed on the ground-glass by means of the ordinary coarse and fine adjustment-screws of the microscope.* After focussing, however, it will be found necessary to make a trifling alteration in the adjustment, for the object-glasses being made with an "over-correction," in order to compensate for the "under-correction" of the eye-piece, their visual and chemical foci do not correspond; and thus the actinic rays are brought to a focus slightly beyond the visual rays. On this account the object-glass will need a certain amount of depression varying with the power, and the higher the power the less alteration will be required; usually with a quarter of an inch objective the chemical and optical foci are so nearly coincident that the difference may be overlooked in practice. The amount of depression required for each lens can only be ascertained by repeated experiment, but the following data which apply to my own object-glasses (Powell and Lealand's) may be taken as an approximation. The one inch glass requires a depression amounting to one turn and a half of the fine adjustment screw (about one seventy-fifth of an inch.) The half inch requires about half a turn of the same screw.

The most satisfactory illumination is a strong sunlight reflected directly upon the object by the concave mirror. Light reflected from a white cloud opposite the sun, will indeed answer the purpose, but the time of exposure is necessarily greatly increased, and the impression when obtained is much inferior in point of brilliancy and distinctness.

The "collodion" process is doubtless the best that can be used for microscopic purposes. Indeed, if the direct sunbeam be employed as the illuminating agent, no good result can be obtained with a less sensitive material, for the situation of the image on the prepared plate is continually altering with the altering position of the sun. The time of exposure must differ considerably according to the intensity of the illumination, the medium in which the object is mounted, and the nature of the object itself. When using the direct rays of the sun I have generally found from fifteen to forty-five seconds sufficient for a collodion negative.

Recent discoveries, by means of which sensitive plates may

* It is not the aim of this paper to explain the details of ordinary photographic manipulation. For information on these points, the reader must consult some one of the numerous manuals of photography.

be constantly kept ready for use, have, as previously stated, removed one great impediment to the prosecution of microscopic photography. The point to which attention should now be directed, is the attainment of some simple method of artificial illumination. The illuminating agents now in common use are all greatly deficient in actinic power; and though photographs have been taken by their light, they are practically unavailable. It is evidently impossible that this application of photography should become at all general so long as it is entirely dependent on a brilliant sunlight, or on such agents as the electric and oxyhydrogen light, but if some easily produced flame, rich in actinic rays, could be devised, then we might reasonably look for a very extensive development of this branch of the art. It could then be practised in all weathers, and at all hours, and there are few objects which could not be represented successfully by its means.

ZOOLOGY OF THE INTERNATIONAL EXHIBITION.

Though there are very few contributions to the International Exhibition that directly claim the attention of the zoologist, those that illustrate the great subject of economic zoology are literally numberless, and to classify or analyse them in detail is both impossible and unnecessary. The British colonies present the best examples of complete exhibition, they show us the animals and their products side by side; elsewhere we see products only, except in certain special exhibitions in the English and French departments of a strictly zoological kind, and having little or no relation to economics. As we traverse the nave we catch a sight of skins, furs, fleeces, here and there stuffed specimens of birds and mammals, but the forms are those we are mostly familiar with, and it is only when we have sought out and examined the objects we had marked for inspection in the catalogue, that we can take a leisurely view of lions, tigers, parrots, macaws, and reindeer, which are generally placed as a sort of sign-posts to guide and attract visitors to manufacturers' collections of materials and furniture. Still there is as much for the zoologist as he would expect in an exhibition which has for its main idea to illustrate the progress of handicrafts and the mutual commercial relationships of the nations, for of necessity many of the most important industries carry us direct to the ocean, the pasture, the wilderness, and the jungle, and invite us to consider the ways of Nature in fashioning her creatures so that life and happiness may go together, and the combination subserve the purposes of man. The converse might be said, perhaps, if we were to indulge in some severe philosophy, and the spirit of Pope's lines on the mutual relations of man and goose, would have a new illustration. But dealing with the practical, and, following as nearly as possible the order of the catalogue, it will be seen that the United Kingdom exhibits products only, and though these are of a common-place character, they offer points for the consideration of the scientific visitor neither unimportant nor uninteresting.

Traversing the Tasmanian Courts, we find interesting exhibitions of the products of the whale fishery, which has become so important a branch of the industry of that colony. The Commissioners' collections (194—330), and those from W. Powel (560—566), and M. Sanderson (579—580), show that the sperm whale still abounds in the Southern Ocean. The jaws of the sperm whale forming the apex of the trophy will indicate that fish of immense size are captured. The whales furnishing the two great jaws produced respectively oil and head-matter worth £1150 and £900. *Balæna marginata, Australis,* and *Antarctica,* the Australian, New Zealand, and Cape whales; *Catodon polycyphus,* the South Sea sperm whale, and one or two species of *Delphinidæ,* afford the sport and profit of the southern fisheries, which the Tasmanians have developed with so much spirit, and which attract American vessels to share the risks and rewards of the chace. There are now twenty-five whaling vessels attached to the port of Hobart Town, and these employ a fleet of 131 boats, two of which are suspended from the Tasmanian trophy. Last year the exports of oil and head-matter amounted to £60,350. New Zealand does not illustrate its position in regard to the whale fishery, but Queensland calls attention to another of the *Cetacea* in the exhibitions of dugong oil (22, 24). This is obtained from *Halicone dugong,* one of the herbivorous whales, and the most interesting, zoologically, of any of the series exhibited, so that we wish a complete skeleton had been forwarded for addition hereafter to some of our museums. This fish is found in great herds at the mouth of the Brisbane, and is easily captured. The flesh would probably prove to be as good for food as that of the porpoise (*Phocœna communis*), which, from the time of Henry VIII. to that of Queen Elizabeth, was considered a royal dish. Certainly the oil is likely to acquire as much fame for its curative properties as that from the liver of the cod, and the Tasmanians have but to make its merits known to secure good markets, and the extension of the fishery. From the *Cetacea* to the *Phocidæ* is but a short zoological step, and in the Tasmanian Court are specimens of elephant sealskin. (461.) *Macrorhinus proboscideus,* which the visitor will notice as capable of many useful applications in the arts. This is the far-famed sea-elephant of the Atlantic and Southern Oceans, which owes its name as much to its enormous size as to the possession, by the male, of a proboscis. An adult specimen of this species measures about twenty-five feet in length. Compare this specimen of seal leather, like rhinoceros hide, with another in the Denmark Court, where J. W. Taylor, of Greenland, has a most interesting collection (No. 183). These examples appear to be the produce of the harp-seal, *Calocephalus Greenlandicus,* which has less wool than other species, and the hair of the leather flat and lustrous. Amongst the specimens is the skin of a seal fœtus, which may remind the vistor that in certain remote parts of Her Majesty's home empire, cows are killed just before their time of calving, for the sake of the skins of the fœtuses for first class gloves.

Horns appear in a thousand different shapes. In the Indian department Messrs. Halliday and Fox (130) show buffalo horns worthy the attention of students of the genus *Bos,* for the Arnee is represented with others less rare. Natal (2) presents us with samples of horns of the *Cervidæ* of South Africa. New Brunswick (31) sends a pair of moose horns of gigantic dimensions. Let none who take interest in horns miss an inspection of the horn furniture in the Austrian department, class 30, from H. Kietel of Vienna (1206).

Visitors bent on natural history studies, will have to consider the contributions of classes 4 and 25 together. In the first are wools, in the second skins, fur, feathers, and hair. The sub-class B contains a grand collection of wools from the Royal Agricultural Society of England (1007). The Austrian fleeces are equally interesting, but the French merinos surpass in beauty all the many contributions in this section, and whoever has the patience to search them out—scattered as they are through many provinces—will be able to read the history of the merino and the hitherto ineffectual efforts to mould its gaunt outlines to models adapted for meat production. Classify all the wools, and the result will be that climate is the main element in determining their character. Low temperatures favour the growth of shaggy wools and abundant grease: high temperatures produce silky fleeces almost free from grease, and merge the sheep and goat into such approximative forms that at last it is hard to distinguish them.

The English furs comprise gatherings from every climate of the world. From the tropics, lions and tigers; from arctic wilds, white and blue foxes; from Siberia, sables. The South Sea sealskins, shown by Mr. Lillicrapp (4505), took three years to collect in the Falkland Islands. Generally, sealskins are scarce, beavers more scarce; the first is following the second in the process of extermination. Among the colonies New Zealand shows but a poor fauna, but the Australian settlements exhibit proofs of possessing a wealth of animal life, to which none of the European or American communities can offer anything like a parallel. Here, in various forms, we have products of the kangaroo, opossum, platypus, flying opossum, black cat, tiger cat, and immense collections of birds, mostly of gay plumage. In 1872 the Australians may send specimens of home-bred blackbirds, thrushes, sparrows, and starlings; these are all naturalized, and are increasing wonderfully, to the benefit of the agricultural interest. The case of grey and black opossum furs in the Tasmanian Court, is one of the most beautiful of the contributions from the Australians.

Notwithstanding some of the main features of the disastrous journey of O'Hara Burke into the interior of Australia, the camel is so far a successful introduction that the means of exploration are added to by its whole value for traversing vast regions of desert destitute of both herbage and water. There is not a single contribution of any kind from either of the provinces to illustrate this new item of Australian wealth and power, but we may name, in passing, a very interesting collection of objects from the interior, collected by J. M. Stuart, and exhibited in the South Australian department, under the north-east transept, by Mr. J. Chambers (77). The fitness of the more tropical parts of that continent for the camel is prefigured in the success which has attended the introduction of the Lama, Alpaca, and Vicuna. New South Wales, the parent colony of the group, leads the way in an enterprise which is likely to change the whole character of the pastoral districts by the substitution of alpacas for sheep. At the back of the Court is a case containing seven stuffed specimens—lama, alpaca, and five crosses between them. The crosses show several intermediate stages between the bare head and woolly covering of the lama, and the covered head and fine, long, hairy wool of the alpaca. The Commissioners exhibit articles manufactured from alpaca wool (24), and J. Nott (169) shows alpaca tallow and pomade. As an experiment in what is termed "acclimatization," the introduction of the alpaca to Australia must take first rank. The task was undertaken by "an enterprising gentleman named Ledger," and it occupied him during a period of four years to get the flock safely landed. He first visted Australia to ascertain if the climate and native herbage were suitable. He then returned to Peru and collected a flock, but the prohibition of the government against the exportation of the animals rendered it impossible to ship them from a Peruvian port. He commenced the arduous task of conveying them to Chili overland, crossed the Andes slowly but safely with his contraband treasures, and, after innumerable dangers and difficulties, got them to Copiapo, whence they were safely transmitted to Australia.

The flock of 276 was landed at Sydney in November 1858, and in spite of some deaths immediately on arrival, in the following month of April the flock numbered 284, consisting of 46 pure male alpacas, 38 pure female alpacas, 110 pure female lamas, 27 females cross between alpacas and lamas first generation, 11 females from male alpacas and females from first cross, 5 females from male alpacas and females from second cross; 40 lambs first, second, and third cross; 5 male vicunas, 1 female vicuna, 1 male gelded lama carrier. These animals have thriven beyond expectation, and the various crosses, and the right kinds of crosses, promise to become subjects as fruitful of discussion as those relating to the various breeds of sheep. The colony of Victoria obtained alpacas by a quite different process. A person named Gee speculated in a flock which he took to New York, thence to Glasgow, Birmingham, and London. At London some of the animals were sold to Mr. Palliser, Miss Coutts, and Mr. G. Lloyd. Mr. Wilson, editor of the *Melbourne Argus*, bought the remaining thirty animals at £23 per head, and shipped them for Melbourne, where they have increased, multiplied, and are now rendering good profit to their owners. That lamas, alpacas, and vicunas should interbreed is neither new nor curious information, for the probabilities are many and strong that they are all varieties of one cameline type, differing from the camel chiefly in the structure of the foot, which in these is adapted for climbing, and in the absence in the lamas of two small false molars from each jaw. But the breeders of Melbourne and Sydney may work out an interesting zoological problem, and perhaps originate an additional source of national wealth, in ascertaining if the lama and the camel can be made to furnish mules, for it is just such an intermediate form as might be expected from the cross that is wanted for conveying the baggage of exploring parties in the interior.

Among miscellaneous contributions there are stuffed animals of all kinds and from all places. Generally, birds are well done. The British birds from G. B. Ashmead (Educational department), (5588), A. Bartlett (5589), and W. Short (5611), are admirable examples of what may be done for the introduction of natural history studies in schools and families. But the most interesting exhibition of this kind is in the French Court, where M. Florent Prevost exhibits specimens of all the small birds of France, accompanied with preparations of their stomachs and samples of the food they eat. This beautiful collection is accompanied with copies of a pamphlet for free distribution among visitors by the *Société d'Acclimatation.* The pamphlet is entitled *De la destruction du Hanneton* (Maybug) *et de son emploi pour la nourriture des jeunes oiseaux.* If birds are well done we cannot say the same for larger animals. The lions, and tigers, and deer, are mostly stuffed according to museum models,—that is, the body is stretched out in the form of a regular cylinder, and the legs and head are in any position except such as would be seen in life, so that if restored to life in the form and proportions which result from the process of "stuffing," none of the deer would be able to graze, and no tiger or panther could scratch its ears with the claws of the hind foot, a favourite pastime with all the cat tribe when quite at ease. We must make honourable exception to the samples of stuffing shown in Messrs. Nicolay's collection, No. 4512, in the nave. By passing round to the rear of this stall, the visitor will see what is probably the finest example of truly scientific mounting ever accomplished. It is a group of a tiger and a serpent in combat, by J. Kiellick of Buttesland Street, Hoxton, and has been rewarded, as it deserved, with a medal. This is an anatomical study rendered romantically truthful by the spirited conception of the artist. Under the western dome will be seen one of the two royal Bengal tigers sent by Colonel Reid (398), the other we have not found, but it is probably close at hand. Though mentioned last, this is the grandest contribution of a strictly zoological kind in the whole of the Exhibition. In none of our museums have we a specimen so truthfully modelled as this. Here, indeed, is the expression, attitude, and proportions of life; this tiger can scratch its ears, or bound noiselessly through the jungle in pursuit of its terrified prey, or escape the hunter who has marked him for a prize. If the zoology of the Exhibition does not invite lengthened or elaborate comment, it is because man rather than Nature is the subject of its illustration, and if the zoologist finds but little to call for special remark, the ethnologist will be well rewarded, for it has served to bring together a greater diversity of living human forms than could have been hoped for had it been professedly an ethnological congress, and we trust the students of the races of mankind have availed themselves of the opportunities offered them to add to their stock of knowledge derived from observation.

THE INFLUENCE OF MASS ON THE PRODUCTION OF INFUSORIA.

BY HENRY JAMES SLACK, F.G.S.

In the account given of M. Pouchet's experiments on the production of infusoria, in the Intellectual Observer, vol. i. page 88, reference is made to his theory of the influence of the mass of fermenting matter on the character and number of the minute beings whose appearance is observed. If your readers will turn to the article alluded to ("Conditions of Infusorial Life,") they will find ample details of M. Pouchet's investigations, but it will be well to cite his exact words on the particular subject of these remarks. He says, "it is evident from this experiment (one mentioned in an article), and from many others which we have made of the same kind, that the organization and the number of animalcules became elevated in direct proportion to the mass of the body in a state of decomposition."

With a view to test this assertion, I took twelve test tubes an inch in diameter and about three inches long, arranged in two rows in a mahogany stand. By this means the extent of surface exposed to the atmosphere would equal that of a good sized vessel, and thus the chance of catching floating germs would be considerable, while from the small dimensions of each tube a fermentation of very limited extent could be conveniently carried on.

The tubes were charged all alike, with about six drams of distilled water, and exactly three grains of finely chopped new hay in each. The whole set was placed on the mantelpiece of my study, a room with a north aspect, and in which the summer temperature remains tolerably steady. The experiment was commenced on the 4th of July, and the tubes were examined on the 17th of the same month, the thermometer having indicated about 65° during the whole time. The hay had floated in each vessel, and thus was favourably situated for atmospheric influence, and in every case a mouldiness was noticeable. Number 1 contained minute vorticellæ, mostly without stalks, the body when expanded being about 1—400″. When contracted these little creatures were lemon-shaped, the short neck being like the nipple-shaped projection noticeable on that fruit. They were active and lively, showing alternate contractions and expansions, and strong ciliary motion. No. 2 had a number of minute pear-shaped animalcules, with conspicuous vacuoles at the thick end, and at the other a narrowish neck ending in a small expanded tube. I do not know exactly what they were, but their form was much like that of the *Spathidium hyalinum*, drawn in *Micrographic Dic-*

tionary excepting that their necks were narrower. No. 3 contained minute paramecia. No. 4 possessed creatures resembling urostyla, but less than one-fourth the proper size. They had also in front a conspicuous bunch of cilia. The pellicle contained multitudes of dead vibrions, minute and short, with a few of a longer shape.

At a later examination No. 2 contained a quantity of round and pear-shaped creatures about 1—500″ long, frequently changing their form, and being covered with fine cilia. No. 3 had small kolpods. No. 4 kolpods and paramecia. Nos. 5 and 6 kolpods exhibiting numerous minute cells all full of granules. The remaining tubes were similar to the preceding, except one that contained many small rotifers (vulgaris) which preserved their small dimensions for some weeks.

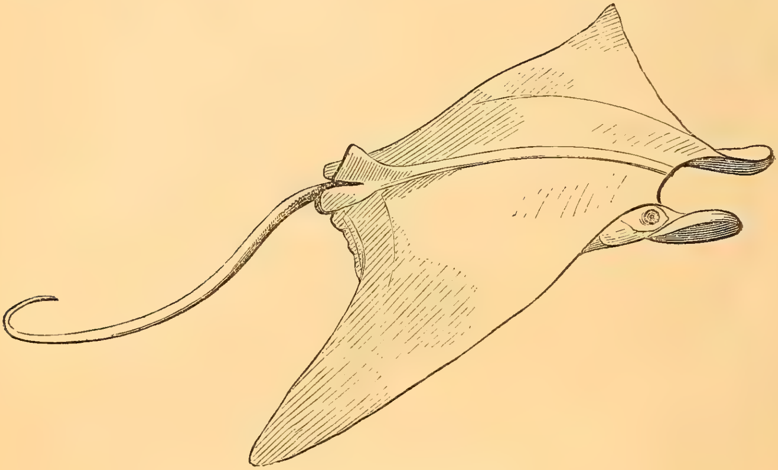
In these cases the quantity of hay was much less than in M. Pouchet's experiments, but in every instance ciliated infusoria appeared, and thus no confirmation of his views was obtained concerning the dependance of organization on mass. It should however, be remarked that all the creatures were minute. Some larger specimens were found after three or four weeks, but not one of full size.

I have thought it might interest the readers of the Intellectual Observer to call their attention to these simple observations, as analogous experiments are easily performed, and although few persons would be disposed to adopt M. Pouchet's theory in its entirety, the real influence exercised by the mass of fermentible or putrescible matter present in an infusion is well worthy of research. In every instance I obtained animals of high organization under the conditions described.

THE DEVIL-FISH OF JAMAICA.

BY THE HON. RICHARD HILL.

The *Cephaloptera* taken in Kingston harbour, on the 10th of April, which I am about to describe, though small, being only four feet in breadth from the extremity of one pectoral to the other, and but two feet one inch and a half from the centre of the head to the dorsal fin, situated at the extremity of the trunk, with a length of whip-like tail, two feet six inches more, —exhibits all the character of the *Cephaloptera Massena* of Risso. As this specimen of a Devil-fish, the smallest with which our fishermen are acquainted, was a gravid female, having within it a fœtus just mature for extrusion, sixteen inches broad, I take it to be a species distinct from any hitherto noticed. It does not resemble the monsters that have been described as common with us—its length of tail being a peculiarity not recorded in any of the accounts of devil-fishes taken in Kingston harbour. The back curves regularly, so that it looks humped; the eyes are lateral, being in the vertical wall of the head, with air valves behind each eye. The tail extends immediately from the angular dorsal fin at the extremity of the trunk. The colour is dark vinaceous violet, and green about the curvature of the head—the under parts are white. It will be seen that the Cephaloptera Massena closely represents the fish I am about to notice in all things but diminutive magnitude.



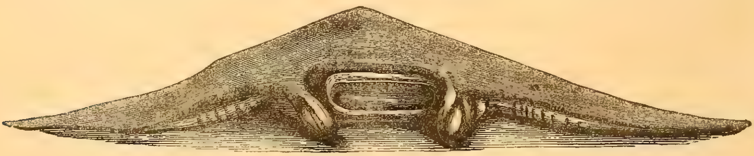
THE DEVIL-FISH OF JAMAICA.

"The species Massena," the great fish of the Mediterranean, says Risso, "until lately unknown to naturalists, is dusky black above, and dull white beneath. The head wide, is as if it had been cut straight along, and is furnished on either side with what is called a horn—a prolonged part of the fin—composed of cartilaginous rays like the pectoral. The two appendices of the head are on their inner side of a white silvery hue, with the extremities black. They display motion at will, directed towards the object the fish desires to approach. The mouth is very wide, and nearly square. The upper lip, ridged with a fleshly membrane, has several ranges of teeth overspreading the upper jaw; the lower is covered with a similar set of teeth in a silver-tinted band. The iris of the eye is of a dull yellow, with the pupil black. The pectoral fins are triangular, with an upward curvature, and two ventral fins are between the pectoral and the dorsal fin. The long slender tail has three angular surfaces, and diminishes to a point."

The monstrous skate, said by Père Labat to have been observed by the negroes of Guadaloupe, and described as fourteen feet French broad, and ten feet from the head to the commencement of the tail, with the tail fifteen feet more, and altogether twenty-five feet long, was obviously a kindred ray to our devil-fish; and the monster spoken of by the early voyagers as suffocating the pearl divers, and known by the name of *Manta*, was a similar animal. But the devil-fishes, best known in Kingston harbour, which we will notice by and bye, differ from these species by having a tail short in length, but agreeing with the specimen recently taken, in being without any serrated spine, like the sting of the sting-ray.

I feel surprised that so careful an observer of distinctions in species as Mr. Yarrel, should have entertained the supposition that Risso, in recording two Mediterranean Cephalopteras, had mistaken one and the same species in two conditions of growth,—the *Giorna*, and the *Massena*. He says:—"I am aware that M. Risso considers he has found, in addition to the *Giorna*, a second species in the vicinity of Nice; but several good authorities believe that his examples of *Cephaloptera Massena* are only old and large specimens of *Cephaloptera Giorna*." Now, independent of the precise distinctions set down by Risso in the two species, he mentions as particular differences the tail spine that is present in one and wanting in the others. His words are conerning the Giorna, "aculeo longissimo ad basin caudæ apterygiæ;" and Massena, "aculeo nullo in caudâ trifariam aspera." This is a very important difference. The aculeus or sting is wanting in all our Cephalopteras, and the lengthened tail is found only in the species I now notice. In that respect it agrees with Father Labat's monster of Guadaloupe, and differs from Le Vaillant's Atlantic specimens, and from the enormous fishes described by Lieutenant Lamont in the *Edinburgh Journal of Science;* and from the gigantic ray taken in Delaware Bay by the smack "Una," and described by Mr. Mitchel in a letter to the president of the New York Lyceum of Natural History, in 1823. Having made these introductory remarks, I shall proceed to give my notes of the fish of April the 10th.

The position of the eyes is peculiar; the direct vision, that is, the seeing of objects immediately ahead of the fish, is cut off entirely by that projecting extension of the pectorals at their junction with the head, which gives the head the appearance of having horns. A divergence of the pectoral fins here forms two flat flaps when opened out, but they are always vertically rolled up, twisted like a coiled leaf, with a twirl that fashions it into a groove, through which the water can pass as through a cylinder, when the fish glides onward. Between these two horned processes of the head, horn-like in appearance, but not horn-like at all in structure, extends the crescent curvature of the head, beneath which opens the wide cavity of the mouth. It stands constantly open, the fringes of the five plates of gills being seen to stretch from one side to the other of the vocal floor. The eyes are placed in the straight vertical walls of the head, for the head is very angular. They are, consequently, capable of surveying objects only laterally. One sees clearly that the habit of the Cephaloptera is that of a ground-feeder. It is formed for shoving through the fields of turtle-grass, *testudinaria,* but, unlike the rays which are likewise ground feeders, it does not seize its prey on the ground, but pushing on through the marine herbage, it takes into its wide open mouth the congregated living things that are in its way—it may be the fish that nestle in the vegetation, or the naked mollusca that depasture there—at once swallowing them, or rather cramming them in with its cranial arms into its mouth and



stomach, without deglutition, having no œsophagus. As the animal in this gathering in of food cannot see forward, it must depend on casualties in the course it steers through the marine meadows for prey. The rolled-up head-fins between the crescented head, sufficiently direct the food to the mouth. The pectorals have the ordinary arrangement of the fins of rays. They move the fish onward by successive flaps, alternately right and left, and left and right. The figure of the fish is flattened, but not flat; the back is round and humpy; the dorsal fin is small and angular, and situated at the commencement of the tail.

"Most men," says White of Selborne, "are sportsmen by constitution, and there is such an inherent spirit for hunting in human nature, as scarce any inhibitions can restrain." Port Royal, usually exhibiting no stir of life out of the garrison or the dockyard, is thrown into a state of bustle and excitement at the intelligence that the naval and artillery officers are away for a day's sport with the devil-fish. Every boat on the beach is launched, and canoes in numbers are seen gliding rapidly, where it is announced that the harpoon has struck a sea-devil. A string of vessels is now fastened to the boat that contains the harpooner, and the retinue is towed away to sea for miles by the monster fish. If they bring him in, a team of oxen—if there were ever such a thing as a team of oxen in Port Royal—would not be able to drag him ashore. Just before I visited Port Royal, some seven years ago, the garrison officers had brought in two fishes after one of these exciting chases, but I learnt little more than that they were captured. A graphic narrative of the taking of two devil-fishes some five-and-thirty years ago, will be found in the eleventh volume of the *Edinburgh Philosophical Journal*, and this narrative, which was communicated by Lieutenant Lamont of the 91st Regiment, I will condense and give here.

The lieutenant had been called to the beach by seeing a multitude gathered to look at a sea-devil floating past. His curiosity turned to surprise when he saw flapping on the surface of the water, about twenty yards from the shore, a large, living, dark-coloured mass, whose shape and size he could not immediately determine, but which seemed prodigiously big beyond anything he could conceive, since it so much exceeded all that he had seen or heard of fishes. The boats were started off to pursue it passing onward. It was harpooned; but no sooner was the monster stricken, than it made off with amazing velocity, towing the boat of the harpooner after him. A succession of boats now came up. These strung themselves on to the harpooner one ofter another, striking each a harpoon as the boats came up. They consecutively formed a long line, but such was the strength of the fish, that the whole retinue were trailed out ten miles to sea. Night was drawing on. To bring the chase to a close another harpoon was struck into the monster, when it made one convulsive effort to get away, and broke loose, carrying away eight or ten harpoons and pikes, and leaving every one staring with astonishment at the success with which it snatched itself eventually from its pursuers.

Lieutenant Lamont gives another account of the taking of a devil-fish within the harbour, when the animal traversed up and down, dragging with such velocity the boat that struck him, that those who followed could not overtake it. The struggle of this monster to get away was tremendous. He plunged in the midst of the boats that now surrounded him; he darted from the surface to the bottom of the water, and from the bottom to the surface alternately, dashing the water into foam on every side, and rolling round and round to extricate himself from the pole and line. Unable by these expedients to get away, he set to swimming and towing the boats now strung together. After continuing this run for a time, this sea-devil then suddenly brought the retinue to a stop by laying himself at the bottom of the water. From this position the stretch and strain of all the boats pulling away from him, could not move him. Slackening their tension they enticed him inch by inch to rise. He once more was afloat, when a shower of musket-balls and pikes literally riddled him through and through. Though wounded in this way, he still floated alive. Until this capture was effected by Lieutenant St. John of the artillery and his military companions, it was supposed that a sea-devil was beyond the main and might of human art or strength. The dimension of this fish was not more than half that of the common size—it was only fifteen feet in width. A man, however, entered its mouth with ease, the space being two feet and a half.

Lieutenant Lamont says, that wishing to know what the sea-devil fed upon, he saw the stomach opened. It was round, and studded with circular spots of a muscular substance. It had transverse muscular layers from one end to the other, and contained nothing but slime and gravel. The weight of the fish was so great that with difficulty forty men, with two lines attached to it, dragged it along the ground.

In the account of the fish taken in Delaware Bay, it is stated that, drawing a boat after it with the celerity of a whale when harpooned, it caused a wave to rise on each side the trough of the sea several feet higher than the boat; that during the scuffle the vast fins of the fish lashed the sea with such vehemence that the spray rose to the height of thirty feet, and rained dropping water around to the distance of fifty feet; and yet the measurement of this fish was only half that of the generality of those seen, being only eighteen feet in breadth. Three pairs of oxen, one horse, and twenty-two men, all pulling together, with the surge of the Atlantic to help, could barely convey it on to the dry beach.

When Lieutenant Lamont speaks of the cavity of the mouth being so wide that two men could be seated within it, it must be remembered that the Cephaloptera—added to a much greater degree of extension than is common with the ray tribe—has a mouth and stomach constructed without any intervening œsophagus. Both form together but one cavity, and the dimensions are disproportionately large to the bulk of the body.*

The largest of these fishes that ever came under my own eyes was when I was on board a vessel of Bordeaux, on my way from Haiti to France. We had just cleared the last of the Bahamas, and as we gently scudded onward with the wind on our beam, we sailed close along one of the Cephalopteras

* Lorenzini's account of the torpedo's structure is:—"Lo stomacho e continuato con la bocca, una sola, et una medisima cavita, la quale a proporzione de la animal è vasta." Quoted by Dr. John Davy, in his account of the torpedo *Researches Physiological and Anatomical*, vol. ii.

leisurely flapping and floundering on the surface of the broken water, striking first one fin into the air and then the other, and presenting a bulk of living flesh half the dimensions of the vessel. The sea-devil is the fish that Barrère and other travellers speak of, of such uncommon dimensions, springing above the surface of the sea, and splashing the water to an immense height when falling into the sea again. It was these fishes that Le Vaillant saw in his second voyage to Africa, the smallest one, which he caught, being twenty-five feet long in the body, and some thirty feet wide in the fins. It is of this fish that Sonnini speaks when he represents a flat fish seen on the surface larger and wider than the vessel he was sailing in. The most interesting narrative is that of Risso, of a fish taken in 1807, in a net at Nice, called a mandrague, a net divided into chambers, and stretched out with anchors, and gathered in by boats. It was a female, *Cephaloptera Massena*, the *vacca* of the Mediterranean fishermen. It weighed 1328 lbs. avoirdupois. When the female fish had been taken, the male, which was afterwards captured, and weighed 885 lbs., haunted for two days the spot where its mate had disappeared. The female had been trussed up, by having its tail stuck into its gills. In this posture it moaned piteously. The companion fish wandered round and round the nets, searching for it, and was finally taken in the same mandrague in which its mate had been caught, but was quite dead. There is something amusingly touching in this love of sea-devils —the moaning captive, and the woe-begone wanderer seeking his lost one, with the lover finding no solace but in dying in the toils in which the object of his affection had perished.

Are we to take the occurrence related by Colonel Hamilton Smith, in the *Boca del Drago* of Trinidad, as appetite or mere devilry? He says that just after daylight, a soldier from the ship he was in was observed by the man in the maintop deserting, swimming from the vessel. He was called on to return, but just at the moment a devil-fish threw one of his fins over him, when he disappeared, and was seen no more.

The sea-devils luxuriate much upon the surface of the sea. In Kingston harbour, where at times they are common enough, they have excited great apprehension by being unexpectedly approached floating on the surface, or swimming just beneath it. The horn-like processes, mistaken for a mouth wide open; the flapping fins so much apart, creating misconceptions of the form of the fish and of its dimensions, and increasing the dread of danger at a distance; and even the disregard of the fish for objects out of the range of its lateral vision, in seeming to be in pursuit of what may be ahead, when it is only indifferent about avoiding it, because it does not perceive it, are incidents that terrify. Sometimes the evening excursionist, on the quiet moonlight waters of the harbour, has been alarmed by a sudden drenching billow in a tranquil sea, nothing being seen to account for the unexpected wave, the fact being that a devil-fish at the moment had been neared by the boat, and had heaved the waters with its fins in hastening away. Fortunately, the Cephaloptera is not as frolicsome as it congeners, the sting-rays. The *Trygon* and the *Myliobatis* will frequently spring out of the water, and pitch themselves on to a distance like quoits. The Cephalopteras are only fond of sauntering about in the sunshine, flapping their breadth of fin in and out, first one fin and then the other. In an early morning sail that I took some years ago from Passage Fort to Kingston, amid the stretch of shoals there, with their clumps of mangroves,* the devil-fishes were to be seen dotting the waters like lotus-leaves in a pond. It is on the sands thereabout that the *Scyllium cirratum* will be found basking by hundreds in the month of July. This scyllium is the nurse-shark, and to these banks the fishermen go to "strike" them, as they phrase it, and take them for their oil. Here a multitude of fishes will be seen sporting at early morning. The *esox* amuses itself with leaping from left to right and from right to left over every stick floating in its way. Here the *Hemiramphus* will be observed spinning along the smooth sea in successive skips, with only his tail in the water, which he uses like the propeller of a screw-steamer; and here we meet with our cetaceous dolphins rolling and tumbling. Inhabitants of the water are very frolicksome in the uprising daylight. I confess that when I see their sportiveness, the evidence of their exuberant enjoyment of life, their swimming hither and thither, sometimes few and sometimes many together, swift or slow, gentle or rapid, just as it pleases them, the element seems to me to have in it that especial pleasantness exhibited by a parcel of boys in a morning bathe. Water has a feeling of comfort exceedingly appreciable, and I think, above all, sea-water.

The Cephaloptera seem to me to include in the different forms of their numerous species (for the species are undoubtedly many) all the caudal diversities of the ordinary ray, or skate family. Some have the whiplike tail of the *Trygon pastinacstæ*, armed with the serrated spine, as the *giorna* of the Mediterranean; some the same flagelliform tail, lengthened and small in diameter, as in the *Myliobatis aquila*, but without the caudal spine, as in the specimen here particularly described, which I would call the *Massenoideæ;* others are short-tailed and spineless, as in the *Raia batis*, or tinker skate of Norfolk (England). Such are the monster skates of Kingston harbour described by Lieut. Lamont. Again, the caudal fin is forked, or double-lobed, as

* For a very interesting account of the mangrove-tree, see Gosse's *Naturalist's Sojourn in Jamaica*, pp. 245—7.

in the torpedo. Such was the form of the tail in the Atlantic specimens taken by Le Vaillant in his voyage to Africa. All these differences elevate the Cephaloptera into a family of the *Plagiostomi*, as distinct as the squatina is from the raia, or the torpedo from the trygon.

Risso concludes his description of *Cephaloptera Massena*, the great monster fish of the Mediterranean, with these observations. He says:—"It is a fish of dimensions so extraordinary, of a shape so remarkable, and endowed with such singular affections, that one undoubtedly feels astonished it has remained unknown till now, living, as it does, in a sea in which systematic fishing has been carried on for so many ages. It is true that it is exceedingly rare, and that its capture is always looked upon as a presage of great events by those whose minds yield to prejudices. These fishes, however, come near shore only when they are driven in by storms."*

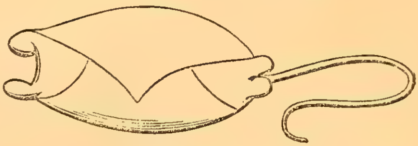
One cannot contemplate the expanse of flesh in a sea-devil without wishing for a sight of the giant economy when the skin is removed, with its numerous phalanges divided into parts; its cartilaginous belt, girding in the cavity of its mouth and stomach; its carpal bones, its pelvic apparatus, and that cranial expansion with its adaptation for scooping in food. The gigantic mass would present a prodigious map of the structure of the fish.

The Cephaloptera affect the surface waters to obtain the necessary degree of warmth for the maturation of the fœtus, the fish being viviparous. Our fishermen say that the mother fish makes the violent leaps she is seen to take out of the water to eject the fœtus from the matrix; that the young fish is then observed to fall from her; and that for a time it swims upon the parent's back, and possibly enters the wide mouth-sack when necessary to seek shelter from apprehended danger. As approach to these monsters is always hazardous, the observation of such a fact as this last must ever be casual and doubtful. Nothing is certain but that its habits are peculiar. Le Vaillant, when speaking of the three fishes he saw in 10° 15′ north in the Atlantic, one so large that it seemed fifty or sixty feet wide, relates that they all three carried each on his horns a white fish about half a yard long, which appeared to be stationed there on duty as

* Le Cephaloptère Massena, est un poisson dont les dimensions sont si extraordinaires, les formes si remarquables, et les affections si singulières, qu'on sera sans doute étonné qu'il soit resté inconnu jusqu'à ce jour; quoique vivant dans une mer sur laquelle l'art de la pêche s'exerce depuis tant de siècles. Il est vrai qu'il y est fort rare, et que sa capture y est toujours regardée comme un présage de grands événemens, par les esprits soumis aux préjugés. Ces poissons ne s'approchent des rivages que lorsqu'ils y échouent par l'effet des tempêtes.—*Ichthyologie de Nice, ou Histoire naturelle des Poissons du Département des Alpes maritimes*, par A. Risso, Membre associé de l'Académie Impériale de Turin. Paris, 1810.

sentinels to keep watch for the safety of the devils, and to guide their movements; that these sentinels passed over their backs when they rose too high, and repassed under them till they descended deeper, disappearing and being seen no more for a time, but reappearing and resuming their post as sentries, when the fish again ascended to the surface. These remarkable habits render the story of the young devil-fish swimming on the mother's back a probable occurrence. "During the three days," says Le Vaillant, "that the calm continued, and the ship remained motionless, these occurrences were many times repeated before the eyes of all on board as to each of the three monsters." These facts relate to the Remora or sucking-fish, but they illustrate the habit of the sea-devils, and possibly explain their association with their young, and their appearing to swim on the back of their mother-fish.

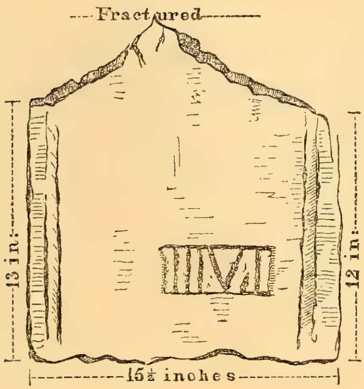
I have said the fish taken on the 10th of April in Kingston harbour, and named by me *Cephaloptera Massenoidea,* was a gravid female. The fœtus was in the stage just prior to birth. The colour on the back was as intensely violet as in the mother sea-devil, and the whip tail just as firm; the radial cartilaginous plates of the head lay flattened. The flukes of fins were folded over the back, lapping one another thus:—



The fins when extended were 16 inches across, the length of the body from head to the tail 24 inches.

Cephaloptera are taken in other harbours of Jamaica beside Kingston. On the 4th of May, 1854, a female devil-fish was caught in Montego Bay, another being seen at the same time in company. There being no shoal-banks about Montego Bay, the sort of grounds they resort to, these fishes had probably strolled from the Cayos opposite, the "Jardinas, or Gardens of the Queen," on the coast of Cuba, a prodigious feeding ground for all our tropical fishes.

[P.S.—Since the above was written the Hon. Richard Hill has communicated an account of another "sea-devil," caught in Kingston harbour on the 18th of April. In this specimen the cranial arms were flat, and not coiled up as in the fish of the 10th; the position of the eyes was different; the tail was only two feet long—quite a rudimentary proportion compared with the body, which was nine feet six inches long, and fifteen feet six inches wide across the expanded pectoral fins.]



ON AN INSCRIBED ROMAN TILE RECENTLY FOUND IN LEICESTER.

BY THOMAS WRIGHT, F.S.A.

In the course of excavations made in the year 1854 in Bath Lane, in Leicester, the workmen found, among other relics of the Roman town of Ratæ, a broken Roman tile, which presented in itself no particular interest. It was an ordinary roof-tile, flanged at the sides, measuring in breadth fifteen inches and a half, and in its present condition, for it is broken at one end, twelve inches on one side and thirteen on the other in length. When perfect, it perhaps formed nearly a square. On examination, however, this tile was found to bear stamped on its surface a legionary mark of considerable interest in regard to the history of our island under the Romans; considerable, I may state, only on account of the very faint glimpses history has spared us of the events which occurred in Britain from the second to the fourth century. It may be taken, indeed, as a very good example how relics of apparently little importance may often throw great light on our primeval antiquities, and how cautious we ought to be in despising or rejecting anything. To explain the interest of this old broken tile, it will be necessary to review briefly the history of the Roman legions employed in conquering and retaining this distant province of the empire.

It is hardly necessary to state that the military force of Rome was originally divided into a certain number of legions, the strength of each varying at different pericds from four thousand to six thousand infantry, with about three hundred cavalry. In Cæsar's first expedition to Britain, he brought with him two legions, which were, as we learn in the course of his narrative, the seventh and the tenth. In his second expedition he brought five legions with him; we know, from an incidental mention of it, that the seventh legion was one of them, and the tenth also probably accompanied it, but the names of the other three are unknown. As on the former occasion, these legions were all withdrawn on Cæsar's departure, and Britain was not again visited by Roman troops until the accession to the empire of Claudius, who, in the year 43, sent Aulus Plautius into Britain at the head of four legions, which are known from various authorities to have been the second, ninth, fourteenth, and twentieth. The first of these was commanded by Vespasian, the future emperor, and they seem to have been all what we should now term "crack regiments," proud of their reputation, and, under the influence of this pride, very ready to mutiny. Under the proprætorship of Sultonius Paullinus, the ninth legion only appears to have been left in the south, while the three others were employed, under Suetonius in person, on the borders of Wales, the second legion being especially occupied in establishing itself in the country of the Silures. At this time, no doubt, the Roman town of Isca, now Caerleon, in Monmouthshire, was founded, as well as Deva or Chester, the former to be the head-quarters of the second legion, the latter of the twentieth. It is well known that in the revolt of Boadicca, in the year 61, the ninth legion, which had attempted alone to arrest the progress of the insurgents, was nearly destroyed, and that Suetonius hurried to suppress the insurrection with the fourteenth and twentieth legions, leaving the second in the country of the Silures. Two thousand soldiers were sent from the continent to recruit the ninth legion, but, as far as we can judge from the accounts of what it had suffered, this number must have been very insufficient. The civil commotions which soon disturbed the Roman empire, prevented the arrival of further recruits during some years, while, besides other troops which were carried away from Britain to assist in the struggle for power, the whole fourteenth legion was carried to Italy by Suetonius Paullinus to support Otho against Vitellius, the latter being, as it appears, universally unpopular among the soldiers in this island. When Vitellius had secured the empire for himself, he was probably glad to remove the brave and not very loyal fourteenth legion to its distant province, and it returned to Britain with the new proprætor, Vettius Bolanus; but when Vespasian, who was personally known to the legions in this island, and was as popular among them as Vitellius was detested, sought to obtain the imperial purple, the fourteenth legion crossed the channel to assist him, and left Britain in A.D. 69, never to return. The number of

Roman legions in this island was thus reduced to three, the second, the ninth, and the twentieth.

All that we know of the subsequent movements of the Roman legions in Britain, which is very little, is gathered from one or two slight allusions in the Roman writers, and from inscriptions found on monuments which have been from time to time discovered on sites those legions had permanently or temporarily occupied. These inscriptions generally are of three kinds, those on tomb-stones, or dedications of altars, etc., or inscriptions relating to buildings which they had erected or repaired. The tomb-stones, commemorating only the deaths and burials of individuals, are but of secondary value, because the fact of the death and burial of an officer or soldier of a legion in a certain place does not necessarily imply that the whole legion, or even any considerable part of it, was there. The votive monuments are of more value; but the most important of all for our purpose are the inscriptions recording work performed by the soldiers. The Roman legions, in this respect unlike the troops of modern times, were never allowed to be idle; when not engaged in hostilities, they were employed on public works, such as making roads, throwing up fortresses, and erecting public buildings of various descriptions, and they commemorated their labours by inscribed tablets of stone, on which in some cases (especially in building defensive walls of great extent) the quantity of work performed by each detachment was stated, or by stamping merely the name of the legion on the tiles or bricks used in the construction. These last mentioned inscriptions are found in great abundance on the sites of the towns which were occupied by the legions.

When Julius Agricola undertook the conquest of the Caledonians, he no doubt carried with him to the north the three legions then in Britain. He was himself the commander of the twentieth legion, and we learn from Tacitus that the ninth legion took part in the decisive campaign against Galgacus in the year 83. This legion appears never to have recovered the losses it had sustained in the war against Boadicea, and it is described by Tacitus as being at this time weaker than the others; yet it was unfortunate enough to be left in an exposed position, where it was surprized and almost cut to pieces by the Caledonians. After this event, the ninth legion disappears from history, and the effective legionary force in the island appears to have been almost reduced to the second and twentieth legions. But when, in the year 120, the Emperor Hadrian repaired into Britain in person to put a check upon the attacks of the formidable Caledonians, he brought with him another legion, the sixth, which had been previously established on the borders of Germany. The emperor had with him in the north, with this new legion, the second and the twentieth, for numerous ascribed monuments still attest the work performed by each of these three legions in the erection of the great wall which by his orders was carried across the island from the Solway to the Tyne.

I must now speak of another peculiarity of the Roman military system, namely, the custom of establishing the different legions through the various parts of the empire in permanent quarters, which the same legion continued to occupy until the empire itself was broken up. We trace, in the narrative of Tacitus, the second legion establishing its quarters in the country of the Silures as early as the middle of the first century, and the twentieth was no doubt stationed at Deva about the same time; while inscriptions found at York leave little doubt that that city, called by the Romans Eburacum, was the station of the ninth legion, which had probably been placed there as a check upon the incursions of the Caledonians. The entire disappearance of the ninth legion after Agricola's last campaign in the north, has been explained by the probable supposition that Hadrian found it so greatly reduced in numbers that he incorporated it with the sixth legion, which he had brought with him from Gaul; and this, again, will explain why the quarters of the sixth legion were subsequently established at Eburacum. In the geography of Ptolemy, usually ascribed to the year 120, and apparently compiled very soon after the date of Hadrian's visit, these three legions only are enumerated as being then in Britain, the second legion at Isca (*Caerleon*), the sixth at Eburacum (*York*), and the twentieth at Deva (*Chester*). Tiles, with the legionary stamps of the second and twentieth legions, have been found in some places in Wales, and probably mark stations at which detachments of those legions were often posted, for reasons with which no historical records have made us acquainted; but the three legions just enumerated were never moved from their permanent head-quarters, until the time when the imperial authority was withdrawn from the island, and we have no account of the presence of any other legion in Britain. When, in the reign of Antoninus Pius, twenty years after Hadrian's expedition, the proprætor, Lollius Urbicus, marched against the Caledonians, he took with him all the legions in Britain, and the numerous inscribed slabs commemorating the building of portions of the great line of defence known as the wall of Antoninus, which have been found from time to time, make us acquainted with the share each of these three legions, and no others, performed in it. In the struggle for empire which ended in the elevation of Severus to the purple, in A.D. 197, the troops in Britain supported the claims of Albinus, and some portion at least of the legions went over to the continent to fight in his cause; but they appear to have returned to their old quarters soon after his defeat, for in the record which is known by the title of the *Itinerary of Antoninus,* and which is supposed to have been compiled about the year 320, we still find the second legion at Isca, the sixth at Eburacum, and the twentieth at Deva. About a century later, on the eve of the final withdrawal of the Roman legions, when the official work known as the *Notitia Utriusque Imperii* was drawn up, it appears from that important record that the twentieth legion had already been withdrawn from the island, and that the second legion had been removed from Isca to Rhutupiæ (*Richborough,* in Kent), probably on its way to the Continent, but where it remained under the disposition of the count of the Saxon shore; but as the sixth legion is there stated to be under the disposition of the *dux Britanniarum,* whose authority extended over all the garrisons in the north of Britain, it no doubt still remained in its quarters at Eburacum. None of these records intimate the presence of any other legion in Britain.

It must thus be a matter of some surprise when we find a monument recording the presence of the eighth Roman legion at Ratæ (*Leicester*); yet such is the case with the tile of which we are speaking, and which, with its stamped inscription, is represented in the accompanying cut. This inscription is easily read as L.VIII. The letters are, as will be seen, reversed, which is not very unusual on the stamps of the legionary tiles, and is explained without difficulty. The stamps for the pottery, and for other articles for sale and for domestic purposes, were engraved deliberately and with care on metal or stone, because they were intended for permanent use; but when the soldiers of a legion were proceeding to the erection of a building, and made the tiles for it, they probably cut their stamp hastily on a piece of wood for the occasion, and at times a worthy soldier thus employed forgot that what he thus cut on the stamp would be reversed in the impression. Examples of similar reversed inscriptions on the Roman tiles, made by soldiers of the second legion, will be found in Mr. Lee's excellent and valuable "Catalogue" of the antiquities collected in the Museum at Caerleon, recently published. The form of the letter L is another peculiarity of this stamp, for, though it is found in other inscriptions, it is not very common. It occurs in the inscription on an altar dedicated to the Deæ Matres found at York, the date of which is uncertain. It is also met with in an interesting Roman inscription on the rock of the Roman stone-quarries on the bank of the river Gelt, near Brampton, in Cumberland, which is engraved and described by Dr. Bruce, in his well-known work on *The Roman Wall* (page 64 of the second edition).

This inscription also is the work of legionary soldiers, and informs us that it was made by men of the second legion, when they were employed in quarrying here in the consulship of Flavius Aper and Albinus Maximus, which fixes the date to the year 207. It appears, indeed, that this form of the letter L was in use during the third century. It may be further remarked, that the peculiar character of this monument of the eighth legion has its significance. A mere tablet might have implied simply that the legion in its march had halted to raise or repair some work of defence; but a tile, and that a roof-tile, marked with the name of the legion, shows that the soldiers were employed in erecting buildings of a different character, and those buildings were most probably for their own accommodation. They were, in all probability, barracks. The tile thus furnishes strong evidence that the eighth Roman legion was stationed for some time at Ratæ, or Leicester, probably at some period in the third century.

We are not very well acquainted with the history of the movements of the eighth legion. It appears to have been stationed on the borders of Germany, and Mr. Roach Smith, in the second volume of his *Collectanea Antiqua* (page 140), enumerates tiles bearing its stamp found at Niederbieber, on the Rhine, which show that it was at some period stationed there. We have no intimation in any historical record of the sending of this legion into Britain, and the date and object of its visit are, therefore, left entirely to conjecture. If it had come over hither with Severus, it would hardly have been left at Ratæ, but would more probably have been taken to the north; and we have no reason for supposing that that emperor brought a legion over with him. But the latter part of the same century was the age of Carausius and Allectus, and when Constantius came over in 292 to restore the rebellious province to the empire, and had need of a very formidable army (as the three legions in Britain would be arrayed against him), it is extremely probable that he brought even more than one legion over with him. The eighth legion was ready at hand, as Germany and Gaul were in his division of the empire. Constantius, victorious, established his residence at Eburacum (*York*), which was now considered as the military capital of Britain; and as he came not to meet a foreign enemy, but to restrain a rebellious population, it is not at all improbable that, during his stay here, which ended only with his death, he may have stationed a legion at Ratæ.

Thus, in this inscribed tile, accidentally preserved, we have, perhaps, the only monument remaining of one of the most interesting events in the annals of our island during the Roman period, and one of which the history is very obscure, the re-conquest of the province by the Emperor Constantius, the father of that Emperor Constantine who went from Britain to make Christianity the State religion of the Roman empire. How many such monuments, in appearance worthless, but which might have assisted in throwing great light on the history of our country, have been destroyed through the ignorance of those who happened to find them! It ought surely to be a warning to us to be cautious in rejecting or neglecting any relic of antiquity, because it may appear at first sight of small value or of trifling importance.

ORGANIZATION AND LIFE.*

FROM the earliest ages of speculative thought, the human mind has occupied itself with the vast and perplexing questions of organization and life; but notwithstanding centuries of experience to show the proper limitations of such an inquiry, it is still rare to find a writer or an investigator who will adhere to an inductive method, and abstain from mingling the guess-work of mere hypothesis with the pursuit of experiment, or the elucidation of fact. An inquiry into organization necessarily belongs to the domain of physical science, and demands physical methods of procedure, which are incapable of dealing with elements of a purely metaphysical kind. Physical science reveals a wondrous order and harmony of forces and arrangements, extending through all the time and all the space with with which we are acquainted; and as our minds take cognizance of such facts, we are irresistibly led to the contemplation of an Intelligent First Cause. Let us, however, distinctly understand that it is not a mechanical process, a chemical process, or a physiological process that conducts us to this result; all that the physical sciences do is to give us information, about which we cogitate according to the laws of thought, and thus arrive at a perception of their connection with a class of powers that no physical methods can reach. The apparatus of the chemist, the scalpel of the anatomist, the microscope of the minute inquirer, or the telescope of the astronomer, cannot be employed without displaying to us the results of Will, Intelligence, and Design; and yet it cannot be said that it is through them that we learn the primary truth concerning the Source and Origin of all the phenomena which Nature presents. An

* *La Vie et ses Attributs dans leurs rapports avec la Philosophie, l'Histoire Naturelle et la Médecine*, by L. Bouchut, Médecin de l'Hôpital Sainte Eugénie. Professeur agrégé de la Faculté de Médecine, Chevalier de la Légion d'Honneur, Baillière.

inquiry into life requires the combinations of physical and metaphysical methods, because under the term life we include things which differ as widely as human emotion and the development of an egg. We say life is one, and we say nature is one, but we do not mean to assert that there is no difference between a granitic mountain and a shooting star, nor ought we to forget the distinction that separates the function of digestion from an impulse of the mind. To call life a *principle* is to place ourselves on the highroad to confusion, because we start with a definition which assumes a knowledge that we do not possess; and we moreover jumble together a variety of causes and effects.

A principle means a *beginning* of some kind. The principles of a science are those elementary facts and conceptions which form its foundation. In another sense, a principle is a first cause. We likewise find that principle is often used to signify not a sense, but a nonsense, and thus we hear of the "electrical principle," the "caloric principle," the "vital principle," or any similar phrase intended to give ignorance a learned look. If we take life to mean all the acts and properties exhibited by living beings, our first business is to separate them, and study each class in an appropriate way. The phenomena that belong to physical science will have a physical cause for their appearance; and a physical cause is not a volition, or an intelligent power, but simply a condition, or assemblage of conditions, that are invariably followed by another state of things that we call an effect. If we ask *why* there is this invariable link between certain antecedents and certain consequents, physical science cannot tell; and it is a metaphysical science that resolves the difficulty by pointing to that Intelligence which is the Great Cause of all.

Those who are curious to study the history of opinion on the question of vital manifestations will find it ably traced in Barclay's *Life and Organization*, and it is interesting to note that, so early as Empedocles, a bold effort was made to avoid the confusion into which investigators are still apt to fall. According to that philosopher every animal possessed a rational and a sentient soul, the former derived from the gods, the latter from the four elements of which it was imagined that the universe was composed. In this rude hypothesis there is an attempt to separate the phenomena of organic life from those of consciousness, which we do not find in M. Bouchut, the latest writer on the same subject, who tells us that "by *vital force* matter *feels*, *moves*, and assumes *forms* more and more complicated, from the creation of vivifiable organic matter to the most completely organized being." This same "vital force" which has bewildered so many subtle heads, M. Bouchut considers he has "demonstrated" to be "extra-organic," and he calls it "an *intermediary of the soul,*"* whose mysterious union with the body represents the entire being. Plunging thus headlong into conjectural metaphysics, we are not surprised to be told that "life creates in each species of creatures the special organs that are to serve as the instruments of its activity. The functions create the organs, and after that all goes on by the mediation of physical laws." We hope this learned Professor does not represent the condition of French intellect dwarfed by Napoleonic despotism; but we read with astonishment his arguments to prove the strange theory we have announced: "All vegetables and animals *feel,*" so runs the book, and they do this "with or without organs of sensibility; they all *breathe,* but with different organs of respiration, from the plants which have no respiratory apparatus, and certain animals that breathe through all their tissues, up to insects which respire through trachæal tubes, fish that have gills, and birds and mammals that possess lungs." "Here is a fact," exclaims our author, "which proves against those who contend that the organ creates the function; and it is infinitely more true to say that the function creates the organ." Whether the animal be a symple polyp or a complicated man, the function is not performed until there is an organ to perform it; the difference is that in the higher creature an immense advance has been made in the adaptation of a special structure to a special use.

Even apart from intellectual manifestations, it is clear that living beings do things that are not done by inorganic matter; but we are not entitled to ascribe the whole assemblage of such acts to a "vital force," or some entity totally distinct from any physical force; nor should we say that "when once *life is incarnated in matter,* it produces effects which in their turn act as causes," and so forth. We can trace the circumstances under which an animal lives, but, apart from religious ideas, we have not the faintest conception of *why* it lives, nor will physical science help us in the research. In his great work on *Logic,* John Stuart Mill remarks that although it would be an important addition to our knowledge, "if proved, that certain motions in the particles of bodies are among the *conditions* of the production of heat or light; that certain assignable physical modifications of the nerves may be the *conditions* not only of our sensations and emotions, but even of our thoughts; that certain mechanical and chemical *conditions* may, in the order of Nature, be sufficient to determine to action the physiological laws of life;" still, "it must not be supposed that by proving these things, one step would be made towards a real explanation of heat, light, or sensation." In the same spirit, Bacon warns us

* *Intermédiaire de l'âme.*

"not to suffer the understanding to jump and fly from particulars to remote and most general axioms (such as are termed the principles of arts or things)," and he adds, "we must not even add wings, but rather lead and ballast to the understanding, to prevent its jumping or flying, which has not yet been done; but whenever this takes place we may entertain greater hopes of the sciences." Had M. Bouchut followed the Baconian advice he would not have told us that the "three attributes common to everything endowed with life are, (1.) *impressibility,* or the unconscious faculty of feeling external impressions without any participation of the nervous system; (2.) corpuscular movement, automatic movement, or *autocynesy,* that is to say, the faculty possessed by the elements of living matter to move themselves in order to form species, and to do this without dependence on the properties of any structure;* (3.) *promorphosis,* or faculty of giving to amorphous elements a form determined beforehand, and conformable with the type of the species." An "unconscious faculty of feeling" is not intelligible: a faculty or facility, for the words are the same in origin and meaning, can be neither conscious nor unconscious, and an unconscious feeling is no feeling at all. In describing the second alleged property of every living thing there is equal confusion. What is meant by the "elements of living matter?" Are the atoms of oxygen, carbon, and so forth, declared to possess an automatic power, independent of the structure to which they belong, "to move themselves in order to form species"? "Impressibility" is affirmed to be "an attribute of life which exists in all tissues, which it animates independently of their textures." The physiologist does not know life apart from some living thing, and when a writer addresses us like M. Bouchut he is substituting metaphysical guess-work for scientific fact.

Life, as we know it, consists in actions that are obviously physical, and in operations that bear no analogy to any physical process. It is probably a complete mistake to represent life as controlling or resisting mechanical, chemical, or electrical forces. While an animal lives, its tissues are built up and taken to pieces according to a regulated method which is compatible with its continued existence, but all the physical operations of its life proceed in strict accordance with physical laws. If its albumen does not coagulate at a temperature that causes other albumen to undergo that change, it is not because a mysterious "principle" determines otherwise, but because the chemical conditions of coagulation exist in one case and not in the other. The power of maintaining heat is purely physical, and combustion follows the same laws in the body of the man as in the

* "En dehors de toute propriété de structure."

furnace of the locomotive. The power of resisting heat is equally physical, resulting from evaporation and other processes which experimental science can trace. When the body is dead, the amount and direction of the forces is altered, and then, of course, the changes that ensue are of a different kind. It is incorrect to say that no change has taken place except the escape or departure of an immaterial principle. The nerves no longer transmit, nor do the nerve centres generate, those physical forces that determine the actions of structure that is alive. Mr. Lionel Beale discovers a complete circuit in the nervous system, strengthening the analogy with phenomena of an electrical kind. Other physiologists trace a connection between the consumption of phosphorus and the amount of thought performed by the brain. Here we have two sorts of incidents, the connection of which no physical investigation can elucidate. The changes in the brain, and in the secretions, no doubt, follow chemical and other physical laws, and are simply the results of the direction and intensity of forces of the same character as those which preside over the material world. They thus form fitting subjects for the research of the physiologist. But when we arrive at the question of why thought is connected with a brain, and why changes in the condition of that brain precede or accompany mental manifestations, our inquiry belongs to a totally different sphere. No polarization of particles, or oxidation of phosphorus can help us here. The ultimate cause is the will of Deity; and if we seek for more we must do so in the direction of utility, and correspondence with that great scheme of creation, of which so small a part is unfolded to our gaze.

Let physical science give up the search for the *why*, and tell us *how* the universe proceeds. We start, and we conclude, with the conviction that an Intelligent and Benevolent Will is in all and over all, and in tracing the wonderful operation of what we call secondary causes, we exalt our conceptions of the only real Cause that animates and guides the mighty whole.

THE HISTORY OF THE SALMON.*

The artificial breeding of fish affords an opportunity of resolving many interesting questions in the history of certain members of the finny tribes, as well as the means of augmenting the supply of food. It is now many years since Mr. Boccius introduced the system of pisciculture into this country, and although we are not able to affirm that salmon has become any cheaper in consequence of his exertions, there appears no reason why our most favourably situated rivers should not, once more, be well stocked with this much admired article of diet, or why ponds should not abound, in which humbler species of edible fish might be reared as a profitable article of trade. As neighbourhoods become populous, and a host of manufacturers settle down on the banks of romantic streams, it will become impossible to enforce any system of preservation, or to prevent the pollution of the water with some material inimical to piscine life. There will, however, remain for many years comparatively secluded streams in which a very moderate expenditure of capital would ensure a large and remunerative stock of fish.

The Stormontfield experiment is only a small one, but it has nevertheless led to important results. The scene of its operations is on the Tay, about five miles from Perth. Three hundred hatching boxes are arranged in parallel rows, with a walk or path between each. "The boxes are filled to within an inch or two of the top, first with a layer of fine gravel, next with one of coarser gravel, and lastly with stones as large as road metal." Before being put into the boxes, the deposits are freely exposed to sun and air to kill the larvæ of water insects that are very destructive to the fish, and currents of clean water from a filtering pond are allowed to flow freely through the apparatus when it is arranged. All being ready, a pair of salmon are captured to supply the spawn and the milt. The ova of the female are discharged in a tub by a suitable pressure and stroking motion of the hand. The milt is added in a similar way, and the water agitated to bring the two into contact. The impregnated spawn is then removed to the propagating boxes, and Mr. Brown tells us that the salmon colour of the ova is noticeably brightened when the milt comes into contact with them. This process goes on pretty quickly, so that in an experiment which began on the 23rd November, 1853, 300,000 ova were deposited in the 300 boxes in the course of

* *The Natural History of the Salmon, as ascertained by the Recent Experiments in the Artificial Spawning and Hatching of the Ova for Rearing of the Fry at Stormontfield, on the Tay.* By William Brown, Secretary to the Literary and Antiquarian Society of Perth. Murray and Son, Glasgow; Paton and Ritchie, Edinburgh; Hall, Virtue, and Co. London.

a month. To settle the question of whether impregnation took place before or after the female deposited her spawn, Mr. Buist had one box filled with eggs to which no milt had been artificially applied, but not one of them hatched, although a similar batch to which the milt had been added soon produced a goodly supply of young.

The following account of the hatching process will be read with much interest, although, to many of our readers, from the numerous accounts that have appeared from time to time in the papers, the information may not be new. Mr. Brown informs us that "on the 31st March, 1854, the first ovum was observed to have hatched, which was 128 days from the deposition of the first, and ninety-eight days from the deposition of the last of the ova. A high or low temperature of the water will accelerate or retard the hatching; ova have been hatched by us in sixty days in a constant temperature of forty-four degrees, but in the rivers of this latitude from 100 to 140 is the time, according to the season. We were furnished with a few ova, and by keeping up a supply of pure water, we were gratified by observing the little creature bursting the shell. The fish lies in the shell, coiled round in the form of a bow, and the greatest strain being at the back, it is the first part that is freed, and after a few struggles the shell is entirely thrown off with a jerk. The appearance of this fish at this stage is very interesting; what is to be the future fish is a mere line, the head and eyes large, the latter very prominent. Along the belly of the fish, from the gills, is suspended a bag of large dimensions in proportion to the size of the fish. This bag contains a yolk which nourishes the fish for six weeks, after which they must be fed." When this bag is absorbed, the young salmon becomes a "fingerling," or parr, from an inch and a half to two inches long. The young parrs are permitted to enjoy themselves in a pond, and are regularly regaled with boiled liver of the ox or sheep ground small. Upon this diet they thrive, and in about a year reach the size of the parrs found in the river.

In 1855 the first migration of the Stormontfield "smoults" took place. "On the 19th May, Mr. Buist, becoming convinced that the fry had become smoults, *i. e.* had taken on the silvery scales, caused a great many to be marked by cutting off the dead, or second dorsal fin, and turning them into the river." The sluice was drawn, but they showed no desire to depart till tho 24th May, when a large shoal went off. "On the 7th July, 1855, the first marked grilse was caught returning from the sea, at a fishing station near the mouth of the river Earn, a tributary adjoining the Tay, a little below Perth. This grilse weighed three pounds, which was a large growth in so short a time, "as the weight of a smoult before it reaches the tidal wave is from one to two ounces." With reference to the time at which the character of the fish is changed, Mr. Brown informs us that one half go off the first year, and the other half remain in the pond; and, he adds, "until the parr takes on the smoult scales, it shows no inclination to leave the freshwater. It cannot live in saltwater. This fact was put to the test by placing some parrs in saltwater, and immediately on being immersed in it, the fish appeared distressed, the fins standing stiff out, the parr marks becoming a brilliant ultramarine colour, and the belly and sides of a bright orange. The water was often renewed, but they all died, the last that died living merely five hours." When the parr is covered with new scales it is ready for sea bathing. When it "returns as a grilse, its scales came off with the slightest handling, and it is only when it returns as a salmon, or has been long enough in the sea, that the scales become rigid and firm."

Among the various experiments in marking the fish to recognize them at a future period, silver rings were employed, but the individuals thus decorated appeared peculiarly attractive to their enemies, and the method failed. Mr. Brown contends that the success at Stormontfield justifies operations on a much larger scale, and it appears that Mr. Ashworth and his brother are making extensive experiments in Galway.

Among the natural history facts established at Stormontfield, we may mention, the proof that the parr is not a distinct fish, but the young of another fish, the salmon parr being the young of the salmon. It also appears that "the male parr is as fit to continue its species as the adult male salmon, but no female parr has yet been discovered with the roe developed." Among the fry that assume the migratory dress during the first year, the two sexes figure in nearly equal proportions, but why some remain behind for another year has not been ascertained. "That the smoults return again to the river in which they were reared has also been proved by the number of marked grilse which have been caught in the Tay since the experiment commenced. The experiment has also proved that the marked grilse of one year return as salmon the next, and we think it has also proved that all the smoults of one year do not return the same year as grilse, the one half returning the next spring and summer as small salmon."

We have selected from Mr. Brown's work—all the more valuable because the information is carefully condensed—a few points of general interest; but we recommend all who are specially concerned, to consult its pages, as it contains a clear exposition of a subject of considerable economical importance, and throws much light upon many scientific questions in the history of the fish about which it treats.

THE ELM AND ITS INSECT ENEMIES.

BY SHIRLEY HIBBERD.

In a paper entitled "Insects Injurious to the Elm," by Mr. H. Noel Humphreys, which has appeared in this work (August, 1862, p. 28), mention is made in somewhat approving terms of M. Robert's proposal to disbark elm-trees, in order to recover them from the diseases alleged to be caused by the attacks of insects. Observations extending over many years, varied occasionally by direct experiments, have convinced me that the elm enjoys an almost total immunity from the attacks of insects, and that, therefore, the accusations made against Scolytus destructor and Cossonus linearis are entirely unfounded, or rather have their foundation in a misconception of the facts. When so able a writer as Mr. Humphreys espouses Robertism, there is danger to be apprehended, and to avert that danger, I assert, in the first place, that neither Scolytus nor Cossus ever injure healthy trees, and that if they did so, the system of M. Robert would be more likely to hasten their death than their recovery. Mr. Humphreys has so truthfully and explicitly described the insects themselves, and their modes of boring and tunnelling in the tree, that there will be no occasion to refer to that part of the subject, except to point out the sources of error in the application of the facts.

It may be as well to state that there is nothing new in the hypothesis which assigns the death of elm-trees to the ravages of xylophagous insects.

There has been much written on this subject, and in nearly every case the writers have adopted arguments similar to those used by Mr. Humphreys, who, so far, is perfectly orthodox in concluding that as these insects are found in diseased elms, that therefore they are the cause of the disease. In the *Edinburgh Philosophical Journal*, 1824, is an account by Mr. M'Leay of the decay of elms in St. James's Park, in which he attributes their destruction to Scolytus. In *Curtis's Illustrations of British Entomology*, No. 11, is an admirable figure of Scolytus destructor, with a description in which the allegation of its destruction of elm-trees is repeated. In 1827 there was published in the *Cambridge Chronicle* (November 9), an account by Mr. Deck, of the decay of some elms in the front of Catharina Hall, in which he said—"their death has been decidedly occasioned by the ravages of a small beetle of the genus Scolytus, and of the species emphatically termed 'destructor.'" An admirably written reply to this, by Mr. J. Denson of Waterbeach, appeared in the *Magazine of Natural History*, 1830.

The journals of more recent date abound with notices on the same subject, and the discussion was reopened by a leading article in the *Times* newspaper of the 30th January, 1862, wherein the *procédé Robert* was cautiously advocated as "worth a trial" in this country.

That Scolytus destructor does bore through the bark of the elm and feed on the alburnum is not to be disputed. But let it be observed that the perforations are made in June and July, when the sap is in full circulation, and any small wound in a healthy tree heals over in the course of a few days. Let a healthy tree be then selected and bored with an instrument, so as to imitate as nearly as possible the action of the beetle. The experiment may be made still more complete by inserting in the borings some small shot or beads, in the same way as the insects deposit their eggs. In the course of a week or less it will be impossible to find those artificial perforations unless the part of the tree where they were made was marked for the purpose, and when the marks are examined, it will be found that the sap has deposited new material sufficient to close the perforations; so that if, instead of shot or beads, real eggs of Scolytus had been inserted, those eggs would be hermetically sealed up, and nothing but a miracle would save the larvæ from perishing. I believe it can be proved to demonstration that the race of Scolytus destructor would be exterminated in one season were the female beetles so misguided in their instincts as to deposit their eggs in healthy elm-trees; the power of vegetation would annihilate the brood by investing every cluster with vegetable tissue so dense as to cause their suffocation, even if the eggs were hatched, and that event would probably be as impossible as for the larvæ to eat their way either in or out. But elm-trees die, and are found on examination to be freely mined by these insects, yet they attest in their death that the insects were not the cause of death, and another experiment will explain it. Cut down a healthy elm, and the next season the root will throw up a forest of suckers. Ring a healthy tree, and unless it can form a new junction by granular extension of the edges of the bark on both sides of the ring, and on the upper edge especially, the same thing will happen; in fact, a healthy tree will refuse to be extinguished unless assaulted above and below, and it is reasonable to conclude that if an army of Scolytus, Cossonus, and Cossus were to commence their ravages in a tree previously in full vigour, the diminished vigour of the head would cause the roots to make efforts at once to replace the head with strong shoots from the roots. But when trees are found in a state of decay, and apparently owing to the ravages of these insects, there is such an absence of suckers and offshoots, that in *that* respect they differ as much from healthy trees of the same species as in their general decrepitude of stem and branch.

But suppose we should for the moment grant that these insects sow the first seeds of dissolution in the life of the tree, will the *procédé* Robert recover them? In attempting an answer to this question we might discourse at considerable length on vegetable physiology, but there is no occasion, for the simple reason that we could say nothing new. M. Robert is said to strip the trees of their bark entirely, "the scolytus and cossuses are instantaneously annihilated, the trees throw out new layers of liber and even increase in bulk more rapidly than their mutilated contemporaries."—(*Times*, January 30, 1862.) If this is a correct account of the process, M. Robert is bold enough to strip the trees down to the *cambium layer*, which would no doubt clear away scolytes, leave cossuses untouched, and cause the death of the trees the same season. But we are very much of opinion that M. Robert has been misrepresented. In two letters addressed to us on the subject by M. Robert, he repudiates the idea of stripping a tree of its whole thickness of bark, and admits that such an operation must be followed by speedy death. He says, moreover, that he proceeds cautiously in removing vermin from the outer bark, and at the same time endeavours to *renew the roots* of the affected trees in order to promote a free flow of sap and a more active vegetation. More than this, M. Robert denies that he has had anything to do with those wretched elms that are to be seen in some of the avenues of Paris, tied with haybands, splintered up with barrel staves, and variously sliced and chopped about as if elaborately operated upon by means of a knife and fork.*

We may come now to a more reasonable view of the case. M. Robert is said to have recovered thousands of trees. But this has not been done by "flaying" them. He removes the outer layers of corky bark, which are often wholly occupied with colonies of insects. The removal of these may be of no immediate benefit to the tree, but the scraping away of the rough external bark without hurting the liber, to say nothing of penetrating to the cambium layer, has the effect of quickening the flow of the sap and improving the health of the tree, and

* "Les principales objections qui sont faites à mon système de traitement des arbres (scarified elm-trees), reposent sur une fausse interprétation. Il est évident, que si j'enlevais l'écorce d'un arbre dans toute son épaisseur, ou jusqu'au bois, dans l'espérance de le sauver, je justifierais la comparaison : 'An operation not much less bold in its own way than that of flaying a human being.' Le remède seroit, à coup sûr, pire que le mal. Mais ce n'est pas ainsi que je procède : je laisse, par un procédé qui m'est propre, assez de tissu cortical pour prévenir l'accident qu'on semble redouter, tout en détruisant avec certitude les larves ou vers qui toute l'écorce renferme, et cela, progressivement, pendant la guérison de l'arbre."—*Extract from a letter from M. Robert to the writer of this paper.*

if the roots are aided by new soil and suitable nourishment, no doubt the trees are benefited, and by the same processes every good gardener would follow to reinvigorate old orchard trees covered with rugged bark.

But for this to be necessary, presupposes a state of disease or debility in the trees operated on. This cannot be caused by Scolytus, which, as we have shown, not only does not, but cannot, attack a tree in full health and vigour. The tree first exhausts the soil in which it is growing, or some circumstance renders that soil no longer suitable for it. It begins to languish; the beetle then discovers that it is a suitable prey, and plays the part of *scavenger,* which is its proper office in the scheme of nature. To Scolytus has been assigned the task of eating up *dying* elm-trees; it never attacks a dead tree, never attacks a healthy tree, but riots in the elm when its reparative powers have already received a shock, and it is passing from life to death by atrophy. The appearance of Scolytus is a *sign* only that the tree has passed its heyday, then it may be possible to recover it by judicious treatment of the roots, and the removal of the epiphlæum, or corky layer; but to leave the roots alone and strip it to the cambium, will be but to hasten the process which has begun already, and with which Scolytus has had nothing at all to do. In a grove of elms, one here and there will be found infested with Scolytus, but the rest are untouched. Did Scolytus originate the diseased condition, all would be attacked alike, but it selects those that are in such a languid state, that when pierced for the deposition of eggs, they are unable to close up the small wound and entomb the larva in a mass of vegetable cells. There is one more proof for those who will observe for themselves, and draw conclusions from facts only. Whenever elm-trees seem to be decaying, it will be found that there is a pavement, or a hard pathway, or a drain, or something else over or near their roots, which prevents those roots exercising their nutritive functions in a normal manner. The elm roots near the surface; it likes a strong loam and plenty of moisture, and free access of air to its root fibres. When these conditions do not exist, or where, having existed, some change of circumstances has taken place, the trees will sooner or later decline in health, and when the process of internal decay has commenced, the insects peculiar to the elm take possession, and make a speedy finish of their work. The prudent forester will lay the axe at the root of an elm the moment he finds Scolytus in it, and take warning from the fact that the conditions of the soil are such that other elms must follow, unless, as M. Robert remarks, some attention be paid to the roots as the source of nourishment to the tree.

SPIRANTHES AUTUMNALIS,

NEOTTIA SPIRALIS, or *Ladies' Tresses.*

BY L. LANE CLARKE.

SCARCELY perceptible to the careless eye is the modest beauty of this little orchid, the last of its family that will unfold for us this year the "Manuscript of God" concerning the orchis tribe.

Deeply interested as all intelligent readers must be in Darwin's delightful book, for the facts he has recorded, the study of the British orchids will henceforth be an ever-recurring recreation to the observant eye.

First, in the early spring, the purple orchis mascula, and last, in the autumn time, this little white Neottia will again and again recall the wonder with which we first learnt the mysterious fertilization of orchids.

Of the three thousand species Lindley has numbered, most varied and fantastic in form are the exotics; but scarcely less curious are the spider, the bee, the fly, and the butterfly orchids of our own woods and meadows, and a minute examination of those which haunt our path will surely be acceptable to the intelligent observer.

The Spiranthes autumnalis is now abundant in dry pastures; it is thickly dotted on the Malvern hills, on the light pastures of the Isle of Wight, and the meadows and cliffs of the Channel Islands.

The spiral cluster of small white flowers is so insignificant in appearance, that more than once I have heard the exclamation of—"*That* an orchid?" Even so—gather one, and come and see.

It will require a microscope to discern all its beauty; but a pocket lens will show us much, and we shall learn from this one specimen what it is quite necessary thoroughly to understand, before we can appreciate the discoveries of Darwin.

The flower spike (fig. 1) is given natural size. The other figures are all more or less magnified.

In the single flower (fig. 2) we observe the plan upon which all orchids are fashioned, the number *three* ruling the plant, however modified by the Creator, "for whose pleasure they are, and were created." Three sepals, three petals, three pistils, and twice three stamens. These are not discernible at first, because the large lower petal, or labellum, is so prominent, and two upper petals are joined together, and one of the sepals adheres to them so closely as to require particular attention.

SPIRANTHES AUTUMNALIS.

Of the three pistils, one is modified into a rostellum or beak, *r*; the other two are confluent, and form a cup, the surface of which is the stigma. This stigmatic surface, *s*, like all other stigmas, becomes at a particular moment highly viscid, attracting and retaining the pollen grains, which throw their granular tubes down the loosened tissue, to fructify the ovules in the ovary beneath, *o*.

Six stamens, according to Lindley and Hooker, are discoverable in the perfect orchis; only one fertile anther is apparent in Spiranthes, which now demands close attention.

In examining a young Neottia with a pocket lens, and looking into the flower, we observe two pale yellow spots in the throat; these are the pollen masses or pollinia lying under the anther cell, *a*, and immediately over the stigma, *s*, attached to the rostellum, *r*, by a boat-shaped disk, in such a position as to render it highly improbable that the pollen grains of that flower can ever touch their own stigma. If a needle is passed into the flower, and this disk touched lightly, it will detach itself, and with it the whole pollinia, as in fig. 5.

This, on being pressed between thin glass under the microscope, will show the square or oblong pollen grains (fig. 6); or if applied to the stigmatic surface of an *older* flower, these bright golden grains will adhere to the glistening green cup, and be a beautiful object under a low power.

Some flowers, if stripped of sepals and petals, as in fig. 4, will show the anther cell empty, the stigma untouched, the flower unfructified—where, then, is the pollinia?

This is Darwin's discovery, that Spiranthes, like so many of its brethren, is indebted to insect visitors for the perfecting of its seed, depending also on the movement of its labellum, which at one period closes the throat, and protects the young stigma until its hour of maturity has arrived, then drops slowly down, opening its honey glands to invite the wandering bee, which bears upon its proboscis the pollinia previously extracted from a younger flower.

Resting on the sunny hills above Torquay, Darwin watched the intercourse between insect and flower. The little Neottia giving forth a sweet perfume to attract the living "winged things;" he saw the humble bee, as I have seen the hovering Syrphidæ and Tipulæ, and small Hymenoptera enter the flower cup; but these only entered one flower, and then flew away, I know not whither. Whereas he saw the bee always alight at the bottom of the spike, and, climbing up regularly, withdraw the pollinia from the upper and youngest flower, then fly to a next plant, rest for a moment on the labellum, which is moved aside, and whilst the insect sipped the nectar, the pollen mass was received by the expectant stigma. Then again mounting the spike, as the long and flexible proboscis was thrust into the scarcely opened flower, it could not fail to touch the sensitive rostellum, and bear away the disk and its pollinia.

The experiment is easily tried, and you will find that once fertilized the stigma becomes dry, and will receive no more pollen. There is no waste in any of the works of God.

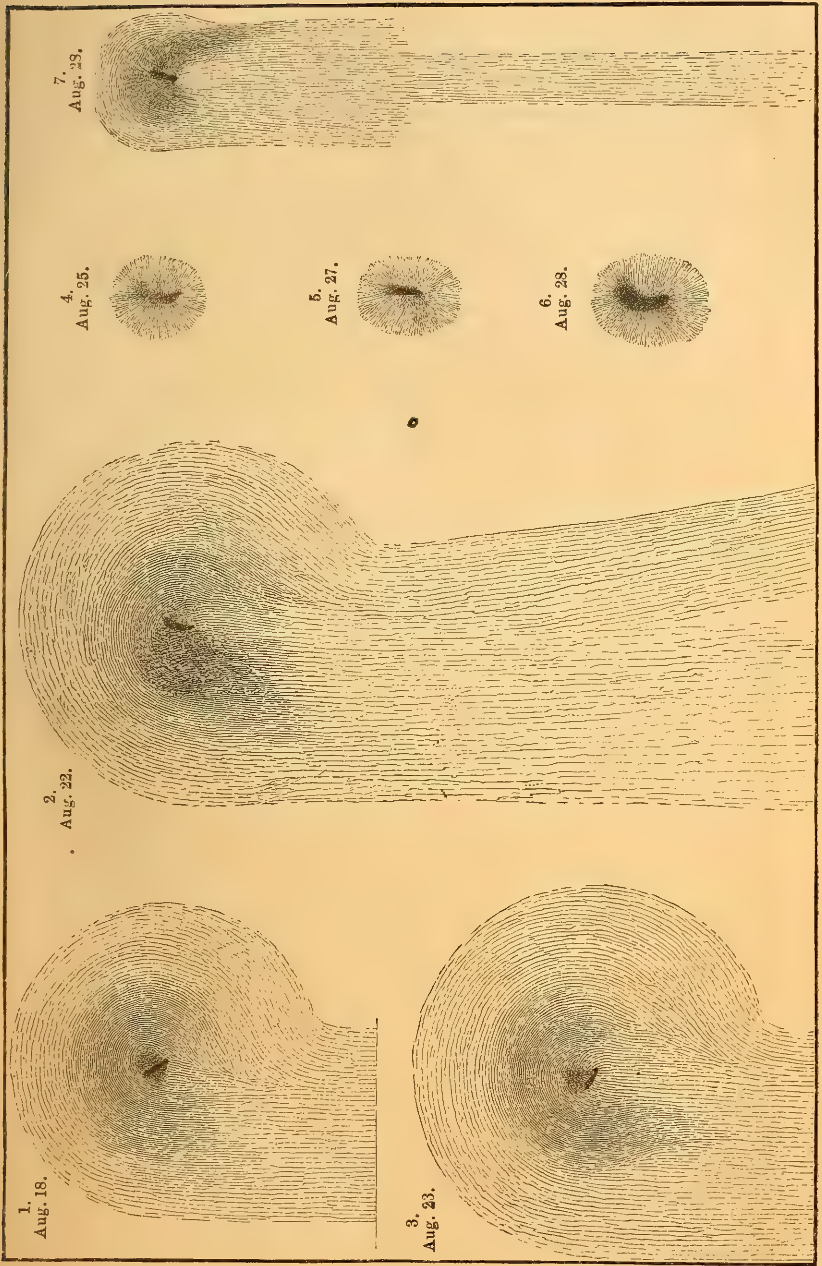
For more minute details of rostellum and disk, we must refer to Darwin's work, as the length of this paper is limited; but I wish to observe that a section of the ovary is well worth looking at, also the seeds, like pretty netted purses, which contain the germ of the future plant, fig. 8. A portion of the cuticle also, from any part of the stem or flower, will show jointed and glandular hairs, giving a crystallized appearance to the surface of these parts.

Fig. 7 is a mature ovary, with the withered sepals on its apex and the bract at its base.

COMET II. 1862.

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

After the magnificent plume of the "Donati," and the brilliant nucleus and wonderfully extended train of our visitant of last year, "Comet II. 1862" has possessed comparatively little claim to general attention; and even in the telescope several of the more interesting features of these most unintelligible bodies have been absent: but in such as have developed themselves, there has been much of an instructive character. There has been no well-marked separation of envelopes in the head, no dark channel like a shadow in the tail; but the emission of luminous matter towards the sun, and the librating or swinging motion discovered by Bessel in Halley's comet in 1835 have been so unequivocal as to be eminently worthy of study. My attention was early directed to these points, and in the following pages will be found such observations as our vapour-loaded skies have permitted, and the capacity of a 5½ inch object-glass has put within my reach. They may probably not be found in entire agreement with those made by other hands, and under other circumstances; and the student must be prepared for greater uncertainty in these matters than might have been anticipated. It is well known to all who have compared the records of cometary phenomena how variously their appearance is given by different instruments and observers; and


1. Aug. 18.
2. Aug. 22.
3. Aug. 23.
4. Aug. 25.
5. Aug. 27.
6. Aug. 28.
7. Aug. 29.

when even the comparatively well-marked features of Donati's Comet have met with discordant delineation at the hands of such men as Struve, Bond, Secchi, Lassell, Dawes, and De La Rue, it cannot, in fairness, be expected that any set of representations should be found in perfect agreement with others, especially under unequal circumstances as to optical power and transparency of atmosphere.

My first observation was on

August 14, in strong moonlight; when the nucleus had the aspect of a small star, with powers of 55 and 170, but became diffuse with 460. The coma was unequally distributed around it, being accumulated towards the sun; in this direction a dim and ill-defined brush of light issued from the nucleus, which was not effaced with 460. The tail, which was short and faint, issued chiefly from the left (inverted) side of the coma, giving an irregular aspect to the head, as though the axis of greatest brightness made an angle of 30° or 40° with that of the tail.

August 18. A clear night, but tremulous definition. The comet is a noble object in the comet eye-piece, power 27. The extent of the coma is very indefinite, but from a comparison with the diameter of the field may be put down at 15′. The tail can be traced with this eye-piece about $3\frac{1}{3}°$, it rises from little more than one-half, or perhaps two-thirds of the coma, on the left inverted, or diurnally preceding, or orbitally following side; towards which side its edge is sensibly concave, as well as brightest and best defined. Its breadth at its origin may be 10′; at a distance of 1° from the nucleus, about 22′. Its structure is streaky some way from the head, but there is no central darkness. Nucleus stellar with 55, 82, and 110; 170 begins to show a hazy border; 460 confuses it; its diameter may be estimated, very uncertainly, 1″ or 2″. A ray issues from it to the left, not centrally or directly, but with a kind of twist at its origin, the nucleus being in a line with its lower (inverted) edge; so that we have a kind of reduced copy of the whole comet in its own interior. 27 shows this ray, but it is much more distinct with 55 and 82, and is still evident with 170 and even 460. No clearly marked trace of an envelope, but something like a feeble sector of light, best seen with 27: the direction of the right side of the tail being assumed as 0°, its commencement may be fancied about 150°: thence it seems to advance, as to the vertex of a parabola, towards the sun; receding on the other side, it encounters the ray at about 210°, and is merged in the general light of the coma somewhere near 270°. All this is exceedingly indistinct; but it is more evident that there is a difference of hue, giving a particoloured and patchy aspect to the head; the nucleus and ray being yellowish, the whole coma, but especially the sector, pale greenish-blue. The extent of the ray may be one-fifth of the radius of the coma. One micrometrical measure of position of tho ray, about 13h. gives 280° : at 10h. it had been estimated larger, perhaps 290°, but this was probably an illusion. Fig. 1 is a rough sketch of the head.

August 21. Haze and clouds : but in an interval comet well seen with 27 and 55. The whole is brighter; the sector more distinct and defined, especially to the left: the ray seems, however, somewhat less distinguished from the sector, and more divergent: measurement frustrated by gathering haze; but I believe the position is much the same.

August 22. A night of such great transparency and fine definition that the *comes* of 110 Herculis is pretty steadily visible. There has been a remarkable change. The nucleus is very small and faint, and, as it were, dissolved; barely star-like even with 27, and fading more and more with intermediate powers up to 460. The ray has become a kind of feather, slightly curved, concave to the inverted right, having the nucleus at the quill end, and expanding at the other to about one-fourth of its length. Its position at 11h. is, by one measure taken along the chord of its general curve, 250°, by a second, 249°·5; the agreement being, of course, accidental in so nebulous an object. The nucleus seems to melt away into the feather, which springs directly and centrally out of it. The sector of last night is much altered; anything beyond 27 is too high for the details of the coma; but it seems of feebler light beyond the end of the feather towards the sun, while a slight increase of brightness flanks either side of the feather, but is much more distinct and extensive on the left, on which side, however, the light seems to be indented by a kind of little bay or inlet, between the end of the feather, and the furthest advance of the light towards the sun. This brighter area, which may be an enlargement of the left side of the sector of August 18th, extends back towards the tail, till it reaches a very indistinct boundary, possibly a portion of a parabola in which the nucleus may stand, making an angle of perhaps 150° with the direction of the feather; the area is terminated on the left by a distinct, though not defined, set-off of light, not effaced with 55, 110, or even 170, which appears to form one side of a parabolic envelope; a narrow dark channel is suspected beyond it, but cannot be verified. The haze exterior to this set-off is suddenly and uniformly fainter; on the opposite side of the head nothing of the kind can be traced. The nucleus and feather are yellow, the surrounding light greenish-blue; but I think the contrast less marked than on August 18th. The diameter of the head is about 17′, but extremely indefinite. The tail is now divided by a darker interior space, much lighter, however, than the sky; the separation commencing some way behind the head, and becoming more distinct in its progress. The right inverted branch is much the longer, narrower, and better defined, reaching certainly at least $3\frac{1}{2}°$, and possibly considerably further; it seems concave to the right, not so perceptibly as before in any one field, but decidedly in the whole length (as to this, however, I have subsequently become uncertain, from noting the deceptive effect of the motion of an equatorial mounting, placed very far out of the meridian). The left branch of the tail is short, broad, comparatively faint, very ill-defined, and not extending more than $1\frac{1}{4}°$ from the nucleus. As far as its light is tolerably distinct, it would seem, with the intervening darker space, to complete the perspective of a hollow structure, but beyond its termination, the other branch streams onwards so distinctly defined on both sides, and insulated on the dark sky, as to preclude any other supposition than that of separate existence; it is here 7′ or 8′ broad, and does not expand at all in its progress; the definition of its edges is remarkable. The coma is generally less luminous on the side turned from the sun, but there is no dark interval for a considerable distance behind the nucleus, and the origin of the tail is confused; the right branch seems to point to the nucleus and the brighter area to the left of it, as far as the set-off; the left branch appears to be a continuation of the left side of the coma, exterior to this boundary; so that the origin of the central darkness might possibly be referred to the dark channel supposed to adjoin this set-off, could its existence be verified; this, however, is doubtful, as the region behind the head is filled with confused haze. The passage of the nucleus near several small stars is very striking. Micrometrical measures of *distance* cannot be taken, in the absence of an illuminating apparatus; and an attempt at estimation is subsequently found in error; but fig. 2 gives something of the general effect.

August 23. Very clear night. Another great change: the nucleus has become strikingly more brilliant, but not stellar, being undistinguishable from the commencement of a luminous arc, shorter, narrower at the further end, and less curved than the "feather" of last night, but of so sharp and vivid a light, especially towards the nucleus, as to bear distinctly every power even up to 460. With a beautiful microscopic eye-piece by Powell and Leland, power somewhere about 300, the nucleus could just, though barely, be distinguished at its end; it is very minute, and cannot exceed 1″. The wider extremity of the arc is less abruptly terminated than that of the feather; its direction is obviously quite changed, and either the feather has retrograded through a considerable space, or has faded and been replaced by a fresh emission at another angle; the only reason for the latter supposition is that, in the position occupied by the feather last night, there is a cloud, very slightly more luminous than the surrounding coma, in which a similar form may be traced; this is visible with a moderate power, but with 27 it extends further, and reaches down to the arc, so as to recall the feeble sector of August 18th, of which the faint cloud may form the most luminous part. It is possible that the nucleus may lie at the vertex, or in the course, of a parabola of haze, of which the left side may be traced in the drawing of last night, but this is uncertain; the set-off in the coma has faded so as to be barely perceptible: the colours in the head continue unchanged. The tail has closed up again so that the darker interior is filled in, and the whole looks narrower; the longer side is now much best defined on its right or external edge, the other being diffused in comparison; it may be readily followed with the comet eye-piece through $3\frac{1}{2}°$, and, precariously, as far again; both with this power and the finder it is seen to enlarge for some distance behind the head, and subsequently to taper off to a thin stream; its general aspect in the finder is straight. Position of chord of luminous arc, measured about 10h. 5m. G.M.T. gives 279°; a little later, 280°; about 10h. 35m. 281°·5. Fig. 3 is a sketch of the head.

August 25. Much cirrous haze, and the comet, though evidently much brighter than heretofore, is probably never quite clear. Another great change is shown with 27. The bright arc has totally disappeared, not a trace of it remaining with any power; and the feather has returned, in its previous form and position, being (9h. 15m.) the only perceptible feature in the head; it is, however, longer than before, and with greater proportional breadth, about one-third of its length, and much less distinguished from the coma, which may possibly be condensing towards the centre of the head. The nucleus is so exceedingly faint as barely to be made out with any eye-piece, the feather being only a trifle brighter at the quill end, which, like the other end, is broader than on August 22nd. 460 shows that either extremity is brighter than the centre; the broad end seems to occupy the exact position of the faint cloud of August 23rd. The edges of the feather are far less sharp than on August 22nd, nor do I think this, or the feebleness of the nucleus, chiefly due to our atmosphere, as the head is very brilliant, both with the comet eye-piece and to the naked eye. Measurement defeated by clouds, but position of chord of feather at 11h. 10m. guessed, very roughly, about 240°. See fig. 4, which represents only the centre of the head.

August 27. Sky very hazy. Nucleus not distinguishable from the commencement of the feather with any power, from 27 to 460. The jet itself is straight in its brightest part, but there is a faint effusion from it to the right, towards the end, where it is less vivid. 8h. 48m. position by a single, but careful measure, 240°. It has made a near appulse, a few minutes before, to a considerable star. 9h. 15m, I can make out the arrangement of the coma better in a darker sky with 82, and the impression of August 9th is revived, that the axis of luminosity makes a considerable angle with the axis of figure, or that the nucleus may lie some way to the left of the vertex of a very indistinct parabola of light. There seems to be a feeble indication of a renewal of the" set-off" or envelope. See fig. 5.

August 28. Much cloud and haze, but the comet conspicuous in occasional clear openings. Feather very striking with 27; having returned to the appearance of the 25th: it is, however, decidedly a good deal longer, with the same proportionate width; more curved, and less sharply defined, than before; the centre being a very little fainter than either end; a feeble branch from the nucleus towards the left beneath, suspected with lower powers, is confirmed with about 300. Nucleus very dim, even allowing for haze, barely visible with 27; sharp and stellar, but very minute, with 55 and 110; with 170 confused, and probably elongated in the direction of the feather. The general aspect is greatly altered since last night: the nucleus was then the almost undistinguishable source of a vehement emission of light; now, it floats, an exhausted speck, in the end of a great cloud, with which its connection might be thought merely accidental; 27 shows a slight darkness to the left of the end of the feather, in the axis of the general structure, recalling the observation of August 22nd. The colours and magnitude of the head remain unchanged, but the tail is much altered; there is little difference in the finder, but in the comet eye-piece it is much more divergent, spreading over 25′ to 35′, 1° behind the nucleus; the two sides are very unlike; the right is still for a short distance the better defined and stronger, resembling the edge of a hollow structure, but there is nothing corresponding on the other side, which is feeble and diffuse, and there is no appearance of central obscurity. For 1° or more, the right side is somewhat convex, but it grows rapidly faint, and is soon blunted or rounded off towards the axis; further on, the old straight narrow stripe may be traced, and presumably in its original position, but it is now much more feeble; it may reach 4° or 5°, but its length is quite uncertain, as is a suspicion that it may be on the whole concave. What, however, is undoubted, and very remarkable, is that the brighter side at its origin is no longer directed towards the nucleus, or near it, but much further outwards; it seems, in fact, to be one branch of a parabola, whose vertex lies exterior to the feather, though much within the coma next the sun, and corresponding, perhaps, on the other side, with the line of the old set-off, of which, however, no trace remains. Measurement impracticable from clouds, but position of chord of feather estimated about 250°. See figs. 6 and 7, the latter on a much smaller scale.

A succession of cloudy weather unfortunately terminated this series of observations at a time when they possessed the greatest interest, from the combination of a recent perihelion passage, subsequent to which the sun's influence is found to attain its maximum upon comets, with the nearest approach to the earth. Some remarks and deductions, aided by comparison with the more valuable observations of others, are reserved for a future opportunity.

Our readers will not fail to take every opportunity of studying the phenomena of Mars; the snows of his S. pole, and the curious configurations of his surface.

Only two occultations are visible at Greenwich during the month of October, and those at inconvenient hours.

OBSERVATIONS ON COMET II. 1862.

BY THE HON. MRS. WARD.

The second comet discovered in this year* has passed into southern skies, having, while yet above our horizon, faded away from unassisted sight. It made its nearest approach to the sun on August 23rd, and to the earth on August 30th, having been visible to the naked eye—visible, that is to say, where the state of the weather admitted of any heavenly body being observed, from about the 1st of August.

Those who viewed it on one of the calm clear evenings between the 23rd and 30th of that month may have seen it, much as in our Plate, at a conspicuous height in the heavens, the broad pale head seeming somewhat to surpass in size any of the larger fixed stars in its neighbourhood, but to yield in brightness to many of the smaller ones, while the tail, transparent and filmy, scarcely as evident as any part of the Milky Way, almost faded from view as one gazed at it, and seemed best recognized by slightly averting the eye. Yet no one could for an instant glance at the starry heavens, and fail to see it was there.

Such, I think, is a fair description of Comet II. The cir-

* Comet I. was discovered by M. Schmidt on July 2nd, and for a few days was faintly visible to the naked eye.

cumstances under which it was observed were favourable rather than the contrary. It remained during nearly a month in that part of the heavens where the stars, as viewed in our latitudes, do not set, from their nearness to the Pole; it came, not in the twilight nights of midsummer, but at a time when five hours of real darkness could be reckoned on; and above all,

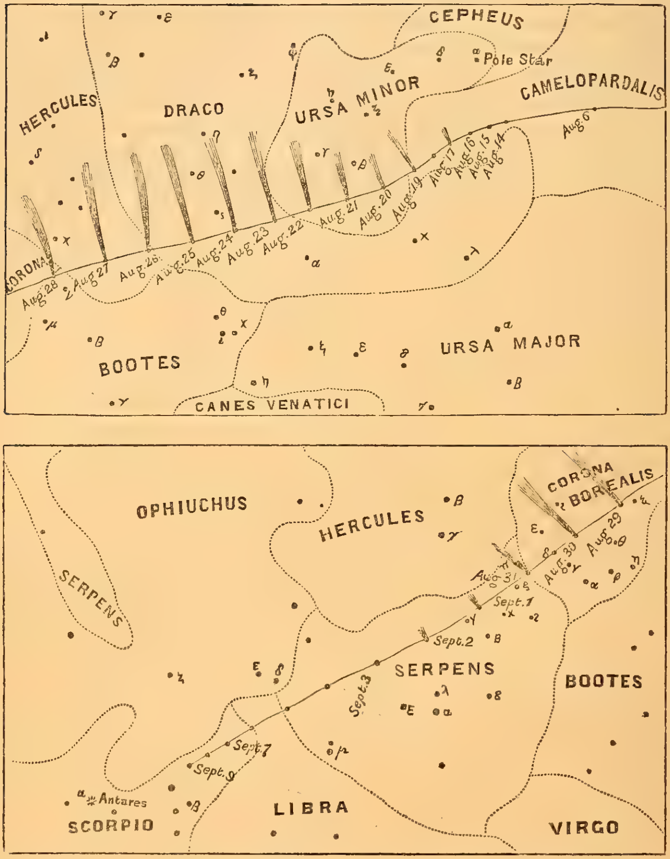


FIG. 1.—Plan of the Apparent Path of the Comet during nearly the whole time in which it has been visible.

the moon was absent during the greater part of the comet's best fortnight.

But I doubt not that many an intelligent circle of observers have felt somewhat discontented with Comet II. They have emerged from the more genial glare of a moderateur lamp "to see the comet," and, baffled in attempts to view its lofty position from a window, have scanned it out-of-doors, and I fear have agreed among themselves that it was "not worth the trouble of looking after." May we arrest some such party of observers, and ask them to pursue the subject of comets with us during a few pages? till perhaps the general interest of the theme may lead them to reconsider their verdict, and welcome every comet for the opportunities which it affords for the elucidation of problems interesting from their very difficulty.

The comet which we have just seen, has come, as all conspicuous comets, with one remarkable exception—Halley's Comet—have come, unexpectedly, and unforetold. It was discovered, independently, by at least three observers,* about the third week in July, as a faint, hazy comet, discernible only in the telescope. In the same manner, Comet V. of 1858, better known as "Donati's Comet," was discovered. Others have escaped notice till detected with the naked eye. No sooner however is a comet seen, than the work of prediction begins. The comet is subjected to a most rigorous inquiry. The elements of its orbit are roughly calculated, and improved as observations accumulate, by a multitude of ardent and expert computers. Old records are ransacked, and old observations put into tangible shape, so as to rescue from oblivion the orbits of ancient comets which present any similarity to that of the new visitor.† Then, the comet's probable changes of apparent position and brightness for several weeks to come are estimated, with a degree of minuteness which might well lead the uninstructed to suppose that the stranger must have been confidently expected for a long period.

Halley's, as we have said, is the one conspicuous comet which was really expected. Its appearance in 1758 had been foretold by Halley many years before. It came punctually, and was again promised for the year 1835. Those who remember the announcement of its approach in the almanacs which came out at the end of the year 1834, and who subsequently saw the comet in the following October, are likely to have obtained a strong impression of the degree of regularity to be found among the movements of these strange wanderers. Nor is Halley's the only comet which has been observed to return, although no other visible to the naked eye has done so. There are six comets, visible in the telescope, and known as the "comets of short period," which have several times returned at the calculated dates, and again retreated from view. They are remarkable for the smallness of their orbits which, notwithstanding their elliptical shape, are entirely included in

* These were Mr. Tuttle, at Cambridge, in America, on July 18th, MM. Toussaint and Pacinotti at Florence, on July 22nd, and M. Rosa at Rome on July 25th.

† Herschel's *Outlines of Astronomy*, art. 597.

that of Neptune. The period of these six comets vary from about three years and a quarter—that of the comet known as Encke's—to seven years and a hundred and sixty-three days, that of Faye's Comet. The probable returns of other comets have been foretold, but the day of fulfilment, in many cases, is far away; centuries, or even thousands of years hence.

Is then so little known, it may be asked, about each comet which appears? Have they not then the interest which belongs to the planets as known and established denizens of the solar system? Rather say they have a very special interest of another kind.

A comet—speaking in a general way—is composed of head and tail. There is a large ill-defined mass of light called the head, which is usually much brighter towards its centre, offering the appearance of a vivid *nucleus* like a star or planet. "From the head," I quote Sir John Herschel, "and in a direction opposite to that in which the sun is situated from the comet, appear to diverge two streams of light, which grow broader and more diffused at a distance from the head," and these commonly uniting into one mass of filmy light, and extending to an immense distance, form the comet's tail. This is not a matter of seeming. It is not merely that the brightness fades away from the region of the nucleus to that of the tail; *the nucleus forms the tail,* and subsequently retains a control over it, and this, says Mr. Bond, in his valuable account of Donati's Comet, "is one of the most curious phenomena presented in nature."

When a comet approaches that part of its parabolic or elliptical path which brings it nearest to the sun, some extraordinary phenomena begin to be observed in the region surrounding its nucleus. The nucleus (sometimes becoming suddenly brighter than before) throws out a jet of light *towards the sun,* which jet, though bright at its point of emanation from the nucleus, fades rapidly away, and becomes diffused as it expands into the "coma," or head. Another and another jet succeeds; and each, while expanding in the coma, curves backwards, as if impelled by a force of great intensity directed from the sun. And thus the comet's tail is formed. These strange phenomena, though observed in the cases of the great comet of 1811 and of some others, were first noted with minute attention by the illustrious Bessel in the case of Halley's Comet in 1835. The very night on which these wonders first manifested themselves was also signalized by the commencement of the tail of that comet. It is impossible (says Professor Grant) to doubt that this appendage derived its origin from the nebulous matter which had been in the first instance raised from the head by a force directed to the sun, and was subsequently impelled by a powerful force in the opposite direction.

Again, in the case of Donati's Comet, the nucleus, about a fortnight before the day of its nearest approach to the sun, might be plainly observed to throw out faint rays of light towards that luminary. At Rome, on September 16th, 1858, M. Rosa (one of the discoverers of Comet II.) observed *two* divergent streams of light shot out from the nucleus of Donati's Comet. These proceeded for a short distance towards the front of the coma, then abruptly turned backwards and streamed into the tail; and M. Rosa compared them to long hair when brushed upwards from the forehead, and then allowed to fall on each side of the head. Six days later they had given place to a fan-like bright sector (or semicircular disc of light). On the 27th, this "fan" appeared more spread out. On the 30th, the fan still continuing, a new set of phenomena began to appear. A succession of luminous hoods or "envelopes" were observed, like canopies over the nucleus from which they had been emitted, and these too ultimately streamed back into the tail.

The reader must not suppose that this streaming motion was visible to the eye. Taking into consideration the great distance of the comet, a movement of a thousand miles a day (such as, for instance, was observed in one of those strange "envelopes" of light) could not be detected as motion, though sufficiently evident in its effects. Thus Bessel, watching Halley's Comet, with unremitting attention during one long night in October, from sunset to sunrise, was rewarded by seeing a jet from the nucleus describe in that time an arc of thirty-six degrees; and Bond was able to observe the germs of the "envelopes" at the surface of the nucleus, and to trace them through successive stages to their full development.

Such changes, then, varying in detail, but bearing a considerable general resemblance in all bright comets which have been closely watched with the telescope, go on before the eyes of astronomers; but meanwhile, the cause of them remains a profound mystery; nay, more, they are seemingly in defiance (says Mr. Bond) of the best established properties of matter, the laws of gravitation and inertia. Here he speaks of the developments observable in the comet's own physical structure. With regard to the motion of comets in space, *there* the laws of gravitation do hold good; but, strange to say, it is the *nucleus* alone which moves in obedience to the attractive force of the sun and planets. "Immense volumes of matter," continues Mr. Bond, "apparently of the identical substance of the nucleus, go to compose the enveloping nebulosity and the tail, but from the moment of leaving the central body, their motion is perfectly inexplicable, without assuming them to be under the influence of laws of force, which greatly modify that of gravitation."

But I pause, for I fear the younger members of the party who have so patiently listened to the tale of "enveloping nebulosity," "gravitation," and "inertia," may tire of the recital. Shall we try a lighter strain,—a sort of short-hand or bird's-eye view of the subject?

Here, let us say, is a comet. Let us take Halley's Comet; for although possibly some of our other celebrated comets have come just as punctually, there were no Halleys or Newtons two or three thousand years ago to predict them. Here, then, is a comet which has obeyed the sun during seventy-five long years, coming back at last, and showing becoming deference on its way to Jupiter and Saturn, by lingering a little as it passed them by; here it comes, steadily and solemnly, when lo! a jet of light, apparently similar to itself, darts forward with force sufficient to overcome the motion which it must have had as a part of the comet's small, hard heart; strange enough, but stranger still, it soon tends backward, in opposition to both its original pace and its newly achieved outburst. Backward it streams, with what enormous force, and to how extraordinary a length! A comet—I could give name and date—emitted a tail sixty million miles long in two days; and the same comet brandished said tail in the manner of a straight and rigid rod, right round half a circle, in the space of two hours! in defiance of all received laws. It was *seen to do it;* eyes were not deceived, for the eyes of Newton saw it, and similar feats have been recorded since his time on the part of successive comets.

So, as we gaze after little Comet II. and wish it a long farewell, we say to it, with half-admiring perplexity, "You belong to a strange family; in part you obey our laws, and in part you are influenced by quite a different code—shall we ever understand you better?"

And not far from such thoughts are more solemn feelings, of deepest reverence for Him unto whom all his works are known, from the beginning of the world—who sees beautiful order where our limited senses seem to behold confusion, and who reigns supreme alike over the army of heaven and among the inhabitants of the earth.

I shall now trace the story of Comet II., so far as observations have hitherto been reported to me. Discovered first in Europe, July 22nd, it appears to have been concealed from the view of astronomers by adverse weather till near the end of the month, when Mr. Romberg observed it at Leyton, near London; its appearance through the telescope being that of a round nebula, strongly condensed in the centre.* On August 1st he observed the tail; Mr. Crumplen also saw it at Euston

* Letters to the *Times.*

Road, noting a dark appearance down its centre, and estimating its length at about a degree and a half. On the same evening M. Bulard saw it at Algiers, and M. Littrow at Vienna. On August 3rd it was viewed by various astronomers, among them Mr. Dawes, who was struck with the remarkable distinctness of the nucleus.* He noted that on the side farthest from the sun its edge was hard and sharp, but that on the side next the sun "a condensed stream of nebulous matter issued from the nucleus, gradually expanding itself, and at length falling back on all sides, and becoming mingled with the general coma of the head." "The whole appearance," he adds, "strongly reminded me of a fountain, ascending to a moderate height, and then falling over on all sides in fine spray."

Fig. 2, though belonging to August 15th, seems well to illustrate this description. It represents the comet as seen in an inverting telescope. The jet of light is also noticed by the other observers on August 3rd. On the 5th, Mr. Dawes observed similar phenomena; but truly remarks that about this time the sky usually presented an aspect more like December than August. Nevertheless, a few notes were made on the 7th by other astronomers. Professor Challis observed an approach to the form of a sector in the bright central portion of the coma, and he noted that the right border of the comet's tail seemed brightest when seen in the telescope.

FIG. 2.

Mr. Howlett, F.R.A.S. (to whose kindness I am indebted for the figures which illustrate this part of the narrative, as well as for much information concerning the comet), first saw it on the 14th, and took the above sketch on the 15th, at nine P.M. On the early morning of the same day, Mr. Hind estimated the comet's brightness to the naked eye, as being about equal to Gamma in Ursa Minor, and the tail three degrees in length.

Meanwhile, I had enjoyed no single view of the comet. For a whole fortnight I had vainly watched to see even a single star winking through my large staircase-window. But late on the 17th, a starlight night came at last; I then, to make up for past disappointments, watched the comet carefully from midnight till half-past one. I knew where to look, from the calculations which had appeared in the *Times*, and at once saw the "woolly appearance" which had been familiar to my eyes in the case of the great comet of 1861, in its last days of feeble visibility. I could not see the tail with any certainty till I viewed it with the telescope; then it became visible, but not to

* *London Review*, August 16th.

any great distance from the head. The whole head was decidedly brighter than the tail, and I noticed a remarkably round effect in its shape, and also that in some way the comet's eastern side was somewhat better defined than the western. I imagined a sort of curve in the comet's general shape, but the whole object was so faint that I could not define what its form might be.

I saw it next on the morning of August 20th, at four o'clock, but only to observe it fade in the daylight shortly after the disappearance of Eta in Ursa Minor; again, however, in the evening I saw it well on a black sky, its tail now tolerably visible, though short, and through the telescope displaying a streaked and unequal appearance. I thought the head not so much brighter than the tail as it had appeared on the night of the 17th.

Meanwhile, some friends at Florence had observed it on the 16th. Even there, adverse weather had frequently concealed it from view, and when seen on the 16th, the tail was barely perceptible.

FIG. 3.

Mr. Howlett furnishes me with the annexed sketch of the comet (fig. 3), as observed on the 19th, accompanied by the following note:—"Observe the very strikingly *partial* method of the development of the comet's tail, which was almost exclusively confined to the eastward of the imaginary line joining the nucleus and Zeta Ursa Minoris, towards which I could trace it on the 19th instant, at eleven P.M., for eight degrees. At this time the preceding luminous jet appeared to me to form an angle of about 168 degrees with the general direction of the comet's tail." Mr. Howlett also remarks—"What a contrast the appearance and form of the comet presented, as drawn respectively on the 15th and 19th instant."

I should here perhaps explain that my reason for employing Mr. Howlett's drawings in preference to my own (which strongly resemble them), is, that the telescope which he employs, being three and a quarter inches aperture, brings out the delicate details of the comet with more completeness than I can expect from mine, which is an inch less in aperture; and his plan of drawing is likely to ensure much correctness. He does not make his sketches literally at the telescope, being impeded by the well-known obstacle in the way of representing faint objects by night, namely, the difficulty of seeing the object in the greater brightness of the lamp used to throw light on one's drawing. He first obtains a good general idea of the comet by carefully viewing it with an opera-glass or an eye-piece of thirty dia-

The Comet at 10 p.m. [illegible]

[illegible], del.

[illegible] of Comet, as seen with the Telescope, August [illegible]th., [illegible] p.m.

meters, to ascertain the direction of the tail, and also of the jet from the nucleus, and having carefully observed these particulars for about a quarter of an hour (the telescope being out of doors), Mr. Howlett, re-entering his house, marks them down by slightly scratching on black paper with a penknife, the paper being supported on a pane of glass, and held before a lamp, which renders the slightest scratch at once apparent. He then repairs to the telescope, applies a higher power, generally 120, and earnestly scans the comet till some new feature is fully impressed on his mind. Then he returns to the lamp, and very carefully notes down what he has seen. Sometimes ten minutes are employed in making sure of a fact, and as long a time in fitly representing it. Thus the drawing goes on till completed. Any scratch *de trop* is rectified by a little thick ink applied to obliterate it. These transparencies represent nearly the whole comet; but except in my tinted plate, I have copied only the head of each.

My own plan, though as different as might well be, I am inclined to think is also very efficient. I place my telescope on a table out of doors nearly opposite a window. Inside the window stands a lighted candle, and in front of it a powerful condensing lens (belonging to my microscope), placed at that precise distance from the candle that it casts a narrow stream of light to a great distance. I have a piece of card or paper and a pencil on my table, and when I choose I can place the paper in the brilliant light from the lens without allowing the glare to reach my eye. My drawings, being done in pencil, represent stars by black dots, and the brightest parts of the comet by the darkest shading, but I frequently copy them at once in imitation of the real appearance.

Perhaps the two plans could be combined, and the black paper and lamp conveyed to the open air; only that comets take us by surprise, and we hastily improvise a plan, instead of losing time by making many experiments.

On the 19th, Mr. Dawes also observed the comet, and notes that the nucleus was no longer so singularly sharp and distinct as on the 3rd. From this time, the weather appears to have improved, and many observations have reached me; but space permits me to give few besides my own and those of Mr. Howlett.

The comet, on the evening of the 21st, appeared to me as a conspicuous and beautiful object. The texture of the tail seemed streaky, as on the 20th, appearing like folds of the most delicate gauze. The nucleus and jet of light reminded me of the shape of a shuttlecock, the feathers turned to the right and sloping downwards, and surrounded by a bright glare of light. Its changed its aspect in a fitful manner, or at least appeared to me to do so. I do not know that this fitful appearance was real, and not caused by weariness of the eye; I only know that nothing of the kind ever occurs when I am engaged in examining the nebula of Orion; and on this evening any fixed star which I observed continued sharp and unchanged as long as I looked at it.

This was the only occasion on which I observed either by the telescope, or with the naked eye, any momentary variation in the comet's appearance. Something of the kind, however, appears to have been occasionally observed by others. "All of us," writes my correspondent at Florence, "have remarked that the light of the tail varied, and seemed at moments to dart upwards in a stream from the nucleus, somewhat like an aurora on a small scale." Similar to this was an appearance observed at Versailles in the case of Donati's Comet, but strongly and vividly marked, like everything connected with that glorious phenomenon. The narrator, Dr. Montucci, states that, in September 1858, he, in company with another person, saw the comet suddenly fade away, tail, head, and nucleus—the nucleus disappearing a few seconds after the rest. For upwards of a minute (and this happened in clear weather), not the slightest vestige of the comet was visible, and then "the nucleus, so to say, caught fire again, and the superb tail shot out again in a blaze like a sky-rocket." This whole affair occupied about five minutes, and occurred five or six times in the same evening. It was also observed on subsequent evenings.* A similar phenomenon, as far as the disappearance of the tail goes, was observed on July 4th (by a correspondent of the *Morning Herald*), as occurring with the great comet of 1861.

Such appearances are referred to also by Mr. Hind in his treatise on *The Comets*. "There is," he says, "one singular appearance in the trains of great comets which we must not pass over in silence. It consists of apparent vibrations or coruscations, similar to the pulsations peculiar to the Aurora Borealis. These vibrations commence at the head, and appear to traverse the whole length of the tail in a few seconds of time. The cause was long supposed to be connected with the nature of the comet itself, but Olbers pointed out that such appearances could only be attributed to the effects of our own atmosphere." This kind of movement is recorded as having been observed in the tails of comets in 1607, 1618, 1652, and 1662, and, more recently, in that of 1769, and the great comet of 1843. Should another remarkable comet appear, the observation of this phenomenon would be an important employment for those who observe principally with the naked eye; and I would say to them, "You cannot view a comet too earnestly, too carefully. It hangs there, apparently an established

* From the *Comptes Rendus* of the Academy of Sciences.

ornament of the heavens, yet in how few days it will have gone away, and as far as you are concerned, for ever!"

On August 22nd, the comet showed well—I thought it curved decidedly; my idea was that the tail set out from the head as if to slope to the right, then suddenly bent to the left, and thenceforward was straight. Mr. Howlett also saw the comet well in England (fig 4). He makes the following note:—"On August 22nd the jet from the nucleus (the nucleus was very faint) appeared to me almost in a straight line with the tail. I did not observe anything of the fan-shaped appearance which it has since assumed. A pretty group of five stars from the seventh to ninth magnitude probably, was on that evening to be seen near the head of the comet. One of these, about 3′ 40″ to the eastward (following side) of the nucleus, was quite immersed in the coma, which just skirted upon two other small stars on its preceding margin. The tail, as seen here" (in Kent), "500 feet above the sea level, appeared about seven degrees in length."

Fig. 4.

Unfortunately, neither Mr. Howlett or I succeeded in seeing the comet on August 23rd. It would have been satisfactory to have been able to record its appearance on that evening, as it then gained its nearest point to the sun. Professor Challis saw it at Cambridge, but speaks of having found the night less favourable for observation than he could have wished.* Mr. Chambers, at Eastbourne, was more fortunate. He noted that the jet of light was inclined to the direction of the tail by an angle of about sixty degrees; and by five different measures he estimated the tail at twelve degrees in length.†

On August 24th Mr. Howlett obtained a fine view of the comet (see tinted Plate). He makes the following note:—"The nucleus had thrown out a very conspicuous and broadly fan-shaped jet. The west side was the most sharply defined, and seemed to me very nearly in a line with the general direction of the tail, which latter I could trace for about eight degrees in the direction of Eta Draconis. The coma appeared to me at this time to be cleft, as it were, or at least to exhibit a rather marked deficiency of luminosity in the north-east quadrant, which greatly enhanced the fan-shaped appearance of the jet." Mr. Chambers's note for the same evening is:—"The sector or jet of light has greatly increased in amplitude. It now covers fully 120° of a circle." The tail, he says, extends nearly or quite to Eta Draconis

* *London Review*, September 6th. † *English Churchman*, September 28th.

His observations were made with an excellent refractor, aperture three inches, and powers employed from 21 to 120.

On August 25th, Mr. Howlett obtained another good view of the comet, fig. 5. He says:—"The deficiency (that is of luminosity in the N.E. quadrant) seemed to be filled up again, but the western edge of the jet was far from being in a right line with the general direction of the tail, forming with it, indeed, an angle of some 160° towards the west side."

On this evening I was able only to obtain a momentary glimpse of the comet between clouds; I had but time to note its position and to remark that it was very white and brilliant. But on the next evening (26th) I had my *best* view of it. I began to look for it while Arcturus and Vega only were *clearly* visible, and the Ursa Major stars to be made out with great difficulty. I could not, however, detect it till the latter were all bright, except Delta. Then the comet showed and decidedly brighter than Delta. It increased in brilliancy as evening advanced, and its tail seemed to reach as far as 16 in Draco (see tinted Plate). I thought it nearly as *large* as Donati's in the days immediately preceding September 30, 1858, but far from being as *bright*. It was more like the subdued light shown in the well-engraved view of the comet of 1819 in Herschel's *Treatise on Astronomy*. I thought the comet's tail of considerable breadth at its extremity, and was pretty sure of a decided line of light to the left.

Fig. 5.

My view through the telescope was not satisfactory, for the sky began to cloud over as I concluded my general scrutiny of the comet's appearance. The nucleus and jet of light seemed small and somewhat long.

On the 27th the sky was overcast here, but Mr. Howlett saw the comet clearly, and, as he afterwards told me, the tail on that evening appeared longest to him, namely, thirteen degrees. His drawing of the head, fig. 6, is accompanied by the following note:—"Some very pretty groups of minute stars were now to be seen involved in the tail and coma. One was about 4′ N.E. of the jet.

Fig. 6.

The tail, he says, "was *concave* on its orbital *preceding* side." He also thought it somewhat deflected at its extremity towards the north-east. His next view was on the 30th; but meanwhile I had seen the comet to considerable advantage on the 28th and 29th. On the 28th the comet's head appeared to me to be large rather than bright. I could compare its apparent size (to the naked eye) with that of Alpha in the Northern Crown, but its degree of lustre with some far smaller star. I believed the tail to be of a broad and fan-like shape, and to extend as high as Eta in Hercules, but in excessive faintness. Very different in this respect from Donati's Comet, the curve of which I could compare, I remember, with one cut out in paper, and held over its brilliant "preceding margin," in rather close proximity to a candle.

In the telescope I noticed that the nucleus had no star-like appearance whatever, but with the jet presented the appearance merely of a long and cloudy patch of light. There were some picturesquely placed stars in the field of the telescope, to the left of the comet; and having noted their places accurately on paper, I was much surprised and interested to observe how rapidly the comet neared them. I had observed them first at about nine in the evening, noticed their change of place at ten, and had completed my notes of the comet's appearance more than an hour later, when it occurred to me to take out the telescope again, and ascertain how far the comet might have accomplished its transit across those stars. It had actually (at twelve P.M.) left the stars far to its right, and two bright stars which I had thought too far off to introduce in my first sketch were now below the comet, looking about as near it as the stars Eta and Zeta in Auriga do to the star Epsilon, as seen by the naked eye. On the 29th, though the evening was very fine, and all the sinuous windings of the Milky Way distinctly shown, I felt sure the comet was not so clearly visible as on the 26th, when any one could at once see its tail, even through a glass window. On this evening, though I put all candles and lamps out of sight, I failed to see it through that window otherwise than as a pale and rather large fixed star.

In the open air it was better, the tail showed faintly, and I still thought I saw a slightly more decided outline to its left than its right side. The telescopic view was rather good. The head stood out well from the black sky, and on this evening the nucleus was bright. I wished very much for a sight of it through the most suitable instrument possible. The roundness of the head was striking, and one could have almost supposed there was no tail,—that part of the comet being so much fainter than the head, and also somewhat narrower.

On the 30th, between drifting clouds, I caught sight of the comet, most picturesquely placed as a temporary ornament of the Northern Crown, and felt with what a new interest these passing comets invest our old familiar constellations.

Mr. Howlett's last transparency was made on this evening (fig. 7). He thus describes the comet:—"The tail that evening appeared to me much more uniformly distributed, and the jet, which was now directed towards the western or preceding orbital side of the nucleus, was pretty sharply defined on the same western margin, but feathery on the eastern side, where, too, the coma was chiefly condensed."

Fig. 7.

Mr. Howlett quite corroborates my observation, that the comet had diminished in brilliancy and length of tail since the 26th and 27th. He observed it again on the 31st, but was not able to make a sketch of it. He could not trace the tail to a greater distance than three degrees.

No further observations have reached me; but I was myself able to view the comet on Sept. 1st, 2nd, 7th, and 9th. On the 1st, moonlight began to conceal it. The moon, however, set at ten o'clock, and I could then observe a very decided diminution in the comet's brightness. On the 2nd the moon did not set till after the comet had disappeared along with the stars of Serpens, behind some trees; and in the bright moonlight the comet had not seemed more than a round "woolly" star.

On the four following evenings the sky was overcast. On the 7th, a day before full moon, I had lost my account of the comet's probable place, but, nevertheless, gave myself a task to detect it. In one minute I found it out, and then made sure of it with the telescope. A yellow star was in the same field of view. The comet appeared small, and of a roundish shape, but not at all regularly circular. There was no visible nucleus, but a perceptible brightness about the centre; no tail whatever.

On September 9th I saw it for the last time.

There was very bright moonlight, in which even the stars Epsilon and Delta of Ophiuchus were not very readily visible. Trees hid Antares, but I could guess at its position, which with that of Beta (in Scorpio) helped me to ascertain the comet's probable situation. Long staring at the sky, I imagined a pale spot a little way north of Beta. On this I fixed my telescope, and very plainly saw the comet, faint and small on a light grey sky; yet there was a look of some importance in its aspect, giving one the idea, that had moonlight been absent its tail would still have been visible.

I looked long at it; the ideas of retreat, disappearance, and a long parting impressing themselves very vividly on my imagination as I removed the telescope, leaving Comet II. to pursue its long mysterious journey.

P.S.—Sept. 18th. Two days after my concluding observation of the comet, namely, on September 11th, my friend at Florence had an interview with M. Toussaint of the Observatory there, who, with M. Pacinotto, had been a discoverer of Comet II. M. Toussaint kindly lent for my benefit three bulletins received by him from M. Chacornac, of the Paris Observatory, saying that they contained a full statement of particulars relating to Comet II. M. Toussaint added, verbally, the following remarks; that he had observed two branches in the comet's tail, the right (when viewed without inversion) being shortest. Fig. 8, copied from his diagram, shows the relative lengths of the two sides of the tail. Fig. 9 represents merely the head of the comet, as sketched by him to illustrate his description of its telescopic appearance, showing the nucleus, the flame which projects towards the sun, and the surrounding vapour.

Fig. 8.

Fig. 9.

The report of M. Chacornac will, doubtless, be read with interest. He was one of the most successful observers of Donati's Comet, having frequently watched that remarkable object from the time of its rising, after midnight, till daylight rendered it invisible. I should mention, that in my translation I have always employed the word "aigrette" where he has used it, and that the word "jet" is also transcribed without alteration. With this short preface, I commend to the readers of the Intellectual Observer these bulletins from Paris, which have certainly reached their new destination by a somewhat circuitous route—*via* Italy and Ireland.

APPEARANCE OF COMET II. AT PARIS.

NOTE FROM M. CHACORNAC.

The second comet of this year, now visible near the Pole, presented to view, on the morning of the 10th and 11th of August, a luminous aigrette, analogous to that which was observed in Halley's Comet at the time of its last appearance. The sector was much more brilliant than the rest of the nebulosity, and turned towards the sun. Its amplitude was forty-six degrees at three on the morning of the 10th; on the 11th, at ten minutes past two in the morning, the amplitude proved to be sixty-five degrees. Thus this sector widened, like that of Halley's Comet, as the nucleus approached the sun.

Besides this alteration, which might be compared to the expansion of the corolla of a convolvulus, the eastern branch of the sector which, on the morning of the 10th, was the most extended and brilliant, and which measured an arc of forty-five seconds, exhibited only a rudimentary form on the morning of the 11th. The western ray, on the contrary, became developed, and subtended an angle of sixty-three seconds, and its brightness surpassed that of the eastern ray.

On the 10th, the nucleus presented the aspect of a fusee ("d'une fusée"), that is to say, it had a much longer diameter in the direction of the radius vector than in that of the perpendicular. The proportion of these two diameters was as one to three. I had not hitherto observed the nuclei of comets to be lengthened in this direction. The great comet of 1858, and that of 1861, both exhibited the contrary phenomenon; the lesser diameter of their nuclei were towards the direction of the radius vector.

On the 11th, this aspect had much diminished, and the two diameters of the comet's nucleus approached equality. No certain trace of polarized light was visible in the nucleus; and still less could it be detected in the light of the sector.

In short, the appearance of luminous expansion in the form of an aigrette directed towards the sun, presented by Halley's Comet, and which had already been observed by Heinsius in the head of the comet of 1744, are not exceptions peculiar to the nature of those comets. The great comet of 1858, that of 1861, and even the last comet of short period which has appeared, have presented luminous expansions, which I have observed, and which may be compared to a vaporous jet directed towards the sun, and forced to retreat by an action emanating from that luminary.

This comet, which now presents to the eye a brilliancy equal to that of a star of the fifth magnitude, and may be expected to become ten times brighter, will probably offer appearances which will assist in the study of the physical constitution of these bodies.

SECOND NOTE FROM M. CHACORNAC, ON THE SECOND COMET OF 1862.

In continuing to describe the changes which have occurred in the present comet's head since the 10th of August, it may be said that four distinct aigrettes have become disengaged from the nucleus by a succession of phenomena, analogous to those which were seen in Donati's Comet at the time of the disengagement of its envelopes.

When a new aigrette is about to be developed, the nucleus of the present comet assumes an elongated form, in the direction of the radius vector, and its extremity, turned towards the sun, is terminated by a feeble tuft, ("houppe") which gives it the aspect of a burning torch. Some hours later, the nucleus extends in the same direction, and the part facing the sun becomes more diffused in enlarging. Next day, a long ray, which may be compared to those observed around the sun at the moment of a total eclipse, may be seen turned towards that luminary, but no longer following the direction of the radius vector; it deviates therefrom by a certain angle, opposed to the proper movement of the comet. Other rays, of about half the size, visible on each side of that first mentioned, complete the aigrette. The nucleus, then, is seen as a clearly-defined luminous centre, occupying the apex of the cone formed by the aigrette. These objects being sufficiently well-marked in outline, can be perceived through the vast nebulosity which envelops them; and from this nebulosity escape feeble particles of cometary matter, which go to form the tail, in the direction opposite to the sun.

Later, the outlines of the rays and of the aigrette become less clear, and the principal ray continues to be inclined on the axis of the tail in a direction opposed to the movement of the comet, in the same shape in which a flame is inflected when exposed to a current of air.

While thus inclining, the ray augments the amplitude of the aigrette. When it comes to form an angle of only about 100 degrees with the then direction of the tail, it is extremely diffused, enlarges along with the aigrette, and their much-weakened light becomes confounded at the borders with that of the nebulosity. Then the nucleus again becomes oval; a new ray, a new aigrette are prepared to pass successively through a set of phases similar to those we have just described.

Thus, from the 12th to the 17th of August, we have seen three rays and three aigrettes detached from the nucleus.

To give an idea of these luminous expansions turned towards the sun, we may state, that the principal ray measured on the 17th, towards eleven o'clock in the evening, an angle of two minutes. That is to say, it extended beyond the nucleus over a space four times greater than the diameter of the earth.

On the same evening, the comet presented to the eye the appearance of a nebulous star, of a brightness nearly equal to that of the star Gamma in the constellation of the Little Bear. Nevertheless, the tail, on account of its dimness, could scarcely be distinguished to the length of a degree.

THIRD NOTE FROM M. CHACORNAC ON THE SECOND COMET OF 1862.

The comet continues to present interesting phases in the development of its aigrettes.

In attentively following the form of the jets which escape intermittently, I have just remarked a fact still more strange than those described in the preceding notes. In the latter I pointed out that one of these jets or rays, darted firstly in the direction of the sun, was afterwards turned aside in a direction opposed to the movement of the comet, so that on the next day it could be observed making an angle with the direction of the previous day ("avec la direction de la veille").

The fine weather which has lately come having permitted me to follow during whole nights the mode of transformation of different vaporous jets which have been disengaged from the nucleus, I will recount the phenomena in the true order of their succession.

Firstly, it is necessary to say, that the ray of the previous day, directed nearly to the sun, was not that which one saw next day inflected in a direction opposite to the movement of the comet; the latter was a new ray emitted by the nucleus in this very direction.

From the 17th to the 20th of August, pondering on the forms presented by the rays, alternately rectilinear and clear, or curved and diffused, I already felt doubtful of the identity of these two jets; but, following the opinion of Bessel about Halley's Comet, I believed in some analogous movement of the aigrette of the present comet, all its other phenomena seeming to confirm this analogy.

Three nights in which the sky was completely overcast, left me in this belief. On the 22nd of August, the sky having again become clear, I persevered from nine in the evening till four next morning in following the slightest variations perceptible in a jet directed to the sun, and I believe I have detected its true nature.

In the night from the 25th to the 26th of August, having been able to repeat the observation on another jet which I also saw again on the evening of the same day, I give a summary which will truly interpret the phenomena. ("Voici sommairement quelle serait la véritable interprétation des phénomènes.")

The nucleus of the comet emits in the direction of the sun a vaporous jet, whence seem to escape particles of cometary matter as a jet of steam escapes from a machine. This jet preserves, during a certain time, a rectilinear form, which seems to indicate a considerable force of projection emanating from the nucleus. Soon afterwards it bends slightly, and presents the appearance of a curved cone, bearing much resemblance to a horn of plenty, as usually represented. At this time the gaseous particles accumulate at that extremity of the jet nearest to the sun, under the form of rounded clouds; and this appearance seems to indicate that at this distance from the nucleus the force of projection is conquered by a resistance which is opposed to it.

Some hours later, this luminous jet takes a diffused aspect, and shows that the nucleal emission has ceased to go forth in this direction. At the moment when it commences to change its form, and at an angle of position inclined about thirty degrees towards the east, the first traces of a new ray may be seen, its development presenting the same phenomena as those which preceded it. Sixteen hours later, in the direction of those first traces visible on the previous day, may now be observed a new ray, and this latter continuing in this interval of time to lose shape ("se déformer"), appears dispersed in the hemispherical envelope like a fog, scarcely preserving any traces of its original form and direction.

In its successive transformations this new ray offers in the sequel the same appearances as that parallel to the radius vector.

Since the epoch of the comet's perihelion passage, the jet which nearly corresponded to the radius vector inclined gradually westward to that point to which the other ray tended on the 30th of August, precisely in the direction opposite to the tail of the comet.

APPLICATION OF DIALYSIS TO THE PRESERVATION OF BUILDING STONES.

The discoveries of Mr. Graham regarding the process of dialysis were described in a paper by Mr. Tegetmeier in our last volume. The prognostic of the speedy application of the process to the useful arts has been rapidly verified in a practical application of very considerable interest.

The ease with which, by the aid of dialysis, solution of silica (flint) of almost any strength can now be prepared, has suggested its use as a cementing material for binding together the particles of porous and perishable stones, and other similar materials. This application was originally proposed by Mr. W. Crookes, but it has been found that there are some drawbacks to its employment. The flint solution, in many cases, gelatinizes on the surface of the stone, and, drying up, scales off, bringing with it the outer particles of the stone surface. Mr. A. H. Church, whose researches on the formation of certain silicious minerals we have already noticed in the Intellectual Observer, has improved this process so as to obviate its defects. He attains this result by the use of a solution of baryta in the first place, the flint solution being applied afterwards; in some cases where the nature of the materials to be operated upon requires it, the order of application of these solutions is reversed. The effect of the completed process is very marked. Porous stones become almost non-absorbent; their hardness is greatly increased, and their liability to injury from atmospheric influences, almost, if not entirely, removed; brick, terra-cotta, and many other materials are likewise rendered nearly waterproof, while plaster of Paris casts are greatly improved in durability and appearance by this treatment.

The rationale of the process is very simple. The successive application of solutions of baryta and of silica causes the deposition within the substance of the stone of the insoluble and unalterable silicate of baryta; no soluble, and therefore unnecessary and injurious, salt being produced, as is the case in other processes for the preservation of stone from decay. Where, for instance, silicate of soda and chloride of barium are successively applied, not only is silicate of baryta formed, but also an equivalent proportion of chloride of sodium or common salt. By the washing out of this soluble compound by the action of rain, the continuity of the protective coating is impaired; and if the salt be not removed more serious consequences may ensue by its crystallization, deliquescence, or efflorescence.

PROCEEDINGS OF LEARNED SOCIETIES.

BY W. B. TEGETMEIER.

ENTOMOLOGICAL SOCIETY.

New Coleoptera from Cochin China.—The discoveries of M. Mouhot in Cambodia and Cochin China were described at page 240 of our first volume, in the account of the meeting of the Geographical Society held March 10.

Since that date M. Mouhot has fallen a victim to his scientific exertions, a circumstance which gave a melancholy interest to the grand collection of Coleoptera, many new to science, which he had obtained from the mountains of Lao, in Cochin China, and which were exhibited by Mr. Stevens. Mr. A. Wallace exhibited a new and very admirable plan of mounting small Coleoptera and other insects on slips of thin transparent gelatine in the place of card; the advantages being twofold, firstly, that the use of gum is unnecessary, as the insect adheres firmly to the moistened gelatine; and, secondly, that the underside of the insect is readily examined, as the gelatine may be obtained in sheets which are perfectly transparent and colourless. This latter advantage is one of no slight importance in those cases where only single specimens of rare insects are contained in a collection.

On the same evening Mr. Smith exhibited a singular specimen of the common hive bee, *Apis Mellifica.* The head had the peculiar form and large eyes of the drone or male, and the legs and wings of the right side were also those of the drone.

The left side, however, was that of a neuter or common worker, whilst, as if to complete the singularity, the sting was straight, resembling that of the fertile female or queen bee.

Insect Flying under Water.—*September* 8. Mr. John Lubbock showed a small British Hymenopterous insect, not more than a line in breadth, which had been captured swimming under water by means of its wings. It had been determined to be one of the Ichneumons, the *Polynema fuscipes.* Little is known of the habits of this insect, and it is difficult to account for the circumstance of one of a parasitic group being found in such a situation. Mr. Lubbock had ascertained that it was able to live four hours under water without the necessity of coming to the surface to breathe, but that if a number were submerged for a longer period, as during a whole night, they were found dead in the morning. There was nothing in the external structure of the insect that would have suggested an aquatic habit had it been captured out of water. In those birds that fly under water, as the black Guillemot and common Razorbill, the wings are always very small in proportion to the size and weight of the birds, and have consequently to be used with great rapidity and without intermission when the animals are flying in the air.

This shortness, however, renders them admirably fitted to a subaqueous mode of progression. In the *Polynema fuscipes*, however, the wings are of full size in proportion to the insect, a circumstance that renders its peculiar habits more remarkable.

GLEANINGS FROM THE INTERNATIONAL EXHIBITION.

Frog in Block of Coal.—We have much pleasure in stating that the earnest protest we entered against the exhibition of this absurdity has had its desired effect. Shortly after the publication of our last number calling attention to it, a letter appeared in the *Times* signed P.; which was generally attributed to a most eminent Metallurgist and Professor at the Government School of Mines, repeating the objections we made. Since then others of an equally indignant character have been published. Whether the Commissioners who have so generally mismanaged the Exhibition would have removed the animal we are not aware; but the difficulty was suddenly brought to a conclusion by its death.

Live Animals in the Exhibition.—In the original announcement issued for the guidance of exhibitors it was distinctly stated that no live animals could be exhibited in the collection; without giving any notice to those exhibitors who wished to show the specimens of the new Ailanthus silkworm, Ligurian bees, and other domesticated insects, the Commissioners allowed a few exhibitors to show live animals, thus, two exhibitors of bee-hives were so favoured.

The frog above alluded was another exception; but, perhaps, the most useful animals in a living state are those contained in a glass in the Victoria court; we allude to the Australian medicinal leeches. These from their colour are obviously a distinct species from our officinal animal, and as they appear unusually hardy, having performed the voyage from Melbourne in distilled water, they might, perhaps, be successfully acclimatized in this country. Their hardihood may be judged from the fact, that only four out of a large number have died during nine months since they were captured in Victoria, and that since they have been in the Exhibition they have commenced breeding, having produced cocoons.

Delarue's Photographs of the Moon, and of the Great Solar Eclipse.—It may be in the recollection of many of our readers that a corps of astronomical observers amply provided with instruments visited Spain at the period of the great Solar Eclipse of 1860, in order to make and record observations during the passage of the Moon over the Sun's disk. Mr. Delarue, accompanied by a strong staff of photographic assistants was of the party; and the very large and valuable photographs showing the various phases of the eclipse are the results of his journey. All persons at all interested in astronomical studies should avail themselves of the opportunity of inspecting these valuable records, which enable the most transient phases of the phenomenon to be studied with a degree of careful attention that would be impossible but for the aid of photography.

Development of the Human Body.—Dr. Liparzik exhibits a series of beautiful models by Francis Müller, illustrating the gradual development of the human figure from birth to adolescence. These models show the results of many thousand observations and movements, and are extremely valuable to physiologists, educators, and artists. In connection with this subject there should also be noticed the valuable series of models of Dr. Roth, shown in Class 29; these indicate how the normal development of the body may be most surely obtained by the aid of gymnastic actions, and apparatus designed to exercise each part. In addition to these valuable aids to healthy development, Dr. Roth exhibits specimens of shoes and other articles of clothing which do not produce deformity by exerting undue pressure on any part of the body. The hygienic value of these garments is very great.

Models of Buildings.—Amongst the more remarkable models of buildings in the Exhibition may be mentioned that of Lincoln Cathedral made nearly from 2,000,000 old corks by an agricultural labourer; though not made accurately to scale, this model is remarkable for its correctness, and is a good instance of the great amount of work that may be accomplished by persevering industry during leisure hours.

The model of the Cathedral of Milan in the transept is executed by a professional designer, and is accurately made to scale, being carved in soft wood; it is, perhaps, one of the most exquisitely finished models ever constructed, showing tne exact character of even the smaller carvings in the original edifice.

Singing Machine in the Austrian Court.—The singing machine has not maintained the opinion that was expressed respecting it before its exhibition. It is not properly a singing or articulating instrument, but should rather be described as an organ with a vox humanus stop.

NOTES AND MEMORANDA.

Ramsay on the Glacial Origin of Lakes.—In a paper which will be found in the *Quarterly Journal of the Geological Society* for August, 1862, Professor Ramsay gives reasons for considering that the great Alpine lakes, such as Geneva, Zurich, Constance, Maggiore, Lugano, Como, and others, "do not lie among the strata in basins merely produced by disturbance of the rocks, but in hollows due to denuding agencies that operated long after the complicated foldings of the miocene and other strata were produced." He remarks that none of these lakes lie in simple sinclinal troughs, and that in no case of lakes among the Alps is it possible to affirm that we have a sinclinal hollow, of which the original uppermost beds remain. After showing the objections to various theories of the formation of the lake hollows, he observes, "Now, if the Lake of Geneva do not lie in a sinclinal trough, in an area of subsidence, in a line of fracture, nor in an area of mere aqueous erosion, we have only one other great moulding agency left, namely, that of ice." He then shows that "when at its largest, the great glacier of the Rhone debouched upon the miocene beds where the eastern end of the Lake of Geneva now lies." It was "about 2200 feet thick when it abutted upon the mountains, and when it first flowed out upon the plain at the mouth of the valley of the Rhone, the ice, according to Charpentier, must have been 2780 feet thick. Add to this the depth of the lake of 984 feet, and the total thickness of the ice must have been 3764 feet at what is now the eastern part of the lake." "I conceive, then," he adds, "that this enormous mass of ice, pushing first N.W., and then partly W., scooped out the hollow of the Lake of Geneva most deeply in its eastern part, opposite Lausanne, where the thickness and the weight of ice, and consequently its grinding power, were greatest." He applies similar reasoning to other Alpine lakes and to the great lakes of North America, also to lakes in Cumberland and Scotland, and elsewhere.

Geikie on the Last Elevation of Central Scotland.—In the same journal, Archibald Geikie, Esq., of the Geological Survey, describes the evidence he has obtained, to show that a "portion of the coast of the Firth of Forth has been elevated not only within the human period, but even since the first years of the Roman occupation."

Burning Gunpowder in Vacuo.—M. Bianchi lays before the French Academy his experiments on the combustion of gunpowder in a vacuum. He found that this substance, and also the fulminates, burnt quickly if loose in an exhausted vessel, and suddenly brought to a temperature exceeding 2000°. If, however, the powder was placed under similar circumstances in a pistol, it inflamed with the suddenness exhibited in the air. Gun cotton slowly disappeared, the layer nearest the source of heat going first, but without the production of any light. In all these cases the products of combustion were the same as in air. Combustion also took place in nitrogen, carbonic acid, and other gases which do not support it, and there was little diminution of the ordinary rapidity of the process.

Cure for Hooping Cough.—Dr. Joset states that infusion of wild thyme effects a cure in this troublesome complaint.

Artesian Wells in the Desert of Algiers.—*Cosmos* informs us that in five years terminating with 1859-60 fifty wells have been sunk in the Algerine Sahara, capable of yielding 36,761 litres of water per minute. 30,000 palms and 1000 fruit-trees have been planted. Numerous oases have been recovered from ruin, and two fresh villages established. The expense has not yet reached 298,000 francs, and has been covered by a slight additional tax, and by voluntary contributions from the Arabs. The water is slightly saline, and a little bitter from the presence of Epsom salts, but it is not found to be unwholesome.

The Consanguinity Controversy.—M. Beaudouin communicates to the French Academy an account of his "breeding in and in" with a flock of three hundred sheep without any apparent ill effect; but in this as in similar cases, the alliances between the two sexes were strictly regulated, and all weak and undesirable animals were excluded. In one case, during a period of twenty-two years, a sheep was born in this flock exactly reproducing the primitive type. M. Beaudouin agrees in the main with M. Sanson, but observes that he generalises too fast when he says that the inconveniences attributed to consanguineous connections have no foundation in observation. "We should add," observes M. Beaudouin, "when such unions take place between selected individuals." M. Gourdon, after reviewing the proceedings of the most celebrated cattle-breeders, contends that Durham oxen, New Leicester pigs, Ditchley sheep, and other successful examples, are, however useful to man, monstrosities, constituted in opposition to all the laws of health, and that connections of consanguinity always produce mischief, although it may be convenient to resort to them for special purposes.

Temperature of Spheroidal Liquids.—In a paper sent to the French Academy, M. S. de Luca states as the result of his experiments on water in the spheroidal state, that the liquid in this condition does not wet the vessel which contains, and receives heat by radiation and by occasional and imperfect contact with its sides; this heat is employed in volatilizing the superficial layer of the liquid, and in producing a vapour by which the radiant heat is absorbed, and consequently the spheroidal liquid varies in temperature, being cooled in proportion as the evaporation goes on.

An Innocent Green.—The *Chemical News* gives the following, on the authority of the *Journal de Pharmacie,* as an innocent substitute for arsenite of copper in pastrycook's work. Infuse for twenty-four hours 0·32 grammes of saffron in 7 grammes distilled water. Then take 0·26 grammes of carmine of indigo, and infuse them in same manner in 15·6 grammes distilled water. Mix both liquids, and a beautiful green is obtained, 10 parts of which will colour 1000 parts of sugar. To preserve the colour evaporate the liquid to dryness, or convert it into a syrup.

A Powerful Fulminant.—Mr. J. Horsley, writing in *Chemical News*, states that three parts of ferricyanide of potash and four of chlorate, make a violent fulminant, which explodes on being rubbed with a hard substance. Too great caution cannot be employed in such experiments, and the quantities should be *very* small. Mr. Horsley gives a timely warning of the danger of exploding white gunpowder by friction, and he calls the mixture of equal parts of chlorate and red prussiate of potash "a treacherously powerful fulminant."

Alcohol from Coal-Gas.—We read in *Cosmos* the following description of a patent taken out by the Sieur Castex in December, 1854:—"In burning organic matter the smoke which is disengaged can be entirely absorbed by concentrated sulphuric acid. This sulphuric acid mingled with water, and distilled, yields alcohol. To facilitate the absorption of all the smoke of the organic matter, it is made to pass over a substance like coke, wetted with the sulphuric acid. Before sending out coal-gas it may be treated according to this method." M. Berthelot first mentioned to the Academy his synthetic mode of preparing alcohol in January 1855.

Professor Wyman on Infusoria.—The *American Journal of Science* gives the details of a number of experiments relating to the controversy concerning the generation of infusoria. Professor Wyman, apparently operating with great care, obtains results nearer those of Pouchet than of Pasteur. He boiled various infusions of animal and vegetable matter, and sealed them in flasks containing only air that had been exposed to a red heat. Nevertheless, in a number of instances, he obtained infusoria, usually Vibrio Spirillum and Bacterium, but sometimes ferment cells, monads, and kolped-like bodies. He cannot reconcile his results with the theory of the dissemination of eggs.

Dagron's Microphotographs.—The Abbé Moigno gives a most enthusiastic account of the new method of preparing and exhibiting microphotographs invented by M. Dagron. After describing a process by which a series of the minute sun pictures are taken in rapid succession, he proceeds to inform us that a number of "cylinders of common or flint glass are prepared in advance, about five or six millimetres long and two thick. The second extremity of these cylinders is spherically rounded in a hollow, to transform it into a magnifying lens. To one extremity of the cylinder a microphotograph is fixed with Canada balsam, and the edges ground by an optical tool to efface the marks of the union. "This is the photomicrographic cylinder, one of the most delightful conquests of science and art. . . . If we look at the plane end of the cylinder we see the picture with great difficulty as a black almost imperceptible point, and M. Dagron was naturally led to do for the second extremity what he had done for the first. He fastened on a second picture with Canada balsam, he rounded the glass in another hollow, and he obtained a cylinder which twice performed the functions of microscope and object holder." In other cases he fixes the picture so that it can only be seen when the glass is held at a particular angle. As the originality of these methods was disputed, and their merit referred to Sir D. Brewster, who gave some similar hints, the Abbé Moigno obtained a letter from that philosopher vindicating M. Dagron's claims to the invention.

Claude Bernard on Vascular and Calorific Nerves.—In two papers, which will be found in *Comptes Rendus*, M. Bernard describes his "experimental researches on the vascular and calorific nerves of the Great Sympathetic," and thus states certain general conclusions to which he has arrived. "It seems to me proved that the vascular and calorific nerves are special motor nerves. Before mingling with the mixt nerves, these nerves constantly emanate from the ganglia of the Sympathetic, where they may be always found concentrated as in a kind of plexus. These nerves afterwards distribute themselves in a special and exclusive manner to the vessels, and cannot be replaced by ordinary nerves, since, as we have seen, the motor nerves which animate the fibres of a muscle, do not distribute themselves to these vessels. Moreover, as I shall hereafter show, the vascular and calorific nerves have special physiological properties, and special reactions upon chemical agents." In another place, he observes—"My experiments on the Great Sympathetic of the posterior and anterior limbs, as well as on that of the head, demonstrate that the vascular and calorific nerves are throughout topographically and physiologically independent of the muscular nerves properly so called; from whence arises this general proposition, that the vascular circulatory apparatus possesses a special vascular motive system, and that the movement of the blood can be accelerated or retarded in the vessels either locally or generally, without any participation of the nervous motor system belonging to muscular movements. The local and functional congestions that periodically occur in certain organs, are examples of this independence of the circulatory movements, and fever furnishes us with a striking pathological example."

Naudin on Hybrid Plants.—M. Ch. Naudin lays before the French Academy an account of his experiments with Datura Tatula and Stramonium. On crossing, he obtained plants which he calls Stramonio-tatula, and from the seeds of these he obtained offspring of the same sort. From these plants he took seed, and reared twenty-two fresh plants, of which five reproduced the characters of D. Stramonium, nine reproduced those of D. Tatula, and partially returned to the Tatula type, and six were nearer to it than to the hybrid type of the first generation.

Picrate of Aniline.—We are indebted to Mr. John G. Dale, F.C.S., of Church, near Acrington, for a specimen of this new and interesting substance, which is, as he observes, a very pretty object for the polariscope. He says: "I find the best way to crystallize, is that recommended by Mr. Davies of Warrington for his sulphate of copper and magnesia. I make first a cold saturated solution of the salt in alcohol as free from water as possible. Put a few drops on the slide, and dry it quickly over a spirit-lamp. You will by this means get a transparent varnish over the glass, from which the salt will crystallize in beautiful disks upon cooling. Sometimes the crystals do not appear with the first application, owing to the film being too thin; then it will be necessary to repeat the operation. The crystals should be kept from the air, as they soon get dark coloured." By following the above directions we have obtained beautiful results. Some of the disks have presented exquisite arborescent, rose forms very suggestive of ornamental designs. A pleasing effect is produced by revolving the polarizer, and the selenite stage may be used with advantage.

Mr. Glaisher's Balloon Ascent.—The second scientific ascent of this year took place on September 5, and the descent was safely effected near Ludlow. The aeronauts passed through 2000 feet of cloud saturated with moisture, above which the air was clear. At three miles above the earth a pigeon was let loose, but could not fly, and dropped like a stone. Two others were similarly affected, but at four miles high a fourth managed to get to the top of the balloon. At five miles Mr. Glaisher felt symptoms of blindness, and the thermometer was 37° below the freezing point. He afterwards saw the barometer at ten inches, indicating $5\frac{3}{4}$ miles, but was unable to register it, and he shortly became unconscious. Mr. Coxwell retained his faculties, and ascended for another ten minutes, the aneroid indicating about six miles. Mr. Coxwell then felt faint, and his hands were powerless, so that he had to pull the valve with his teeth, and the balloon commenced its descent. At five miles the air was perfectly dry, and at the greatest elevation the temperature seemed as low as 44° below freezing, but Mr. Glaisher did not read the index until he was out of the car, and it may probably have been disturbed. As the balloon descended, Mr. Glaisher recovered, and recommenced his scientific labours, having reached a far greater height than was ever before attained.

A New Application of the Thermometer.—Every one accustomed to the use of the thermometer must be familiar with the fact that it gives no account of the effects of various temperatures, draughts, and damp upon the sensations. During the last great balloon ascent of Mr. Glaisher, a temperature of 17° was felt to be *warm*, because the voyagers had just quitted a region where the instrument registered some degrees below zero. So in leaving a room heated to 80° or 90°, a temperature of 60° will be felt to be cold. It is one of the advantages of the thermometer that it has no sensations, yet it would be an advantage if we could sometimes use it to measure the magnitude of those influences which affect sensation as to heat and cold, and the mode of so using it is very simple. A few years since Dr. Jonathan Osborne communicated to the British Association some experiments on the use of a *heated* thermometer as a means of instructing the physician as to the influence of climate on health, but the subject was neglected, and he has again called attention to it in an essay on the subject in the *Dublin Quarterly Journal of Medical Science.* One use of the heated thermometer is to explain the difference observed in the effect on invalids of climates having similar thermometrical characteristics. Thus the western coast of Ireland has a mild and genial climate if tested by the thermometer only, yet the trees are stunted in their growth by the constant wind blowing from the Atlantic, and invalids do not reap such advantages from a residence there as would be predicated by trusting to the thermometer only. So, during a severe frost, if the air is still, the cold is not much felt, but if there is a moderate breeze or a gale, even with a moderate rise of the thermometer, the sensation of cold is keenly felt, and, in point of fact, as regards health and comfort, the temperature is lower, though the thermometer says differently. In Petersburg, during the greatest severity of the winter, the drivers of public vehicles are bound to be at their stands, but if there is a wind, they may stay at home, for the cooling effect of wind might then prove fatal. The author thus describes the principle on which the use of the heated thermometer depends:—"The bulb being heated up to 90° Fahr., represents the heat of the surface of the human body; when in this state it is exposed to a cooler medium, whether air or water, or mixture of both as moist air, and allowed to cool to 80° Fahr., the time for cooling these ten degrees represents (inversely) the cooling power exerted by that medium, whatever it may be, or however applied. This cooling power is derived from other agencies besides difference of temperature, as from radiation of the neighbouring objects, conducting power of the surrounding medium, and more especially from currents causing various proportions of it to be brought into contact with the heated body within a given time. Now these agencies have their combined results exhibited in the degree of rapidity with which the cooling is effected. Placed, as we are, in a medium with few exceptions, always below 80°, we are constantly undergoing a process of cooling. In our ordinary clothing we feel just comfortable at 56° indoors; but when exposed to a current of air, even at the same temperature, we feel cold in proportion to the force of the current, or in proportion to the conducting power imparted to it by increased moisture. Both these are agencies of which the thermometer takes no notice. Its indications are furnished by the contractions or expansions of a fluid, whether mercury or spirit, which always maintains the same temperature as the surrounding medium, and accommodates itself to these changes by altering its own density in the same proportion. The living animal, on the contrary, as always maintaining a temperature of its own, and as constantly resisting cooling agencies, is not to be considered as passively submitting, like the fluid of the thermometer in its ordinary state. When heated to 90° Fahr., that being nearly the temperature of the surface of our bodies—in the rapidity with which it is cooled, depending on the intensity of the cooling influences, it furnishes an index to their combined effect. It does not depict the force of any one of the cooling influences taken singly, but gives the sum of them all acting simultaneously." The facts illustrated by the heated thermometer are at least six in number, according to the experiments hitherto performed by Dr. Osborne. It shows the conducting power of air and water; the cooling effects of currents of air and water; the effect of wind in cooling the body and all other objects of a higher temperature than itself; the refrigerating effect of air admitted into apartments; the degree of heat derived from fires in rooms as compared with the cooling effect of currents rushing towards the fire; and the cold and heat of climates as actually felt by human beings. It is evident that a heated thermometer is capable of many useful applications.

Re-introduction of Montgolfier Balloons.—The recent scientific ascents that have been made by Mr. Glaisher and Mr. Coxwell, appear to have given a new impulse to ærostation and to have removed it from the class of merely hazardous amusements to the domain of science. In connection with these ascents we may notice the re-introduction of Montgolfier or heated air balloons. It has long been the opinion of many scientific men, that fire balloons are safer and much more easily managed than such as are inflated either with pure hydrogen or the coal gas which is now employed as a substitute. The prejudice against their employment has arisen from the supposed danger of the balloon taking fire from the burning materials employed in rarefying the air, but this danger seems very much overrated; as far as we are aware, no accident from fire ever occurred to a simple fire balloon. One fatal case occurred in France, in which two balloons were employed, the upper filled with hydrogen, the lower with heated air, but the evil result of this manifestly absurd arrangement does not militate against the employment of the simple Montgolfier balloon. M. Godard, an æronaut attached to the French army, has recently ascended from the Pré Catalan in a Montgolfier balloon having a capacity of 4000 cubic metres, which can be inflated in less than half an hour; the fuel used for the purpose being compressed cakes of rye straw. On the last occasion he made a successful descent near Maisons, having performed the journey in twenty six minutes.

Horne and Thornthwaite's Equatorial Stand.—We have examined the equatorial stand produced by the above-named opticians in answer to the demand made by the possessors of moderate-sized telescopes—a demand which we have reason to know has been much increased by the aid afforded to private observers through the succession of astronomical papers in our own pages—and we consider it an excellent instrument for the purpose, and at the price. It consists of a firm pyramidal stand of cast-iron resting upon three bearing-screws, by which, with the aid of the usual spirit-levels, the requisite adjustment can be made. The declination and hour circles are six inches in diameter, and by means of verniers can be read off with all the nicety that any ordinary observer can possibly require. The polar axis is easily inclined to the angle needed by the latitude of the place, and provision is made for fixing the telescope firmly, and securing it precisely at right angles to the axis on which its vertical movements are made. The motions are all smooth and steady, and the workmanship very good.

THE INTELLECTUAL OBSERVER.

NOVEMBER, 1862.

PHYSALIA PELAGICA.

(The Portuguese Man-of-War.)

(*With an Illustration in Colours, from a Living Specimen in the Aquarium of P. H. Bird, Esq.*)

BY H. NOEL HUMPHREYS.

The wide range of zoophytic life, comprising as it does so many objects equally remarkable for singularly anomalous organization and exquisite colouring, presents us with no form combining more remarkable structure with a display of more truly gorgeous tints than the singular creature popularly known among English sailors as the Portuguese man-of-war. This beautiful zoophyte, as seen floating—sometimes singly and sometimes in vast numbers—on the tropical seas, attracted the attention of naturalists at a very early early period, though the nature of its structure and its place in natural history were only acurately defined at a comparatively recent epoch. In modern times it has been known among seafaring men of different countries by several such names as the galley, the frigate, or other appellations of similar import, in consequence of the crest which it has the power of erecting along the ridge of the back, which, when caught by the wind, assumes somewhat the appearance of a natural sail, by means of which it seems enabled to glide rapidly over the surface of the water. This, however, is not the case, as it does not move by this means, nor does it appear to possess the power of imparting any special direction to its course, which is entirely at the mercy of wind and wave. Our own sailors probably gave it the more distinctive name of the Portuguese man-of-war,* from first meeting with these creatures about the latitude of the Portuguese island of Madeira.

* Our neighbour, Dr. Julian Evans, informs me that while residing in Madeira, a Portuguese physician inquired of him, with half angry feeling, why this poor, powerless creature, was called by the English a Portuguese man-of-war, and whether any insult to the Portuguese navy was intended? To which he replied that the name doubtless arose in that glorious period of Portuguese history, the beginning of the 17th century, when the Portuguese man-of-war, like the Physalia, was seen on almost every sea.

The Brazilians call this creature the *mourica,* and the French *la frégate.* The body itself, upon which the sail-like ridge or crest arises, is of a slight semi-diaphonous structure, and has somewhat the aspect of an unusually solid soap bubble, glistening with a more than ordinary amount of iridescent hues.

Although a native of the tropical seas, it is probable that stormy weather, or a long continuation of south-westerly winds, have occasionally carried specimens into the Mediterranean, in the southern regions of which a Physalia might flourish for a considerable time during the summer season, if general circumstances were favourable. It is only in this way that we can account for the knowledge which Aristotle obtained of this singular creature. We know that through the munificence of his patron, Alexander, he was enabled to employ collectors of animals in the interior of Africa and in the far depths of Asia, and in no other way could he have seen specimens of such a vast number of animals of all classes, as he has accurately, or at all events, unmistakeably described. Well-preserved remains of terrestrial animals, and of many kinds of fish, might reach the great Greek naturalist in this manner; but the evanescent nature of the Physalia, which almost immediately loses its beauty on being taken from its native element, would not, after a long transit from distant regions, have reached him in such a state as would enable him to describe it scientifically. So that, unless specimens occur in the tropical parts of the Red Sea, there is no other way of accounting for his possession of fresh specimens. The supposition, however, of the Physalia being occasionally carried into the Mediterranean will explain away this difficulty; and the case no doubt very frequently occurs, as the specimen from which our illustration was drawn had been driven by stress of weather as far north as the coast of the Isle of Wight. In examining or describing a rare and curious form of animal life, it is always interesting, as well as instructive, to retrace the course pursued by successive naturalists, in their endeavours to assign to it a fitting name, and find out its proper place in the scientific arrangement of the animal kingdom. I shall therefore endeavour to follow the labours of successive naturalists in their attempts to define the precise nature of the Physalia. The earliest modern name of this zoophyte, Acalepha pelagica,* or sea nettle, is derived from the ancient name conferred upon this class of marine creatures by Aristotle, in consequence of the venomous sting caused by the poisonous tentacula of several members of the group; a sting which leaves after it a white pimple precisely similar in appearance to that caused by a nettle. Aristotle included in this group the Actiniæ, now popularly known as

* Ακαληφη, a nettle, and Πελαγος, the sea.

sea anemones. Pliny, who had probably more abundant opportunities of observing the nature of this singular form of zoophytic life, adopts the name of Aristotle, translating it into Latin, as Urtica marina. Linnæus, in modern times, only knew this zoophyte from the account of it by Sir Hans Sloane, in his description of a voyage to the West Indian Islands, a curious and interesting work, the title page of which announces that it is "*illustrated with the things described, in large copper-plates as big as the life.*" The descriptiou in this work is, of course, very imperfect; but the Plinian name, Urtica marina is adopted, which Linnæus changed to Holothuria physalis. The generic term Holothuria was, however, erroneously adopted, under the impression that this zoophyte was more nearly allied than it is to the Holithuridæ, some of which are, like the creature under description, very beautifully tinted with iridescent hues. The specific term physalis, from the Greek, physe (φύση) a bladder, was adopted by Linnæus in consequence of the bladder-like form of the body, by means of which this creature floats upon the surface of the ocean, and this last name, so appropriately invented, is the one by which the genus itself is now distinguished. Cuvier, one of the first great general naturalists who succeeded Linnæus, separated the Actiniæ from the Acalephæ, placing the latter in a separate group, as *Acalephes fixes,* their habit being to adhere to rocks, in a somewhat plant-like manner. But afterwards, following Eisenhardt, he placed the Actiniæ with the Polyps, and then separated the Acalephs into two divisions—*Acalephes simples,* a division including the Medusæ, or jelly-fish, and *Acalephes hydrostatiques,* being those furnished with an apparatus for floating on the surface of the water, in the form of a bladder. The species under description formed the type of the last named group, as Acalepha hydrostatica. The term hydrostatica was not, however, so correct as the simpler pelagica, from the Greek word Πελαγος, the ocean, because it does not float at *will,* by the means of an apparatus under its command, but simply from the reason that its structure causes it to float on the surface of the ocean quite independently of its own volition. Lamarck was the first to determine that the conspicuous bladder-like body was in fact the chief generic character of this singular creature, and he therefore transferred the ingenious and characteristic name which Linnæus had only made a specific one, into the more honourable position of the generic appellation, making our Portuguese man-of-war assume, in scientific classification, the distinctive title of Physalia pelagica, or sea-bladder, which it still bears.

In 1829, M. Eschscholtz, the Prussian naturalist (with whose name every lover of flowers is so well acquainted, through the medium of the beautiful Californian flower which was named after him, Eschscholtzia Californica), published a most interesting methodical memoir upon the Acalephæ, which he termed *System der Akalephen,* which still forms the basis of more recent systems, and has been followed in the main by Blainville, by Brandt, and also by M. Lesson, to whose work, as the latest, I shall refer again, for the most recent scientific information on the subject.

The first really characteristic representation of Physalia pelagica was that published by Mr. Bennett, as recently as 1834, in his charming *Gatherings of a Naturalist in Australia.* This figure is, however, in some respects not thoroughly accurate, according to the specimen I have so recently seen, and from which the drawing at the head of this essay was most carefully made.

Mr. Bennett, like a truly enthusiastic naturalist, commences the account of his own experiences in connection with the Physalia pelagica, with a few hints on the general richness of the shores of Australia in every form of marine life. Harvey, he tells us, has described above six hundred species of sea-weed, and the total number of the Australian Algæ is estimated at over one thousand. Innumerable forms of zoophytic life, we are informed, exist on those shores which are still unknown, or very imperfectly described, and there are vast numbers of beautiful molluscs belonging to the genera Doris, Tritonia, Eolis, and other genera. Many of the creatures belonging to these divisions of natural history, and which are truly resplendent in their iridescent colours, are found in almost endless variety on the vast shores of Australia; and at Port Jackson, and in the neighbouring bays, it appears that the beautiful Physalia pelagica, or Portuguese man-of-war is frequently found in the greatest profusion; the coast, after a storm, being strewed with heaps of these stranded zoophytes. The inflated oblong bladder, which forms the apparent body of this creature, glows, as Mr. Bennett expresses it, "in delicate crimson tints, as it floats upon the waves." But it is not only with crimson tints that it glows, there are veinings of rich purple and opaline flashes of azure, orange, and green, changing in position at every movement, and its long dependent tresses, or rather tentacles, are of the deepest purple, the rich tone of which is seen even beneath the water. In Mr. Bennett's account we are further informed that the bladder or body in a full grown specimen of ordinary size measures about five inches the longest way, and the long dependent tentaculae are from four to five feet in length, and capable of being extended much farther when shot out for the capture of prey. The bladder is tough, slightly elastic, and semi-transparent. It is rather pointed at one end, which has been termed the beak, and rounded at the other. Along the highest part of what may be termed the back, forming a kind of ridge, is a crest, which can be elevated or depressed at will, and it is much larger in some specimens than others. This ridge or crest is sulcated and fringed at the edges. The lower part of the vesicle or bladder is of a light blue colour, streaked or veined almost imperceptibly with delicate green pencillings, the crest and beak being of a rich carmine, changing in various lights to a bronzy-green or purple. But these beautiful hues fade very soon when it is taken out of the water, with the exception of those of the long purple tentaculæ, which retain their colour till decomposition takes place.

This singular floating bladder, with its marked crimson ridge, from which purple veinings extend down the sides, might, by a fanciful naturalist, be considered as the primal foreshadowing, or, as he might say, the nebulous origin of the fish form, the dorsal ridge foreshadowing the spine, and the blue veins marking the position for the future ossified radiations. The raised crest might represent the dorsal fin, the cartilaginous beak the position of the bony mouth, while the office of the gills and the ventral fins may be represented by the branchiæ or short tentacles, the air-bladder forming the natural basis of many animals calculated to float in the water. Such a fanciful notion is not altogether extravagant, and in this age of speculative science, some physiologist, wedded to the hypothesis of gradual development, may be found to work out the theory that the Physalidæ are what Laplace might have termed the nebulous stage in the gradual creation of fishes.

It has been said that the Portuguese man-of-war has the power to collapse by the exclusion of a portion of air from the bladder, for the purpose of sinking in the water, as fish do, and that it does, in fact, exercise this power on the approach of storms, when it seeks protection for its delicate structure by sinking to a great depth below the agitated surface. Mr. Bennett, however, positively asserts that it possesses no power of the kind, and that no apparatus can be detected, on the most delicate dissection, by means of which collapse or expansion could be governed. He states that he has seen them, in storms, turned over by the waves, when their great buoyancy causes them to regain their position without effort. He has observed also, in tempestuous weather, that so far from having been able to sink into the ocean depths for protection, they have been cast upon the shore in great numbers, the vesicle still remaining fully expanded. He also found that the air could not be forced out of the bladder except by violently bursting its tough vesicular tissue. The long tentacles appeared to Mr. Bennett to consist of a series of globules containing fluid matter, and having a plate or sucker at the free extremity which these creatures can fix tightly on their prey, not only securing it but benumbing it by exuding a glutinous substance (having a faint odour) which produces that effect. Persons attempting to take up these seemingly harmless and helpless creatures, are soon made to repent their rashness, for the tentacles, with wonderful suddenness, dart their numerous suckers to the hand and arm, inflicting the most painful sensation, which sometimes produces rather serious consequences. Being anxious to convince himself of the precise character of the sting of the physalia, Mr. Bennett seized one by the vesicle, when it instantly raised its long purple tentacles, by muscular contraction of the bands situated at their base, and they entwined themselves about his hand and fingers, inflicting severe pain, and adhering so tightly as to be exceedingly difficult to remove. The stinging sensation continued so long as the minutest portion of the tentacles remained attached to the skin, producing not only local pain, but much constitutional irritation. The pain also extended up the arm, gradually increasing in extent and severity, and seeming to act along the course of the absorbents; the general sensation resembling that of a severe rheumatic attack. The pulse was accelerated, and a feverish state of the whole system was produced, the muscles of the chest being at the same time much affected, and producing, as in rheumatism, a painful difficulty of respiration. Even the secondary effects were very severe, and lasted for more than three quarters of an hour, a certain unpleasant numbness continuing for a whole day. The marks, where the tentacles had adhered, remained for some time longer, and had the precise appearance of nettle stings. The degree of intensity of the pain appears to depend on the age and size of the zoophyte, as does also its duration. The application of cold water has been found to increase the severity of the symptoms, but vinegar or oil appear to afford some relief. The irritating power is retained for some time in the vesicles of the cables after they are detached from the body of the zoophyte; and even linen cloth, used for rubbing off the tightly-adhering portions, was found, when touched, to produce a tingling and pungent sensation.

Mr. Bennett captured great numbers, of different ages and sizes. The older specimens, he observed, had lost the rich carmine tint of the crest, which had assumed a dull orange tone. On taking a Physalia out of the water, it was observed that the bladder quivered with a contractile muscular power, and the beak also, but there was evidently no power of contracting the vesicle or expelling the air. After closely examining the lower appendages attached to the base of the vesicular body, Mr. Bennett arrived at the conclusion that they varied in form; while Cuvier thought that some of them might serve as suckers, some as ovaries, and the larger ones merely as tentacles. The shorter appendages, Mr. Bennett stated, have no stinging power, and were evidently provided with openings that seemed to perform the office of mouths, through which food was absorbed. These mouths were always expanded, as if seeking prey, at the moment that the long purple feelers were darted out to a great distance to secure an object aimed at, by adhesion, and also by benumbing it. By a strong contractile power, in the exercise of which the long tentacles shortened themselves by assuming a corkscrew form of folding, the prey was brought up close to the mass of shorter appendages or suckers, which, after the manner of polyps, Mr. Bennett conjectured might each be attached to a separate and independent stomach.

Mr. Bennett observed, in a specimen caught in a net, several small fishes benumbed in the entanglements of the long purple feelers. On placing the specimen, together with its captured prey, in a large tub of sea-water, he was able to watch the commencement of the absorbent process. The semi-transparent vessels of absorption showed plainly the passage of portions of the fish, looking like those surgical preparations of the absorbents which, to show their structure more plainly, are injected with mercury, the portions of fish appearing to glisten like silver within the absorbent tubes. He was anxious to ascertain whether these tubes communicated with any central receptacle or stomach, and was induced to consider, after careful dissection, that they did not, but found the tissue of the bladder much thicker where the tubes were attached. The bladder itself he found composed of a double skin, the external one being formed of longitudinal fibres, and the internal one like a cellular membrane, both in appearance and consistence. He found it difficult to cut through the two coats at once, but they were easily separated, and when the outer was taken off, the air did not escape through the inner one, which still remained perfectly inflated. On cutting through a portion of the inner coat, the air still did not all escape at once, as though some delicate internal compartments still safely retained separate portions. In this state it still floated. When, however, he cut entirely through the lower part of the vesicle, the power of floating suddenly ceased, and the tentacles became paralysed. It will be seen when we come to the latest discoveries concerning the Physalia pelagica, that with all his care, Mr. Bennett just missed a part of the structure; the apparent absence of which induced him to believe that each sucker formed in itself a separate system of absorption and digestion. When confined in a tank the Physalia still exhibited all its powers, darting out its tentacles, which seem admirable organs of prehension, and unerringly seizing and benumbing their prey in a similar manner to those of some kinds of actinæ, which have also a power, not precisely of lengthening the tentacles themselves, but of shooting forth from them a slender thread to a very great distance, the end of which is so constructed that on touching its destined prey it benumbs it like the tentacle of the Physalia. In several of the Medusæ also, it may be recollected that a similar power is possessed of shooting forth filaments from those dangerous pendent locks from which their name is derived. The Cyanea capillata, for instance, which drifts to the English shores after storms, being one of the most dangerous; and its tawny fibrous mass when seen floating on the water or lying on the beach should therefore be carefully avoided. It appeared also, on watching the actions of the Physalia in the tank, that it had no control over the direction of its own course, which seems to prove, judging from its powers when in confinement, that in the open sea it must be governed entirely by the wind, the wave, or the current.

More recent investigations, however, have induced some naturalists to consider that the suckers, or feeding tentacles, are also to a certain extent organs of locomotion, and that at the same time they act as brancheæ, or breathing organs. It has also been suggested that these creatures, as occurs in several of the lower kinds of animal life, may, in the course of their development, undergo several material changes of form, so as to exhibit at different periods striking differences, not only in their internal structure, but also in their exterior aspect. If such be the case, the Physalia may, as yet, have been described as a complete animal, whereas the expanded, or bladder-form of its existence, may only be its last phase of development, during which several organs may have disappeared, or have been only rudimentary; just as the ventral legs of the caterpillar disappear in the perfect insect, while the wings and antennæ of the butterfly or moth already exist within the body in a rudimentary state. This supposition may serve to explain the different opinions of naturalists on several points of Physalean structure, and for the points of difference described by M. Lesson in his *Histoire Naturelle des Acalephes*, published in 1843, ten years later than the remarks of Mr. Bennett. The principal differences which occur in the anatomical descriptions of these eminent naturalists are, first, that M. Lesson conjectures that the sudden injection of the long tentacles with a fluid forms the principal cause of their power of excessive extension; and secondly, that he actually has discovered a distinct central food reservoir, or stomach, not perceived by Mr. Bennett. M. Lesson states that, running along the base of the air-bladder, which is of much thicker texture than the upper part, he detected a digestive tube covered above by a membranous fold, and below by muscular tissues attached to the numerous sucking tubes. He describes also a well-defined liver, secreting a caustic fluid. These discoveries appear to prove that the Physalidæ do not belong to the true polyp form, composed of a number of separate existences vitally attached to a central polypidom or rudimentary spine, as in the Alyconium digitatum (Dead-man's Fingers), or to the Pennatulidæ (the curious Sea Pens), but are of a much higher order of zoophytic life, if indeed they are to be classed as zoophytes at all. M. Lesson also gives a more precise account of the various appendages attached to the base of the vesicle than had been attempted before. There are, he says, four simple tubes without mouths, starting like the others from the digestive apparatus; and these he considers strictly breathing-tubes. The rest of the mass of short tubes he considers mouths, and the long tubes simply tentacles, as described by Mr. Bennett. M. Lesson admits six kinds of this class of Analeph, or "Sea nettle;" but to his division of *Cystisomes* (a name which he has framed out of the Greek words *cystis*, a bladder, and *soma*, a body, as being more descriptive of the bladder-body by which the Physalia is distinguished), he only assigns the single species Physalia pelagica, now under description, and which he further distinguishes from the allied kinds by the numerous prehensile tentacles.

Several strange stories have long been in circulation among the West Indian Islands regarding the deadly poisons prepared from the dark purple tentacles of the Galley, or Portuguese man-of-war. Among these, there is a legend that a negro cook determined to destroy his master by putting a small portion of these purple tentacles into some food, which, however, produced but little effect; and he then resolved to dry a quantity, which he reduced to a dark blue powder,—the first dose of which, in some soup, it is said, caused the victim to die in dreadful convulsions. M. Lesson has, however, disproved all these idle stories by actual experiment; the dried substance, he says, is absolutely inert; he has tried it upon dogs without its producing any effect. He has also seen dogs partake of the fresh tentacle, which, while it stung the lip wherever it came in contact with the external skin, was perfectly harmless in the stomach. After a storm, and when a number of Physaleas have been cast ashore, he also states that fowls being fed on them fatten quickly, and that the flesh of fowls so fed proved as wholesome as that of poultry fed in any other way.

Dutertre in his interesting account of the Antilles gives a curiously detailed account of the *galley* or *frigate*, as the French sailors term the Physalia. When full grown, he says the bladder-body is of about the size of a goose's egg, and when the shore becomes crowded with shoals of these creatures, it is, he says, a certain sign of coming storms. He describes the sensation of the sting as similar to the pain caused by a splash of boiling oil, and recommends brandy beaten up with the powdered berry or nut of the mahogany-tree as the best remedial application, but says that, at best, treatment can do no more than reduce the pain, and that the effect will not, under any circumstances, entirely subside till *after sunset*, considering himself very lucky in having been stung as late in the day as two P.M., so that he had less time to suffer than those who had received stings earlier in the day. Lebbord, in his *Voyage aux Antilles*, gives an engraving of the Physalia, but not a very good one, and Savigny, in his account of the wreck of the "Medusa" describes the agony of sailors seized while in the water by the tentacles of the *ortie de mer*.

The specimen from which our drawing was taken was, it is believed, the first ever seen alive in London. It was obtained by my friend, Mr. P. H. Bird, M.R.C.S., while visiting the Isle of Wight in July last. He heard of an extraordinary creature having been secured by the captain of a trading vessel; and being an enthusiastic naturalist, hastened on board to see the marine wonder, of which very extraordinary accounts had reached him. He immediately recognised it as the Portuguese man-of-war, in whose tentacula a small Smelt was entangled and benumbed in the manner described by Mr. Bennett. Mr. Bird lost no time in making those little arrangements which caused it to change hands, and procuring a large barrel, placed it longitudinally, so as to serve as a temporary aquarium; making other arrangements for the conveyance of his treasure to London, where he looked forward to seeing it disport itself gaily in the large tank in his conservatory in Norfolk Square. The journey was performed under favourable circumstances; but on its arrival many of the long purple tentacles were found to have been worn off by the action of the water against the sides of the barrel; but the shorter appendages were still perfect, and still brilliant in all their opaline tints; while the bladder-body was as magnificent as ever with its iridescent carmine, changing, with every change of light, to green, yellow, or purple. Many of Mr. Bird's friends were fortunate in seeing it in a living state in his aquarium, but, in spite of fresh sea-water obtained every day, its London existence was exceedingly brief, and many who had long wished for such an opportunity of closely examining a Physalea pelagica were disappointed of obtaining a sight of it. However, several drawings were made from the life, and our colour-printed engraving was taken from one made by Mr. Bird himself, carefully compared with another made by a friend, which Mr. Bird considered more perfect in regard to some details, which he had very carefully observed, but had not defined with sufficient care in his own drawing, owing to the pressure of professional engagements which interrupted him before he could give the last touches to his work. On the whole, our engraving may be considered the most accurate portrait yet published of the Portuguese man-of-war.

HINTS TO BEGINNERS WITH THE MICROSCOPE.

BY T. RYMER JONES, F.R.S.

Few things are more discouraging to the student when first entering upon microscopical research than the frequent disappointments he has to encounter in his endeavours to procure living subjects for observation. He reads the instructions usually laid down in works upon the microscope, provides himself with a multiplicity of apparatus, landing-nets, jointed rods, phials with elaborate contrivances for their attachment and detachment, cases of bottles, and corked tubes, etc., and yet when he gets to the water-side, too often finds that, with all his appliances, he is unable to procure the creatures of which he is in search, reminding us forcibly of those amateur fishermen to be seen on the banks of every river, armed with all the paraphernalia procurable in London, and yet unable to catch a single fish, while the poor ragged lad who accompanies them, furnished only with a rod and line of his own rude manufacture, soon manages to fill his basket.

We ourselves, in our younger days, enthusiastic though we may have been, found our ardour very considerably damped when, after a walk of twenty miles, we have returned wearied, as from a day's shooting, with nothing but experience for our pains, whilst, as we now know, every object of which we were in want was easily obtainable in the nearest pond, had we but understood how to set about procuring it. We write not, be it remembered, for scientific readers, some of whom, perhaps, may smile at the simplicity of these remarks; our advice is addressed to the beginners with the microscope, who will probably be benefited by the following suggestions:—

Let us suppose that the young naturalist sets out in search of infusorial animalcules, furnished *secundem artem* with a dozen bottles, to be filled with different kinds, and is told to procure samples of the water from each place that he visits likely to contain these invisible atoms: he does so, but when he gets home in the evening to his microscope, however much better he may be for the exercise, he finds himself woefully taken in when he comes to examine the contents of his several phials; for, notwithstanding all that has been written about the astounding numbers in which Infusoria exist and their universal distribution, the probabilities are, that in his whole collection he does not find a dozen specimens worthy of attention.

True it is that in stagnant water wherein animal or vegetable substances in a state of decay abound, certain forms are met with in numbers absolutely incalculable, *Monads, Spirilli, Euglenæ,* and others, now by general consent referred to the vegetable kingdom,—thousands of these crowd every drop of the fluid containing them; such, however, is by no means the case with the more highly organized forms of which the microscopist is generally in search, their presence is almost exclusively restricted to the immediate vicinity of the plants they frequent, and on which they are found as numerously as sheep in a pasture, wandering over their surface by the agency of their cilia (*Paramecium, Kolpoda,* etc.), creeping along their stems by means of hooked leg-like appendages (*Himantopus charon,* etc.) attached to them by highly irritable stems, which shrink from the slightest touch (*Vorticella*), or sometimes forming a very garden of living arborescences; if, therefore, instead of bringing home bottles of the water, the caterer for the microscope were to procure but a very small quantity of the verdure skimmed from the surface of the pond, we will venture to say that he would secure variety of specimens and abundance of delightful recreation.

There are, moreover, particular plants which are preferred by certain species, and on which they are almost exclusively found. The floating duck-weed, for example, is the favourite resort of *Vorticella, Stentors,* and the larger species of Infusoria, as well as of whole tribes of other interesting microscopic creatures. This, however, should be obtained from a clear pond, and from undisturbed water; some quiet little spot, situated in the corner of a field, for instance, from which boys and cattle are excluded, and to which the sunshine has free access, not very large, but deep enough to allow of the growth of the larger aquatic plants. Such a locality is an invaluable adjunct to the microscope. The sportsman may rent his moors and the angler his streams for the sake of a few grouse or trout—we envy him not—a table-spoonful of the duck-weed skimmed from such a pond is worth all the moors in Cumberland to one who prefers the society of his microscope to the companionship of his pointer or his fishing-rod.

Suppose, again, that *Hydræ* or the *Polyzoa* are the objects sought after. To expect to find these in water taken haphazard from the pond is a very precarious speculation; by fishing up, however, some of the sticks which testify by their appearance that they have been floating about for months, and scraping them with a pen-knife, or, better still, stripping off portions of their bark, the collector will be pretty sure, in favourable situations, to procure the objects of his search; or thin slices may be shaved from the exterior of submerged piles. Any or all of these taken home in a jar of clear water will be sure to afford materials for study.

The leaves and stems of the water-lily are the favourite resort of many beautiful species, and on them may be likewise found the eggs of several kinds of insects and mollusca. To obtain these some pains must be taken at the water-side: the leaves should be gently placed with their under surface uppermost in a wide saucer, or shallow dish, filled to a little depth with the clear element, and after remaining undisturbed for a short period should be examined with a pocket lens. Should anything be found worthy of preservation, the part to which it is attached may be cut out with a sharp penknife, so that it may be more easily and safely carried.

By far the most fertile field, however, and one to which we would specially direct attention, will be found in those confervoid growths that in summer time mantle the ponds, covering them with a sort of green carpet, composed of a thick felt, made up of interlacing fibres of such tenuity that it may almost be compared to the pulp from which paper is manufactured. Whoever has watched in early spring the gradual formation of this wonderful growth, will understand at once how valuable a resource it affords to the microscopist. During the winter season, in truth, our ponds are desolate enough; animal and vegetable life seem quite extinct; and whilst the "snow-broth" is on the waters it is almost superfluous to recommend our young friends to employ themselves at home in grinding thin sections of anything rather than expose themselves to chilblains, benumbed fingers, and bad colds. No sooner, however, does genial spring again call forth latent vitality, and the returning sun shines brightly on the water, then, as by general consent, nature revives—green tufts appear, in which the younglings of the year find refuge, and to these alone the naturalist should have recourse. Every little bunch of young confervæ gently gathered from the surface of a stone, will at this time be found to swarm with nascent beings, or with creatures in their tenderest stage of early growth, while in the water all around no living thing is met with. As spring advances, vegetation spreads over the bottom of the pool, confervæ of all kinds begin to multiply with such rapidity that, rising like a cloud, they tinge the water red or green, according to the colour they assume. Few people trouble their heads about the growth of these confervæ, or suspect the miraculous combination of circumstances upon which their rapid increase depends.

They are composed individually of thread-like filaments, made up of cells or microscopic segments, filled with vegetable granules; every microscopic cell as it becomes mature divides into two young ones, and those thus formed divide again, and thus from hour to hour this process of division is repeated.

We are all familiar enough with the prodigious results obtained by continually doubling the product of any given number even as many times as there are nails in a horse's shoe or squares upon a chess-board, and know that by this process we soon arrive at arithmetical expressions far beyond what our minds can appreciate—millions and billions, and other numbers which it is easier to talk about than to comprehend—and yet how inadequate are sums like these to express the increase of the progeny of the confervæ, during a single day, by this process of spontaneous fissure!

These confervæ, moreover, have another mode of reproducing themselves which is even still more prolific and more wonderful. The cells of which they consist are individually capable of forming progeny in their interior from which similar growths are developed. When a portion of one of these organisms is examined under the microscope, its cells may at certain periods be observed to contain numerous spherical granulations which, as they approach maturity, become pear-shaped, and provided at one extremity with a little rostrum or beak, their body is filled with a green material (*endochrome*), and they generally exhibit a minute red spot, once described as an eye, but now recognised to be a globule of oil. As these germs become perfected they may be seen moving restlessly about in the interior of the cells in which they were formed, striking the walls of their prison with their little beaks, as though anxious to get free. At length the walls of the cell become ruptured and its liberated contents escape into the surrounding water, through which they speedily begin to move hither and thither with astonishing rapidity—now progressing in a straight line, now wheeling round and round, and, anon, lowering their beaks they begin to oscillate upon them like peg-tops waggling just before they tumble down. Sometimes they stop altogether and again resume their curious and eccentric movements. After two or three hours of such exercise, their motion becomes much retarded, and at length, after faint struggles, entirely ceases, and the little *zoospores* lie as though they were dead; the vital principle, however, is still active within them, they soon may be seen to expand in their dimensions, to become partitioned off internally, and finally to send off two or more rootlets by which they become attached and stationary. Strange transition, from the roving life of an animal to the fixed condition of a plant!

Possessed, as the confervæ are thus found to be, of limitless powers of reproduction, it is no longer surprising that they spread through the water in every direction, and at length reach from the bottom quite to the surface. As the heat of summer increases, the scene changes—the dead cells, emptied of their contents and filled with air rarefied by the heat, become at length buoyant, and the whole mass rises slowly to the surface carrying with it, entangled in its meshes, innumerable hosts of microscopic beings, all of which find food and shelter in the recesses of the floating mass, while the water of the pond is left comparatively destitute of living inhabitants. The principle upon which the microscopic contents of the water are thus collected together is very similar to that adopted in clarifying liquids by means of the white of an egg; the albumen in its fluid state is first equally diffused through every part; it is then coagulated by heat, and mounts to the top bringing all impurities with it, and leaving the liquid below quite clear and pellucid.

During almost the whole of the last summer our only fishing ground has been the round pond in front of the palace in Kensington Gardens, the surface of which has been covered with a scum composed of these confervoid growths: of this we have at the present moment a small jar before us which, for a whole week, has afforded us an inexhaustible supply of microscopic forms, endless in variety and most interesting in their character. We will place a little of it under the microscope merely for the purpose of enumerating the organisms which it may chance to contain:—*Desmideæ* and *Diatoms* present themselves in rich abundance; a few splendid *volvoces* roll about in stately leisure; *gonium pectorale* shows itself in all stages of development. There are at least twenty species of cilated Infusoria; two or three gorgeous specimens of *Actinophrys;* several kinds of Rotifers, young Planariæ and various Entomostraca of all ages, *Hydra fusca,* many minute larvæ of insects, and two or three specimens of *Nais proboscidea.* Such is the microscopic wealth contained in a minute bunch of confervæ taken up at random. We might have brought dozens of bottles of water from the same pond without obtaining a specimen worthy of examination.

These remarks are merely intended as hints to guide the beginner in his first researches. All that we wish to insist upon is, that microscopic animals are always more or less associated with aquatic vegetation, upon or in the vicinity of which only they are to be obtained with any degree of certainty.

THE FUNGUS FOOT OF INDIA.

BY THE REV. M. J. BERKELEY, M.A., F.L.S.

Every advanced practitioner is well aware of the immense influence which fungi exercise in the production or aggravation of disease in the animal as well as in the vegetable kingdom. A hundred memoirs or more might be quoted bearing more or less directly on the subject, besides the great work of Robin; but unfortunately, in a few instances only, the persons who have recorded their experience have been sufficiently acquainted with fungi in general, to give anything like a complete history of the cases which have fallen under their observation, even if proper leisure was available for researches which require not only time, but continuous attention. Mere mycelia have in consequence been described as perfect plants, mistakes have been made in important points of structure, and productions of an undoubted fungoid nature been referred to Algæ, though agreeing with them neither in habit nor physiology, while the commonest moulds have received new names, and several conditions of the same species have been registered as autonomous productions.

One of the most curious and important cases of disease produced by fungi which have hitherto been recorded, is one on which a report was made in March 1860, by Dr. H. Vandyke Carter, the Professor of Anatomy and Physiology at the Grant Medical College of Bombay, a disease which unhappily occurs in many parts of India, and is known amongst Indian practitioners as the Fungus Foot, or Fungus Disease of India, or under the scientific names of Podelcoma or Mycetoma. This disease, which has hitherto occurred amongst natives only, is undoubtedly due to the presence of a fungus which eats into the bones of the lower extremities, including the base of the tibia and fibula, and in process of time causes death from exhaustion, unless a timely amputation is made above the diseased part.

Dr. Carter kindly forwarded to me his original memoir immediately after its publication, accompanied by illustrative specimens preserved in alcohol. He has since had an opportunity of investigating other cases, which have enabled him to make some additional observations, recorded in the seventh volume of the *Bombay Medical and Physical Society's Transactions*, in which he was materially assisted by my friend, Dr. H. J. Carter, whose labours as an acute observer and physiologist are well known in this country as well as in India. The latter gentleman has placed at my disposal his notes and sketches, and I am therefore in a condition to lay before the reader of this Journal, so far as it may be interesting to the non-medical world, a summary of a most curious matter, and one which at the same time is peculiarly suggestive.

As the fungous matter assumes various forms, it will be well, in order to avoid confusion, to notice the most prominent separately, taking the most typical first.

1. The first case, then, is that in which the bones of the foot and the base of the leg bones just above the ankle, for the disease never ascends higher, are perforated in every direction with roundish cavities, varying in size from that of a pea to that of a nut or pistol bullet, the cavities being filled up with a dense fungous mass of a sienna red within, but externally black and resembling a small dark truffle. From these cavities, canals lead to the surface, from which a purulent fœtid discharge is poured out, often accompanied by little pieces of the fungus. The masses and granules are imbedded in a whitish semi-opaque glairy substance of homogeneous consistence, while the walls of the canals have an opaque yellow tint, and are readily torn. The whole of the surrounding softer parts are converted into a gelatiniform substance, taking the place of the muscles, the tendinous and fatty structures being less readily changed. The foot presents externally the peculiar turgid appearance which it so often assumes in bad cases of scrofula. Besides the canals, pink stains or streaks are observable on the skin, and penetrating the subjacent tissues, filled with spherical or ovate groups of minute bright orange coloured particles, and containing occasionally a few larger cells, the nature of which has not at present been ascertained, though it is conjectured that they present the earliest appearance assumed by new attacks of the disease.

Of the structure of the large truffle-like bodies I am enabled to give an excellent figure made by Dr. H. J. Carter, from a case which he examined immediately after amputation, and which is of course far better and more satisfactory than any which could be made from the preserved specimens. The parts in which the structure is most visible present precisely the characters of a true Oïdium, such as *O. fulvum* (fig *a*, p. 255). Short beaded tawny threads arise from a common base, consisting of cylindrical articulated filaments, having at their tips large spore-like cells. These, however, do not appear to germinate *in situ*, but to become enormously dilated, their albuminous contents assuming at length a resinous consistence, while many of them burst, and nothing remains except fragments of the old cell walls. The resinous matter is inflammable, but its exact chemical nature has not yet been ascertained.

If, however, these large terminal cells be a form of fruit, they are not in all probability the only form, for on three occasions the black fungous masses, either in maceration in water, preserved in alcohol, or scattered purposely on rice paste, to see if any further development would take place, gave rise to a peculiar mould, which it can scarcely be doubted is the perfect condition of the species, though at present it has not been observed in any other situation; a circumstance, however, which need excite no surprise, as so little attention has hitherto been paid to the minute fungi of India. Further observations will, I doubt not, demonstrate immediate connection with the disease. Of this fungus I am enabled meanwhile to give a sketch from Dr. H. J. Carter's original drawing, and its beauty and singularity are both sufficient excuse for its reproduction in this place. The change from the early yellow or colourless transparent threads and sporangia to a fine red or crimson, make it a most lovely object for the microscope.

The fungus made its appearance only in the months of April and May. I have great hopes next spring that I shall be able to cultivate the species myself from specimens placed in my hands, as so many moulds are grown with the utmost facility on rice paste, which affords an admirable opportunity of examining them in every stage of growth, proper caution being taken not to confound different species with each other, as several will sometimes appear together, or in succession on the same mass of paste.

The fungus resembles closely the genus *Mucor*, but there is no columella in the sporangium—a character which accords with Chionyphe rather than with Mucor. Indeed I do not see a single character in which it differs generically from Chionyphe, though the two recorded species occur only under snow. It is very possible, however, that the proper habitat of our fungus may be upon damp soil. It consists of a thin filamentous stratum spreading in every direction over the paste, so as to form little slightly raised patches (fig. *d*, p. 256). The threads which are about 1-5400 of an inch in diameter, are more or less branched, and contain masses of grumous matter which give them an articulated appearance. These masses pass from a bright yellow into red. Short lateral branches from the mycelium give rise to a globose sporangium, which at first contains a single nucleus, but as it grows exhibits different phases of cell formation, and finally gives rise to short subfusiform spores, each of which contains a nucleus or oil globule at either extremity. The sporangia, which attain sometimes a diameter of 1-400 of an inch, like the mycelium, change from yellow to red, but some apparently are colourless. The spores when ejected germinate very rapidly, giving rise to fresh threads, which are at first perfectly straight. Some of the threads of the mycelium, and probably the younger, are distinctly articulated, and in this case there is uniformly a nucleus or oil-globule at the upper extremity of each articulation, near to the dissepiment. The sporangia are sometimes covered with a network of threads, the exact origin of which is at present obscure, but the same appearance occurs in *Mucor stolonifer*, Corda, which often accompanies our Chionyphe on the paste (fig. *e*, p. 256).

The species may be characterized as *Chionyphe Carteri;* hyphasmate ex albo flavo-rubroque; sporangiis demum coccineis; sporis breviter fusiformibus.

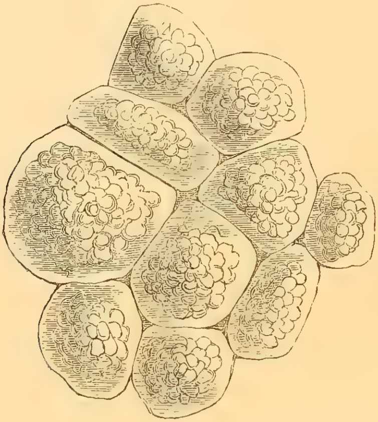
The name will serve to record the labours of the two Carters, united in their love of science though not in consanguinity, and there will be something of the same economy as regards nomenclature as that of which Ovid speaks with reference to a double birthday, "Una celebrata est per duo liba dies."

Before passing to the other forms, I must add a word about the pink streaks mentioned above. It is highly probable that many of our common moulds occasionally commence with a similar condition. The first indications of vegetation on tainted meat or paste assume the form of little gelatinous spots of various colours, consisting of extremely minute distinct cells, and these seem to be an early stage of common species of Aspergillus and Penicillium, or other genera. If there be any truth in the notion which I have entertained for some time, that hospital gangrene depends upon some vegetation of this nature acting as a putrefactive ferment, there may be good reason for believing that the red spots in question are really the commencement of the disease under consideration.

2. We now come to a second form under which the disease appears. In this the black fungous masses are entirely wanting, and in their stead masses are found of what looks like sloughing tissue. White granules, however, occur in the cavities and in the discharge, which appear to be a form of the same fungus, though the identity has not been proved. Under the microscope it wears the appearance of a congeries of large cells filled with smaller, much after the manner of *Microhaloa firma*, as figured by Kützing (fig. 1, p. 252). The accompanying sketch, after Dr. H. J. Carter, represents a portion after immersion in sulphuric ether. According to Dr. H. V. Carter, these bodies have moniliform threads on their surface, but these I have not seen. Whether the perfect form of the plant be the same or not, the phases of the disease produced by it are exactly the same, and the malady admits of no other remedy.

3. A third case is known under the name of the Madura foot, from its having occurred at Madura. In this case the foot becomes enormously enlarged about the instep, though not so

much at the ankle, while the toes are hypertrophied, and almost lost or imbedded in the mass. The small bones are nearly destroyed, leaving behind a pallid or reddish tissue, while the others are more or less excavated. There are the same canals and external sanious apertures. In some parts they are filled with the same fleshy tissue, in others lined with it, where large cavities are formed by the junction of several canals containing broken up osseous tissue from the exposed bones around, grey fragments and masses of pigment. The pink colour is partly owing to a general diffusion of pigment which tinges the oil-globules, and partly to the presence of very numerous single or



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aggregated elliptic particles. These granules are from the fiftieth to the 1-130th of an inch in diameter, and occur sometimes as single ellipses, sometimes as two combined at the extremities of their major axes, and sometimes as square bodies with rounded extremities divided crucially into four. They do not seem to be cells, at least cells of cellulose, containing a grumous mass, but resemble rather certain Palmellæ. They are quite visible to the naked eye, insomuch that when the sawn surface is first exposed to view, it appears as if strewed with grains of red pepper, and pains were therefore taken by Dr. Carter to assure himself that they were not particles accidentally introduced through the open window. Further examination convinced him that, though different in colour, they were similar in essence to the granules described in the second form. None of the black fungous masses appeared, but there were globular opaque bodies of various size which now require

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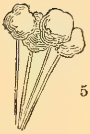

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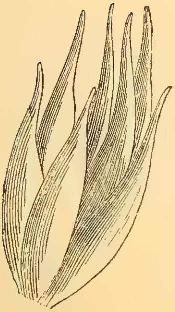

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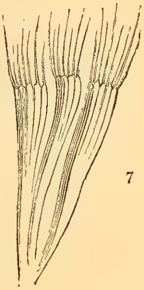

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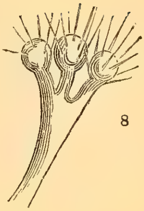

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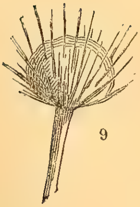

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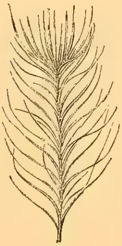

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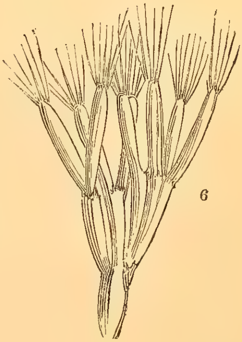

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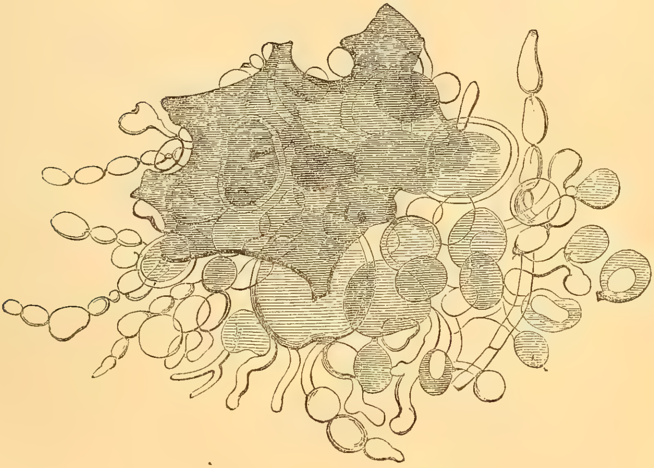
notice, and which, though at first apparently so different, are closely connected with the fungus of the first form.

The foundation of these bodies, of which one is represented, slightly magnified, at fig. 2, consists of one or more large mother-cells filled with a mass of daughter-cells as represented in the plate at p. 256 (fig. *b*, *c*). These are clothed externally with a radiating growth assuming a vast variety of forms, some only of which are here represented from Dr. H. J. Carter's sketches. The structure often so exactly simulates that of minute moulds, that it is very difficult to get rid of the notion that they are really vegetable growths. Pure sulphuric ether, however, dissolves them completely, and shows that they are merely different forms assumed by stearine. Sometimes the white mass consists of straight slender threads radiating in every direction, each of which is surmounted by an elliptic spore-like body (fig. 3), or by a regular globe (fig. 4), while occasionally the threads or crystals are shorter and the globe irregular (fig. 5). Sometimes the globules are absent, and in one case the fundamental cell budded like the receptacle of an aspergillus (fig. *e*, p. 256); each new cell being separated by an articulation and supported on a short stalk, as represented in the plate. Sometimes the outer coat consists of regularly dichotomous or trichotomous fascicles of linear crystals, which are free above (fig. 6); sometimes, on the contrary, the fascicles are dilated above with ciliary processes (fig. 7), or occasionally lobed (fig. 8); while occasionally there are straight radiating bodies surmounted by a globular mass, pierced and surrounded by cilia, after the manner of volutella (fig. 9). Another form appears under the guise of little feathers (fig. 10), while a not unfrequent one consists of leaf-like, oblong, strongly acuminate scales, simulating the leaves of mosses (fig. 11). The foundation is, however, in every case an organized cell, the red colour of whose daughter-cells is precisely that of the oidioid thread of the black fungus. Whatever may be thought of the second and third forms of vegetable growth, this, at least, must be considered as identical with the first, though at present the Chionyphe has not been raised from its globules, which, however, are so closely involved in stearine, that their germination is scarcely probable.

Dr. H. V. Carter has in his second memoir entered at some length into the probable mode of introduction of the evil, but as his observations depend mainly on the erroneous reference by Corda of the genus Æcidium to the group of Myxogastrous fungi, the spores of which in germinating frequently put on the characters of such infusoria as amœba, and whose subgelatinous spawn consists of a substance analogous to, if not identical with, the sarcode of Dujardin, it is not necessary to follow him on this point. There is not the slightest ground for supposing that the disease depends on inoculation with the spores of any of the truly parasitic fungi belonging to the tribe of rusts and mildews, and, therefore, more or less closely allied to Æcidium; but great reason, on the contrary, as appears from what has been stated above, and in the Appendix B to the second memoir, for looking to the origin amongst the mucors, even were there not something like direct proof.

It is well known that mucedinous fungi make their appearance within cavities of vegetables which have no apparent connection with the outward air. Nothing, for example, is more common than to find a pink mould (*Trichothecium roseum*) in the middle of a nut; and an allied vegetable production (*Dactylium*



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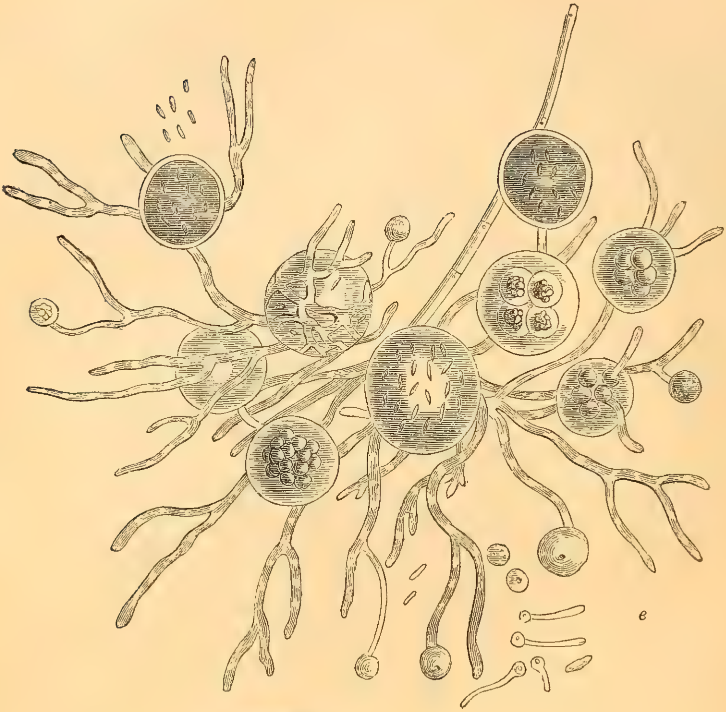
oögenum) has been found in an unbroken egg. Even the cells of plants themselves produce fungi which fructify within them. How the spores are carried there is at present a mystery, which may some day be cleared up, like the origin of many intestinal worms, which can no longer be brought forward as an argument for equivocal generation. There is, however, reason to believe that amœboid growths are not confined to such dust-like fungi as the Æthalium which is such a pest in pine-stoves; and zoospores have already been ascertained to occur in certain moulds, as, for example, in the Peronospora which causes the potato murrain. The Fungus foot is confined to the natives who go about with naked feet, and the spores might easily be



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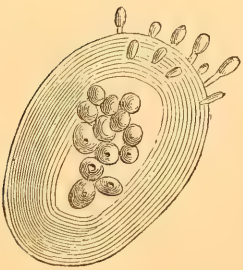

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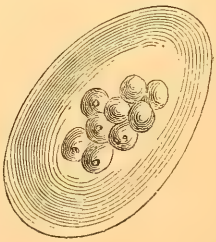


introduced through some scratch, even were it impossible for them to penetrate by the pores of the skin. When once introduced beneath the cuticle a single spore might soon perform the work of destruction spreading in every direction, and according to the peculiar condition of the secretions, the mycelium might put on a hundred different modes of growth. Besides, if the fungus is capable of causing the absorption of solid structures like bone, it is easy to conceive that a spore in contact for some time with a moist foot might penetrate the cuticle simply by absorption. Cleanliness in the first instance seems to be a preventive, but when the fungus is once established, there seems to be no cure save amputation—which, happily, when resorted to in time appears to be completely successful, as the disease never spreads beyond a certain point, though, if it be allowed to take its course, death will ensue from the exhaustion consequent on pain and the continuous discharge.

In some cases it would seem as if the foot was already in a diseased state when the fungus was introduced. At least the history of one case which apparently commenced with a boil on the instep, which was treated by native doctors, a thorn being used several times as a lancet, indicates such a lesion as might well encourage the growth of a fatal parasite.

Explanation of the Plate, p. 256.—*b* a single cell magnified which has been freed from the coat of stearine by immersion in pure sulphuric ether; *c* a budding cell similarly treated; *d* the red fungus, *Chionyphe Carteri*, springing from particles of the black fungus scattered over rice paste; *e* a portion of the same magnified, showing the sporangia in different stages of growth, from their first origin to the dispersion of the spores, and some of the latter germinating.

ON THE AURORA BOREALIS.

BY DAVID WALKER, M.D., F.L.S.

An appearance so remarkable as the Aurora could not fail to attract the attention of early observers, and afford cause for much conjecture.

About the earliest theory respecting its origin, supposed that it was produced by the refraction of the sun's rays; another, that it depended on a mixture of the atmosphere of the sun and earth; while many ascribed it to the effects of the magnetic fluid. But as the science of electricity became better known and more fully developed, when its luminous effects were shown, and especially when a resemblance was traced between the luminosity displayed by the passage of an electric current through a partially exhausted tube, and the appearance of Aurora, all previous hypotheses were abandoned, and the theory of Cavendish pretty generally adopted, which supposed that Aurora is dependant on electricity, transmitted through regions where our atmosphere is in a very rarefied state; at the same time it considered that some connection could be traced with the magnetic force of the earth. Since the laws of meteorology have been more fully understood, and the practice of recording meteorological observations more widely extended, the appearance of Aurora has attracted proportionate attention, especially in its connection with the local variations of the magnetic needle, and the disturbances noticed in the atmospheric electrometers. Such observations have shown, among other facts, that an Auroral light has been simultaneously perceived over a very extended space, *e. g.* the Auroral light and magnetic disturbances of 1831, 1839, and 1859, were noticed at the same time, not only in the northern hemisphere, but also in the southern. Tables of the comparative frequency of the appearance of Aurora in different places, however, indicate the neighbourhood of the Arctic zone as that in which these phenomena most frequently occur.

Electricians and astronomers have endeavoured to ascertain the height of the Aurora above the earth by measurement of its arc, but the results of their observations, taken from different points of view, and perchance not directed to the same Aurora—each observer seeing his own particular arc—are discordant. Thus, of two observers who calculated the height of an Aurora in January 1831, one made it eighteen miles, the other ninety-six. The ancients believed it to be very great, even beyond the limits of our atmosphere. Cavendish supposes its *usual* elevation to be about seventy-one miles above the earth, at which height the atmosphere must possess but $\frac{1}{150000}$ part of the density of that at the earth's surface. More modern observers think it seldom rises above the region of the clouds, while Parry, Wrangel, Struve, Fisher, Farquharson, and others, ascribe to it a very inconsiderable height.

Observations made in Aberdeenshire tend to prove that at times it is not more than half a mile above the surface of the earth. Parry, in January 1825, whilst watching the variations in the forms of an Aurora, saw a ray of light dart down from it towards the earth, between himself and the land, which was some 3000 yards from him, two other officers of the expedition witnessing it at the same time. I believe I am correct in stating that many Arctic observers believe the Aurora to attain a very small elevation in high latitudes. Hood and Richardson observed the same Aurora from different places; to the one it appeared in the zenith, forming a confused mass of flashes and beams; to the other, many miles distant, looking in the same direction as the first observer, it presented the aspect of a low illumined arch. Sir William Hooker informs me that, while passing a night on the summit of Ben Nevis, he distinctly saw the Aurora hang in the valley between a neighbouring elevation and that upon which he stood; also, that at another time, during a fall of snow upon a mountain side, he observed the particles to be distinctly luminous, the air giving evidence at the same time of the presence of much free electricity. General Sabine tells me that he has seen the Aurora low down, and passed through it, as one would walk through a mist. On the nights of the 30th and 31st March, 1859, I noticed the Aurora between myself and the land. The patches of light could plainly be seen a few feet above the surface of the water in Bellot Straits, the opposite land being about two and a half miles distant; and I am confident that had the land been sufficiently high, many of the Auroras seen during the winter above the water space in Bellot Straits would have been seen suspended above the water or ice at a low elevation.

I give an abstract of over two years' continuous observations in the Arctic regions. More than half the number of Auroras noticed were seen in the direction of an open water space, where much evaporation was going on; these Auroras beginning to appear at various degrees above the horizon, over a fog bank. Many were observed when minute spiculæ of snow were visible in the atmosphere, or when a mist gradually filled the air, also when cirrous clouds were seen, even when their presence could only be detected—on account of their thinness—by the formation of a halo round the moon. Occasionally, when daylight appeared, and the Aurora became gradually invisible, in its place thin fleecy clouds were noticed.

Several of the Auroras affected *the electrometer* and the magnetic needle, causing in the former marked and increased divergence of the gold leaves, and considerable oscillation and variation in the movements of the latter. I will copy from my journal the notice of one Auroral exhibition:—"Dec. 17th, 1857, at 6·30 P.M., observed a faint Aurora from S.S.E. to E; nothing particular in its appearance, it died out about 7·15. At 10 P.M. observed a bright Aurora extending from S. to N.N.E.; a low bank of fog, 5° above the horizon, formed the edge of an arc about 1° broad; 2° above this another arc was situated, about 4° broad; these changed into broad luminous clouds at times, and then again formed one thin long arc, extending continuously from S. to N.N.E., with streamers ascending 8° to 10° towards the zenith; the colour generally a yellowish-green, but once it was quite reddish in the E., at which point the Aurora was most intense and constant. I again noticed the pulse wave; it oscillated from S.S.E. to E.; the 'merry dancers' sometimes was the form assumed; once or twice there was an instantaneous intensity in the light of the whole mass, and as quick a relapse to the original.

"In the thick body of the Aurora the light was so intense as completely to hide the appearance of stars of the first magnitude,—through the streamers the stars showing, although but dimly. At 11 o'clock, I noticed a shooting star of a very bright character; it descended from 35° degrees above the horizon, and below Saturn towards the horizon, but on approaching the Aurora it was dimmed and then completely obscured; it fell very slowly, when it came to the thick band it left a tail 2° behind it. No sounds were heard with the Aurora; those bands which did appear were as luminous as those of last night, but were more confined to one part of the sky. 12 P.M.: still continues, more concentrated and a little brighter; dense streamers longer and altogether higher above the horizon. Since the appearance of the Aurora, the wind has increased. Temperature —21°. 4 A.M.: the Aurora still brilliant and in the same direction, forming more of an acriform shape, and changing sometimes to a reddish hue. 9 A.M.: still apparent, now crosses the zenith, not in streamers but in shapeless patches of thin light, from S.W. across the zenith to W. and W.S.W.; also from E. to N.W. a broad band, about 70° above the horizon in E., is very persistent against the blue background; the stars are visible through it. *Minute spiculæ of snow visible through the atmosphere.* As the daylight increased the Aurora became less visible, and at 10 A.M. it was not seen, but in its place thin fleecy clouds appeared, just as if it had been the cloud which had been rendered luminous. At 10 30 A.M., whilst the cloud still remained, I connected an electrometer with the copper wire in the observatory, when distinct separation of the gold leaves took place. At 6 P.M. an Aurora was visible from E. to W. and N.W. across the zenith; it was in the form of bands or streamers. I again tried the electrometer, and again perceived distinct divergence of the gold leaves. This Aurora disappeared about 7 P.M. Again, at 8·30, there was an Aurora, stretching from S.S.W. to S.S.E., in the form of a bent arch or horseshoe, the key being in S.S.E. Again the electrometer was connected, and a still greater divergence of the gold leaves than before was noticed. This may be from the greater luminosity of the Aurora. I tried paper saturated with iodide of potassium, interposed between two platinum wires, connected with the chain and the water, but no decomposition took place and no spot was obtained. 12 P.M.: this Aurora is still visible, but with no particular shape; it extends from S.S.W. by S. to N., and not only horizontally but vertically scintillations appear. It is most luminous towards the S. where occasionally a wave appears, not like a pulse, as was the case the last two nights, but as if the cloudy appearance had been connected in the S.S.E. with an electric machine which, when turned, caused a flash of light to proceed from S.S.E. to S. Thin streamers passing towards the zenith; the body of the light decidedly obscures the stars of all magnitude behind it. Temperature —23°·5, bar. 29° 82."

So much for my own observations. Before, however, deducing thence any theory, I will condense a few of the latest and most plausible. M. Biot's is in substance as follows:—That the luminous clouds of which the Aurora consists are composed of metallic particles, reduced to an extremely minute and subtle form. Such metallic clouds—if the expression may be permitted—will be conductors of electricity, more or less perfect, according to the greater or less proximity of their constituent particles. When such clouds arrange themselves in columnar forms, and connect strata of the atmosphere at different elevations; if such strata be unequally charged with electricity, the electrical equilibrium will be re-established through the intervention of the metallic columns, and light and sound will be evolved in proportion to the imperfect conductibility of the metallic clouds, arising from the extremely rarefied state of the fine dust or vapour of which they are composed. If the metallic cloud possess the conducting power in a high degree, the electric current may pass through it without the evolution of light or sound; and thus the magnetic needle may be affected as it would be by an Aurora, though none be visible. If any cause alter the conductibility of those columnar clouds, suddenly or gradually, a sudden or gradual change would follow in the splendour of the Aurora.

M. Becquerel objects to this theory that the existence of metal, in that uncombined form in which alone it has the conducting power—in volcanic eruptions—is not yet proved. In explanation of which objection, it should be added that M. Biot's theory supposed the electricity to proceed from polar volcanoes.

Professor Faraday, in vol i. of his *Researches*, remarks:—"I hardly dare venture, even in the most hypothetical form, to ask whether the Aurora Borealis and Australis may not be the discharge of electricity thus urged towards the poles of the earth, from whence it is endeavouring to return by natural and appointed means above the earth to equatorial regions."

Humboldt says:—"The Aurora Borealis has not been described merely as an external cause of a disturbance in the equilibrium of the distribution of terrestrial magnetism, but rather as an increased manifestation of telluric activity, amounting even to a luminous phenomenon, exhibited on the one hand by the restless oscillation of the needle, and on the other, by the polar luminosity of the heavens. The polar light appears, in accordance with this view, to be a kind of silent discharge or shock, at the termination of a magnetic storm, the disturbed equilibrium of the electricity is renewed by a development of light by lightning, accompanied by pealing thunder."

M. De La Rive, after speaking of the two electricities of the earth and atmosphere, and the recomposition going on between them, and stating that the great electrical discharge takes place at the poles, proceeds:—"This discharge, when it has a certain degree of intensity, will be luminous, especially if, as is nearly always the case near the poles, and in the higher regions of the atmosphere, it meet on its way those extremely attenuated frozen particles out of which the loftier clouds and mists are formed." More lately still he expresses similar and more elaborate views. (See abstract in the INTELLECTUAL OBSERVER for August.)

In the Arctic seas there is always more or less evaporation from the surface of the exposed water, and according to the time of year the area of exposed sea surface will be great or small. Towards the end of August and beginning of September, as the sun's altitude decreases, the nights become gradually colder, the surface of the sea is frozen over, and the difference between the temperature of the air and water increases. [For my purpose I will speak of the sea of Baffin's Bay and Davis's Strait.] With the advance of the season, the evaporation, which in summer appears as fog, in winter takes a different form; for wherever a space of water appears, and the temperature of the air is colder than that of the water, the vapour of the water, in rising from its surface, becomes visible as a dense mist over that place, and is termed "frost smoke," or "water blink." The mass of ice filling Davis's Strait and Baffin's Bay is broken up by winds, tides, and currents, and spaces of water appear among the fields of ice; throughout the winter the air in the neighbourhood of these spaces is always loaded with extremely minute spiculæ of snow, recognizable as "frost smoke." As the cold increases, the number and intensity of Auroras, seen at any place on the Greenland coast, would be in proportion to the proximity of the edge of the ice to that place, for, as a rule, Auroras increase in brilliancy as they approach the zone of the line of winter ice. If we draw a meridian line passing through the middle of North America, we find the annual number of Auroras increase up to 62° N., where they appear in all parts of the heavens; farther north the number decreases, and the display is seen more frequently in a southerly direction. The same rule will hold good of a meridian passing up Davis's Strait, only the maximum point of auroral intensity will be situated several degrees to the *northward* of 62°. Still more so will be the comparison for a meridian passing through Central Europe. Early in the winter, at the northern posts of Greenland, the Aurora is seen indefinitely higher up in the sky, and nearer the zenith, than at a later period of the year, when, after the sea has been, to a great extent, covered over with ice, the Aurora locates itself towards the open water spaces. During the first fifteen months of Dr. Kane's stay at Rensselaer Harbour, no Auroras were seen, or open water space noticed. At the south of Greenland, where the ice of Davis's Strait edges upon the waters of the Atlantic, a greater number of Auroras is seen than in any other place along that coast line. Most of the Auroras noticed during the last Arctic expedition were in the direction of the open space of water seen during the day, such spaces being, as usual, marked by the "frost smoke."

From the above well-authenticated facts, I cannot but believe that these Auroras were connected with the vapour arising from the open water spaces, and that they were caused by the condensation and subsequent freezing of the particles of vapour; such particles evolving positive electricity, and by induction from the surrounding atmosphere producing a light transmitted from particle to particle, thus rendering the whole mass of vapour luminous, the lower edges of the arch of the Aurora being the place where first this condensation and freezing takes place. And if such be the cause of many of the Auroras near the Arctic circle, I see no reason why the same effect should not be produced elsewhere under similar circumstances.

Whenever the temperature of a cloud, charged with particles of vapour, is lowered—either by changing its position, or by the access of a colder atmosphere—and the particles become frozen, then electricity will be evolved, and by induction a luminosity will appear; such clouds meeting with others of opposite electricity, would communicate by means of streamers, these also being luminous. In other words, a vaporous cloud, passing through a region where the air is of lower temperature, becomes condensed, and, if the temperature be sufficiently low, composed of minute frozen spiculæ, which induce recomposition between other clouds of different electricity near them, causing streamers and bands to flash out light. These appearances will present themselves wherever there are clouds composed of frozen particles, acted upon by the surrounding atmosphere or by neighbouring clouds, so that no altitude will be too great or too inconsiderable for the appearance of Aurora so long as the atmosphere contains the necessary conditions for the evolution of this light. Oftentimes in this country, and in crossing the Atlantic, I have seen Auroras which at times assumed simply the appearance of cirrous clouds. The wind may occasion a pulsation in the body of an Aurora, and even a greater degree of brilliancy, the friction produced by it perhaps causing an increase in the electricity evolved.

I believe Aurora is never seen, except when clouds or other similar vapours are exposed to the process of congelation. We know by Mr. Glaisher's last balloon ascent that a temperature of -20° occurs at a height of six miles above the earth, at the same height clouds exist; here, then, according to this "congelation" theory, Auroras may appear, or at any other heights where similar circumstances are to be found. It may be argued that Auroras are often seen on a clear night when no clouds are visible, but there is *no proof* that vapour-masses do not exist at the same time; in fact, often when no such masses are seen in the sky, a halo round the moon or sun will exhibit irrefragable evidence that such are present, though they be otherwise undistinguishable.

This theory would go far to account for the more frequent appearance of Aurora in this country lately, the amount of cold having been greater during late winters: last winter, however, being mild, very few Auroral displays were noticed.

PLUCKER ON SPECTRUM ANALYSIS.

THE following is a translation of two articles which have appeared in *Cosmos*, from the pen of the celebrated philosopher of Bonn, and will be regarded as a very valuable contribution to our knowledge of a new and interesting subject. It tends, on the one hand, to correct exaggerated notions of the facility which the new process affords of ascertaining the constitution of the sun, or other remote bodies, while, on the other, it opens a wide field for further research and discovery. M. Plucker observes :—" Spectral analysis, as conceived by me in 1858—9, consists in introducing the gas to be examined in tubes, of which one portion is capillary. After having conveniently rarefied the gas by means of a mercurial evacuator, the discharge of an induction apparatus is made to pass through it. The electric current, condensing itself in the capillary tube, renders incandescent the gas which it contains. The light is sufficiently bright to afford a beautiful spectrum, which is usually composed of a certain number of brilliant and characteristic lines, one of which, whose position is exactly determined, indicates the nature of the gas which is the subject of the experiment.

"I have thus operated on the ordinary gases and on certain vapours. When the vapour of a substance introduced into the tube has not the density necessary to cause the current to pass through it, a lamp is employed to increase the vaporization until the current traverses it, and produces incandescence. In this way I have treated mercury. Following the same principle, to obtain the spectrum of metallic sodium, I first fill the tube (which I have named after Geissler, the ingenious artist by whom it was constructed) with a neutral gas, hydrogen, whose spectrum is known.

"The spectra of different bodies in a gaseous state may be divided in several classes, each exhibiting peculiar characteristics, and the following considerations arise from the varied appearances they present. If the light received by the spectroscope contains all the colours whose refrangibility increases from the red to the extreme violet, the continuous spectrum that is obtained is composed of an infinite number of superimposed bands, of which each has the breadth of the slit as seen through the telescope. The Drummond light offers an example of this kind. If, on the contrary, the incident light only contains a limited number of colours, the spectrum is discontinuous, the luminous bands being separated by black spaces. These bands tend to become mere lines if the aperture of the slit is reduced. Hydrogen gas and chlorine, together with the vapours of iodine and bromine, offer examples under the conditions described in my memoir.

"If the index of refraction of two successive colours differs very little, the two corresponding bands are partially superimposed the one over the other, and then, if a good telescope is used, the middle of the composite band exhibits a double intensity, sharply bounded by two bands, the breadth of which is equal to half that of the slit. As the slit is narrowed more and more, the most luminous central portion diminishes in breadth, and disappears entirely when the breadth of the direct image of the slit is less than the distance of the median lines. The two simple bands are then separated by a dark space. The distance of lines in the midst of the two bands* is independent of the width of the slit. The beautiful double ray of mercury affords an illustration.

"If the incident ray contains a continuous series of colours, the intensity of which decreases rapidly as their refrangibility increases, while the colours immediately inferior in refrangibility are wanting, the corresponding portion of the spectrum presents a space which is very luminous towards the red side, and becomes more and more obscure towards the violet. If similar spaces succeed each other, the appearance is presented of a column grooved and illuminated by daylight. The blue and violet portions of the spectrum of nitrogen, when seen through a good telescope, behave in this way. Analogous results occur in the case of spaces whose illumination diminishes from the violet to the red, of which I will hereafter cite an example. If the incident light contains, within certain limits, continuous colours, with the exception of periodical interruptions, the spectrum obtained is divided by double lines into a series of coloured spaces. I have counted in the red, orange, and yellow portion of the nitrogen spectrum eighteen coloured spaces, all of the same breadth. If the spectrum is fine, we observe two of these spaces added to the shadow next the yellow, and three in the green that follows it. The spectrum of sulphur, which M. Geissler was the first to obtain, is entirely composed of similar coloured spaces, the breadth of which is augmented from the red to the opposite side.

"If we admit that the active force developed by the heat that renders the gas incandescent is of the same order in the case of a continuous spectrum, as in a spectrum composed of one or many bands of homogeneous light, we must conclude that the intensity of these bands is infinitely greater than that of light of equal refrangibility in the continuous spectrum. It follows, on one hand, that we must reject all idea of absorption to explain the appearance of similar bands in the place of a continuous

* "Milieu des deux bandes."

spectrum; on the other hand, it results that if we employ considerable magnifications, and augment the refraction, the bands in question will remain distinctly portrayed, while the continuous spectrum and the coloured spaces become almost imperceptible. Thus, when employing the telescope of the great spectroscope apparatus of Steinheil, I immediately perceived that the bands of the homogeneous light which I admitted into the violet part of the nitrogen spectrum only existed under the conditions cited, while, in the case of hydrogen, I was able to confirm the existence, in the obscure part of the spectrum, of homogeneous bands of very feeble intensity.

"When, for the sake of giving a more elevated temperature to a rarefied gas, I caused the current occupying a larger space to pass through the capillary tube, I have observed, from the commencement of my researches, a change of colour accompanying the change of intensity. In other words, the relative luminous intensity of the different homogeneous lines which usually constitute the spectra of gases, is seen to be a function of temperature. I subsequently showed that in the case of hydrogen, the intensity of the three lines forming the essential part of its spectrum, do not diminish in equal proportion, and that the red line is extinguished first as we approach through the rarefaction of the gas to the point beyond which it cannot transmit the electric current. Latterly many experiments appeared to contradict my former observations, and this led me to fresh exertions, especially with a view to carry the elevation of temperature to a greater pitch than I had hitherto done.

"If we employ spectrum tubes in which the gas is extremely rarefied, little is gained in the way of increasing the luminosity of the spectrum by pushing, beyond a certain limit, the power of the induction coil, whose discharge traverses the tube; but by operating in the manner indicated in a former memoir, a new course is opened to us. M. Hittorf, Professor of Chemistry and Physics in the University of Munster, was kind enough to associate himself with my recent labours; and in confining myself at this moment to one class of phenomena, I shall select from our experiments those which illustrate the transformations experienced by the spectrum of the same gas, as its temperature is augmented more and more by the passage of currents of increased strength. In the first place I will allude to the spectrum of hydrogen. If we pass the discharge of a large Ruhmkorff coil through a capillary tube, very narrow and not long, filled with this gas at a pressure of about half an atmosphere, a spectrum is obtained similar to that afforded by employing a small coil and a great rarefaction of gas; but if we interpose, as suggested by M. Ruhmkorff, a Leyden jar, to increase the energy of the current, the spectrum completely changes its appearance. It becomes continuous; the violet and blue lines no longer arise from the ground, which has become lustrous, and we notice at one extremity of the spectrum the red line become broader, and surpassing in brilliancy the adjacent parts. Lastly, if we direct the spectroscope towards the broad part of the tube surrounding the electrode, where the light, before entering the capillary tube is less concentrated, an intermediate phenomenon is presented to our view. We still see the three primitive lines, but while the red one remains pretty much as before; the two others appear in bloom, the violet more than the blue.

"Nitrogen gas behaves in a manner altogether different; the beautiful spectrum of this gas, as I at first obtained it by means of the small induction apparatus, remains essentially the same when the great apparatus is used without the bottle and its tension is augmented to about 100 millimètres. When, however, we introduce the Leyden jar, all is changed; the new spectrum contains no trace of the old one: it is composed of a great number of beautiful lines of refrangibility one (partially separated by fine black lines), and not one of them is like the former spectrum. Sulphur and selenium afford analogous results. The spectrum of oxygen is weak under the old conditions, but if the tension of the gas is about 100 millimètres it gives with the great induction coil, and the Leyden jar, a spectrum of great beauty, composed of lines of refrangibility one. The greater intensity of the current brings out a great number of new lines. The same thing happens with chlorine and iodine.

"The former spectrum of the vapour of mercury was essentially composed of three brilliant lines, of which one is double. In the new one, other lines are added, especially red lines, and a double orange line, which at first were not even indicated; and at the same time the feeble lines on the ground of the first spectrum are less developed, as is the case with hydrogen. In this same spectrum of mercury, the green and orange rays, sharply bounded when the temperature is weak, dilate themselves more and more towards the red as the heat is increased."

Having thus illustrated the physical appearance of the spectra, M. Plucker makes the following remarks on their employment in chemical analysis:—"It seems that no compound body in a gaseous state can escape decomposition if we augment its temperature sufficiently. To effect this result, we introduce the gaseous body into a Geissler tube, then we heat the minute thread of gas in its capillary portion by means of an induction current. We then examine the incandescent thread of gas with a prism. In my former spectrum tubes a feeble current sufficed to obtain the spectrum of highly rarefied gas, but in this case the decomposition, if it occurs, is often partial. Two of these tubes—one containing carbonic acid, and the other carbonic oxide—give the same spectrum, namely, that of the last gas, which is not essentially changed by augmenting the force of the induction coil: as beyond a certain limit the temperature of the gas is not increased. In the new tubes, containing gas of a greater density, a stronger coil is required than in the old tubes, to bring the gas to a given heat; but the gas assumes a much higher temperature as we increase the power of the coil. Thus, in two recent experiments we gave to the two gases a pressure of 100 millimètres, and illuminated them with discharges of a great Ruhmkorff coil. In discharging the apparatus in an ordinary way we obtained the ordinary spectrum, that of the carbonic oxide; but upon interposing a Leyden jar of convenient dimensions, we instantly descried the beautiful spectrum of oxygen, identical with that obtained when the tubes were filled with pure oxygen at the same pressure, and transmitted a current of electricity in the same way. . . . I therefore conclude, that at a lower temperature the carbonic acid is resolved into carbon and carbonic oxide, and at a higher one this latter gas is itself decomposed, whether we introduce it in the first instance into the tube, or obtain it by the action of the current upon carbonic acid. This is not all, for immediately after the decomposition the temperature falls, and the recomposition of oxygen and carbon ensues.

"In citing these examples of the decomposition of bodies, as evidenced by spectral analysis, the decomposition of the vapour of water must not be passed over. We introduce water into the interior of the new tubes, and, before sealing them in a lamp, we boil the water to expel the air. If we then make the electric current pass, without the Leyden jar, we obtain only the three rays of hydrogen on a dark ground. With the addition of the Leyden jar we get the oxygen spectrum also, clearly defined. This experiment illustrates the facility with which the current traverses hydrogen gas. If a rarefied gas contains the least trace of water, the water is decomposed, and the hydrogen rays, especially the red and blue, are exhibited in the clearest manner. If, for example, we cause the electric discharge to pass through a tube containing nitrogen which has been dried, but without extreme care, and we establish a communication with a mercurial evacuator, we see first, as we produce a vacuum, the beautiful spectrum of nitrogen, which is replaced by that of hydrogen as the limit of rarefaction is approached. As a third illustration, I shall take chloride of zinc. After having introduced a small quantity into the spectrum tube, the vacuum is made as complete as possible. We then obtain, on heating the tube, first the chlorine spectrum, slightly developed, but easily recognizable; afterwards continuing to heat the gas, this spectrum, which at first augments in intensity, gradually disappears and that of metallic zinc comes into view. At last we see only the spectrum of this metal, which is essentially composed of four lines eminently brilliant and sharply defined; one being red, more refrangible than the red ray of hydrogen, and the three others occurring in the regions of green and blue. If the tube is permitted to cool, we notice the phenomena in inverse order, the zinc spectrum disappearing first and being replaced by that of chlorine. Excepting the non-coincidence of its bright rays, chloride of cadmium comports itself like chloride of zinc.

"Mr. Miller has lately presented to the Royal Society of London very remarkable photographs of the brilliant bands of the spectra of all the metals, but they do not seem to be as sharply defined as ours. The difference may probably be explained by the greater elevation of temperature of which his were produced. I conclude, from the facts previously cited, that these spectra were 'en marche' towards the continuous spectrum.

"If we can employ a sufficiently powerful induction coil, we may produce the spectral effects with gases having a pressure of one atmosphere or more. We might even pass a continued current of gas through the capillary tube instead of closing it hermetically. A glass tube open at both ends and having an inch or so rendered capillary in the middle, with platina wires thrust up as far as the capillary portion, becomes a veritable chemical analyser. We place one of its extremities in communication with the apparatus in which the gas to be examined is developed, or with the neck of a retort yielding any vapour, and the fluid gas or vapour becomes incandescent as it passes the capillary portion of the tube, where the platina wires are connected with an induction coil. If we wish to operate at ordinary pressures we let the gas escape freely at the other end of the analyser, and if we desire a lesser pressure it is easily obtained. The essential character of the analysis thus briefly sketched is that it not only enables us to recognize particular substances that may enter into the composition of a given body, but to exhibit all its elements. To do this in a sure and complete manner it is necessary to ascertain for each body the changes which its spectrum undergoes at each successive elevation of temperature. We must also take account of the greater or less facility which different substances offer for the transmission of the current, and likewise not forget the transport of the substance of the electrodes.

"Up to the present M. Hittorf and myself have only touched the borders of the chemical question, and of other questions related to it, but the sphere of application of the new mode of analysis appears to us great."

RESTING EGGS, OR STATOBLASTS OF A PLUMATELLA.

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

(*With an Illustration.*)

On the 29th June, 1861, the day being fine and hot, my attention was called to an entangled mass floating in the large pond at the bottom of Hampstead Heath, behind Jack Straw's Castle. On drawing a portion of it ashore by means of a landing hook, it was evident that the capture consisted of fresh water polyzoa. The cœnœcium (common house) or polypary was very compact, and composed of numerous tubes, having a multiplicity of openings; but none of the branches projected far from the main stem, which clung to, and surrounded the long fine stalks of some defunct water plant. This mode of growth was more like that of certain marine forms of polyzoa than of any which I had been in the habit of finding in ponds or streams; and as the pocket lens could only afford general evidence of relation to the Plumatella family, I hastened home to call the microscope to my aid. A branching tuft of the polyp tubes was soon placed in a zoophyte trough, illuminated by Wenham's parabola, and viewed under a two-thirds objective. The effect was splendid. The living flowers expanded freely, the tentacles assumed a pearly lustre, and the vibrating cilia glowed like scintillating jewels as they caught the light. It was evident that the *lophophore* or "crest-bearer," from which the tentacles proceeded, was crescent-shaped, or, as it is technically termed, *crescentic*, and not circular; and the tubes, taken separately, bore a strong resemblance to those of *Plumatella repens;* but I had never seen or read of this species forming a colony in such a dense enveloping mass. Of course, a reference to Professor Allman's splendid work on the Polyzoa was my first resource, but not finding the difficulty solved, I bottled up a good specimen, and sent it by post to that able naturalist's address. Unfortunately, the creatures did not reach him alive, and this circumstance, together with a pressure of other engagements, prevented his settling the point, whether they could be identified or not, with any recorded species. My own impression was in favour of considering them as varieties of P. repens, as the tubes had neither furrow nor keel, and I noticed no characters that assimilated them more closely to any other member of the Plumatella family.

I gave my specimens abundance of water in a large glass jar, in which some anacharis and myriophyllum were growing, and left them in an airy room, where I hoped they would flourish. My house was at the time in a state of siege, assailed by bricklayers, carpenters, painters, plumbers, and other enemies of scientific work, and from this cause my polyzoan visitors did not receive the attention they deserved. After a week or two I returned to their examination, and found to my vexation that the whole colony had departed this mortal life. Their houses also were in a very dilapidated condition, quite unfit for preservation, and I could only console myself by noticing that the good polypides had made abundant provision for the perpetuation of their race, by leaving behind them thousands of *statoblasts,* or resting eggs.

The generation of these creatures takes place in three modes. First, by the eggs developed in an ovary, attached by a short stem or peduncle to the *endocyst,* or internal and vital membrane of the cells. The male organs, which fertilize the eggs, occur in the same cells as the ovaries, and are connected with the *funiculus,* literally, "little rope," the name given to the flexible band by which the body of each polypide is moored to the bottom of its cell. The second mode of increase is by the growth of fresh cells, as off-shoots from the colony; and the third is by the production of *statoblasts,* which are probably only *caducous** buds, that is, buds destined to fall off at a certain time, and wait for their development until appropriate circumstances arise. Professor Allman could not detect any mode by which these statoblasts could be expelled during the life of the particular polypide in whose cell they are formed, but after the death of the animal, decomposition clears their way, and they find no difficulty in falling out. As a rule, they are objects of considerable beauty, more or less oval in form, and surrounded by a marginal ring of a different colour, and in which the cell structure makes a pretty pattern of the network kind. In Cristatella mucedi, remarkable for the locomotive properties of the entire colony, the statoblasts are round, and still further decorated with projecting spines. In the specimens under our notice, these objects were like those produced by undoubted *Plumatella repens,* and I was curious to see whether any of them would develop, and reproduce, or omit, the peculiarities of the maternal form. For this purpose hundreds, or thousands of them were placed in a glass jar full of water, and having a few bits of anacharis for their vegetable companions. The summer ended, the autumn came, the autumn passed, but no appearance of activity was manifested by the little egg-buds, which either floated on the surface of the water, or adhered to the sides of the vessel. Occasionally I squeezed one between the glasses of a live box, and from the appearance of the contents, conjectured

* Caducous (*caducus,* ready to fall), see Henslow's *Dictionary of Botanical Terms.*

Plumatella emerging from Statoblasts.

that they were in good health, although persisting in their inexplicable rest. The cold of winter was not likely to summon their dormant powers to exertion, so they were allowed to repose on a shady shelf, the glass jar being lightly covered over to exclude the dust. By spring time the anacharis had died, and the water was reduced to half its bulk by evaporation, leaving many of the statoblasts high and dry on the glass. Fresh water was poured in, and the vessel removed to a lighter place.

On the 18th of May a few of the statoblasts were discovered gaping, the shell having opened like that of a walnut. A group were speedily transferred to a zoophyte cell, and placed on the microscope stage; one polypide appeared just out—just hatched, I would say, but we must remember that we have to do with a peculiar kind of bud rather than with a genuine egg; the tentacles of the new-born polypide were beautifully expanded, but for an hour or two it was impossible to discern the crescentic form, and it might easily have been taken for a Fredericella, whose tentacles are arranged in a beautiful bell-shaped pattern, like those of the common sea-side members of this most interesting group. As far as I could make out, the circular aspect arose from a close approximation of the two arms of the crest-bearer, or lophophore, and the inconspicuous position taken by the tentacles on its inner side. In another specimen the exit from the shell went on under our eye, and the sketch which my wife made, and which forms a tinted plate, gives a good idea of how the infant polyzoon looked.

The glass jar containing the main stock of statoblasts stood in my study window, which has a north aspect, so, for the sake of varying the circumstances, I placed a few dozen in a bottle, and exposed them to as much sun as a dismal summer afforded, on a southern greenhouse shelf, keeping off the extreme glare by a thin paper screen. In this position three or four developed themselves, but the greater warmth did not exert as much influence as might have been supposed. The few specimens I obtained were used up in microscopic examinations, and a pause ensued, which was not broken till the 22nd of August, when I noticed a few more young polypides in the glass jar; those in the bottle remained as before. Since that date I doubt whether any progress has taken place, and as I did not succeed in keeping any specimen long enough to form a series of new cells and branches, I cannot tell whether they would have reproduced the compact entangled form or "gone back," as the florists say, to the simpler pattern in which the P. repens is usually found.

Probably in a good sized fresh-water aquarium in which the natural conditions of a pond would have been more accurately imitated than in my jar and bottle, the fate of the statoblasts might have been different. More might have developed, and those that emerged from their curious resting-house might have lived the full term of their race, and resembled the fruitful vine in the number of branches they would have put forth.

As some readers may not be familiar with the characteristics of the polyzoa, a few words on that subject may not be out of place. In form they resemble the compound polyps, with which group they were formerly confounded, but their structure is more complex, and their zoological rank higher. The polyps have no distinct membranous stomach, but only a cavity with one orifice; they are, in fact, living bags, having, as Dr. Grant says, "a variable number of highly prehensile tubular tentacula round the mouth." The polyps belong to the sub-kingdom Cælenterata, defined by Professor Greene in his excellent Manual* as "animals whose alimentary canal freely communicates with the somatic cavity" (*i. e.* general cavity of the body). Substance of the body made up of two foundation membranes, an outer or extoderm, and an inner or endoderm, which correspond in mode of growth with the primitive layers of the germ; no distinct neural and hæmal regions, and nervous system absent in most. Peculiar urticatory organs or thread cells usually present." The polyzoa have a distinct digestive tube with two orifices, one for entrance, and the other for exit. Their tentacles are stiffer in appearance, and not warty looking, as in the polyps, and they are furnished with two rows of cilia, the motion of which is always up one side and down the other. The intestine is bent round, so that the anus lies near the mouth, and one nervous ganglion situated near the mouth is very easily seen in many species. This ganglion acts as a rudimentary brain, and seems the source of the nerve power belonging to each individual. Recently Dr. Fitz-Müller has discovered that these creatures also possess what he terms a "colonial nervous system,"† which establishes a communication between each individual and the colony of which he forms a part.

To return to my statoblasts: I may mention that I am still keeping them to see whether any further instances of development will occur, and I should recommend any one who possesses a fresh-water aquarium to endeavour to raise colonies of these very beautiful and highly interesting animals by similar means.

* *Manual of the Sub-kingdom Cælenterata*, by Joseph Reay Greene, B.A., Professor of Natural History, Queen's College, Cork. Longman.

† See INTELLECTUAL OBSERVER, No. vii. p. 67, vol. ii.

PICTET ON THE METHOD OF DETERMINING THE AGE OF FOSSIL GROUPS.

M. F. J. Pictet, under the title of "Discussion de quelques points Palæontologiques," publishes, in the *Bibliothèque Universelle* of Geneva, some very important comments on a discourse delivered by Professor Agassiz, in reference to the classification of the Museum at Cambridge, United States, in which the last named philosopher observes :—

"Until now, geologists, in identifying the horizons of the successive deposits which form the crust of our globe, have started with the idea, universally admitted, that animals of the same geological age are either identical, or closely related over wide geographical extents. Nothing is further from the truth than this hypothesis, and it suffices to compare the fauna of the present period in distant continents to see how much they differ. If the remains of ancient times, belonging to the same geological periods, have, in general, appeared identical or closely related, that arises principally from the fact that they have been studied in the same geographical zones. Actually we find the same resemblance between the animals that live in the temperate zones of Europe, Asia, and North America; but when we pass to other climates the scene changes completely. It was the same in past ages, as we are taught by the tertiary mammalia in Southern Africa and in Australia, and I have no doubt this fact would be confirmed by more ancient formations as yet incompletely known. The specific differences between remains of the same age, found in deposits remote from each other, are more clearly demonstrated every day. Since I began to compare the fossils of America with those of Europe, I have been led by degrees to infer that we should probably never be able to establish the specific identity of animals that lived at great distances from each other, although they were contemporaneous. The doctrine of the identity of fossils of the same age requires great modifications. I am already certain that species of the same family, belonging to different epochs, but found in corresponding latitudes, are often more nearly related than species of the same age belonging to different zones. The time is rapidly approaching when zoological affinity alone will not be considered a sure criterion of contemporaneity; nor will the most striking zoological differences be held sufficient proof of difference of geological age. I have arrived at this result, unexpected, and perhaps painful, to geologists, by a careful comparison of numerous ancient faunas, arranged in the manner which I have already explained. If this discovery renders, on one hand, the determination of formations by means of fossils, more difficult for those who are not familiar with zoology, it furnishes, on the other hand, the most instructive proof of the successive changes which have occurred at different periods on different parts of the surface of the globe, and it shows how, in the earlier ages, there existed, in different portions of the earth, combinations of living beings quite distinct from those which now occupy the same localities, and, at the same time, similar to those which at present exist in other quarters. In proof of this view, I now confine myself to mentioning the resemblance that exists between some extinct faunas of the Jurassic period, and the actual fauna of Australia. We can trace a similar resemblance between the extinct faunas of other periods, and the living faunas of other parts of the world. On another occasion, for example, I pointed out the resemblance between the fossil floras and faunas of Œningen and those of the temperate zone of the Atlantic states of North America."*

Upon this passage M. Pictet pronounces the following comments :—

"We are quite in accord with M. Agassiz, that an identity of faunas is not in *every case* a proof that they were contemporary, and that a difference between faunas does not always prove that they have belonged to a different geological age. But it is not sufficient for us to break up confidence in rules that have been generally admitted ; we must also show in what cases safe conclusions can be reached, and what methods must be pursued. We will commence by considering the case of an identity between two faunas.

"If two indentical faunas are in each other's neighbourhood, stratigraphy has proved a thousand times that they must have been deposited in the same sea, either by showing that the beds which contain them are continuous, or by demonstrating that they occupy the same place in an analogous series. Nothing, according to us, nor according to M. Agassiz, shakes the generally admitted assertion that *identical faunas, situated in the same geographical region, are contemporaneous.*

"If identical faunas are separated by great intervals on the surface of the earth, the question alters, and it may be that identity is no proof of contemporaneity. M. Agassiz, in the citation we have made, speaks of analogous faunas found in different ages and at great distances. This singular agreement does not yet rest upon facts sufficiently ascertained, and, without wishing to contest its reality, we perceive rather a direction for the future labours of science than an acquisition already made. Such comparisons present great difficulty, for it becomes

* Not having M. Agassiz's lecture at hand, this passage is retranslated from M. Pictet's article.

a question of analogies and not of identities, and there is great scope for personal peculiarities of appreciation. M. Agassiz, for example, evidently does not intend to assert that the fauna of Œningen is *identical* with that actually living in South America; he merely wishes to say that there exists, between these two populations, more or less intimate relations, resulting from the identity of certain genera, and an analogy between a portion of the species. We do not doubt that researches undertaken under this hypothesis, would furnish new and precious documents.

"We may, however, while still considering the case of identical faunas, separated by great geographical intervals, look at another side of the question, which has not yet been touched upon by the learned Director of the Cambridge Museum, and which is not directly connected with the arrangement proposed for his collections, but which appear to us to possess great interest. If a series of identical faunas find themselves over a long space parallel to a degree of longitude, it may be that, according to our view, these resemblances are associated with a series of identical, but not contemporary climates. We will cite an illustration that has been supplied by the study of an interesting memoir of M. de Strombeck, in which this geologist shows the parallelism of the cretaceous faunas from Hanover to the middle of France, to which Algeria may be added. A series of identical cretaceous faunas succeed each other throughout this long interval, and we find them well developed in Switzerland, where they form a precious intermediary deposit. At this day Hanover and Algeria have very different faunas, and it is probable that in ancient times the climate of these two regions produced an analogous result. If we consider the two cretaceous faunas identical in Hanover and Algeria, it is probable that each lived in the two countries when they acquired a mean equal temperature, a circumstance that could not have taken place at the same epoch. We may well conceive the probability that this fauna lived in Hanover at an epoch when the earth was much more highly heated than it afterwards became, and that it always had a tendency to radiate and extend itself. In proportion as the climate changed, and the temperature became lower, the individuals that wandered towards the south could continue to exist, while those which journeyed northward would be destroyed. The centre of the fauna has thus been displaced, and by continuing this action it has successively occupied Germany, Switzerland, the basin of the Rhone, Provence, and at last Algeria, where the climate adapted to it arrived at a later time. When this fauna thus arrived at its new southern limits, its northern limits must have been also reached, and when it occupied the south of the geographical area, it is very probable that it was extinguished in the north, and probably in the centre. We might find many analogous examples from which we should draw the conclusion that *identical* faunas, separated by great geographical *spaces, may indicate identical climates which were not contemporaneous.* Let us only remark, that as analogous causes produce similar effects, it will ordinarily happen that in different regions the *series* of faunas will themselves be identical. The identity of faunas, insufficient to prove absolute contemporaneity, will thus serve to show that they had a similar relative age in the series to which they belong.

"If we now occupy ourselves with the case in which the faunas differ from each other, we find ourselves confronting an investigation a little more delicate and a little more difficult.

"In the case where the geographical distances between the faunas are not considerable, their difference will most often result from the circumstance that they were formed at different epochs. This is one of those facts which stratigraphy has so often put in evidence that we need not insist upon it. In a given region we frequently find different faunas superimposed in an identical order that proves their regular succession in time. But this rule is subject to important exceptions. Just as in natural seas, the association of different species follows the nature of the sea-bed, that of the waters, their depths, etc.; so, during the same geological periods, different faunas may have been deposited on muddy beds, on rocky banks, in profound depths, etc. Geologists and palæontologists have for a long time demonstrated these facts, and have given the names of 'muddy facies,' 'coralline facies,' etc., to deposits in which contemporary, but dissimilar fauna have been preserved. Every one knows the curious researches of Edward Forbes, on the different associations which the existing seas present under analogous circumstances; and, more recently, M. Alphonse Milne-Edwards has given a new extension to these facts by the discovery of species altogether new and unknown, obtained from very great depths. We may therefore say that, according to circumstances, the difference between faunas of the same geographical region may sometimes correspond with the same epoch, sometimes with a different epoch.

"It remains to be seen if, besides the stratigraphical evidence, which is alone incontestable, the palæontologist is completely disarmed when he endeavours to deal with these particular cases. We do not think so, and we believe, on the contrary, that the nature and composition of the faunas, generally bear with them the answer to these questions. Two dissimilar parallel faunas are ordinarily characterized by biological differences, manifested by the existence of certain genera, and the absence of others. Thus we easily recognize a fauna deposited in a muddy bottom by the presence of genera which live buried in mud, and by the absence of others which have need of naked rocks, such as corals and perforating mollusks. Inverse characters distinguish a coralline and a litoral fauna. We might say that these dissimilar parallel faunas form the complement one of the other.

"Two dissimilar successive faunas present inverse characters. If we take them together in their entirety, and over a certain extent, we shall see that in general they do not exhibit biological differences, that they are composed of the same genera; but that the species have been modified, although retaining the same sort of life. We shall easily comprehend these facts on comparing two successive faunas of the same facies—muddy, or coralline.

"It is evident that there is no general rule for the practical resolution of these difficulties, and that these directions, dictated by a judicious method, presuppose an ample collection of palæontological and stratigraphical facts.

"Lastly, there remains the case in which dissimilar faunas are separated by great geographical spaces, and here we recognize the truth of the opinion expressed by M. Agassiz. There is a greater difference between two contemporaneous faunas separated by great geographical distances, than between two faunas of the same region, but of different age, provided the epochs are not very remote. This fact is incontestable, and may be proved by comparisons drawn from all periods. An example, taken from recent epochs, will suffice to make its bearing known. The tertiary fauna of Australia is much like the modern fauna of that country, and not at all like the tertiary fauna of America and Europe. It is the same with these last, and we find, particularly in the fauna, so abundant and so remarkable, that occupied the American continent before the present period, all the types that were precursors of the fauna that we find there to-day, such as the edentata, the apes with thirty-six teeth, etc. In each country the fauna of one epoch derives its characteristics from two factors: the one resulting from that constant law of modification of which every part of palæontology supplies the proof; the other, and less powerful, is the condition of the organization of the preceding fauna that served for a point of departure."

"It is not necessary that we should call the attention of our readers to the importance of these facts, in reference to the explanations we seek in order to elucidate the cause by which the succession of faunas takes place."

THE FOSSIL HUMAN SKELETON FROM GUADALOUPE.

Letter of Admiral Sir Alexander Cochrane *respecting the* Fossil Human Skeleton, *from* Guadaloupe, *now in the British Museum. Communicated by* S. P. Woodward, F.G.S.

The following document seems never to have been printed, and is not so much as mentioned by Mr. Charles Kœnig, in his letter to Sir Joseph Banks, published in the *Philosophical Transactions of the Royal Society* (vol. civ. p. 107, 1814). Nevertheless it appears to be worth preserving, not only because it is the narrative of the most important person concerned in the acquisition of this celebrated fossil, but inasmuch as it corrects several slight inaccuracies in the popular versions of the discovery, and suggests some considerations which have been overlooked by all other writers.

The occurrence of fossil skeletons at Guadaloupe was first noticed in 1805, by M. Manuel Cortès y Campomanès, an officer of the French government. They were described by General Ernouf, governor of the colony, in a letter to M. Faujas Saint-Fond (*Annales du Muséum*, vol. v. 1805), and afterwards by M. Lavaisse, in his *Voyage à la Trinidad* (1813). Ernouf says that on that part of the windward (or north-east) side of the Grande-Terre, called La Moule, skeletons are found enveloped in "masses de madrépores pétrifiés," very hard, and situated within the line of high water. M. Lavaisse adds that the bed with human skeletons is nearly an English mile in length; and that he found in it hatchets and other implements, made of a basaltic or porphyritic rock, as well as bones. No mention is made of *pottery*.

It appears then that the skeletons were not found "on the main-land of Guadaloupe," as represented by Dr. Mantell and Sir C. Lyell, but on the adjoining island of Grande-Terre, which is separated indeed by a very narrow channel. It is described as a flat limestone country, consisting chiefly of the debris of corals, with here and there single hills of shell-limestone; while Guadaloupe, properly so called, is entirely volcanic.

The block of stone brought home by Admiral Cochrane was originally of a flattened oval form, about a foot and a half in thickness, and weighed nearly two tons. There were no marks of the tool upon it except the few holes evidently made to assist in raising the block, and it had very much the appearance of a huge nodule disengaged from a surrounding mass. The situation of the skeleton in the block was so superficial, that its presence in the rock on the coast had probably been indicated by the projection of some of the more elevated parts of the left arm. The bones, when first laid bare by the Museum workman, were soft, and had a mouldering appearance; but after an exposure for some days to the air, they acquired a considerable degree of hardness. Sir H. Davy ascertained that they still contained part of their animal matter. The rock is calcareous, with traces of phosphate of lime (found by Dr. Thomson), and was said to be harder than statuary marble. It has a yellowish-grey colour, and is formed of disintegrated white madrepore, with a few fine particles of red madrepore, and occasional fragments of those corals; it contained also the shell of a recent land snail (*Helix acuta*), and the "magpie" Trochus (*T. pica*), a common sea-shell of that coast.

This subject is also treated of by Baron George Cuvier, in his famous *Discours sur les Révolutions de la Surface du Globe* (Ed. 3, Paris, 8vo, 1825; originally published in connection with his *Recherches sur les Ossemens Fossiles*, of which the best edition is the 4th, 8vo, Paris, 1834, with 4to Atlas). After referring to the skeleton obtained with so much labour by General Ernouf, which came into the possession of the English, he says that *more recently* General Donzelot had extracted another example, now placed in the Cabinet du Roi (Jardin des Plantes), at Paris, and of this he gives a description and figure. It was imbedded in a softer sandstone, also containing a recent land shell (*Bulimus Guadalupensis*, Fér.) of a species still inhabiting the island. The lower jaw is preserved, but the skull is wanting, as in the former specimen. The other skeleton is extended in the usual position of the burial; but this has the knees doubled up, and seems to have been interred in the sitting position customary among the Caribs. They may have belonged to individuals of two different tribes. General Ernouf explains the circumstances by reference to a tradition of a battle and a massacre on this spot, of a tribe of Galibis by the Caribs, about the year 1710. The name Galibi was said to have belonged to an ancient tribe of Caribs of Guiana, but according to a suggestion of Sir Joseph Banks, it may have originated in the substitution of the letter *l* for *r*, in the word *Caribee*.

The only other article of any importance connected with this subject is a Report by Dr. James Moultrie, on a Skull of the Guadaloupe Fossil Human Skeleton (communicated by Dr. Shepard to *Silliman's American Journal of Science and Art*, vol. xxx. p. 361, New Haven, 1837). The remains consisted of four cranial bones, a fragment of the lower jaw, and the lower part of a thighbone, imbedded in a matrix exactly like a portion of the rock given by Mr. Kœnig, from the British Museum specimen, to which they were said to have originally belonged. They were brought from Guadaloupe by M. L'Herminière, and placed in the museum of the Literary and Philosophical Society of South Carolina, in August 1816, and were purchased in the November following by the Medical College of the State, for its Museum in Charleston. "These relics," says Dr. Moultrie, "have been supposed to belong to the head of an individual of the Carib race. This is undoubtedly a mistake. The anterior posterior diameter is too short, the occipital region too flat, and the lateral and vertical developments too full, upon a reconstruction of the cranium, to justify such a supposition. Compared with the cranium of a Peruvian in the Museum of the Medical College of the State of South Carolina, the craniological similarity manifested between them is too striking to permit us to question their national identity."

Without attaching too much importance to this ethnological opinion, it may yet be doubted whether the interment of the skeletons was quite so recent as supposed by General Ernouf. Admiral Cochrane has suggested the probability that it took place before the sea had encroached upon that portion of the shore, so as to cover it at high water, a change of no great amount, as the tides in the Antilles only amount to two or three feet; and the volcanic activity of La Souffrière, in Guadaloupe, may well have caused such a slight oscillation of level on a neighbouring shore. The beach must have consisted of loose sand at the time of the interment of the bodies, and the process of solidification may have taken place gradually, as indicated by the subsidence and displacement of some of the bones. The narrative of Admiral Cochrane, and the statement of Mr. Kœnig, equally convey the impression that the coral sand formed a sort of concretionary mass around the bodies, which doubtless supplied the phosphoric acid since detected in the stone. If Guadaloupe was densely wooded like most of the West Indian Islands when first discovered by Europeans, it would have been equally natural for the savage inhabitants to guard against hostile intrusion, or settle their own private differences, and bury their dead on the open sandy shore. There are great accumulations of shell-sand at the Island of Ascension, described by Mr. Darwin, and to them the turtles come to bury their eggs: it sometimes happens that the beach consolidates before the young are hatched, and when quarried for building purposes, the petrified eggs containing bones of the little turtles are exposed to view, as in the specimen presented by Mrs. Kenyon to the Geological Society. Deposits of calcareous sand are also cemented by the percolation of fresh water, as mentioned by Sir Alexander Cochrane. The ancient province of Pamphylia, in Asia Minor, is described by Professor E. Forbes and Captain Spratt as being wholly composed of *travertine*, full of holes and caverns, in which innumerable streams diappear from sight to burst forth afresh after a passage underground. On this coast the beaches are all petrified, and the fisherman who runs his boat ashore upon what appears to be a bank of sand or shingle, will find her bottom stove in upon a rock. The admiral refers to the bone-breccia of Gibraltar, in terms which make it desirable to say that the rock itself is a mass of gray secondary limestone, of uncertain age, containing *Terebratulæ*, similar to *T. fimbria* of the inferior oolite; and that the reddish coloured rock with *monkey-bones* is only found in caves and fissures. It is a modern deposit, such as occurs in all limestone countries; in this case the caverns having been much frequented formerly by soldiers of the garrison and pic-nic parties, numerous tobacco pipes and chicken-bones have become mingled with human remains and those of the older natives of the rock.

(Copy of Letter.)

64, Welbeck Street, *August* 27, 1813.

"My Lord—The stone that I brought from Guadaloupe, of which I spoke to your lordship, was found near to the port of La Moulle, situated on the Windward side of Grande Terre. The French Government had directed this and another that was discovered to be carefully cut from the Rock, an operation very difficult to effect, from their position being within the line of high water, consequently the workmen could only be employed when the tide had receded from the Shore, and to preserve the Body entire they were under the necessity to undermine it, carefully removing the surrounding Rocks. The first that was brought round to the seat of Government was I understand sent to France in a Ship of War, and this was to have followed had the Island not been taken at the period it was. The expense of cutting out the one I brought home I was told exceeded three thousand Pounds, but of this I can speak with no kind of certainty, as the administration carried with them all their Books and Papers. By a man of considerable abilities in mineralogy, now resident at Guadaloupe, I was informed that the body contained within this stone lies in a diagonal position, the side appearing on the upper edge of the stone, he described this to me and pointed out the arm and some other parts. I had it in contemplation to saw it in two, so as to have cut the body asunder in a line from head to foot, I afterwards thought it better that it should be conveyed to England in its present state. There is no trace in the History of the Island that can lead to the cause of this extraordinary petrefaction, nor have I heard of any conjecture as to its original formation. My idea is that previous to the discovery of America the inhabitants were in the habit of burying their dead near the Sea in the Sand, the dryness of which had kept the body in a state of preservation until the Sand had formed an incrustation round it, in this it may have been assisted by the filteration of Water from the Sea, which is known in that Country to contain much calcareous matter, as is visible in the formation of the white coral; in many places the spring Water has the same effect, which probably was an agent on the present occasion, as the Sea appears to have gained considerably upon the Sand in that Quarter by its annual progress; that part which was originally dry became submersed, and now forms the Rocks upon the Shore, out of which these 'Galibies' or human Bodies have been cut (this being the name given by the French Chemists).

"At Gibraltar I have observed many bones in the Lime stone of which that Rock is composed that resembled those of the human Body, but upon examination they were discovered to be of the Monkey Tribe. I have also observed there the constant increase of Matter occasioned by the filteration of Water from the Rock, now if one of those Animals happened to die under this filteration, the deposited Matter would soon form an incrustation round the body, altho' this could not take place at Guadaloupe in the same manner as at Gibraltar, I still consider them as analogous to each other, as the same effects are I believe produced in many parts of England.

"I submit these my ideas with much diffidence, well knowing that upon the Stone being inspected more able conjectures will be formed by those better competent to decide the question.

"I have the honour to be your Lordship's

"Most obedt. humble Servt.

"ALEXR. COCHRANE.

"The Honble. Lord Melville, etc. etc. etc."

LIFE IN THE DEEP SEA.*

THERE is a curious tendency in the human mind to allow itself to be misled by negative evidence. It arises chiefly from the conservative spirit of indolence which does not like to be disturbed in its repose, and which is better satisfied to believe that things do not exist, because we have not found them, than to undertake the labours of a fresh search. There is likewise a readiness to establish a scientific orthodoxy upon insufficient evidence, and to resent, as a pestilent heresy, whatever facts, opinions, or conclusions militate against the canons of credence which have been arbitrarily laid down. A good philosophical training removes prejudices, and establishes a readiness to believe upon sufficient proof being adduced, propositions that contradict its previous ideas. But while professed students of science feel

* *The North Atlantic Sea Bed. Part I.* By E. C. Wallich, M.D., F.LS., F.G.S. Van Voorst.

this influence in the earlier portions of their career, they often suffer a psychological ossification as age creeps over them, and they become as great opponents of novelty as if the powers of knowledge were exhausted and nothing new could possibly be true. Of course, as our store of facts grows larger, and sound induction establishes a larger number of principles from which accurate deductions can be made, many of the discoveries of science will simply realize anticipations previously formed; but we must still expect that Nature will be for ever a region of wonder and surprise, in which many things that were undreamt of, or which were even inconceivable before their discovery, will come to us with all the unquestionable credentials of belief.

Every department of science can offer illustrations of these views; but in none have old conceptions been more completely revolutionized than in marine zoology, so far as relates to the inhabitants of the profound depths of the sea. It was assumed that life rapidly diminished with increasing profundity, and that our plummets soon arrived at a region where no "dim beams," "amid the streams," "wove their network of coloured light," but where the world of waters rested for ages in unbroken silence and lifeless gloom. There was, however, little excuse for the extent to which these opinions were carried; for, as Dr. Wallich reminds us, the late Sir John Ross published in 1819 an account of his having obtained in Baffin's Bay various "sea-worms," "shrimps," and other creatures from "depths greatly exceeding those at which animal life was supposed to exist; and nearly thirty years subsequently Sir James Ross also reported having dredged up living creatures from great depths in the Antarctic seas;" but these important discoveries met with no attention, and it may be fairly said that the capture of the deep sea starfishes by the "Bulldog" was the first incident that materially modified pre-existing and erroneous views. To show the process of reasoning adopted by distinguished men in reference to this subject, Dr. Wallich quotes Mr. Page's *Advanced Text Book of Geology*, that, "according to experiment, water at the depth of 1000 feet is compressed one three hundred and fortieth of its own bulk, and at this rate of compression we *know* that at great depths animal and vegetable life, as known to us, cannot possibly exist." If Mr. Page had written "we guess," instead of "we know," he would have more accurately described the groundwork of a decision which naturalists had arrived at by common consent, without either examining the deep sea bed to ascertain what it really contained, or without acquainting themselves with some of the principal conditions that would determine whether or not it could offer the means of existence to any living thing. In the same spirit which dictated Mr. Page's remarks, Professor Philips, in his *Origin and Succession of Life on the Earth*, expresses the belief that at 300 fathoms life is extinct, thus completely ignoring the 800 fathoms sounding from which Sir John Ross brought up a *caput medusæ*, and the various creatures he obtained at a somewhat smaller depth.

In science, as in other spheres of human activity, au unreasoning credulity often follows an equally unreasonable scepticism, and we are glad to notice that Dr. Wallich, while laudably anxious as "King of the Deep Sea," to increase the number of his subjects, boldly resists arguments in their favour, which although tempting are not conclusive. Thus Professor Ehrenberg assumed that the presence of undecomposed fleshy matter (sarcode) in foramenifera, whose shells were found at very great depths, was a proof that they had been alive in the situation in which they were discovered; but Dr. Wallich demonstrates the fallacy of this reasoning, although he expects its conclusion will ultimately prove to be correct, and that hereafter specimens will be obtained whose *vital movements* will leave the question in no doubt.

Before examining the circumstances under which deep sea organisms live, we will advert the most startling acquisitions which Dr. Wallich made, especially to his famous starfish hawl. He tells us the sounding was taken in lat. 59° 27′ N.; long. 26° 41′ E., about halfway between Cape Farewell and the northwest coast of Ireland. The depth was 1260 fathoms, and "adhering to the last fifty fathoms of the line, which had rested on the ground for several moments, were thirteen *Ophiocomæ*, varying in diameter across the arms from two to five inches." These animals moved their arms after reaching the deck. The starfishes so remarkably obtained appeared to be living in the midst of their "normal haunts." In their digestive cavity was found a quantity of fresh-looking *globigerinæ*, and they seem to have been associated with creatures of a still higher type. Thus we read "in these soundings (including that in which the starfishes were obtained) taken in the undermentioned positions and depths,—namely, lat. 59° 27′ N., long. 26° 41′ W., depth 1260 fathoms; lat. 58° 23′ N., long. 48° 50′ W., depth 1913 fathoms; and lat. 56° 43′ N., long. 11° 55′ W., depth 1268 fathoms,—many cylindrical tubes occurred, varying from one-eighth to one-half an inch in length, and from one-fiftieth to one-seventieth of an inch in diameter. These were built up almost exclusively of small globigerine shells, and still more minute calcareous debris cemented together. Two or three such tubes were found by me in each of these soundings; but I failed to extract the animals from them in a sufficiently perfect condition to admit of identification. I am nevertheless able to state positively that the tubes contained some species of Annelid, and think it is highly probable that certain borings, to be seen on foremeniferous shells in the same deposits, may have been effected by it. But whether this be the case or not, it is quite clear that an Annelid lives at the depths indicated, and there builds up its tenement."

At 682 fathoms Dr. Wallich met with a Serpula, and a cluster of apparently living polyzoa, and also a minute living Spirorbis. From a depth of 445 fathoms he fished up a couple of living "amphipod Crustaceans," and a "filamentous Annelid," and when we consider how these creatures could accommodate themselves to such localities, we have to take into account the "extraordinary fact that the *Ophiocomæ*, the *Serpula, the Spirorbis* of the deep soundings,—one and all belong to well-known littoral species." From these facts Dr. Wallich observes: "We are irresistibly led to the inference that their acclimatization must have kept pace, during a vast sequence of generations, with the changes going on in the portion of the sea bed inhabited by them, and hence that, under sufficiently favourable circumstances, species may accommodate themselves to conditions differing so widely from those under which they were originally created, that their subjection to them, under circumstances less favourable, inevitably results in their extinction."

From what is known of deep sea life, we should be cautious in pronouncing judgment upon the far deeper portions of the ocean bed than our investigations have yet reached. There may be, probably is, a limit to the descending zones of life, but where it lies, seems rather for experiment than for deductive reasoning to tell. The more immediate question for solution is, how the creatures that have been discovered manage to live, under circumstances differing so widely from those in which we are accustomed to trace the mutual relations and dependance of animal and vegetable forms. Vegetable structures have not been found alive at greater depths than 2400 feet, while animals are now known to exist at 15,000 feet below the surface level. If any sort of plant lives much below the above-mentioned depth, it must perform its functions without the stimulus of light; and if animals exist far below the regions of vegetable life, they must be released from that dependance upon the latter, which we have been accustomed to regard as an universal law. Such are the interesting problems which the marine zoologist has to solve.

The pressure of great depths only opposes itself to life under peculiar forms. At a depth of a mile it amounts to 2640 lbs. on every square inch, or 160 times as much as we have to sustain on the surface of the globe. A close vessel would need immense strength to resist anything of the kind, but if the pressure from within can equal that from without, its physical force would not necessarily destroy any organism exposed to its effects. Dr. Wallich judiciously indicates the difference between certain well-known experiments and the conditions under which deep sea creatures live. Thus, "in the case of pieces of wood and meat, and corked bottles containing air, which have been sent down to great depths, in order to demonstrate the effects of pressure, it is evident that precisely those conditions are present which are never to be met with in creatures constituted to live under it. In short, they prove too much; for they prove clearly that, in defiance of all obstacles, a state of equilibrium is rapidly engendered between the interior and the exterior of the wood, the mutton, and the bottles, and that whensoever this takes place no further change is experienced. If suddenly submerged, that is to say, before the pressure has time to overcome the resistance of the cellular and fibrous tissues of the two first, and of the earth employed in the last, diminution of bulk and consequent compression of the structure must inevitably result; but, on the other hand, if the submergence be gradual, the diminution in bulk is by no means a necessary consequence, and the change brought about is a simple displacement of a lighter medium by a heavier, according to a well known law of fluids." This is no doubt right in principle, but scarcely correct in detail, as all portions of an organism may not be thus permeable, and those which the heavier fluid cannot penetrate, must be subject to the pressure which it exerts on all sides. It will, however, be admitted without difficulty, that marine animals like the star-fishes or the annelids of Dr. Wallich's dredgings would not be injured by the weight of water, if gradually submerged; and having disposed of one difficulty of deep sea life, let us turn to another, in which the function of respiration is concerned.

Some valuable experiments on board the French ship "Bonité" give us an insight into the quantity of gaseous matter existing in the water at different depths, which appears, within the limits investigated, to increase as the surface is left behind. From these investigations, and on other grounds, Dr. Wallich concludes that "since the tendency of fluids to absorb gaseous bodies is constant under all circumstances, although, as already stated, the quantity they are capable of appropriating increases with the pressure, it follows that the deeper the stratum of water, the greater must be the amount of gaseous matter held in solution by it." But the ocean is not a closed vessel, in which the liquid and the gas are squeezed together without possibility of escape, and if water at a mile down contains more air than the strata above it, the effect must be produced by the operation of a powerful attraction increasing with the compression and depth, so that every layer of water drags the air from the layer above it, and is in turn robbed by the stratum beneath itself. This may be so, but we do not think it is proved to be the case, in an increasing ratio throughout all depths. The "Bonité" experiments were not conducted at great depths, the greatest being only 2243 Paris feet. They seem however to show that, while the quantity of nitrogen is diminished as the pressure is augmented, that of carbonic acid and oxygen is considerably increased, and might accumulate to a deleterious extent if it were not rendered innocuous by the constant formation of carbonate of lime.

Within considerable limits of downward range, we may conclude from the preceding facts, that deep sea creatures are provided with the means of breathing in water, in the same way as their similarly organized inhabitants of the ocean nearer the surface level; but how do they feed? The starfish may devour the humble creature that inhabits the forameniferous shell, but what is the latter to do when dinner-time comes? Dr. Wallich admits the difficulty of furnishing an answer without appealing to a process of nutrition for which he says there is no acknowledged precedent. It is the custom of scientific men, upon insufficient evidence, and in the face of well-known facts, to assume that no animal can assimilate inorganic matter that has not previously been brought within the vital circle by vegetable forms. Dr. Wallich conjectures that if the Protozoa* can separate from the water the carbonate of lime to form their shells, they may also be able to make a similar direct use of other inorganic materials to serve as food. It is certainly, as he says, in vain that we attempt to establish a definite line of demarcation between the two kingdoms of nature, and although some philosophers still "stand upon the ancient ways," the majority are disposed to surrender the notion that the lowest living forms can be distinctly divided into animals and plants. Further researches may show more clearly the gradutions by which animal and vegetable characteristics are blended together; but if respiration enables the animal to assimilate the oxygen of the air, and, through the introduction of salts of iron into the stomach, that metal finds its way into the blood, the first link of the chain of connection is found in the highest forms of animated being.

The geological importance of Dr. Wallich's researches is very great, as strata cannot now be considered to have been formed in shallow seas, *merely* on account of their containing the remains of animals that we are accustomed to associate with moderate depths, nor are the biological aspects of the new

* Literally "first living things"—that is to say, simple or elementary creatures, at the beginning of the zoological scale.

truths less singular and instructive. From *à priori* reasoning it might have been imagined that if, through long ages, a littoral species of an animal so highly organized as a starfish had become acclimated to totally different conditions of depth, pressure, darkness, and aeration, it would also have undergone constitutional changes that would have been reflected in its structure, but no such alteration seems to have taken place in the subjects of Dr. Wallich's investigation. We inquire whether the deep sea ophiocomæ which belong to a littoral species were themselves in earlier life the occupants of shallower waters, and made a voluntary or involuntary migration to the depths below; or whether they were the born children of the abyss, the lineal descendants of some pilgrim fathers of their race whose wanderings date back to the period when changes of level and in the distribution of land and water necessitated an alteration of their abode. The *Ophiocoma granulata* appears to be a creature of determined adhesion to a particular type. It ranges from the confines of the Arctic circle to the British shores, able to make itself at home from ten fathoms to 1260, and in either of these extreme conditions, or in any of their intermediaries, to rear a family for the perpetuation of its name.

No similar adaptability seems to belong to any member of the vegetable world. Dr. Wallich met with no proper Algæ below two hundred fathoms, and his deep sea dredging only yielded Diatoms whose frustules "indicated a molecular condition of the protoplasmic matter, differing so materially from that observable in similar organisms taken in a living condition in shallow water as to render it certain that the vegetable life ceases at a limit far short of that to which animal life has ever been shown to extend." This assertion may be too dogmatic to suit the actual condition of our knowledge; but if it should be found that there are regions in which, so to speak, every animal is his own vegetable, it will reveal to us fresh secrets pertaining to the great mysteries of organization and life.

A book like Dr. Wallich's would naturally command a large circle of readers, and we regret that its mode of publication will restrict it to a very few. Science is not so profitable that many of its votaries can afford fifteen shillings for a stout quarto pamphlet, offered as an instalment of the entire work. We can hardly imagine that the profundity of his researches appeared to so able an observer to necessitate a corresponding elevation of the price of the narrative in which they were enshrined, and we should like to know whether he has been a victim of the "Lords Commissioners of the Admiralty," under whose sanction, the title-page informs us, the *North Atlantic Sea Bed* has been brought out, or whether his worthy publisher, who has done so much for zoological science, determined in this case to address himself exclusively to that very limited class whose pecuniary and cerebral developments go hand in hand. The less wealthy student to whom costly pamphlets are unattainable luxuries need not, however, lament his fate, as a concluding extract from Dr. Wallich will give him the cream of the whole matter, and show, for his economical edification, that:

1. "The conditions prevailing at great depths, although differing materially from those which prevail near the surface of the ocean, are not incompatible with the maintenance of life.

2. "Assuming the doctrine of single specific centres to be correct, the occurrence of the same species in shallow water and at great depths, proves that it must have undergone the transition from one set of conditions to the other with impunity.

3. "There is nothing in the nature of the conditions prevailing at great depths to render it impossible that creatures originally, or through acclimatization, adapted to live under them should become capable of living in shallow water, provided the transitions be sufficiently gradual, and hence it is possible that species now inhabiting shallow water may at more anterior periods have been inhabitants of great depths.

4. "On the one hand, the conditions prevailing near the surface of the ocean render it possible for organisms to subside after death to the greatest depths, provided every portion of their structure is freely pervious to fluid; on the other hand, the conditions prevailing at great depths render it impossible for organisms still constituted to live under them to rise to the surface, or for the remains of these organisms after death to make their appearance in shallow water.

5. "The discovery of even a single species living normally at great depths warrants the inference that the deep sea has its own special fauna, and that it has always had it in ages past; and hence that, many fossiliferous strata, heretofore regarded as having been deposited in comparatively shallow water, have been deposited at great depths."

RESULTS OF METEOROLOGICAL OBSERVATIONS MADE AT THE KEW OBSERVATORY.

BY CHARLES CHAMBERS.

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

1862.	Reduced to mean of day.					Temperature of Air.			At 9·30 A.M.; 2 P.M.; and 5 P.M. respectively.		
			Calculated.								
Day of Month.	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.	Rain, read at 9·30 A.M.
	inches.	°	°		inch.	°	°	°			inches.
July 1	29·907	58·8	52·1	·80	·401	67·4	48·3	19·1	9, 10, 8	W, W by N, W by N.	·000
,, 2	29·784	56·5	47·9	·75	·347	66·5	56·1	10·4	10, 9, 5	SW, WNW, WSW.	·000
,, 3	29·863	49·6	46·7	·91	·333	57·7	48·4	9·3	10, 10, 9	W, WSW, SW by S.	·000
,, 4	29·868	56·2	45·1	·69	·315	63·9	45·3	18·6	7, 7, 7	SW by W, SW, SW.	·257
,, 5	29·545	60·3	56·3	·88	·462	70·8	51·6	19·2	10, 7, 8	E by S, S by W, S by E.	·025
,, 6	...	...	...	...	...	67·5	56·8	10·7	...	...	·234
,, 7	29·620	56·7	49·1	·78	·362	64·2	55·0	9·2	9, 10, 5	SW by S, SSW, SW by S.	·020
,, 8	30·045	62·0	51·8	·71	·397	71·0	52·9	18·1	7, 5, 3	W, SW by W, SW by S.	·319
,, 9	29·985	55·2	54·5	·98	·435	64·3	53·7	10·6	10, 10, 10	SSW, SW by S, SW.	·015
,, 10	29·754	55·8	48·4	·78	·353	64·3	55·0	9·3	10, 9, 10	SW by W, W, SW by W.	·132
,, 11	29·889	53·8	40·1	·63	·265	62·2	45·8	16·4	10, 5, 7	W by N, W, W.	·110
,, 12	29·435	57·8	54·5	·89	·435	67·5	51·5	16·0	10, 10, 9	SSW, SW by S, SW.	·382
,, 13	...	...	...	...	...	70·0	49·5	20·5	...	...	·126
,, 14	29·835	61·7	56·4	·84	·464	70·2	56·5	13·7	8, 6, 10	SW, SW by S, SW by S.	·002
,, 15	29·759	58·0	48·6	·73	·356	66·3	50·9	15·4	3, 8, 3	S, SW by S, SW.	·002
,, 16	29·749	55·6	50·8	·85	·384	63·9	49·8	14·1	7, 5, 9	W, SW, NW by W.	·111
,, 17	29·878	56·7	49·6	·79	·368	64·9	46·9	18·0	8, 7, 10	SW, SW by S, SW by S.	·050
,, 18	29·977	59·0	43·1	·58	·294	67·4	54·9	12·5	3, 3, 3	W, NW by W, W by S.	·026
,, 19	29·975	56·8	53·2	·89	·416	66·4	53·4	13·0	10, 10, 8	SSW, SW by S, SW by S.	·003
,, 20	...	...	...	...	...	67·3	49·7	17·6	...	...	·000
,, 21	30·193	59·3	44·3	·60	·307	67·3	52·6	14·7	4, 8, 3	NNW, W, W by S.	·000
,, 22	30·153	58·0	47·1	·69	·338	66·2	44·7	21·5	4, 10, 10	SW, SW, SSW.	·000
,, 23	29·931	53·5	53·4	1·00	·419	61·4	51·1	10·3	10, 10, 10	NNE, N by E, NW.	·197
,, 24	29·983	60·1	57·3	·91	·478	68·0	51·8	16·2	10, 8, 4	S, SW by S, SW by S.	·031
,, 25	30·062	63·1	50·4	·65	·378	70·4	56·7	13·7	3, 1, 1	WSW, W, W.	·000
,, 26	30·018	66·5	55·6	·70	·451	74·8	49·0	25·8	0, 1, 1	SW by S, SSW, SW.	·000
,, 27	...	...	...	...	...	69·2	52·4	16·8	...	...	·015
,, 28	30·109	61·6	47·3	·62	·340	69·5	46·4	23·1	2, 2, 3	SW by S, NE, —.	·000
,, 29	30·050	62·0	47·6	·62	·344	70·4	48·7	21·7	0, 10, 8	NE, NW by N, NW.	·000
,, 30	30·074	60·0	47·7	·66	·345	69·0	53·3	15·7	7, 5, 4	N, SW, W.	·000
,, 31	30·058	60·6	52·6	·77	·408	69·8	49·7	20·1	10, 3, 4	SW by S, WSW, SW.	·000
Monthly Means.	29·907	58·3	50·1	·77	·378			15·8	...	...	2·057

HOURLY MOVEMENT OF THE WIND (IN MILES) AS RECORDED BY ROBINSON'S ANEMOMETER—JULY 1862.

Day. Hour. 12	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.
A.M. 1	7	14	6	6		15	15	6	7	15	8	9	7	12	10	10	10	12	3	9	10	2	5	4	18	1	5		2	2	5	8·1
2	8	14	7	6		12	13	8	9	15	8	5	6	9	6	10	9	13	4	12	11	2	3	5	18	2	5		1	2	4	7·8
3	7	17	7	5		13	11	6	10	12	7	5	9	12	6	8	8	15	4	13	8	3	5	3	19	3	3		2	5	6	8·0
4	11	18	8	6	49	20	12	6	11	13	9	7	6	12	3	9	8	18	9	8	10	2	5	6	20	2	5		3	4	4	8·8
5	11	20	6	7		15	14	5	13	15	10	8	5	11	5	10	7	14	8	8	9	4	7	4	21	1	5		2	5	7	8·9
6	10	17	7	6		15	17	4	10	15	11	10	5	13	6	9	8	11	12	12	7	2	9	6	18	1	5		5	4	8	9·1
7	12	17	10	6		18	20	5	17	15	11	12	6	14	11	12	10	9	13	18	11	4	10	9	17	1	5		6	5	14	11·0
8	13	16	14	7		18	18	6	18	17	12	13	6	17	13	15	8	13	21	20	13	3	9	11	22	1	9		5	9	17	12·6
9	14	18	11	9	6	21	20	8	19	18	12	15	8	20	13	15	12	13	27	20	11	4	8	12	20	5	9		9	6	18	13·4
10	14	17	10	11	8	18	20	8	19	15	13	13	8	16	14	15	12	12	23	20	12	5	8	14	18	4	9		8	7	21	13·1
11	15	16	10	11	13	20	23	7	17	15	8	13	12	22	15	15	12	12	21	20	16	7	8	13	20				9	8	24	14·4
12	13	19	7	13	14	22	14	9	21	17	9	20	15	22	15	18	12	13	27	18	13	6	10	17	15				8	10	21	14·9
P.M. 1	16	20	7	14	7	23	16	10	25	14	11	19	15	26	19	19	15	12	27	19	11	9	7	23	17	38		16	7	7	25	15·7
2	17	20	6	11	5	25	14	11	23	18	12	18	20	20	19	18	17	11	30	19	10	11	9	21	16				8	6	25	15·7
3	18	20	5	11	7	25	18	11	21	13	10	17	20	23	22	21	19	10	25	19	11	8	8	20	15				7	4	26	15·5
4	19	19	6	10	7	19	20	14	26	16	9	11	18	18	23	19	17	10	25	20	11	10	7	21	13	11		1	6	7	24	14·6
5	19	21	6	8	7	17	25	17	23	12	9	10	22	19	22	12	11	7	23	19	10	12	6	28	14	12		3	6	8	25	14·4
6	18	19	6	7	5	19	22	18	22	12	6	88	17	17	13	8	14	9	22	14	12	10	3	25	10	12		1	5	5	17	12·5
7	16	16	8	7	5	18	14	16	17	13	4	14	16	16	9	11	13	7	17	13	8	8	4	29	7	10		1	5	5	17	11·5
8	15	12	5	4	5	15	10	11	19	12	7	10	12	17	8	11	7	5	11	12	6	7	3	28	6	6	163	2	11	2	12	9·7
9	14	9	5	5	10	13	10	7	17	7	8	5	10	17	9	8	8	4	10	8	5	5	1	21	3	7		3	18	4	14	8·8
10	15	9	5	4	6	15	8	9	16	7	7	8	11	15	8	7	8	3	10	9	4	1	2	20	2	7		4	12	6	10	8·3
11	16	10	8		8	17	9	8	16	8	11	10	11	14	10	7	10	5	7	10	1	4	4	19	5	8		5	9	5	13	9·2
12	14	10	7		11	12	7	10	13	6	8	7	8	12	8	8	12	4	8	9	1	2	2	17	2	7		6	3	5	10	7·9
Total Daily Movement.	332	388	177	347		425	370	220	409	320	220	267	273	394	287	295	267	242	387	349	221	131	143	376	336	139	265		157	131	367	11·1

RESULTS OF METEOROLOGICAL OBSERVATIONS MADE AT THE KEW OBSERVATORY.

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

1862.	Reduced to mean of day.					Temperature of Air.			At 9·30 A.M., 2 P.M., and 5 P.M. respectively.		
Day of Month.	Barometer corrected to Temp. 32°.	Temperature of Air.	Calculated. Dew Point.	Calculated. Relative Humidity.	Calculated. 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.	Rain—read at 9·30 A.M.
	inches.	°	°		inch.	°	°	°			inches.
Aug. 1	29·989	66·2	48·6	·56	·356	73·7	52·2	21·5	1, 1, 1	SW, SW, by W, SSW.	·000
,, 2	29·964	61·5	50·3	·69	·377	70·9	51·8	19·1	10, 6, 10	WSW, W, W.	·000
,, 3	...	...	...	...	...	72·7	48·8	23·9	...	... ...	·068
,, 4	29·913	62·9	50·2	·65	·376	71·0	46·9	24·1	6, 2, 3	SW by S, SW by S, S by E.	·000
,, 5	29·646	61·8	49·9	·67	·372	69·4	57·4	12·0	4, 5, 4	SSW, SSW, SSW.	·000
,, 6	29·772	59·3	47·2	·66	·339	67·5	51·0	16·5	4, 8, 4	W by S, SW by S, SSW.	·003
,, 7	29·390	55·8	54·6	·96	·436	66·2	54·4	11·8	10, 7, 7	SSE, SW, SW.	·115
,, 8	29·516	54·0	46·8	·78	·334	64·5	51·8	12·7	8, 8, 7	SW, W by S, WSW,	·171
,, 9	29·771	55·9	47·8	·76	·346	63·3	53·5	9·8	8, 10, 10	NWbyW, NWbyW, NbyW.	·115
,, 10	...	...	...	...	...	63·7	46·3	17·4	...	... ...	·000
,, 11	30·112	57·0	48·4	·75	·353	64·0	53·9	10·1	10, 9, 8	NW, SW by S, W by N.	·020
,, 12	30·114	60·1	51·8	·76	·397	67·7	48·3	19·4	8, 6, 10	SSW, SW, SW by W.	·000
,, 13	29·920	59·8	55·6	·87	·451	67·7	50·5	17·2	10, 9, 10	NW, S, SSW.	·000
,, 14	29·743	57·9	57·0	·97	·473	65·8	54·3	11·5	10, 7, 10	SW by S, SW by S, WSW.	·350
,, 15	29·773	59·2	56·7	·92	·468	66·0	53·8	12·2	9, 9, 6	SW by W, SE by E, S by E.	·377
,, 16	29·759	56·4	55·6	·97	·451	62·4	51·8	10·6	10, 10, 10	NNE, N by E, N.	·186
,, 17	...	...	...	...	...	59·0	55·7	3·3	...	... ...	·944
,, 18	29·946	55·2	48·6	·80	·356	62·3	54·6	7·7	10, 10, 2	N, NW, NE by N,	·317
,, 19	29·934	62·8	53·7	·74	·423	70·0	47·5	22·5	1, 1, 0	SW by S, SW, SW by S.	·008
,, 20	29·984	59·9	53·6	·81	·422	67·3	51·0	16·3	9, 10, 10	S by W, WSW, NW.	·000
,, 21	29·899	63·3	56·2	·79	·460	71·0	56·0	15·0	4, 9, 9	S by W, S, SW by S,	·000
,, 22	29·904	59·3	49·0	·70	·361	67·6	55·0	12·6	10, 4, 7	NNW, W by N, W by N.	·016
,, 23	30·158	59·2	50·1	·74	·374	67·3	46·2	21·1	4, 6, 10	SW, SW, SW.	·000
,, 24	...	...	...	...	...	67·3	44·5	22·8	...	... ...	·002
,, 25	30·182	59·8	46·0	·63	·325	67·9	47·3	20·6	2, 1, 1	E, E, E by N.	·000
,, 26	29·888	62·6	51·0	·68	·386	70·5	51·9	18·6	5, 3, 4	E, E by S, E by S.	·000
,, 27	29·953	61·3	50·1	·69	·374	69·5	54·0	15·5	1, 4, 4	NE by N, NE, NE.	·000
,, 28	30·089	60·2	48·6	·68	·356	67·8	47·8	20·0	2, 3, 2	NE by N, NNE, NE.	·000
,, 29	30·133	56·6	51·0	·83	·386	64·6	47·6	17·0	3, 10, 10	NE by N, N by E, NNE.	·000
,, 30	30·065	57·0	49·0	·76	·361	65·0	47·9	17·1	4, 7, 4	NNE, NE, N by W.	·000
,, 31	...	...	...	...	...	66·3	54·9	11·4	...	... ...	·000
Monthly Means.	29·905	59·4	51·1	·76	·389			15·8			2·692

HOURLY MOVEMENT OF THE WIND (IN MILES) AS RECORDED BY ROBINSON'S ANEMOMETER.—AUG. 1862.

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																																
A. M. 1	10	2	4	4	7	16	9	16	7	4	6	3	5	10	3	2	14	13	1	6	1	5	6	1	5	10	7	1	1	3	5	6·0
2	6	5	3	3	8	15	9	11	6	4	6	2	5	9	4	2	15	13	0	4	3	5	5	1	5	7	11	2	2	2	5	5·7
3	5	4	3	3	9	11	14	15	5	4	5	2	5	9	3	3	12	10	1	5	4	6	5	3	3	8	11	1	1	2	4	5·7
4	5	5	5	3	7	12	11	17	7	5	4	2	4	3	3	3	13	10	2	5	1	8	5	3	5	4	7	1	1	3	3	5·4
5	7	6	7	1	6	12	15	13	6	3	6	0	6	4	1	7	10	8	1	6	3	6	5	3	5	9	7	1	2	2	7	5·6
6	9	5	5	1	4	13	20	14	6	3	4	1	8	5	1	5	9	9	2	5	2	6	5	6	7	8	6	1	2	3	8	5·9
7	15	5	4	3	8	16	24	17	8	4	6	2	12	3	2	5	9	12	1	3	3	8	5	5	6	10	7	1	2	2	7	6·9
8	15	7	5	9	14	18	25	20	10	5	7	5	16	6	3	7	9	13	2	4	3	9	5	6	13	13	6	2	3	5	9	8·8
9	18	8	4	10	16	22	27	20	10	6	5	5	14	7	3	11	10	15	5	3	2	8	6	2	18	17	13	1	5	6	10	9·9
10	15	9	4	12	15	19	29	19	14	5	8	7	13	10	3	11	11	14	7	1	3	6	5	7	20	13	12	8	7	6	11	10·5
11	16	11	6	13	13	21	32	14	13	8	7	8	15	8	2	14	15	11	11	1	4	5	6	3	20	15	10	8	7	6	10	10·7
12	14	10	6	11	14	24	33	14	12	8	5	8	13	11	5	14	14	10	12	2	5	8	7	4	15	15	11	9	10	8	11	11·1
P. M. 1	17	11	6	12	29	23	26	17	11	11	6	10	17	9	4	15	12	11	15	2	4	8	8	5	20	16	12	10	10	10	10	12·2
2	18	9	6	14	30	24	21	22	11	11	7	12	15	6	3	12	11	9	16	4	3	10	9	4	25	15	11	11	10	7	10	12·1
3	15	9	5	13	27	28	18	11	10	12	8	12	15	13	5	10	12	8	15	4	5	10	6	5	24	15	13	9	12	7	11	11·8
4	15	8	2	14	26	26	18	16	12	10	9	12	13	11	6	14	9	6	14	2	3	9	8	9	21	16	8	9	13	4	13	11·5
5	17	8	3	16	23	27	22	16	14	13	9	9	14	7	3	12	8	7	14	1	5	8	5	9	21	16	6	8	12	1	12	11·2
6	13	7	3	15	24	22	19	13	7	9	6	11	13	4	1	14	8	4	13	1	5	10	5	5	14	13	9	3	11	2	10	9·5
7	11	5	6	18	23	17	17	11	8	5	6	10	14	3	1	12	5	1	10	0	4	8	1	2	15	12	4	3	11	1	5	8·0
8	9	7	13	12	20	14	15	11	5	6	3	10	14	2	2	14	5	3	10	1	5	5	2	2	17	10	9	2	8	3	3	7·8
9	8	7	9	9	19	19	18	10	4	5	4	6	10	1	2	14	7	3	10	0	6	7	0	1	18	9	5	3	3	2	7	7·3
10	5	5	6	7	17	15	20	9	4	7	4	5	9	2	1	15	12	2	7	1	6	6	3	6	15	8	3	2	3	2	10	7·0
11	4	5	3	7	16	9	19	9	4	7	4	7	10	2	2	15	12	2	7	2	7	6	1	7	10	8	2	2	1	3	7	6·5
12	2	4	3	8	19	8	19	7	3	4	3	5	12	3	2	11	14	0	6	3	5	4	2	5	10	7	0	2	3	3	5	5·9
Total Daily Movement.	269	162	121	218	394	431	480	342	197	159	138	154	272	148	65	242	256	194	182	66	92	171	115	104	332	274	190	100	140	93	193	8·5

RESULTS OF METEOROLOGICAL OBSERVATIONS MADE AT THE KEW OBSERVATORY.

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

1862.	Reduced to mean of day.					Temperature of Air.			At 9·30 A.M., 2 P.M., and 5 P.M., respectively.		
			Calculated.								
Day of Month.	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.	Rain—read at 9·30 A.M.
	inches.	°	°		inch.	°	°	°			inches.
Sept. 1	29 964	55 0	49·4	·83	·366	61·4	45·1	16·3	10, 10, 10	N, NNE, NE by N.	·000
,, 2	29·709	59·1	52·5	·80	·406	67·4	53·8	13·6	4, 6, 7	SW by W, SW, SW.	·050
,, 3	29·629	54·3	44·3	·71	·307	61·4	50·0	11·4	4, 7, 2	SSW, SW, W.	·238
,, 4	29·785	55·2	47·9	·78	·347	63·9	42·1	21·8	2, 8, 10	SW, WNW, WNW.	·016
,, 5	29·831	54·8	49·7	·84	·369	63·5	43·1	20·4	3, 9, 9	NNE, NE by E, —.	·000
,, 6	29·948	56·6	50·7	·82	·382	64·2	49·5	14·7	1, 10, 9	W by N, W, SSW.	·008
,, 7	...	...	...	...	...	67·7	50·7	17·0	...	... ...	·000
,, 8	30·082	61·2	57·1	·87	·475	68·5	48·0	20·5	10, 10, 9	SSW, WSW, SW.	·006
,, 9	30·026	60·7	54·8	·82	·439	68·0	54·8	13·2	10, 9, 9	W by N, SW, SW by S.	·003
,, 10	29·950	53·5	46·9	·80	·336	60·7	53·9	6·8	10, 3, 1	N, N by W, NNE.	·219
,, 11	30·104	53·6	43·3	·70	·296	62·4	40·1	22·3	1, 9, 9	NW, W by N, W by N.	·000
,, 12	30·152	55·9	50·2	·82	·376	64·5	39·2	25·3	2, 4, 9	SSW, SW by W, SSW.	·008
,, 13	29·888	58·0	51·8	·81	·397	66·4	54·2	12·2	10, 5, 10	SSW, SW by S, SW by S.	·003
,, 14	...	...	...	...	...	63·9	56·1	7·8	...	... ...	·015
,, 15	29·974	62.2	53·8	·76	·425	69·9	54·8	15·1	3, 3, 7	NE, ENE, NE by N.	·153
,, 16	30·211	56·8	48·6	·76	·356	64·5	53·9	10·6	10, 3, 10	NNE, NNE, NE.	·007
,, 17	30·359	55·0	47·4	.77	·341	61·4	47·6	13·8	10, 9, 10	NE, NE, NNE.	·000
,, 18	30·376	57·2	49·7	·78	·369	64·4	43·3	21·1	3, 0, 2	NNE, NNE, NE by N.	·000
,, 19	30·320	61·0	46·9	·62	·336	67·3	50·9	16·4	4, 0, 0	ENE, E by N, ENE,	·000
,, 20	30·207	59·7	48·3	·68	·352	67·0	51·3	15·7	3, 0, 1	N, E, NE by E.	·000
,, 21	...	...	...	...	...	59·4	54·9	4·5	...	... ...	.004
,, 22	30·119	52·4	42·0	·70	·283	57·5	51·3	6·2	10, 10, 9	NE by E, E by N, E.	·000
,, 23	30·055	54·9	46·0	·74	·325	62·1	37·3	24·8	7, 9, 7	E by S, E by S, E.	.000
,, 24	29·866	56·4	52·0	·86	·400	63·2	48·0	15·2	9, 10, 10	E, E by S. ENE.	·003
,, 25	29·890	58·1	54·6	·89	·436	65·5	51·4	14·1	10, 10, 5	SW by W, W by S, SW by W.	·110
,, 26	29·895	58·7	56·5	·93	·465	66·9	49·9	17·0	9, 10, 6	S by E, SW by S, SSW.	·010
,, 27	29·877	59·3	58·2	·97	·492	67·1	54·0	13·1	9, 9, 9	E by S, E, E.	·030
,, 28	...	...	...	...	...	65·9	55·4	10·5	...	... ...	·020
,, 29	29·772	58·9	59·4	1·00	·513	66·0	56·7	9·3	10, 10, 10	SE by E, SSE, SSE.	1·359
,, 30	29·850	56·2	52·3	·88	·404	65·8	54·1	11·7	4, 7, 10	SW by S, SW, SW.	·335
Monthly Means.	29·994	57·1	50·5	·81	·384			14·7			2·597

HOURLY MOVEMENT OF THE WIND (IN MILES) AS RECORDED BY ROBINSON'S ANEMOMETER.—SEPT. 1862.

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																															
A.M. 1	2	5	13	3	2	3	5	3	3	5	2	2	9	13	8	10	7	3	9	10	14	14	3	5	3	2	1	2	1	10	5·7
2	6	5	14	2	2	2	4	1	5	5	5	3	8	8	10	12	10	3	9	12	13	15	4	5	6	1	3	2	2	6	6·1
3	5	4	15	0	1	1	6	2	2	3	3	1	4	7	11	11	9	1	9	15	13	12	4	6	2	1	2	2	2	6	5 3
4	5	6	16	1	3	3	4	2	3	4	3	1	6	8	10	11	9	1	11	13	12	12	2	5	1	1	2	2	5	10	5·7
5	5	4	17	2	1	3	5	3	3	4	2	1	5	13	10	12	9	0	11	13	11	12	2	7	1	3	2	2	1	14	5·9
6	7	6	18	2	1	3	7	2	0	9	3	1	7	8	7	13	9	1	10	12	11	12	2	6	2	1	3	2	1	12	5·9
7	6	1	19	2	1	3	7	1	4	11	4	1	7	5	6	11	11	0	11	14	13	15	2	7	5	3	2	1	3	12	6·3
8	8	1	18	6	2	4	6	1	5	10	4	1	11	11	8	12	16	1	15	16	15	13	4	5	6	5	4	4	3	16	7·7
9	10	4	22	6	5	3	7	5	4	10	4	3	12	8	8	13	18	7	15	21	15	16	8	12	6	10	7	4	4	17	9·5
10	13	4	21	4	10	4	8	7	5	9	6	6	11	12	13	17	18	9	18	19	14	15	5	18	8	12	7	4	4	18	10·6
11	14	5	20	3	10	4	7	8	3	11	7	11	15	8	13	16	19	11	22	23	15	16	14	20	12	16	6	4	8	22	12·1
12	11	7	22	3	9	5	9	9	9	11	11	12	16	6	13	19	17	9	23	22	15	18	12	20	10	16	5	7	7	20	12·4
P.M. 1	10	8	21	5	11	3	9	9	9	11	7	13	14	8	5	18	16	7	25	22	14	19	14	20	8	12	7	3	7	21	11·9
2	9	9	22	5	8	3	5	8	8	11	6	12	21	7	7	18	18	12	23	23	18	17	14	18	7	16	6	6	9	21	12·2
3	11	8	19	6	11	2	5	7	6	12	5	12	23	3	10	17	16	13	24	23	18	18	13	16	7	14	4	10	4	16	11·8
4	11	7	19	5	3	2	3	7	8	10	5	11	20	5	15	17	14	14	19	20	22	20	12	18	7	14	4	8	6	13	11·3
5	9	9	16	6	1	3	4	8	9	8	2	11	16	5	12	20	16	12	21	20	21	18	10	19	3	14	5	11	6	13	10·9
6	9	12	8	5	1	3	3	7	8	3	2	11	16	6	12	15	15	9	18	18	19	17	10	13	6	12	5	9	7	8	9·6
7	6	10	8	2	1	4	2	7	8	1	2	9	16	6	11	18	14	9	15	14	17	15	7	16	8	11	3	5	2	9	8·5
8	6	9	7	2	2	6	2	5	6	2	1	10	14	7	14	14	9	9	9	16	17	9	8	17	5	7	6	4	4	8	7·8
9	9	10	7	2	2	5	4	5	6	2	2	9	9	8	13	15	10	11	8	17	16	10	6	11	6	1	5	3	5	10	7·6
10	10	10	6	2	2	5	3	4	7	6	2	10	12	9	13	8	7	7	10	18	11	8	5	12	4	3	3	1	5	7	7·0
11	10	9	9	3	2	5	4	3	7	6	2	8	12	10	14	8	6	4	8	19	15	8	5	8	3	4	3	2	10	6	7·0
12	7	10	5	3	3	5	2	2	6	4	3	7	12	8	11	8	5	5	10	14	13	4	5	5	2	2	1	1	10	6	6·0
Total Daily Movement.	199	163	358	80	94	84	121	116	134	168	93	166	296	189	254	333	298	158	353	414	362	333	171	289	128	181	96	99	116	301	8·5

MICROSCOPIC WRITING, ENGRAVING AND PRINTING.

In our September number (page 143), we gave an account of Mr. Webb's ingenious instrument for microscopic writing. The principle as then explained appears to be substantially the same as that of Mr. Peters's Microscopic Pentagraph; and the results obtained by it are equally worthy of remark. At the date of our last notice Mr. Webb only exhibited specimens of minute writing on glass, but he has recently introduced a very elegant novelty in the shape of microscopic engraving and printing from copper-plates. In this manner he has produced highly-finished copies of the Lord's Prayer, the Apostles' Creed, God Save the Queen, Rule Britannia, and sixteen lines of verse on the International Exhibition. Many visitors have engraved their own address cards, by writing their names with a pencil on paper, and leaving the instrument to diminish and transmit the motion to the diamond point by which the letters were inscribed on a small copper plate.

To print from these delicate plates requires peculiar care and skill, but all the difficulties have been ably surmounted by Mr. Fautley, who has been working in conjunction with Mr. Webb, and the microscopic engraving, although scarcely visible to the naked eye, as a faint stain upon the paper, comes out with beautiful distinctness and regularity when placed on the stage of the microscope, and viewed with an inch or two-thirds object-glass. If the famous wizard Merlin should return to earth, and desire to print his magic book, Mr. Webb and his colleague would be able to reproduce the pages with "ample marge;"

> "And every marge enclosing in the midst
> A square of text that looks a little blot;
> The text no larger than the limbs of fleas."

They could indeed supply a diminished copy, as our readers will see when they receive the specimen we have had engraved for their delectation,* and in which the letters are considerably less than the size indicated by the poet's zoological comparison. That this is no exaggeration they may learn by micrometrical measurement, which Mr. Webb assures us will show that some of the letters only measure the half-millionth of an inch!

Mr. Webb has shown us some blocks of glass nearly inch cubes, on which he had engraved microscopically, and from

* A beautiful specimen of the engraving will be forwarded to readers who will send a directed envelope enclosing two postage stamps to Messrs. Groombridge and Sons, 5, Paternoster Row.

which he had printed specimens, using blacklead instead of ink. He also explained the difficulty in finding an ink that would deliver itself from such exceedingly minute cuttings on copper, but his present process is so successful that he has printed the Lord's Prayer from a copper-plate in a space not exceeding one-thousandth of an inch.

DOUBLE STARS—OCCULTATIONS.

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

The unforeseen arrival of the comet, now on its way into the depths of space, occasioned an interruption in our list of double stars, which we shall now resume; and in preparing work for the lengthening evenings, let us indulge the hope that the weather may prove more propitious than has generally been the case during the past season. Some of our readers may perhaps have been expecting an earlier notice of several beautiful pairs; but we have not been desirous of subjecting them needlessly to that neck-twisting which is the inseparable nuisance of the achromatic in amateur hands, and the comfort of viewing them at a lower altitude will be a sufficient explanation of the postponement. We bring forward, then, at last, the brilliant gem which has so long adorned the neighbourhood of our Zenith—

46. *a Lyræ, Wega,* or *Vega,* sometimes less accurately denominated *Lyra.* 43″·4. 135°·2. 1 and 11. Pale sapphire and smalt-blue. Optically double. The great star is a most splendid and lovely object in the telescope; not dissimilar in the quality of its light to Sirius, though inferior in brilliancy. It seems, however, hardly possible that Wollaston can have done it justice, in assigning to it only one-ninth of the light of Sirius: nine *Wegæ* compacted into one would surely far outvie any star in the firmament. But independently of this estimate, its brightness has been diversely rated. The result of its comparison with Arcturus has already been given in the Intellectual Observer, No. VI. p. 435. The elder Herschel, in 1806, gave, as comparative places in the scale of magnitude, Capella 1·25; Lyra 1·30; Procyon 1·40. His son, in his *Outlines of Astronomy,* ranks Capella, Lyra, and Procyon all of equal magnitude; but in his *Results of Observations at the Cape,* in 1847, says—"within my own distinct recollection I always considered Capella inferior to Lyra, whereas it is now decidedly superior." On the contrary, Laugier, with Arago's apparatus, found the quantity of light from Wega 617, that from Procyon 445; and Seidel, with Steinheil's photometer, found for these

stars 100 and 71 (a result very nearly agreeing with Laugier's), Arcturus and Capella standing at 84 and 83 of the same scale. We seem to be here reduced to the conclusion that either the methods hitherto employed of investigating relative brightness are worthy of little confidence, or the results are vitiated by variation of light. Difference of colour, as referred to in our p. 435, may not be without its influence, and possibly other unknown peculiarities may be concerned, since Humboldt has remarked that from some such cause Wega scintillates less than Arcturus and Procyon. From the probability that so splendid an object must be within measurable distance from our eyes, the attention of observers has been much directed to its parallax, but with no great success. W. Struve's later observations gave its amount 0″·2613, inferring a distance 771,400 times greater than that of the Sun; so that if our solar distance were represented by 1 foot, that of Wega would be 146 miles; and its light would take 12 years in reaching us. Peters, however, finds less than half this parallax; Otto Struve, combining both, prefers 0″·1549, widening in proportion that already amazing interval; while Airy considers all these results as problematical, and the parallax so small—that is, the distance so enormous,—as to be unmeasurable by our present instruments. With these data before him, who can view that glorious object without the impression that he is gazing upon a sun far greater in dimensions, or at any rate in splendour, than our own, and bearing a yet more impressive testimony to the majesty of its Creator? Wega is so situated, that in consequence of that slow motion called "the precession of the equinoxes"—the result of the attraction of the Sun and Moon upon our protuberant equator—by which the axis of the Earth is continually changing its position with respect to the stars, it might ultimately take the place of the Pole Star, but only after β and α *Cephei* and δ *Cygni* had successively gained and relinquished that distinction; and after a *computed* period of 12,000 years.

Thirty-five companions to *Wega* have been counted (of course with some low power) in the field of the great achromatic, of 14·95 inches aperture, at Harvard University, Cambridge, United States. Of these one is much closer than the rest, and we must now try to find it; but if we succeed, we shall only perceive a very minute speck, barely distinguishable so near the vivid blaze of its overpowering neighbour. Yet who shall say what, in its uncomputed and incalculable and incomprehensible distance, may be the intrinsic splendour and magnitude of that minute speck, so insignificant in our eyes; upon any estimate, doubtless very far exceeding the bulk of our eight-thousand-mile globe? Independently, however, of this consideration, which is common to it with hundreds and thousands of similar objects, it possesses some interest both as the point of departure from which the parallax of the great star is measured, and as a well-known test for instruments of a moderate size. It is evident that a certain proportion of light is requisite. I believe it might be seen with $3\frac{1}{2}$ inches of real excellence. I have caught it, but only in very fine weather, with $3\frac{7}{10}$; four inches ought to hold it pretty steadily in a clear atmosphere. Increase of power is serviceable, as tending to draw away that little point from the dazzling blaze, and to place it on a quieter and darker background; and thus Sir W. Herschel found it invisible with 227, but visible with the same aperture with 460; and when Kitchener could not see it in his 5-feet achromatic with 250, he perceived it easily with 350 and 450. In my present instrument I see it with 55. What must be the light-grasping capacity of Sir John Herschel's $18\frac{1}{4}$-inch speculum we may guess from his statement, that he has well seen and measured it in broad twilight, just after sunset, and with a moon!

The next star to *Wega* (at the present season above it) is a peculiarly beautiful and remarkable object, commonly called ϵ *Lyræ*, though more correctly by a combination of Bayer's alphabetical with Flamsteed's numerical designation—

47. $\epsilon^1 4$ and $\epsilon^2 5$ *Lyræ*. This is a quadruple, or more properly a double-double star. First of all we have a pair 3′ 27″ apart, just far enough to be separately distinguished by a very keen sight. Herschel I. once mentions having so seen it; Bessel could divide it at thirteen years of age, and I have met with two modern instances in England; but to the generality of eyes it will probably appear (as it does to my own) what Smyth calls it, "an irregular looking star." This pair, of course, is widely separated in the telescope, while at the same time it is perceived that each of the components is again closely double—a beautiful combination. The data of ϵ^1 are 3″ 2, 20°·6, 5 and $6\frac{1}{2}$, yellow and ruddy: those of ϵ^2 are 2″·6, 150°·9, 5 and $5\frac{1}{2}$, both white. Each pair is believed to be in slow motion, ϵ^1 the most northerly, with a period of about 2000 years, the other as fast again: while both may possibly revolve round a common centre of gravity in years innumerable by the skill of man. Struve differs from other observers (except Dembowski) in ascribing a bluish tint to the smaller star of ϵ^1; this peculiarity attaches to the observations of five years, and is the more remarkable as the colours of this great astronomer are usually accordant with those of other standard authorities. He also suspects variable light in one of the stars of ϵ^2. An aperture of $2\frac{1}{4}$ inches, perhaps even a little less, is sufficient, if really good, for these beautiful pairs. With large instruments three more stars are added to the group; one, which Dawes calls 9·5 mag. is comparatively

obvious; two others, between the principal pairs, 45″ apart, the "debilissima" couple of Sir J. Herschel, though both rated 13 mag. are considerably unequal, and form an admirable test for light. With $3\frac{7}{10}$ inches I had pretty certain glimpses of the one and occasional suspicions of the other; with $5\frac{1}{2}$ both are easily seen.

Just to the left of *Wega* we shall observe two small stars almost in a line with it. The nearest of these is—

48. ζ *Lyræ*. 43″·8. 149°·6. 5 and $5\frac{1}{2}$. Topaz and greenish. This is a noble though wide object; but merely optical. 1850·77 and 1855·68, with $3\frac{7}{10}$ inches, I thought the smaller star 7 and 6 mag. It now appears as in Smyth.

The further of the two is—

49. δ^1 and δ^2 *Lyræ*. Bluish and fine orange, with many companions. This pair is not in the Bedford Catalogue, but forms a very noble object under a low power.

A little below these two small stars, but somewhat more to the left, we find two more similarly arranged on a parallel line, but brighter, being of 3 mag. We must turn the telescope on the one to the right, which is—

50. β *Lyræ*, a *quadruple* group. 45″·8. 60″. 71″. 150°·1. 319°·5. 25°. 3, 8, $8\frac{1}{2}$, and 9. Very white and splendid, pale grey, faint yellow, and light lilac; with a minute pair *s*. The large star is a marvellous object, from its variation of light. This, according to Argelander, takes place in 12d. 21h. 53m. 10s., but with two maxima and minima during that period, each maximum reaching the same point between 3 and 4 mag., the minima being unequal, alternately above and below 4 mag. The duration of these singular changes has also been found variable, increasing from the year 1784, when it was discovered by Goodricke, to 1840, and subsequently slowly decreasing; a wonderful but by no means exceptional instance, which probably indicates the existence of some unknown general law. A question may perhaps be entertained, as to a possible variation in the colour of this curiously mutable star. Smyth, who gives it as above for the epoch 1834·73, states the hue of γ, the 3 mag. star to the left of it, to be "bright yellow" (1834·59). I found with $3\frac{7}{10}$ inches γ always (1849·77, 1850·47, 1850·51, 1850·7) much less yellow than β, if not white. 1862·77, with $5\frac{1}{2}$ inches, I found γ the paler in tint, though the difference was not considerable. Schmidt thought the colours always nearly the same, yellowish-white, from 1844 to 1855. Herschel and South made β white. The possibility of a variation in the brightness of γ also has been mentioned by Smyth; and there seems nothing unlikely in the idea, which at any rate deserves consideration, that change of magnitude may be, in some cases, attended by change of hue.

51. η *Lyræ*. 28″·3. 84°·8. 5 and 9. Sky-blue and violet (1834·74). I found the large star yellow, 1849·76 and 1850·77, with $3\frac{7}{10}$ inches; and 1849·93, with Mr. Bishop's 7-inch achromatic in the Regent's Park: pale yellow, 1862·77, with many powers of $5\frac{1}{2}$ inches. On the other hand, Struve makes it *cœrulea* during 5 years, about 1830. It lies in a beautiful field, containing a pretty open 8 mag. pair *s p*, and a smaller open pair, 10 and 11 mag. *f* a little *n*. To find it let a line joining *Wega* and γ be taken as one side of an equilateral triangle—the opposite angle to the left will fall near two small stars, the uppermost of which is η; or η is about one-third of the distance from *Wega* to γ Cygni—

The two stars β and γ *Lyræ* point at some distance *s f*, on to the left, a little above a glorious object.

52. β *Cygni*. *Albireo*, in the beak of the swan. 34″·4. 55°·6. 3 and 7 (perhaps, Smyth says, underrated). Golden-yellow and smalt-blue; merely, as it seems, in optical juxtaposition, though one of the most splendid and beautiful as well as best-known pairs in the heavens. Any telescope, fit to be turned upon the stars at all, will show it, though of course it will gain greatly with increase of light and power.

We will now examine some interesting objects in the head of the long winding constellation *Draco*, many folds of which lie between *Wega* and the further part of *Ursa Major*.

A line from β *Lyræ* through *Wega* falls at some little distance upon a 2nd mag. star in the Dragon's head, γ *Draconis*, or *Ras al Tannin*, worth looking at for its fine deep yellow hue, but more remarkable as passing almost exactly through the zenith of Greenwich, in consequence of which Bradley, in observing it vainly for a parallax which his instrument could not detect, was led, in 1728, to the discovery of the aberration of light. A similar line from γ *Lyræ* through *Wega* falls upon another 2nd mag. star in the head, β *Draconis*, or *Alwaid*, almost exactly *n* of which, at a short distance, lies—

53. ν^1 and ν^2 *Draconis*. 61″·9. 311°·8. Both 5, and pale grey. A bright pair, suitable for a small telescope, which seems to have a proper common motion.

As far from ν, *p*, as β is from γ, we get our next object—

54. μ *Draconis*. 3″·6. 206°·7 (1830·79). 3″·3. 200°·3 (1839·53). 4 and $4\frac{1}{2}$. White and pale white. This beautiful double star is undoubtedly binary, with a period, Smyth thinks, of about 600 years. Two inches of aperture, he found, would show it. Secchi's measures give, for 1857·5, 2″·746 and 188°·37, so that its progressive motion is striking.

Two lines, through γ and β, and through ν and μ, converge a little beyond—

55. 17 *Draconis*. 3″·8. 115°·7. 6 and $6\frac{1}{2}$ Pale yellow and

faint lilac; converted into a fine triple group by the juxtaposition of another white 6 mag. star (16 *Draconis*), at 90″·5 and 194°·6. These are, as yet, said to be stationary.

A little *n f* ν, that is, above it at the present season, and forming the N. point of a triangle, of which γ and β are the base, is ξ, a 3 mag. star. A line through ν and ξ soon falls upon—

56. 39 *Draconis*. 3″·3. 5°·5. 5 and 8½. Pale white and light blue; a 7 mag. ruddy companion stands at 89″·2 and 21°·7. There is a suspicion of binarity here; but Secchi remarks, as Struve had done, the discordancy of measures in so distinct an object.

The previous line through ν and ξ continued through the last pair, will show us, if bent a little to the left,—

57. *o Draconis*. 30″·4. 347°·6 (1830·78). 30″·3. 345°·5 (1837·89). 5 and 9. Orange and lilac. This beautiful pair, if physically connected, as Smyth thought probable, is a striking exemplification of the fact already referred to, that the magnitude of stars is no criterion of their distance.

We now leave the accumulation of double stars so curiously clustered together about the head and neck of *Draco*, and return to *Cygnus*. We have already taken *Albireo* (No. 52) on the beak. The rest of the constellation, when on the meridian, lies N. and W. of this point. In following the galaxy from *Albireo* towards *Cassiopea*, we soon find it crossed by a somewhat bent line of three nearly equidistant 3 mag. stars (besides a fourth to the left). These are δ, next the head of *Draco*, γ in the centre, and ϵ. A little above γ we come to *a*, *Al Ridph*, the *lucida* of the constellation; a star whose entire inaccessibility to the ordinary questioning of parallax, and absence of proper motion, indicate a distance perfectly incomprehensible; as its brilliancy under such circumstances exalts it, not improbably, to the dignity of being one of the largest bodies in the universe. If we now suppose a line from *a* to δ, a little outside (or N.) of it, we shall find—

58. o^2 *Cygni*, an orange 4 mag. star, which with o^1, 5½ mag. cerulean blue, at 5′ 38″, and 63 P.XX. 7½ mag., of the same colour, at 1′ 46″·6, forms a fine bright group, in one of the glorious fields so continually occurring in galaxy regions. A 16 mag. companion, 15″ from o^2, is not likely to fall under the notice of any observer with less than 6 inches of aperture.

59. χ *Cygni*. 25″·7. 72°·9. 5 and 9. Golden-yellow and pale blue. This pair is relatively fixed, but has probably a common proper motion. It will be found less than half way (about two-fifths) from β to γ, a little to the right.

A line carried from γ through *o* (No. 56) nearly as far again, will pass a little above a very pretty, though not easy object—

60. ψ *Cygni.* 3″·5. 184°·2. $5\frac{1}{2}$ and 8. Bright white and lilac.

OCCULTATIONS.

There will be three occultations at convenient hours during the present month. The earliest will be a fine one, well worth looking for. Nov. 6. δ Arietis, $4\frac{1}{2}$ mag., will disappear (at Greenwich) at 10h. 6m., and reappear at 11h. 22m. 24th, a 6 mag. star, No. 6539 B. A. C. (*i. e.* of the British Association Catalogue) will be covered by the moon's limb at 6h. 31m., and come forth at 7h. 4m. 30th, 45 Piscium, 6 mag., will be occulted from 7h. 21m. till 8h. 22m.

PROCEEDINGS OF LEARNED SOCIETIES.

BY W. B. TEGETMEIER.

BRITISH ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.

The Thirty-second Annual Meeting of the British Association was held this season at Cambridge, under the presidency of Professor Willis, who delivered the inaugural address, which was chiefly devoted to the details of the Society's expenditure. In the lecture devoted to Intellectual and Physical Science, Mr. J. Nasmyth described "The Features of the Sun's Surface," as at present known. The spots he regarded as gaps or holes in the luminous surface of the sun, exposing the dark nucleus, and over this appears a thin, gauze-like veil, then comes the penumbral stratum, and over all the luminous stratum, which he had discovered to consist of lenticular or willow-leaf shaped masses, crossing each other in every direction, so as to hide the dark nucleus, except at the spots. These objects were found to be in constant motion, shooting over the whole surface. Some of them were as large as the surface of the whole earth.

The Rev. Dr. Pritchard regarded the discovery as one of very high importance in the knowledge of the physical constitution of the sun.

In connection with this subject, Professor Selwyn showed several "autographs of the sun," taken with his "heliautograph," which consists of a camera and instantaneous slide, attached to a refractor of $2\frac{3}{4}$ inches aperture, the principle being the same as that of the "photoheliograph" made for the Kew Observatory. Two of the autographs taken have the edge of the sun in the centre of the photographic plate, showing that the diminution of light towards the edges of the disc is a real phenomenon, and not wholly due to the camera. In two taken on the 4th of August, the great spot (20,000 miles in diameter) appears on the edge, and a very distinct notch is seen, giving evidence that the spots are cavities; but observations and measurements tend to show that this evidence is not conclusive, for there was still a remaining portion of photosphere between the spot and the edge. The phenomena shown in these autographs appear to confirm the views of Sir J. Herschel, that the two parallel regions of the sun where the spots appear, are like the tropical regions of the earth, where tornadoes and cyclones occur. The faculæ seem to show that the tropical regions of the sun are highly agitated, and that immense waves of luminous matter are thrown up, between which appear the dark cavities of the spots, whose sloping sides are seen in the penumbræ. Other analogies between solar spots and earthly storms were pointed out, and reference was made to the glimpses of the structure of the sun exhibited by Mr. Nasmyth as confirming the above views.

One of the most important and popular papers read before the Association was that of Mr. Glaisher on his recent BALLOON ASCENTS. Mr. Glaisher stated, that the first ascent was from Wolverhampton on July 17. Owing to the force of the wind, considerable difficulty was experienced in the preliminary arrangements. The ascent took place at 9·43 A.M., and at once the balloon was quiescent. The swaying to and fro had ceased in an instant, and I at once proceeded to fix the instruments. At the height of 4000 feet we entered a stratum of clouds of nearly a mile in thickness. A height of more than 10,000 feet had been passed before I could put all the instruments in working order. The sky was of a deep Prussian-blue colour, without a cloud of any kind upon its surface. At starting, the temperature of the air was 59°; at 4000 feet, 45°; and descended to 26° at 10,000 feet; and then there was no variation of temperature between this height and 13,000 feet. During the time of passing through this space, Mr. Coxwell and myself both put on additional clothing, feeling certain that we should experience a temperature below zero before we reached an altitude of five miles; but, to my surprise, at the height of 14,500 feet, the temperature, as shown by all the sensitive instruments, was 31°; and at each successive reading, up to 19,500 feet, the temperature increased, and was here 43°. When we had fallen somewhat, the temperature again began to decrease with extraordinary rapidity, and was 16°, or 27° less than it was twenty-six minutes before. At this time—about eleven A.M.—we were at a height of five miles, when we began to descend. Immediately afterwards we entered a dense cloud, which proved to be no less than 8000 feet thick, and in passing through which the balloon was invisible from the car.

The most important ascent took place from Wolverhampton on the 5th of September. It commenced at 1·3 P.M.; the temperature of the air was 59°; at the height of one mile it was 39°, and shortly afterwards we entered a cloud of about 1100 feet in thickness, in which the temperature fell to 36½°, and the air was saturated with moisture. We reached two miles in height at 1·21, three miles at 1·28, and four miles at 1·39. In ten minutes more we had reached the fifth mile, and the temperature had passed below zero, and then read minus 2°. Up to this time I had experienced no difficulty in breathing, whilst Mr. Coxwell, in consequence of the necessary exertions he had to make, had breathed with difficulty for some time. Mr. Coxwell ascended into the ring, and I endeavoured to reach some brandy which was lying on the table at a distance of about a foot from my hand, but I was unable to do so. My sight became dim. I looked at the barometer, and saw it between 10 and 11 inches, and tried to record it, but was unable to write. I then saw it at 10 inches, still decreasing fast, and just managed to note it in my book; its true reading, therefore, was about $9\frac{3}{4}$ inches, implying a height of about 29,000 feet. I was losing all power, and endeavoured to rouse myself by struggling and shaking. I essayed to tell Mr. Coxwell I was becoming insensible, but I had lost the power of speech. I saw Mr. Coxwell dimly in the ring; it became more misty, and finally dark. I was still conscious, and knew I should soon be insensible, and I suddenly sank as in sleep. On recovering consciousness, I heard Mr. Coxwell say, "What is the temperature? Take an observation, now, try." I could neither see, move, nor speak, but I knew he was in the car trying to rouse me. I then heard him speak more emphatically, "Take an observation. Now *do* try." I then saw the instruments dimly, and Mr. Coxwell very dimly, then more clearly, and shortly afterwards said to Coxwell, "I have been insensible;" and he replied, "You have; and I nearly." I recovered somewhat quickly, and Mr. Coxwell said, I have lost the use of my hands; give me some brandy to bathe them. His hands were nearly black. I saw the temperature was still below zero, and the barometer reading 11 inches, and increasing quickly. I resumed my observations at 2·7, recording the barometer reading 11·53 inches, and the temperature minus 2°. I then found that the water in the vessel supplying the wet-bulb thermometer, which I had by frequent disturbance kept from freezing, was one mass of ice. Mr. Coxwell then told me that whilst in the ring he felt it piercingly cold; that hoar frost was all round the neck of the balloon; and on attempting to leave the ring he found his hands frozen, and he had to place his arms on the ring and drop down; that he found me motionless, with a quiet and placid expression on the countenance; that he at first thought I was resting myself; that he then spoke to me without eliciting a reply, and then observed my arms hanging by my side, and my legs extended, and found I was insensible. He then felt that insensibility was coming over himself, and that he could not assist me in any way; that he became anxious to open the valve; that his hands failed him; and that he instantly seized the line between his teeth and pulled the valve open two or three times, until the baloon took a decided turn downwards. Some pigeons were taken up. One was thrown out at the height of three miles; it extended its wings and dropped like a piece of paper. A second, at four miles, flew vigorously round and round, apparently taking a dip each time. A third was thrown out between four and five miles, and it fell downwards. A fourth was thrown out at five miles, and it fell downwards. A fifth was thrown out at four miles when descending; it flew in a circle, and shortly alighted on the balloon. The two remaining pigeons were brought down to the ground. One was found dead, and the other, a carrier, had attached to its neck a note. It would not, however, leave, and when cast off the finger returned to the hand. After a quarter of an hour it began to peck a piece of ribbon by which its neck was encircled, and it was then jerked off the finger, and it flew with some vigour finally towards Wolverhampton. One of the carriers returned to Wolverhampton on Sunday, and this is the only one we heard of.*

These ascents have led me to conclude, firstly, that it was necessary to employ a balloon containing nearly 90,000 cubic feet of gas, and that it was impossible to get so high as six miles, even with a balloon of this magnitude, unless carburetted hydrogen varying in specific gravity from ·370 to ·340 had been supplied for the purpose.† The amount of ballast taken up affords another clue to the power of reaching great heights. Gay-Lussac's ballast was reduced to 33lbs. Rush and Green, when their barometers, as stated by them, stood at 11, had only 70lbs. left, and this was considered a sufficient *playing* power. We found that it was desirable to reserve 500lbs. or 600lbs.; as it was evident that a large amount of ballast was indispensable to regulate the descent. Secondly, it was manifest throughout our various journeys that excessive altitude and extended range as to distance are quite incompatible. The too readily-accepted theory as to the prevalence of a settled west or north-west wind, was not confirmed in our trips. Nor was the appearance of the upper surface of the clouds such as to establish the theory that the clouds assume a counterpart of the earth's surface below, and rise or fall like hills or dales. The formation of vapour along the course and sinuosities of the river, during an ascent from the Crystal Palace, was a very remarkable demonstration. The principal conclusions deduced from these observations may be briefly stated: that the temperature of the air does not decrease uniformly with the height above the earth's surface, and that, consequently, more elucidation upon this point is required, particularly in its influence on the law of refraction. That an aneroid barometer can be made to read correctly certainly to the first place, and probably to the second place of decimals, to a pressure so low as five inches. That the humidity of the atmosphere does decrease with the height with a wonderful increasing ratio, till at heights exceeding five miles the amount of aqueous vapour in the atmosphere is very small indeed. That observations up to three

* It is evident, from this description, that Mr. Glashier was supplied with the heavy, tame variety of pigeon, known as the English carrier, which is dull of flight and does not possess the faculty of returning from long distances. Moreover, Mr. Glashier must have been very badly advised, to place ribbons round the birds, which would severely impede the flight even of those quick flying Belgian "Smerles," whose rate of speed enables them to pass an express train as if it were a stationary object.—W. B. T.

† The average specific gravity of ordinary coal gas is ·500. The gas employed by Mr. Glaisher was specially made for these ascents, being highly heated, so as to obtain a low specific gravity.—W. B. T.

miles high, even of a delicate nature, can be made as completely in the balloon as on the earth; that at heights exceeding four miles they cannot be made quite so well, because of the personal distress of the observer; that at five miles high it requires the exercise of a strong will to make them at all; that up to three miles high any person may go into the car of a balloon who has any ordinary degree of self-possession; that no one with heart disease or pulmonary complaints should attempt four miles high.

NOTES AND MEMORANDA.

The Distorted Skulls of Wroxeter.—Dr. Henry Johnson, of Shrewsbury, communicates to the Royal Society an explanation of the deformity exhibited by nine and twenty skulls discovered at Wroxeter. He ascertained that the soil in which they were found was acid, and then made an experiment by keeping a piece of fresh bone for a month in water impregnated with carbonic acid, which was found to be flexible at the end of that time. He therefore concludes that the deformity of the skulls was not congenital, but posthumous, and occasioned by a softening of the bones soon after interment, and the pressure of the superincumbent soil. After the animal matter of a bone has disappeared, it would break, not bend.

The Photographic Transparency of Bodies.—Professor W. Allen Miller has laid before the Royal Society a valuable paper on this and an allied subject, "The Photographic Effects of Metallic Spectra, obtained by means of the Electric Spark." He finds that "colourless bodies which are equally transparent to the visible rays, vary greatly in permeability to the chemical rays;" that "bodies which are photographically transparent in the solid form preserve their transparency in the liquid and in the gaseous states," and that colourless transparent solids, which exert a considerable photographic absorption, preserve their absorptive action with greater or less intensity, both in the liquid and gaseous states." Glass vessels could not be employed in these experiments, "as they all, even in thin layers, shorten the spectrum by from three-fifths to four-fifths, or even more, of its length." Rock crystal, cut in thin slices and polished, was the only substance the Professor found he could use with advantage. After atmospheric air and certain gases, rock crystal, ice, pure water, and fluor spar are most perfectly diactinic, and rock salt is scarcely, if at all, inferior to them. Among the salts of inorganic acids, the nitrates are the most remarkable for their power of arresting the chemical rays. Most liquids, except water, arrest more or less of their rays, and they are stopped by trichloride and oxychloride of phosphorus, although perfectly transparent and limpid. Reflection from a metallic speculum caused a great loss of actinic power.

The Long Spectrum of Electric Light.—In 1853 Professor Stokes exhibited this spectrum at the Royal Institution, using electric light. He had previously found that glass was opaque for the more refrangible and invisible rays of the solar spectrum, and that electric light contained rays of still higher refrangibility. Rejecting the glass, and using a prism and lens of quartz, he obtained a spectrum which, when thrown upon a highly fluorescent substance, was found to be six or eight times as long as the ordinary spectrum. He has recently laid further researches before the Royal Society, and among the metals he has examined he finds aluminium capable of producing the largest number of rays of extreme refrangibility. With some metals, broad and lightly convex electrodes exhibited the invisible lines better than wires, and the Professor adds: "The blue negative light formed when the jar is removed, and the electrodes are close together, was found to be exceedingly rich in invisible rays, especially invisible rays of moderate refrangibility. These exhibited lines independent of the electrodes, and therefore referable to the air."

IMMENSE CASTING.—A mass of iron for a pile hammer has just been cast at the Usines de l'Horme, near St. Chamond, that weighs 38,000 kilogrammes; 1 kilogramme is equal to 2·670 lbs. avoirdupois. It will be transported to Rive-de-Gier, on a truck drawn by eighty-eight oxen, harnessed in fours, and led by twenty-two waggoners.—*Cosmos.*

VARIABLE NEBULÆ.—M. D'Arrest announces that two other nebulæ in Taurus, only eight or nine degrees from that of Mr. Hind, exhibit indubitable variability. The first is that discovered by M. Tempel at Venice on the 19th October, 1859. It had 3h. 37m. 7s. R.A., and 23° 23′ D. This nebula of the Pleiades was described by M. Tempel as easily visible. In December, 1860, MM. Peters and Pope saw it with difficulty through the equatorial at Altona. In August, 1862, M. D'Arrest could no longer see it with the powerful telescope at Copenhagen. The second of the nebulæ in question is one of those observed at Bonn, and afterwards on the 5th February, 1859, by Mr. Tuttle, at Cambridge. Now it is almost invisible. These three nebulæ are the only ones, according to M. D'Arrest, whose variability is beyond doubt.—*Cosmos.*

NEW GUNPOWDER.—M. Schultz, a Prussian captain of artillery, has invented a new powder, used for the first time at the Frankfort rifle meeting. It is said to be cheaper, lighter, and more effective than the common sort, and to leave the barrel quite clean after thirty discharges. It is in brownish-yellow grains, like wood saw-dust. Its composition is not stated. The Austrians are reported to be successful in the employment of gun cotton for artillery.

CLOSING FRUIT JARS.—The *Homestead* recommends instead of corks, tying the mouths of the jars, while still hot, with strips of cloth, saturated with equal parts of beeswax, resin, and tallow. The superfluous cloth should be cut off, and then dipped in melted wax, with half its weight of tallow.

AN AMALGAM OF CADMIUM.—As most amalgams are brittle, it is remarkable, as Dr. B. Wood mentions in *Chemical News*, that equal parts of cadmium and mercury should form a tough and highly malleable composition.

ENGELMANN ON INFUSORIA.—Dr. Arlidge publishes, in *Annals of Natural History*, an abstract of researches in infusoria, by T. W. Engelmann. This observer confirms Müller's discovery of spermatozoa in *Paramecium aurelia*, and says they are not, as usually represented, thin rods equally pointed at both extremities, but have a bulky anterior, and a thinner posterior extremity of greater transparency. Their maximum length is 0·008 of a millimetre. "The embryonic development observed by Stein in *Stylonichia mytilus*, also fell under his notice. In 1859 he found specimens containing embryonic corpuscules; but it was not till the autumn of 1861 that he met with examples which illustrated a further stage in their history. These latter were individuals of medium size, and mostly contained but one large embryonic globule, placed between the two nuclei, close behind the angle of the anal aperture. Placed over it, on the central aspect of the animal, there always existed an elliptic or rounded opening, of variable size, which was the outlet for the escape of the mature ovum. On one occasion only was an elongated and rounded dorsal aperture found, in addition to the abdominal foramen just named, and serving like it for the escape of the embryos, the act of birth was several times witnessed; sometimes the embryonic globules escaped as such, at others they developed tentacles, and assumed the acinetiform figure usually described." He does not know the subsequent history of the embryos, but does not believe in their immediate transition to the ordinary form of Stylonichia, and is disposed to accept Stein's view of an alternation of generations. He rejects Balbiani's doctrine that the acinetiform beings seen to emerge from the interior of various infusoria are parasites. Many other interesting particulars will be found in Dr. Arlidge's notes.

A MICROSCOPIC VERTEBRATA.—Dr. Wallich publishes, in *Annals of Natural History*, a drawing of the jaw of a minute animal, found in mud dredged up by him at St. Helena. It contains two rows of saw-like teeth, with four larger conical teeth in the front, arranged in two pairs; the hindmost pair being very sharp and slightly curved backwards. The extreme length of this specimen is $\frac{1}{100}$ of an inch, and he estimated the creature to which it belonged as being only $\frac{1}{20}$ of an inch long.

New Spider from Cochin China.—Dr. Albert Günther figures and describes, in *Annals of Natural History*, a spider from the above named locality, remarkable for the prolongation of its abdomen, which is "anteriorily produced into a very long, thin, cylindrical process, which is twice bent, so that its basal half is leaning backwards on the back of the abdomen, while its terminal half is directed upwards and forwards. The cephalo-thorax being united with the abdomen at no great distance from the spinners, the anterior portion of the abdomen with its appendage, is situated vertically above the thorax."

Zooteira Neligata.—Dr. T. Strethill Wright describes, in the *Quarterly Journal of Microscopic Science, New Series, No. VIII.*, this elegant creature, which he found in oyster-shells, dredged from deep water, in the Firth of Forth, near Edinburgh. He says, although the animals are not common, yet we occasionally meet with a shell completely covered with a dense forest of them, each consisting of a clear, glassy stalk, surmounted by a silvery star, and it is difficult to imagine a more gorgeous microscopic display than such an assemblage affords, especially when illuminated by oblique sunlight of various colours under low powers. Zooteira is an actinophrys mounted on a contractile pedicle. The long hair-like appendages of the head Dr. Wright terms "palpocils," and he observes, "the animal remains for days with its palpocils sometimes stiffly extended, at other times slightly relaxed, and yielding in gentle curvatures to the currents in the water, and again at other times all thickened and clubbed at their extremities. When any small animalcule comes into contact with a palpocil, it is instantly taken prisoner, and the appendage recoils inwards with its prey to the body of the Zooteira, like a released thread of caoutchouc. In this way the whole of the body is sometimes studded with captured animalules, over which a film of endosare slowly creeps, and engulphs them."

The Genus Freya.—In the same journal, Dr. T. S. Wright states that certain protozoa, which he formerly described as *Lagotia*, must be called *Freya*, as that name was given to them in a memoir of Claparède and Lachinan, written before, but not published till after, his own paper. Dr. Wright now describes several new species, and explains how F. producta constructs its tube or cell. The adult animal (related to the Cothurnia Vaginicola, etc.) is furnished with two long curved "rotatory lobes." Its larva, which is free swimming, secretes the lower part of its cell, and fixes itself. It then builds up the long neck of the tube, carefully moulding the plastic matter with its immature lobes, which it uses as a pair of hands, just as sabella and serpula mould their tubes with their secreting leaflets. Having erected its tube to the requisite height, it finishes it off with a handsome trumpet-shaped mouth, and then retires to develop its long rotatory lobes. "The cell of this species is furnished with an immensely prolonged neck, formed of a ribbon of chitine, spirally wound in a tube, cemented by a thick internal gelatinous layer, from which it derives its green colour, and covered by a thin layer of that peculiar glutinous secretion which is used by various aquatic animals to attach themselves and their habitation to the sites where they dwell. This glutinous stuff Dr. Wright calls "colline."

New Planet.—On the 29th of August, M. Tempel discovered a new planet of 10 magnitude. M. Luther also thought he had found a new body of the same kind, but it turned out to be M. Goldsmidt's Daphne, discovered in 1856, and which has been lost sight of for six years.

The Great Comet of 1861.—*Cosmos* says that M. Sluzki, of Moscow, has computed the time of revolution of this body to be 400 years.

The Aplanatic Eyepiece.—Since our report of Mr. Burr's paper at the Astronomical Society, on the Aplanatic Eyepiece made for telescopes by Messrs. Horne and Thornthwaite, we have made several trials of one constructed on the same principle, but of considerably higher power than that to which he referred with such strong commendation. The subject of our experiment corresponds very closely in power with a Huyghenian eyepiece, estimated at 300, with a 42-inch telescope, having a fine 3-inch Gauss objective, by Steinheil, of Munich, remarkable for the lightness of its field. It is only upon certain objects, and in very fine weather, that such an eyepiece can be fairly tried, but we have obtained a good definition of small stars, and a splendid effect upon the grand mountain scenery near the terminator of the moon before and after its full. The field is rather larger than with the Huyghenian, but the difference is not so great as in lower powers. It is also rather lighter, and on the most favourable evening of our experiments we were disposed to give it a decided preference for certain objects. From the fact of the surface of the field lens being in the focus of the eye combination, extraordinary care in freeing the former from dust is essential. It would not be fair to either the makers or our readers to say more at present, except that, as the new eyepiece is not expensive, we strongly advise astronomers to investigate its merits by actual use. Mr. Webb has employed a miscroscope object-glass for high powers, "the field lens of the ordinary construction being omitted, and the microscope object-glass taking the place of the lens next the eye." This plan works well, but it is too costly for ordinary use.

Microscopic Address Cards.—The minute cards supplied by Mr. Webb are wonderful specimens of microscopic engraving and printing. You receive a Lilliputian glazed card, without the slightest trace of any inscription. A strong pocket lens shows two faint and delicate lines, impossible to decipher: but if the little curiosity is transferred to the stage of the microscope, and examined with an inch or two-thirds objective, you at once see a name and address in elegantly-formed letters, and greatly admire the skill by which so marvellous a result is obtained.

Fish Hook Spiculæ.—We have received from Mr. Baker, of Holborn, a slide containing spiculæ of the *Hymedesmia Johnsonii* (a sponge from Madeira), and which are stated to be new objects in this country. They have the form of a double fish-hook, and on the inner surface of each hook is an extremely sharp knife edge projection, corresponding with a similar and equally sharp projection from the inside of the shank. These minute knife-blades are so arranged that, in addition to their cutting properties, they would act as barbs, obstructing the withdrawal of the hook. The two hooks attached to one shank are not in the same plane, but nearly at right angles with one another, so that when one is horizontal, the other is vertical, or nearly so. A magnification of 400 or 500 linear does not in any way detract from the sharp appearance of the knife edges, and they may take their place with the anchors of the Synapta, as curious illustrations of the occurrence in living organisms, of forms which man was apt to fancy were exclusively the products of his own contrivance and skill. We presume these hooks of the Hymedesmia answer the usual purpose of spiculæ in strengthening the soft tissue, but they must likewise render the sponge an awkward article for the Madeira sea slugs to eat.

Determining the Distance of the Sun.—M. Foucault has devised an ingenious apparatus for determining the velocity of light, and from the results thus obtained he computes the distance of the sun from the earth without leaving his study. M. Babinet in stating these facts to the French Academy, observed: "Astronomy by the measure of aberration tells us that the mean velocity of the earth round the sun is $\frac{1}{10000}$ of that of light. Taking this fraction of the velocity of light we have the space traversed by the earth in one second, and by multiplying by the number of seconds in a sidereal year we obtain the dimensions of the annual orbit of the earth. Half the diameter of this orbit is the distance of the sun from the earth. The solar parallax, according to M. Foucault is 8″·86, with an uncertainty of about $\frac{1}{800}$.

Archæopteryx lithographica. H. VON MEYER.
Jahrbuch für Mineral: 30 Sept., 1861.
Griphosaurus problematicus. A. WAGNER.
1861, Sitzung: der Münchner Akad: der Wiss.
Griphornis longicaudatus. OWEN.
Nov., 1862, Trans: Royal Society.

THE INTELLECTUAL OBSERVER.

DECEMBER, 1862.

ON A FEATHERED FOSSIL FROM THE LITHOGRAPHIC LIMESTONE OF SOLENHOFEN.

(*Lately acquired for the British Museum.*)

BY HENRY WOODWARD, F.Z.S.

(*With a Coloured Plate.*)

It has always been held that the form and proportions of any symmetrical object may be inferred from the inspection of a part or fragment of the whole. The disciples and admirers of Cuvier have often asserted that it was possible for those who (like that great anatomist) possessed the requisite knowledge, to reconstruct the entire frame of any extinct animal from a single bone, or tooth, or claw. These notions went, doubtless, far beyond the pretensions of the illustrious founder of the science of comparative osteology, and they have led to mistakes and disappointment; but they serve to show the strength of the conviction which long ago found expression in the proverb, "*ex pede Herculem.*"

That the existence of birds at the period of the Secondary rocks should have been first intimated by their *footprints,* may seem strange; but as far back as 1835 a notice appeared in Silliman's *American Journal of Science,* stating that Dr. Deane had discovered impressions *resembling the feet of birds* upon some slabs of red sandstone from Connecticut. Dr. Hitchcock was the first who submitted these tracks to careful scientific examination, and concluded that they had been produced "*by the feet of birds* which must have been at least *four times larger* than the ostrich." These gigantic three-toed footprints have been found in more than twenty places, scattered through a tract nearly eighty miles long, and they are repeated through strata more than one thousand feet thick.* Upwards of two thousand of the *Ornithichnites* had been observed and examined by Professor Hitchcock twenty years ago; but notwithstanding the most diligent and careful search, not a vestige of the organic remains of either bird or pterodactyle have as yet been discovered in these beds. Numerous coprolites occur in

* Lyell's *Manual of Geology,* fifth edition, p. 348.

the Connecticut rocks, and Dr. Dana has very ingeniously argued from an analysis of these bodies, that, like guano, they are the droppings of birds rather than of reptiles.

In the strata between these red sandstones (formerly considered to be of Triassic age and now attributed by modern American geologists to the Lias or Oolite) and the lower Eocene, only two discoveries of reputed bones of birds have been made. The first of these is the *Cimoliornis diomedeus,* a long-winged bird from the chalk of Burham, near Maidstone, described in 1840 by Professor Owen in the *Geological Transactions,* second series, vol. vi., from a leg and wing-bone which he considered to have belonged to "one of the longipennate natatorial birds, equalling in size the albatross."*

In May, 1845, Dr. Bowerbank figured and described (in *Quarterly Journal of the Geological Society,* p. 7, pl. 1) several bones and a part of the head of a pterodactyle, from the same chalk pit at Burham, near Maidstone, and after carefully comparing these with the shaft of the humerus of *Cimoliornis,* he was led to believe that it also was the bone of a pterodactyle and *not a bird.* In Dixon's *Geology of Sussex,* edited by Professor Owen, in 1850, this wing-bone is again figured and described as that of a bird. The arguments in favour of the Professor's theory are there given at length, to which I must refer the reader, pp. 402-3.

In a subsequent work,† the *Cimoliornis* is omitted, and the *Pterodactylus giganteus,* Bowerbank, from the middle chalk of Kent, is recognized as one of the largest and the last of the flying reptiles known.

The second recorded discovery of bird remains in the Mesozoic rocks is noticed in the supplement to Sir Charles Lyell's fifth edition of his *Manual of Geology,* 1859, p. 40: "Mr. Lucas Barrett in 1858 discovered the remains of a bird in the Upper Greensand, near Cambridge, a formation worked extensively for phosphate of lime, extracted from coprolitic nodules. The bird was rather larger than the common pigeon, and probably belonged to the order natatores, and, like most of the gull tribe, had well-developed wings. Portions of the metacarpus, metatarsus, tibia, and femur have been detected, and the determinations of Mr. Barrett have been confirmed by Professor Owen." These bird bones remain unchallenged, but are the only true ones on record.

Ornitholites have been met with in at least a dozen different localities in the tertiary deposits of Europe, and also at two or three places in our own island.

We possess, in the geological collection of the National

* Owen's *British Fossil Mammals and Birds,* 1846, p. 547.

† Owen's *Palæontology,* second edition, 1861, p. 275.

Museum, specimens from the Miocene of Allier, in France, and Œningen, near Constance; from the Upper Eocene of Puy de Dôme, Perignat, and Auvergne; and from the Eocene of Montmartre and Meudon, near Paris; and from our own Eocene of Hordwell and Sheppey. We have also the remains of a large bird from the Sewalik Hills of India; casts of the bones and egg of the Æpyornis from Madagascar, and the entire skeleton of the Dinornis, and very numerous separate bones of this genus and Palapteryx from New Zealand. With the two exceptions of the Eocene slate rocks of Glaris, in which the almost entire skeleton of a small passerine bird, about the size of a lark, has been discovered, and the gypsum quarries of Montmartre, where two or three connected skeletons of different species of birds have been found, these remains consist of *detached bones or fragments only*, or of eggs (from Auvergne) or feather impressions (from Aix and Bonn). Indeed, the whole collection of *Ornitholites* known could be displayed in a single table case of ordinary size.

This, of course, is *exclusive* of the great New Zealand and Madagascar wingless birds, the Dinornis and Æpyornis, the Notornis and Palapteryx, which, like the Dodo and Solitaire, have perhaps all been exterminated by the agency of man, or within the historic period. When we compare this dearth of evidence in the geological record with the vast numbers of species of living birds (very partially illustrated by the collection of stuffed examples in the Ornithological Gallery of the British Museum), we cannot but ask the question—Why are no fossil birds found in strata in which remains of other animals frequently occur, which *at first sight* appear as little likely to have been preserved as the bones and feathers of a bird? Sir Charles Lyell remarks, that "the powers of flight possessed by most birds would insure them against perishing by numerous casualties, to which quadrupeds are exposed during floods." And again, "If they chanced to be drowned, or to die when swimming on the water, it would scarcely ever happen that they would be submerged, so as to become preserved in sedimentary deposits."

That they can be readily preserved under favourable circumstances is proved by the fine examples found at Montmartre and Glaris.

That we shall have to record many more ornitholitic discoveries is, I think, proved by the startling announcement which appeared in print, for the first time in England, in the *Annals and Magazine of Natural History* for April last, headed "On a new Fossil Reptile, supposed to be furnished with Feathers," by A. Wagner.* In May appeared another paper,

* Being a translation from the *Sitzungsberichte der Münchner Akad.: der Wiss*, 1861, p. 146, by W. S. Dallas, F.L.S., of the York Museum.

"On the *Archæopteryx lithographica,* from the Lithographic Slate of Solenhofen," by Hermann Von Meyer.*

In referring to the notices given of this wonderful discovery, I prefer to take H. Von Meyer's paper *first,* as being the palæontologist who *first* really called attention to the subject. He reminds us, that "feathers, or indeed any remains of birds, have hitherto been known in no rocks older than the Tertiary period;" and that in the lithographic slate, osseous remains of birds have frequently been supposed to occur, which upon closer investigation appeared to belong to *Pterodactyles* (perhaps to *Rhamphorhynchi*), from the structure of which we cannot infer that the animals were clothed with feathers, and no traces of feathers were ever seen with the numerous Pterodactyles found, the skeletons of some of which were perfect. He goes on to say, "This rendered it the more surprising, that recently a feather should be brought to light, precisely in the same formation, and even at the same spot, which furnishes the greatest number of Pterodactyles. The object," he adds, "occurring on the stone, agrees in all its parts so perfectly with the feather of a bird, that it is impossible to distinguish it therefrom." After a most minute description he concludes, "The fossil feather of Solenhofen, therefore, even if agreeing perfectly with those of our birds, need not necessarily be derived from a bird. And indeed a feathered animal, differing essentially from our birds, has occurred in the lithographic slate. My informant is M. Witte, of Hanover. This gentleman saw, in the possession of M. Häberlein, of Pappenheim, upon a slab of Solenhofen slate, an animal, of which he remarked that it possessed feathers, and that the feathers of the tail were attached, not as in birds, to the last vertebra, but on each side of the caudal vertebræ. They were, moreover, quite distinctly furnished with stem and vane. The simple tarsus of itself shows that this animal does not belong to the Pterodactyles, and the formation of the tail contradicts the idea that we connect with our birds, yet the feathers are not distinguishable from those of birds. The fossil feather described by me will be derived from a similar animal."

Dr. Wagner's paper (written shortly before his death) was wholly founded on report. Having, like Von Meyer, received from M. Witte, of Hanover, a description of the fossil in M. Häberlein's collection, and also read a notice of Von Meyer's feather from the same formation, he subsequently procured

* Translated from the *Palæontographica,* vol. x. p. 53, by the same author foregoing.

A short notice of these two papers will be found in the INTELLECTUAL OBSERVER, No. 5, for June last, page 367.

from a friend* a fuller description of the fossil, which he quotes at length.

From this report he was led to conclude that the affinities of this wonderful creature were strongest to the Saurian reptiles, and accordingly he regarded its natural covering as merely "presenting a deceptive resemblance to feathers," and he named it *Griphosaurus* (from γρῖφος, an enigma).

Fortunately for English palæontologists, through the exertions of Professor Owen and Mr. G. R. Waterhouse (the latter of whom made it the object of a special journey to Pappenheim), this unique fossil has been acquired for the geological collection in the British Museum. Here it will be open to the observation of all the world, and (before the issue of this present number) will be described by Professor Owen before the Royal Society, under the name of *Griphornis longicaudatus*, who thus indicates his conviction that it is a *bird*.†

The lithographic limestone of Solenhofen, near Munich, presents a strong resemblance in lithological character to the White Lias, but its fossils are probably of the age of the Kimmeridge clay. The formation is of marine origin, and abounds in remains of cuttle-fishes, resembling in condition and character the fossils of our lower Oxford clay at Chippenham, ammonites, nautili, crustacea, fishes, and also of winged insects and pterodactyles. From the immense demand for this stone for lithography, the quarries are as extensive as any in Europe. The quarrymen work upon the lines of stratification, which are beautifully parallel, and all the fossils are found upon the natural surfaces, presenting an impression and counterpart in almost every instance. The stone is often quarried to the depth of eighty or ninety feet! This feathered enigma presents precisely similar appearances to all the other included organic remains, being imbedded upon the surface of one layer, and impressed in intaglio into the one overlying it, which bears not only the cast, but portions of the bones upon its surface.

The feathers, which are most beautifully preserved upon the lower slab, were indistinct *at first*, being originally covered by a thin film of fine calcareous mud, which M. Häberlein removed, so as to exhibit the tail and wings, and some further portions of the skeleton itself. The head, neck, and dorsal vertebræ are wholly wanting. The right scapula and humerus and both the fore-arms are well preserved: the former bones are present on the left side, but imperfect; the fore-arm consists of radius and ulna; a metacarpal bone is present on the left side, lying

* The friend appears to have been his present successor in the museum of Munich, Dr. Oppel.

† The figure presented herewith is sketched from the actual specimen, and carefully reduced. Professor Owen decided at the last moment to retain the name *Archæopteryx*.

beside the radius and ulna; there are also some small detached bones, which no doubt are finger bones. Above the wing feathers on the left hand may be noticed two small slender bones, to which sharp claws, similar to those of the foot, are articulated. These may have been used for clinging, like those of the pterodactyles and bats, or as offensive weapons, like the fighting spur with which the wings of the spur-winged goose of the Cape and Central Africa, the Chaja Screamer (related to the Rails) from Cayenne, and some others are armed.

The "merrythought," or *furculum*, is seen lying between the wings. The ribs, small and unbird-like, are detached, and scattered on the surface, as if the head, neck, breast, and body had been torn off or eaten out by some other bird of prey or small carnivorous animal, wandering at low water upon the estuarine flats bordering that ancient oolitic sea.

The lower right limb is well preserved, and consists of femur, tibia, and tarso-metatarsal bones; to the latter bone four toes are articulated, one hind toe and three fore toes, having severally 1, 2, 3, and (4 ?*) joints, *as in all birds*, and armed with strong hooked claws. The thigh and shank *only* of the right limb remain. The pelvis is well preserved on the left side, showing the cup-shaped cavity in which the head of the femur moved.†

The *sacrum* (so conspicuous in all known birds) cannot be traced in this skeleton, unless the stained surface of the stone indicates its remains. That one existed by which *a few* at least of the sacral vertebræ were firmly fixed together may be fairly concluded, for the hind limbs seem well adapted for hopping, running, or perching; and the wings (which evidently were adapted for flight) must also have received support in proportion to their size from the body of the animal.

The whole of the vertebræ of the tail are completely and beautifully preserved. They are twenty in number, of a narrow, elongated form, the dimensions of which slowly but constantly diminish, so that the last is the smallest. The feathers of the tail are attached in pairs to each vertebra throughout its entire length. It is in the form and number of the caudal vertebræ, and the arrangements of the tail feathers, that the great and striking peculiarity of this remarkable creature lies.

In all recent birds we find the tail very short and powerful, composed of vertebræ varying from five to nine in number, having spinous processes on their upper and under side, and

* The fourth toe bones underlie the second and third, and cannot be certainly counted.

† The fossil is lying on its *back*, so that we view *the underside* of its feathers and bones.

the last vertebra very peculiarly formed, and, with few exceptions, *always the largest.* To this last joint all the tail feathers in living birds are attached, and on it we find that peculiar oil-gland to which the bird applies its beak, and so anoints and renders waterproof every feather of its body.

Taking into consideration the remarkable divergence presented by the tail of this fossil creature from all known birds, and also the antiquity of the formation in which it occurs, we may at least safely infer that (if it be a bird at all) it represents perhaps one of the very earliest examples of its class.

And this seems the more consistent when we consider the analogous change which has taken place in the class of fishes.

For in the oldest fossil fish we find the same curious elongated tail (seen only in the sharks and sturgeon of the present day), in which the vertebral column is prolonged into the upper lobe of the caudal fin, forming the characteristic feature of the *Heterocercal* fishes. Whereas in the almost universally-prevailing type of modern fishes the tail fin springs from *the last joint* of the vetebral column, giving us the order of *Homocercal,* or even-tailed fishes.

That the feathers were real *bona fide* feathers like those of a bird seems to be placed beyond all doubt by the evidence of the impressions of both wings and tail, descending, as they do, to microscopic exactness. It has been suggested that a creature furnished with such feathers *must have had a beak* to keep them in order with.

Among the flying lizards of the Solenhofen slates is one described by H. Von Meyer, under the name of *Rhamphorhynchus,* as having "the *fore part* of each jaw *without teeth,* and probably incased in a *horny beak;* but behind this edentulous portion there are four or five large and long teeth followed by several smaller ones. The tail *long, stiff, and slender.*" Such a flying reptile *might have been endowed with feathers,* in which case the toothless portion, incased in a horny beak, would be well adapted for pluming and cleaning its wings and tail.

Such is the present state of the evidence. There is nothing in this fossil which elucidates the origin of the bird tracks of Connecticut, although perhaps contemporaneous with them.

Professor Owen decidedly inclines to the opinion that this curious creature is a bird, but many very distinguished naturalists, who have carefully examined it, have professed themselves unable to come to any such positive conclusion.

Much light may be expected from the Professor's promised paper, but we must wait for the discovery of other specimens before we can arrive at a complete demonstration of the true character of this wonderful inhabitant of a former world.

10*th Nov.* 1862.

THE ORIGIN OF INFUSORIA.

In a recent address on physiology, delivered before the British Medical Association, Dr. Sharpey said, "In the physiology of reproduction, the old question of spontaneous generation has been lately revived and submitted to further discussion; but, as I think, has been satisfactorily answered in the negative, and especially through the admirable researches of M. Pasteur. That most able and accomplished inquirer has not only proved the non-appearance of infusorial organisms when adequate means are taken to exclude their germs, but he has succeeded in actually demonstrating the presence of such germinal spores in the atmosphere. Air was made to pass through a tube filled with gun-cotton, taken from a sample proved to be free from foreign admixture. The cotton was then dissolved in ether or chloroform, and the sporules of algæ and other small organisms which had been entangled in their passage, were found in the liquid." In a former article, on the "Conditions of Infusorial Life," we gave a faithful account of the real state of this singular controversy, which is decidedly misrepresented by Dr. Sharpey's remarks. In the first place, it is not fair to M. Pouchet, the leader of the heterogenists, whose opinions we by no means espouse, to treat the contest which is eagerly pursued in France, and which has extended to America, as merely a revival of the old dispute about "spontaneous generation." The details of M. Pouchet's views will be found in his own work, *Heterogenie,* or in the article to which we have referred, and we do not intend to re-examine them now; suffice it to say that he reduces all generation to one principle, and conceives reproduction by eggs (*orthogenesis*), and reproduction without eggs (*heterogenesis*), to be the result of the same laws operating under different conditions. "If," says M. Pouchet, "a Supreme Being, whose unity is revealed in every part of the globe, has presided eternally and universally over all the phenomena that have been exhibited on its surface, and if it has pleased him to people the earth with tribes of animals and of plants that have succeeded one another, why not repeat to-day what has occurred in former epochs, for as P. Gorini observes, spontaneous generation is not a greater marvel than normal reproduction." M. Pouchet affirms in another passage that the same "Creative Will" which originally caused physical matter to assume living form, without the previous intervention of sexual elements, operates still. Thus both physiologically and theologically the modern controversy differs from the old, and it is only represented otherwise by those who would rather smother it under evil associations, than patiently wait for a result that can only be reached by much labour and thought.

As we stated in a former paper, the simplicity of the apparatus employed by M. Pasteur gives great value to his experiments, for it must be extremely difficult to shut out all sources of error, when a series of vessels with numerous joints are employed, but some of his opponents deserve equal credit for the method they have adopted. Practically the question to be first decided is, whether any vital organisms can appear in infusions in which existing germs have been destroyed, and to which the access of fresh germs is rigorously prevented. It has been assumed that boiling an infusion destroys any life or germ of life that it contains, and that when air is made to traverse a red-hot tube a similar result takes place. Now it cannot be said that, in adopting these methods, M. Pasteur has "*proved*" the necessary non-appearance of infusorial organisms, as Dr. Sharpey asserts, because opposite results have been obtained by other able experimentors who have made analogous trials. In France Messrs. Pouchet, Joly, and Musset, and in America Professor Wyman, adduce experiments that flatly contradict those of M. Pasteur. We gave some account of Mr. Wyman's experiments in number ix, p. 229, and they will be found in detail in *Silliman's Journal*, or in the *Chemical News* of August 30th. Several of these trials were made as described in the following extract:—"Two flasks each of 550 *c. c.* capacity, and each containing about 20 *c. c.* of beef juice and urine, were hermetically sealed at the temperature of the room, wrapped in cloth, and exposed for two hours in boiling water. The film formed on the fourth day. One of them was opened on the fifth, and the other on the eleventh, aud both found to contain Bacteriums." In experiment 35, pieces of mutton in a hermetically sealed flask were boiled for ten minutes in a Papin's digester, under the pressure of five atmospheres. "No film was formed. The flask was opened on the forty-first day. Monads and vibrios were found, some of the latter moving across the field. No putrefaction, the solution had an alkaline taste." In four instances out of thirty-three no organisms appeared, but the balance of the results was discordant with those of M. Pasteur, Professor Asa Gray being present at the opening of some of the flasks. In experiment 12, the juice of an ounce of beef, to which was added 10 *c. c.* of urine and 40 *c. c.* of water, was boiled twenty minutes in a bolt-head and hermetically sealed. A film formed on the fourth, and the flask was opened on the eleventh day, when there was a distinct rush of air outwards. Large numbers of Bacteriums were found, also small spherical bodies with ciliary motions and oval bodies like kolpods, containing what appeared to be Bacteriums. One of these kolpod-like bodies moved with cilia.

After these experiments, it is obvious that there is something else to be done than simply to acquiesce in the results of M. Pasteur, notwithstanding his scientific eminence and skill. Nor is it true, as Dr. Sharpey appears to conceive, that the presence of germinal spores in the atmosphere, sufficient to account for the appearance of infusoria in solutions, has been ascertained. M. Pasteur certainly discovered some spore-like bodies, but we believe he never identified any of them as eggs of infusorial animals. Professor Wyman states as the result of many examinations of dust deposited in attics, and of the particles floating in air and collected on glass-plates covered with glycerine, that like Pouchet, he found grains of starch, and spores of cryptogams, and much less frequently what appeared to be eggs of invertebrate animals, but that "both eggs and spores may be said to be of rare occurrence." It will, however, be asked whether the eggs of infusoria could be discoverd by the methods employed. M. Balbiani gives a table (which will be found at the close of this article) of the number and dimensions of the ova produced by various animalcules, and as will be seen on reference to our account of his remarks in No. 6, p. 468, he describes them as so transparent that their form can only be made out by employing dilute acetic acid to augment their cohesion and refractive power. It would probably be impossible, especially without the employment of reagents, to see those bodies after they had been caught in a film of glycerine, or still worse, in one of olive oil which MM. Joly and Musset employed, and we should certainly not be warranted in assuming the non-existence of infusorial ova in consequence of the failure of a comparatively clumsy means of investigation.

With reference to the appearance of Bacteriums or similar objects in infusions apparently free from living germs of any kind, we may observe that scarcely anything is known concerning these minute organisms. Ehrenberg placed them among the animals, and inferred their possession of a plurality of stomachs! Other investigators regard them as vegetables, and Mr. H. J. Clark, of Cambridge, U. S., claims some of them as nothing more than portions of decomposed muscular fibre or tissue. Probably these objects, which assume the form of exceedingly minute chains, more or less flexible and moveable, differ widely in their real nature, and some of them may not even be alive at all.

M. Pouchet now deposits with the French Academy a fresh batch of printed and MS. matter on Heterogenesis, to compete for the Alhumbert prize, and MM. Joly and Musset send in for the same purpose their *Nouvelles Etudes sur l'Heterogenie*, a brief account of which is given in *Comptes Rendus*, September 22, from which we select the most interesting facts. They took a series of flasks holding one litre, and containing forty grammes of the same decoction, together with air that had been passed through red-hot tubes (*air calciné*). Then, following the method of M. Pasteur, they caused a little tube containing gun-cotton, charged with dust from the air, and "subjected to the action of burnt air," to fall into flask A. The neck of the flask, also filled with the burnt air, was sealed in a lamp. In flask B, prepared in the same way, they placed a piece of gun-cotton, selected from the middle of a considerable mass of that material which had been kept in a closed bottle, and was as free as possible from atmospheric dust particles. In C they placed the same decoction, with calcined air, and no cotton, while D was subjected, like the preceding, to a second ebullition, but was allowed to remain open. A fifth, E, was closed during the second boiling. After five days A was opened, and found to contain long Bacteriums, and a clot of a branching and entangled mycelium. This was the result obtained by M. Pasteur. B was opened two days later, and contained what the writers call dead Bacteriums reduced to granulations, and on a portion of the gun-cotton which extended beyond the tube there was a fine mycelium identical with that in A. C was opened on the same day with A, and exhibited Bacteriums, but rather fewer than A, and no mycelium. "This result," say MM. Joly and Musset, "confirms once more those which we obtained last year, in repeating the experiment of Schwann, and it proves, contradicting the assertions of M. Pasteur, that air heated and then cooled does not leave intact the juice of meat which has been exposed to ebullition. On the sixth day, D, which had remained open, exhibited no infusoria, but two days later swarmed with long and active Bacteriums. Eight days later E exhibited no infusorial life. Another set of experiments showed that distilled water containing a tuft of gun-cotton charged with atmospheric dust produced few organisms, and sometimes none; that similar water, to which a considerable quantity of dust was added, yielded Bacteriums and monads; that if aster leaves, carefully washed in pure water, were placed in distilled water, ciliated infusoria appeared. Distilled water used to wash a large quantity of mercury from a pneumatic trough "remained unfertile, although one of the enemies of heterogeny affirmed that a single globule of mercury was enough to people any infusion."

Following M. Pouchet, MM. Joly and Musset placed a considerable quantity of a filtered infusion of chopped hay in one vessel, and then floated in it a smaller vessel containing some of the same infusion. In the large vessel they obtained ciliated infusoria, and only Bacteriums and monads in the little one. It is not stated how long they kept these vessels to see what they would yield.

It is possible that after a greater lapse of time ciliated infusoria might have appeared in the smaller vessel, as they can certainly be obtained with very small quantities of fermenting hay;* but if not, it does not follow, as these gentlemen consider, that the existence of germs in the atmosphere is disproved, as the small quantity of filtered infusion may not have contained enough of some particular substance to facilitate the development of any germs which might have fallen into it.

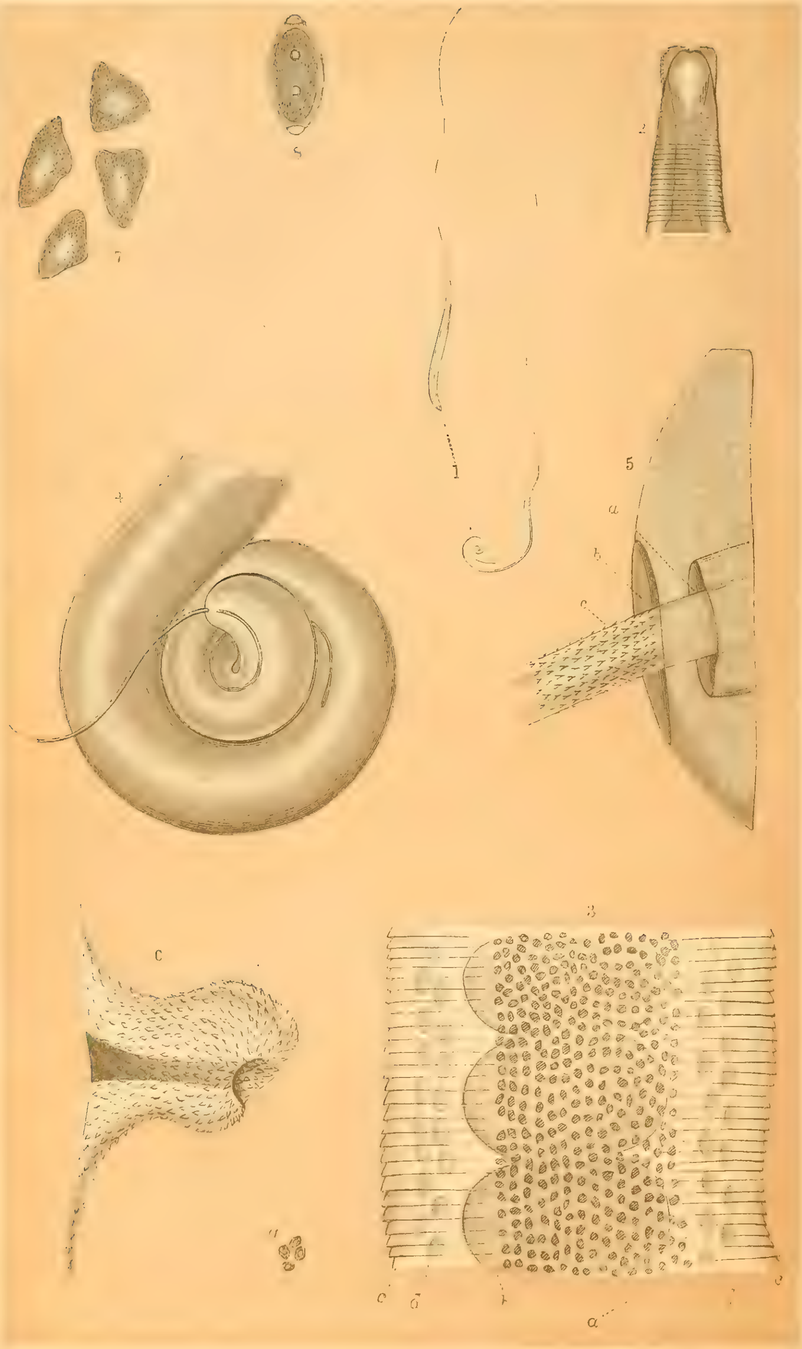
It is evident that controversies of this kind tend to clear up obscure points in the history of infusoria, and it is a pity that in England, as on the Continent, they cannot be regarded from a purely scientific point of view. It is not honest to take no account of facts that contradict our own notions, to cite Pasteur, and omit Pouchet or Wyman. As the matter really stands, there are discrepancies which have to be explained, and the vast assemblage of objects grouped together as "infusoria" differ so widely in structure as to countenance the idea that their mode of origin may not be the same. We may mention that the French Academy has appointed a Commission, composed of M.M. Milne-Edwards, Flourens, Brongniart, and Coste, to report upon the papers on Spontaneous Generation sent in to compete for the Alhumbert prize.

THE EGGS OF INFUSORIA (*Balbiani*).

Name of Species.	Number of Eggs.	Diameter of Eggs in fractions of a Millemetre.†
Trachelius ovum	2	0·120
Amphileptus gigas (?) . .	20—25	0·018
,, anas	2	0·008
Loxophyllum meleagris . .	12—15	0·015
Loxodes rostrum	15—20	0·015
Chilodon cucullus	1	0·005—0·020
Bursaria truncatella . . .	4	0·057
Ophryoglena flava	4	0·018
Spirostomum teres . . .	2—3	0·018
,, ambiguum .	20—50	0·014
Stentor cæruleus	8—15	0·021
Euplotes patella	2	0·014
Stylonichia mytilus . . .	4	0·018
,, pustulata . .	4	0·010
Urostyla (undetermined) .	100 or more	0·007
Paramecium aurelia . . .	4	0·018
,, bursaria . .	2—4	0·014
,, (undetermined)	20—25	0·007

* Mr. Slack tells us that he has obtained kolpods and other ciliated infusoria in vessels containing half a grain of chopped hay and two drachms of distilled water.

† The millemetre is equal to 0·0394 of an inch.



1
2
3
4
5
7
8
a
b
c

THE WHIP-WORM.

BY T. SPENCER COBBOLD, M.D., F.L.S.,

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(*With a Tinted Plate.*)

A MORE appropriate name than the above could scarcely be devised for this interesting parasite. The species which dwells in the human body appears to have been first noticed by the distinguished Italian anatomist John Baptist Morgagni, and it was subsequently described by Buttner and Roederer, under the generic title of *Trichuris*, signifying *hair-tailed* worm. The circumstances which led to its rediscovery are thus recorded by Moquin-Tandon in (Hulme's edition of) his *Elements of Medical Zoology*: "During the winter of 1760-61, a student of Gottingen, who was dissecting the valve of the colon in the body of a young girl five years old, accidentally opened the cæcum, when several entozoa came out. H. A. Wrisberg and some other students considered that these worms belonged to a species not previously known. The prosector, C. T. Wagler, maintained that they were Oxyurides of a very large size. Other persons mistook them for very small Ascarides. From this a serious discussion, or rather quarrel, arose, which might have been easily settled if the newly-discovered worm had only been carefully compared either with an Ascaris or an Oxyuris. Roederer, having heard of the dispute, had the animal in question brought to him, and having examined it with Buttner, they both came to the conclusion that it was a new species." They accordingly named it *Trichuris*, under an erroneous impression that the long, narrow, filamentary part of the body was only the tail. All the species of the genus as now known display this remarkable character more or less conspicuously, and in some, as, for example, in the one selected for illustration in the accompanying plate (fig. 1), the thong-like portion of the worm is extremely attenuated.

As frequently happens upon the discovery of any novelty, all sorts of strange notions were soon afloat as to the significance of this new parasite, and consequently we find an otherwise intelligent physician writing a long dissertation, *De Morbo Mucoso*, with the view of proving that this perfectly harmless little whip-worm was the sole cause of a choleraic dysentery raging in the ranks of a division of the French army then stationed at Gottingen. Other crude ideas, unsupported by facts, were taken up and exploded in due time, whilst the worm itself proved a puzzle to Linnæus and other zoologists. In 1782 that worthy German pastor and naturalist, J. A. E. Goeze, solved a number of difficulties respecting the structure, economy, and zoological relations of this parasite, and in his admirable *Versuch einer Naturgeschichte der Eingeweidewürmer thierische Körper,* we find him remarking as follows:—"The genus is rare. We have hitherto found this worm only in man, in a horse, in a wild hog, in a mouse, and in a footless lizard. From an examination of these, however, it is evident that they are not one and the same species, for they are not all similarly formed; but some, as that described by Pallas, are furnished with other organs. I make, therefore, two classes, as I have before mentioned, and in order that we should in future more agreeably recognize the Hair-head as *Trichocephalos,* I shall prove by undeniable facts that the capillary extremity is answerable to the head." From these and other observations of Goeze, it appears tolerably conclusive that he was the first to give a correct interpretation as to the true character of the narrow portion of the whip-worm. The various forms to which he alludes are now generally admitted to be distinct species; the one from the lizard (*Bipes Pallasii*) having been referred by Rudolphi to a distinct genus, under the title of *Sclerotrichum echinatum.*

Some eight or ten different species of Trichocephalus have been described by helminthologists; the two most common, and by their similarity of external characters likely to be confounded together, being the whip-worm of man and that of our domestic ruminants. The former (*Trichocephalus dispar*) has repeatedly been made the subject of minute investigation, but the latter (*T. affinis*) is comparatively less known, and its intimate structure little understood. We shall therefore confine our remarks principally to the species infesting cattle, and commence our special account of its peculiarities by offering a complete synonymy as follows:—

Trichocephalus affinis, Rudolphi; Gurlt; Miram; Lamarck; Mayer; Dujardin; Diesing; Cobbold (*Linn. Trans.,* vol. xxiii. tab. 33, p. 352).

Trichocephalus Cameli, Rudolphi.

Trichocephalus Ovis, Abildgaard.

Trichocephalus Giraffæ, Clot-Bey; Diesing (species inquirendæ).

Trichocephalus gracilis, Cobbold (*Proceed. Zool. Soc. for* 1860, p. 103).

From careful investigation we are satisfied that Clot-Bey's *T. Giraffæ* and our own *T. gracilis* are one and the same species, both being referable to the *T. affinis* of Rudolphi, which has now, therefore, been found in various kinds of oxen, sheep, antelopes, and deer; in the goat, the giraffe, and also, according to Diesing, in the porcupine (*Histrix cristata*).

If attention be directed to the accompanying plate illustration, it will be seen that we have represented two individuals of *T. affinis*, the upper one being a female, and the lower a male, which is easily recognized by its gracefully curved spiral tail. To the naked eye these whip-worms do not differ materially from those found in our own bodies, but on microscopic examination a distinction, especially in the males, is readily observed. With the pocket-lens, as we have elsewhere remarked, the surface of the worm appears smooth throughout; but, when highly magnified, peculiar markings are seen on the anterior thin portion, which probably also extend over the body proper. The so-called neck presents a tolerably uniform thickness along its entire course; it is so narrow as to measure only from the $\frac{1}{125}$ to $\frac{1}{120}$ of an inch transversely, whilst the finely-pointed head itself, immediately below the mouth, has a diameter less than the $\frac{1}{1000}$ of an inch. In the fresh state the head appears to be lobed; or, rather, furnished with two alæform lobed appendages, as represented in fig. 2; but in preserved specimens these appearances either partially or entirely disappear, leaving one in doubt as to their true nature. Kuchenmeister has noticed the evanescence of apparently similar structures surrounding the mouth of *Trichocephalus dispar*, and therefore supposes that the lobes in question are due to the presence of a peculiar organ, capable of eversion and inversion, and not merely the result of accidental sarcode globules. Be that as it may, it is surprising to notice how completely other well-marked external and internal characters alter or disappear from shrinking and distortion caused by immersion in spirit. This observation especially applies to a very peculiar longitudinal band which commences a little below the head and can be traced on one side of the neck the whole way down to the beginning of the so-called body. This band, which is remarkably distinct in fresh specimens, was first discovered by Dujardin, who states it to consist of prominent and pointed papillæ. Wedl has also described it as consisting of little warts and spines; whilst Kuchenmeister goes so far as to compare these little prominences to the hooklets present on the intromittent organ of the male.

According, however, to our own observations, this band is made up of projecting, bluntly-pointed, polygonal, epidermal cells, which in certain adjustments of the focus refract transmitted light so strongly, that the band of them looks as if it consisted of a regularly arranged series of pigment spots, as shown in fig. 3 *a*; at other times the centre of each cell becomes clear (*a*), and the irregularly polygonal character of each individual cell is rendered more apparent. On one side of the longitudinal band Dujardin also figures and describes a series of minute superficial papillæ, which he associates with a festooned border of the band. We have not observed these prominences, and the festooned markings are manifestly due to the subjacent convolutions of the œsophagus (*b*), being singularly uniform in size and disposition. In the fresh state the dermal rings (*c c*) are beautifully distinct. They are said to extend all round the filamentary neck, but we found them ceasing at a little distance apart from either margin of the longitudinal band. Midway between the latter and the serrated border of the neck there exists internally a double row of oval corpuscles (*d d*), but no vessels or fibres were observed in connection with them. As regards the reproductive organs, the first thing that strikes one is the unusual length of the intromittent organ and its membranous sheath. This character is believed to be distinctive; at all events, it departs very materially from what is observable in *Trichocephalus dispar*, where the sheath forms externally a funnel-shaped tube. The organ in question is also itself included in a sheath-like, muscular mass, apparently concerned in the evolution of the intromittent organ; its free end is shown in fig. 5 (*a*). We have never seen this muscle exserted, but the cloacal opening (*b*) is sufficiently capacious to give it free passage, if necessary. The everted part of the sheath (*c*) measures about the $\frac{1}{19}$ of an inch in length; being perfectly transparent, not always uniform in breadth, but covered throughout its entire extent with minute, conical, sharply-pointed spines, whose apices are directed backwards towards the body of the animal.

The occasional absence of uniformity in the diameter of the sheath seems to us to be a point of some importance; for, unless our examinations had extended over a considerable number of specimens, we might have believed ourselves to have found several distinct forms of *Trichocephalus*. At first this conclusion seemed inevitable; but, finding several intermediate conditions between that of a simple cylinder, on the one hand, and that of a tube furnished with a large flask-shaped distension near the free extremity on the other, it became evident that the variations of outline were only due to the degree of protrusion or contraction to which the organ had, in either case, attained.

To make these appearances clearly understood we have added a woodcut, which should be compared with fig. 4 in the plate, where the sheath is extended to the utmost. In the cut the corresponding letters have the same meaning in both figures, and they bear the following indications:—*a*, epidermis; *b*, cutis; *c*, cæcal end of the testis; *d*, seminal duct; *e*, intestine;

Fig: 1.

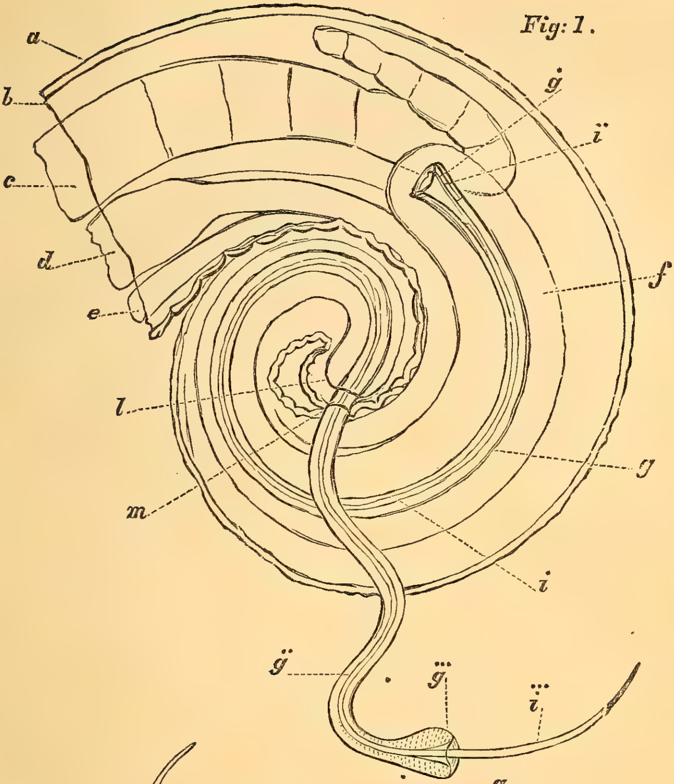
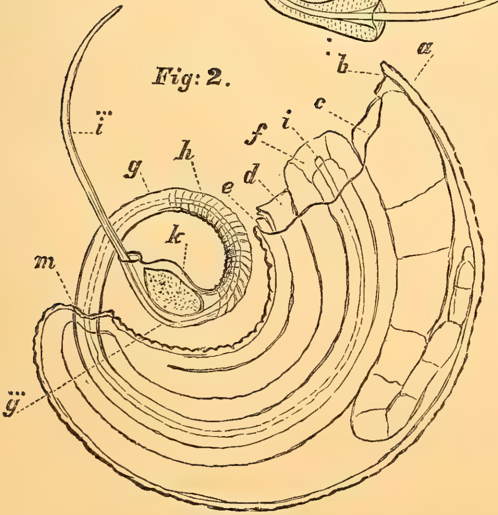


Fig: 2.



f, muscle surrounding the sheath of the intromittent organ, which latter is marked *g*; the same letter with one dot ($\dot{g}$) marks the infundibuliform portion, whilst $\ddot{g}$ indicates the exserted part of the sheath, which is armed with the minute retroverted spines; $\dddot{g}$, shows the flask, or cup-shaped expansion of the free extremity of the sheath; *h* (fig. 2), the rings formed by contraction of a portion of the sheath; *i*, the spiculum; $\ddot{i}$ (fig. 1), the infundibuliform upper end of the same intromittent organ; and $\dddot{i}$, its free pointed extremity; *k*, an oval mass of granules in one of the flask-shaped pouches, apparently consisting of spermatic particles; *l*, the cloacal cavity, and *m*, the anus. These two illustrations have been drawn with the aid of a camera from specimens prepared by ourselves, and mounted for preservation in glycerine. They are pretty objects under the microscope, from the graceful ammonite-like spiral which the tail of the male *Trichocephalus* invariably exhibits. When highly magnified, the free extremity of the spiculum is found to be scimitar-shaped, and rather sharply pointed. There were no markings on its surface, but we observed certain lines indicating the presence of a groove or tube, such as exists in *T. dispar*. In regard to the reproductive organs of the female, Kuchenmeister states that there are no external appendages in *Trichocephalus* comparable to those known to occur in the allied nematodes belonging to the genus *Trichosoma*. So far, however, from this being the case, there is in the present species, at least, a remarkably prominent, and more or less hourglass-shaped sheath projecting from the body (fig. 6); it is obliquely truncated at the free end, where it is also hollowed out, or rather, we should say, inverted, to give origin to the centrally inclosed vagina, whose orifice is somewhat constricted. The surface of this appendage is supplied with small spines, precisely similar to those described in connection with the sheath of the intromittent organ of the male, the spines being here also retroverted. These observations are confirmed by the previous statements of Mayer (*Zeitschrift fur wissen. zool.* B. 9, s. 367), but they have since been disputed by Dr. Eberth, of Wurzburg (on insufficient grounds we believe), in a later number of Siebold and Kölliker's *Zeitschrift*. We do not here propose to reconsider the controverted points, but pass on to remark that the ova, as in other nematodes previous to impregnation, are, at a certain stage, flat and irregularly triangular in outline; the thin limiting membrane by which they are surrounded inclosing finely granular contents, as seen in fig. 7. In the perfectly developed egg, the external capsule, chemically composed of chitine, presents the same characters as in *Trichocephalus dispar*; and at either pole of the ovum where the shell ends abruptly, an inner transparent membrane is seen projecting, in the form of a small mamillary process. This is shown at fig. 8, where the egg also exhibits the yolk undergoing segmentation, and two characteristic nuclei in the mesial line. When fully mature the ova have a longitudinal diameter of 1-340th to 1-320th of an inch.

Having thus dwelt at considerable length on the intimate structure of *Trichocephalus affinis*, it only remains for us to offer a few remarks on the present state of our knowledge respecting the development and migrations of this comparatively harmless species. In point of fact, we know little or nothing of the wanderings of this particular worm, but may legitimately infer the occurrence of certain habits from what we observe in the closely allied *Trichocephalus dispar*. Not long ago Kuchenmeister expressed his opinion, somewhat over confidently, that the little *Trichina spiralis* found in the muscles of the human body was the young of the last named species; but a series of beautiful researches by Virchow and Leuckart, carried on independently, have shown that this view is inconsistent with fact. M. Davaine has also recently applied himself to the determination of the development of *T. dispar* by direct experiment, and he finds that the embryonic formation only takes place within the egg after the ova have been expelled the host, and have been immersed in water for a period of about six months; consequently it may be surmised that either the mature ova or the escaped embryos gain access to our bodies in a passive manner when swallowed with the waters we drink. The subject, however, needs further investigation, and the experiments which we ourselves instituted on this score have hitherto only produced negative results.

ASPECTS OF NATURE IN SOUTHERN PERU.

BY WILLIAM BOLLAERT, F.R.G.S.

In order to illustrate some points of physical geography, I intend to take the reader to Peru, by the same route by which I went, namely, from England round Cape Horn, sighting its coast off Arica, in latitude 18° 20′ south. I had experienced every species of temperature and weather—the cold of a northern winter, the burning, blistering heat in the long calms of the equatorial regions, the frozen seas off Cape Horn; and one series of S.W. gales lasted several weeks, which drove us far to the S.E. with thick and heavy weather, so that when we went on the starboard tack, trusting to clear Cape Horn, on a certain night we got landlocked, a little to the west of the cape, on an iron-bound and savage shore, and within an ace of being wrecked there. However, although our captain had told us to prepare for the worst, kind providence and good seamanship rescued us from our perilous situation, and the following morning we slid past the island of Cape Horn into Nassau Bay, where we took in wood and water. Here we found large quantities of celery gone to seed (originally left by early voyagers), which was a pleasant addition to our peasoup.

I made the acquaintance here, for the first time, with the Red-Men of America; they were called on our charts the Red and Black Magellans, for as yet they had not been christened as Fuegians. I suspect they had been called red and black in consequence of their using red (oxide of iron) and black (charcoal) paint to their almost naked bodies. These miserable-looking creatures, although pure red-men, had a dark tinge, which I then attributed to dirt and the cold climate.

At last we get a favourable slant, running into the South Pacific Ocean, making a fair wind of the S.W. gales common in these latitudes, which soon carried us into warm, and then into hot weather.

Our latitude and longitude tell us we are approaching Juan Fernandez, or Robinson Crusoe's island; we sight it, continuing our course to the north, inclining a little to the east; till one evening a white elevation is seen in the eastern horizon; at daybreak, more white points are observed, and on the following day the mountains of the coast are beheld, and the next morning we approach the shore of Arica.

As we neared the coast, a high, dark, and escarped range of mountains rose abruptly from a placid sea; but when the swell found opposition to its onward course in the rocky barrier, it dashed against it sullenly, with a thundering noise, rising high up, curling round towards, and falling into, its native element, and spreading itself in rugged sheets of foam with a hissing sound. Ere it had died away, there was a repetition of the scene and sounds, that had something solemn in them, added to which not the slightest vegetation was to be seen.

We next came in sight of the "Morro," or headland of Arica, where this same picture of desolation presented itself. Yes, I am not ashamed to confess it, my heart sank within me; but there I was, and there I had to remain for awhile. I was too young then to suppose that I should ever find the least charm in a desert life. It cost me a few silent tears, and it was some time before I could realize my situation.

Here I met with the gentleman with whom I was to be associated in working some silver mines at Huantajaya, in the neighbouring province of Tarapacá; he was then and still is known as Don Jorge, beloved by all who knew him. He had got used to these scenes, and his not quite so lively an organization as my own, had caused him to feel less in comparing the lovely verdure of England with this dark frowning and desert shore.

I geologized, I dug into ancient Indian tombs, examined with wonder the desiccated bodies of the children of the sun, the clothing of the dead, the gold, silver, and copper figures of deities, wonderfully-moulded pottery, and many other things; I botanized in the valley of Arica—for I found tropical plants growing in the bed of the river; I crossed the sandy desert to Tacna, botanized up its valley to the base of the Cordillera, taking note of its wondrous elevation. I looked at and examined the Indian of this locality, he was not the character I had pictured to myself; no, the three centuries of submission to the Spanish rulers had given even the young man an old and downcast look. I could scarcely believe that these were the descendants of those who had conquered for the Incas so much of the length and breadth of this land. If the country I was in was uncheering, the Indian was in conformity with it.

The present Peruanos are criollos, or descendants of Spanish parents; the mestizos are of the Spaniard and Indian female, the great majority being a mixed people, but I found them all kind and hospitable.

My friend Don Jorge had to remain awhile in Arica whilst I proceeded to Iquique, the port of the silver mines of Huantajaya. It was many years later that steamers were found plying along the coast from Panamá to Valparaiso; but the voyage from Iquique to Arica was not difficult, in consequence of the pretty general southerly winds and southerly current;* it could even be made in an open boat or a seal-skin *balsa* or float, and the only little difficulty likely to occur was an upset by a "school of whales," that come in shore at certain times of the year. The return, if by boat, was made during the night when the strong south wind had gone down, and what remained had veered to the eastward—this being the *terral* or land breeze; anchorage was found in some *caleta*, or cove, during the greater part of the day.

At the beginning of 1826, I embarked on board the balandra "San Miguel," for Iquique, with mining and other implements.

* This is sometimes called "Humboldt's current." In September, 1854, the "Guise," Peruvian man-of-war, during a calm of twelve hours, was drifted fifteen miles to the N.W.; so when sailing vessels get to leeward of a port hereabouts, they may be several days fetching into their destination.

On my last voyage to Europe in a sailing vessel, on a S.S.W. course, the third day from Arica, we got out of the cool water of this current, into warmer.

This vessel was a small and rudely constructed sloop employed in the guano trade then carried on for the use of the coast only. Her trips were from the guano deposit of Pavellon de Pica, south of Iquique, to Arica and other ports to the north.

Since that period I have learnt not to be over-squeamish; but what I suffered from the sickening guano stench of the "San Miguel," I have a very vivid recollection of, even at this distant date. We had a twelve days' voyage, having to beat all the way; occasionally at night we got a favourable slant with the wind off the land, without which (having the current against us) our voyage might have been an interminable one, although only seventy-two geographical miles.

The coast was very bold and mountainous; not a tree or the merest sign of vegetation met the eye, and in this distance of seventy-two miles there were only two inconstant little streams, that came dribbling down from the Cordillera through the deep *quebradas* or gullies of Camarones and Pizagua, and they were always brackish, sometimes undrinkable. The next break containing a watercourse is one hundred and eighty-seven miles from Pizagua, where the river Loa flows, but its waters are sometimes as salt as brine.

On this voyage I was fully initiated into the living of the country on board ship. A tea of the Yerba de Paragua, sucked through a tube, very much like hot liquorice water; toasted maize in lieu of bread; the eternal greasy stew of not over-fresh jerked beef, pumpkin, potatoes, and garlic, condimented with the never-failing *aji*, or red capsicum, and this under calms and blistering suns! but how often have I wished for such fare whilst in those and other wild lands.

During the day the swarm of guano-making birds flying about was something prodigious, and their diving for fish (so very abundant in these waters) most amusing. Sometimes, when near in shore, the screaming of seals with the noise of the beating of the billows was anything but harmonious.

The monotony of my voyage was somewhat broken by meeting with an American whaler, who was busy cutting up and boiling a whale down. I went on board to dinner, but the effluvia there was rather more nasty, I think, than that of my own vessel.

One day being near the shore we let go anchor (a large stone in a wooden frame) in a cove. We had not long been there before I heard the captain and crew scream out "Miserecordia!" and looking about saw them on their knees on the deck, devoutly crossing themselves and looking at me as I stood wondering, as if I really were a heretic. I asked the reason of this sudden act of theirs. "Temblor!" said they. I had indeedheard a slight rumbling noise, and then a sort of shake, but had not attributed them to an earthquake; however, in time, I got as sensitive to such occurrences as the natives.

One evening we had a beautiful tropical sunset; it was magnificent, and the colours most brilliant. The day had been cloudless and the sun shining brightly; from gentle breezes it became a dead calm, and it appeared as if we were floating on a sea of glistening ultramarine; and as the sun was setting, the western sky, as if on fire, caused the sea to glow with its glorious reflections. The other portion of the heavens was tinted with light rose and lavender colours, blending harmoniously into one another; and then the changes were so rapid! We see all this wonderful beauty for an instant—in a moment it is gone, and we have to call upon a traitorous recollection for a faint description.

The arrival of the "San Miguel" was an event in the bay of Iquique. On one side was the rugged guano island, on the other high and precipitous mountains, and before us a small collection of the most miserable-looking habitations imaginable; in the rear huge sandhills, and beyond them mountains, mountains, desert mountains!

I was landed by a swift sea-skimming seal-skin *balsa;* the whole population, consisting of some dozen families, were on the beach to give me a welcome, and a thousand inquiries as to when Don Jorge would return, and when we were to begin working the mines of Huantajaya.

The occupation of the inhabitants of this desolate spot consisted in fishing and conveying imported provisions to the mines. Their miserable-looking habitations were built of rough porphyritic stone, cemented with mortar of burnt *sargasso,* or gigantic sea-weed, and sea-shells, and covered with mats brought from the north of Peru. The floors were of bare earth, and at one end was a raised part, which was the sleeping place; a small table and a stool was a luxury. The people appeared very happy, and even very kindly disposed, and seemed as if they were but of one family.

After I had got somewhat accustomed to this strange scene of the most absolute sterility imaginable, I used to wander in the cool of the evening from one habitation to another—*tertuliando,* gossiping and listening to their stories—they to mine. Having a medicine chest, a lancet, and tooth drawer, I very soon was called "El Señor Doctor"! and I think I may most conscientiously state that I never did much harm during my medical career, although I have had to attend to diseases I knew nothing about, and perform operations with similar intelligence. With comparatively harmless medicines I was not very particular as to the dose, but when I had to deal with calomel or strong chemicals like blue pill I was most careful.

I will now say a few words on the general features of the country.

The Peru of the present day stretches from 3° 35′ S. to 21° 48′ S. along the shores of the Pacific, a length of 1250 miles; its greatest breadth is about 750 miles, with an area of 512,122 square miles. After the revolutionary struggle, the Peru of the viceroys was divided into two parts, the one already alluded to, the other was called Bolivia, 700 miles in length by about 500 broad, three-fourths of which is a wilderness. Formerly it was called Charcas and Upper Peru. Its capital is in 19° 3′ S., 64° 47′ W., and known under the names of La Plata, Sucre, and Chuiqusaca.

The population of Peru is about 2,500,000, variously divided into Peruvians, white (the criollos of the Spaniards), and mixed with Indians (mestizos, or cholos, also with some little Negro blood), amounting to 900,000; Indians 1,460,000; Negroes 40,000, who are free, and as they can regulate their own amount of industry, have no inclination to overwork themselves, so large numbers of Chinese are imported to Peru as labourers, miners, and diggers at the Guano Islands.

Now as to the geographical division of the country.

1. The coast, which is rainless. On the north is the great desert of Sechura, on the south the still more extensive desert of Atacama. Some streams of water, the produce, principally, of the melting of snows and glaciers in the Cordilleras, run down steep and deep quebradas or dells, nourishing the bottom only of the valleys of the coast; for where water runs, there only is vegetation seen.

During the winter months of this region, on the lomas or summits of some of these mountains of the coast a peculiar vegetation appears, which will be treated of by and by.

2. The table-land. After a toilsome climb on mule back up the western slopes of the Cordilleras, and getting almost frozen to death, whilst going through the passes, some of which are over 16,000 feet above the level of the sea, and where a stunted vegetation has been long left behind, we descend to elevated table-lands, and of these the most interesting is that in which is situated the great Andean lake of Titicaca, 13,000 feet above the level of the ocean, and enlivened by its own peculiar fish. On the islands of this lake, and on its shores (besides the Incarial Temple of the Sun on the Island of Titicaca) are observed the stone ruins of Tia-Huanacu, some of the oldest monuments found in Peru; which even the Incas admired when they first discovered them.

Out of this Thibet of the New World rise aloft the ranges known as the Andes, from 22,000 to 23,000 feet high above the sea.

We now descend to the east, having had an opportunity, in one day, of reaching a region of eternal glaciers, with no vegetation, and a most difficult atmosphere to breathe, in consequence of its extreme rarity. The peculiar character of that atmosphere once seen is not easily forgotten; it is of so dark an indigo colour as to look nearly black, where stars can be observed shining at mid-day, and the white outline of snow on the ridges of the Andes and Cordilleras is in beautiful contrast with those sombre heavens.

In ascending the Cordillera the traveller may observe droves of the slow-moving and patient llama and alpaca; higher up he comes upon the timid, swift-fleeing herds of the huanaco and vicuña; in the table-land he may have met with a stray puma or even an ostrich from the eastern plains, but the only inhabitant of life he perceives at and above the elevation he has finally reached, is the mighty condor.

In the descent to the east the first vegetation seen is the curious and large dome-shaped, very resinous, yareta plant (a *Bolax*); then the *ichu* grass; this is the natural pasture of the auchenia or llama family, four in number; the vicuña and huanaco which are wild, the llama and alpaca which are tame. We come now upon cacti, the resinous Tola shrub appears, further down grasses cover the mountains, and in their ravines plants and small trees; and descending still further, tropical vegetation is arrived at, covering the tops of the mountains in this region down to the streams and rivers that flow into the Amazon and the Plata.

The silver mines of Huantajaya and Santa Rosa were up in the coast mountains, beyond which there was a great *pampa* or plain where the ores were amalgamated, in consequence of water being obtained from wells there. Further on was situated Tarapaca, the capital of the province, the residence of the *Intendente*, El Señor Coronel Don Ramon Castilla (now president of Peru), and there *terciana* or ague was endemic. Then there was another spot called Pica, where wine and brandy were made, but where the ague was of the *atabadillada*, or spotted fever type; further off still, lived the Indians in the valleys of the Cordillera, on their little farms, and higher up in the mountains they tended llamas and alpacas.

Now, in 1862, Iquique is a large place (the port for all that district, and second only in importance to Callao), containing from 5000 to 6000 souls, including a sprinkling of foreigners of all nations, churches, and some stately houses, a club, hotels —even an Italian opera has been performed there.

In early times the town was supplied with water from the *quebrada* of Pizagua, forty geographical miles distant to the north; now, all that is used for drinking is distilled from the ocean, and sells for about three half-pence the gallon, realizing some £40,000 to £50,000; the fuel for this operation being taken from England or Chile. This great change from when I first knew the place is owing to the discovery and the refining of *Salitre,* or nitrate of soda, some few leagues in the interior.

Iquique stands on a thick stratum of shells near to the sea; on the shore they are in a fair state of preservation, but going inland they assume all the stages of disintegration, until where they touch on the rock of the country they are in fine powder, and on a dark night a slight phosphorescence may be observed in the shell-pits. Independent of mechanical disintegration, chemical changes have been going on, owing to some salt of the ocean having been left with the shells, and among them chlorides of lime, carbonates and sulphates of lime and soda (the last in very fine groups of crystals) are formed. Has this and similar sloping shell plains been elevated by internal forces of the earth, or has the sea retired? Perhaps the former is the more logical supposition.

The climate is so dry that, during a three years' residence there, I only once saw a very slight rain.

The mean winter heat at noon is 67°, the mean summer heat 80°, but in the sun it is scorching. Indeed, the coast would be unbearable on the score of heat if the winds during the long summer of this latitude were not the cool breezes from the south, and were not the climate further tempered by the cool current from the south, running rather rapidly at times along the shores of the Pacific.

The occupations of the natives, when not fishing (which took up but little time), were chatting and smoking. One day I asked an old fisherman, who appeared to me to be always smoking paper cigars, how many he smoked daily? He answered, forty; and this he had done for some fifty years. At the price then of these paper cigars, he had smoked £470 worth, and 730,000 cigars; and this for a ragged, shoeless fisherman! As the sale of tobacco and paper was a government monopoly, in these two articles alone what a tax on his luxury he had paid.

SUBMARINE ARCHITECTURE.

BY SHIRLEY HIBBERD.

When Endymion saw "the giant sea above his head," he was in no better position for moral reflections on the perishability of man's work than we who sit in a small boat off Weymouth, perplexed for the moment by the abundant variety of objects just brought from the sea-bottom by the dredge. Endymion trod his way timidly among things

> "More dead than Morpheus' imaginings :
> Old rusted anchors, helmets, breastplates large,
> Of gone sea-warriors ; brazen beaks and targe :
> Rudders that for a hundred years had lost
> The sway of human hand."

So we, probing amongst the sand and shells, and wriggling annelids, and fleshy lumps of Actiniæ, that have shrunk up in fear of the strange company and altered scene, have our thoughts turned aside from zoology proper by observing amongst the rubbish pieces of tile, chips of crockery, half-decayed nuts, a nail or two, and some other odd reminders of the earth and man which the sea has swallowed, to keep with other things until it shall have receded from these shores and left them buried with its own deposits of shelled and crusted forms, once living tenants of the deep. There is nothing, however contemptible to minds unschooled in observation, but may furnish a subject for thought and a theme for discourse not altogether aimless. As an antiquarian will deduce materials to fill up some old gap in history by the examination of an inscribed tile, so the odd findings of the dredge will be found equally fruitful in furnishing a stimulus to both inductive and deductive reasoning. Here is a piece of tile; *ergo*, it is the work of man. It is encrusted with colonies of serpulæ, and had it remained a few years longer in the watery depths, its shape, colour, and character would have been obliterated by the addition of successive deposits of the same kind, and Nature would have effected that object which she has always in view, the obliteration of the traces of man's art, and the appropriation to her own uses of whatever may fall from his hands. Precisely the same lesson is taught—so says Emilius, sitting at the stern of the boat, and looking with some sort of contempt upon the strictly zoological part of the gathering—by the findings of the dredge as by the exploration of a ruined city. The moment man lets go any product of his industry, Nature begins the work of disintegration. She dissolves, triturates, corrodes; or, if she cannot do either, she hides under a living garment the records of the dead past. But we tell Emilius that Nature does not

BOTTLE DREDGED AT WEYMOUTH, COVERED WITH ENCRUSTATIONS OF SEPULÆ, OYSTERS, ETC., ETC.

wait till man has bequeathed his works to her for resolution into their primary elements. She begins to grind a palace to powder the same day as it is built. The dew and the sunshine are as effectual for the purpose as any other of her agencies, but she does not waste while destroying. She simply appropriates, and so, to justify the decay of the marble column or the sublime statue that enchants the world, she plants it at once with green and golden mosses, teaches the ivy to pierce it with its soft teeth, and, when it has fallen from its base, and the rains have made a pool around it, she sends other ministers to bore tunnels through the mass, and others to clothe it with incrustations, so that it soon becomes wholly hers, for appropriation to new purposes.

Emilius wants to know if it is right to wander so far away from the subjects which gave rise to these remarks, when at the next haul we are presented with a treasure which makes us all forget our peculiar differences of taste and inclination, in admiring the beauty of a new illustration of the relations which may be established between the works of art and the works of nature. Broken bottles are frequently brought up by the dredge, and sometimes these are very beautifully incrusted with colonies of sea-creatures; but here is one complete. It may have been a champagne or a Scotch ale bottle—we cannot tell which—and the deposits on its exterior are more beautiful and varied than any similar example which has ever come under our observation. Here, we agree, is a prize worth the labours of the day—a prize, too, which interests us all, the zoologists and the moralists alike; and as our day's explorations have now come to an end, we discuss its merits and its history during the voyage home.

After removing some of the sand and slimy forms which cling about it, and then carefully laying it on one side in a vessel of sea-water that its numerous inhabitants may be preserved, we begin an investigation of the method in which it has been made so beautiful an example of marine masonry. It is smothered with Serpulæ, oysters, Balani, Lepraliæ, etc., and, whichever way we view it, we see myriads of trumpets, bird-beaks, tentacles, and siphons protruded from the cellular and tubular walls of this incongruous colony, which, like a city on a rock, has a very complete homogeneity in the close relationships of its various inhabitants. We call it the Acropolis, in the marine order of architecture, and the various inhabitants of the shells and tubes we liken to the trades and callings of the people of a terrestrial city. It is no easy matter to distinguish and determine the several species associated in this great colonizing enterprise, but time and patience will do much, and by degrees we make out a sufficient number to furnish a pretty fair idea of the nature of the assemblage. We first of all notice particularly the Serpulæ. These form convoluted tubes in abundance, which are wreathed together and mixed up with other habitations in glorious confusion. Prominent amongst them is the noblest of the race, *S. contortuplicata,* the most easily identified as it pops up its feathery head and blows its coral trumpet in the midst of its meaner relatives, *S. triquetra, intricata, filifornis,* and *rugosa,* all of them abundant, covering the smooth surface of the bottle with tubular and angular constructions, and, in some places, running together into inextricable knots, the tubes overlaying each other, and leaving only just enough room for their several gill threads to peer out like the red faces of a crowd in the street, where the faces are all that can be distinguished. *Filograna implexa,* with its thread-like tubes, may just be identified in the midst of two distinct blocks of *Serpulæ,* but its scarceness is compensated by the crowded state of the masses from which myriads of gill fans are protruded. Equally conspicuous, though less attractive, are the oysters. I have since counted eighteen oysters in all upon the bottle. While in the boat, and our attention divided between inquiry and admiration, we agreed that, as regards oysters, it was "smothered;" a conclusion of far too sweeping and general a kind. Yet we were then not far from the truth, because after counting off eighteen distinct and veritable oysters, there remain some two dozen more little oysters of the size of split peas, embedded in masses of *Serpulæ, Balani,* and *Spirorbis.* But though less attractive still, because untenanted, we agree that the most curious elements in the construction are two shells near the base, firmly cemented and embedded in a mass of sponges and *Tubulipora.* How came they there? Were they attached during the life of the animals, or after the shells had ceased for ever the service they were ordained for in the individual life of the creatures? One of these is an old weather-worn valve of *Cardium echinatum;* the fellow-valve may be there below it, but is not to be distinguished amidst the mass of masonry of which the visible shell is the principal foundation. It is embraced at both edges by *Serpula contortuplicata. S. triquetra* doubles over and over like a miniature coil of rope, which the sea boy has confused, and will be sorely puzzled to restore to order; and at the margin it melts away all round into a mass of little oysters, *Membranipora,* and the remains of *Flustra, Terebella,* and sponges. The other is a shell of *Buccinum undatum* in a far advanced stage of disintegration. It lies far out from the base of the bottle, with its operculum cemented to the back of a large oyster-shell of six or seven years old. It is coated all over with acorn barnacles; the operculum is connected with the oyster-shell by a mass of sponge, and several commixed wreaths of *Serpula contortuplicata,* among the windings of which are several miniature oysters. The spire is covered with patches of sponge, *Lepralia,* and *Balani,* and a sort of stippled marking in other parts of the shell indicate that some other colonies had commenced operations when we hauled it up, and arrested for a while the progress of the submarine architecture.

When we have made this general survey, and are still in doubt as to the genera and species of a few of the deposits, we ask each other in a chorus : "How is it done? who begins it? How is a hold first made upon the slippery surface of a glass bottle?" We take it out of the vessel, detach a few of the Actiniæ that have insinuated themselves between the folds of the Serpulæ, and turn it upside down. The hollow foot is as bright and clean as when the bottle was cast overboard by some party of merry yachters seven, eight, or ten years since. The sea water has not even corroded it, and the vitreous surface has an almost new look and polish. We reverse it, and peep inside. There, too, the surface glistens, and betrays no corrosion by chemical action, and the bottle is as empty as when it first left the glass works. Strange that no troglodytic anemone, no nereis or polyzoon is to be found there. Why should these creatures, that people the sea bottom in myriads, avoid the *inside,* and yet so love the *outside* of a champagne bottle? Does the discrimination betray a faithfulness to Neptune against Bacchus,—adherence to the good uncle, and a careful avoidance of the giddy nephew? No doubt the Serpulæ and Cirripedes have their likes and dislikes, and here is an example thereof.

When we drain the bottle dry, and examine it with a lens, we begin to understand something of the rationale of marine architecture. Every one of the larger tubes and shells rests on a foundation of deposits formed by some lower forms of life. Scattered over the surface are the remains of colonies of *Lepralia* of several species, amongst which *L. Pallasiana* may be distinguished by the form of the cells, as the most conspicuous. These patches thicken towards the larger attachments, and in nearly every case unite around them in unbroken masses, and form the foundations of oysters and serpulæ. There are other patches of *Nolella stipata* (Gosse) the orifices of which are imperceptible to the naked eye, but under a good lens easily discernible, each with its bell of tentacles, which by their quietude contrast prettily with the irritant beaks of the Lepralia. The rarest of this class of encrusting polyzoa are *Membranipora membranacea,* and *M. pilosa,* both of which appear in little detached rings, suddenly invested on one side with the outgrowth of some of the larger patches of Lepralia. Then mixed with these are masses of *Pachymatisma Johnstonia*

(Bowerbank) and *Halichondriæ* of species not determinable. Above these rise the conspicuous and characteristic shells of the *Balanidæ*, and these last mix and intermix in all directions as foundations and superpositions, but there is not one of the *Lepadidæ* to be found anywhere. The process of the superstructure appears then to be very much according to the order of the several creatures comprised in the colony; the lowest and the meanest, the Polyzoa, begin the work, the Cirripedes continue it, and the nobler Annelids and Mollusks take possession when the slippery surface has been roughened and the foundations of the city laid by their humbler predecessors. The proper elevation of the Barnacles to companionship with the Crustaceans proper, by Darwin, has a very pretty confirmation in the free and easy way in which they take possession of all sites, build anywhere, now on a foundation crust of true polyzoa, and now on the worn surface of an oyster, cockle, or whelk shell. There would be an end of the story, but we have yet to account for the attachment of the two mollusks last named in the short description of the species constituting this pretty colony. We know pretty well how serpulæ and oysters anchor themselves. Creatures capable of manufacturing calcareous shells from sea-water can have little trouble in attaching them, and they appear to wait, before taking possession of a slippery substance, until the pioneers of marine colonization have prepared the foundation of the city. But how comes a whelk or a scallop to be mixed up with a mass of oysters, serpulæ, and barnacles, and to be cemented to the base of this bottle. It would be a greater puzzle were they found anywhere but at the *base*, but as they are at the base only we can easily imagine an old shell which has *drifted about for years at the sea bottom* coming at last in contact with the bottle and being involved in a busy mass of tube-forming annelids, getting involved in the cementing process, and so with them becoming attached. Is it possible the Cardium was dragged there by a hermit crab, then involved in the process of cementing by a young colony of serpulæ, and the hermit thereby compelled to quit for fear of being buried alive in his own habitation!

After all this Emilius is not satisfied. He has been testing our observations by experiences of his own in soundings for the Atlantic telegraph, and he detects, moreover, a few flaws in our reasoning. He says the Cardium is so cemented that he cannot understand how it should have become attached during the life of the animal. Would it, for instance, he says, be such a fool as to remain immoveable while a colony of tube-forming annelids laid their foundations, and fixed him secure for ever like a new Prometheus? No; both the Cardium and the Buccinum were surely lying untenanted on the sea-bottom when the bottle sank slowly and in a perpendicular position, and rested upon them, and from that day to the present hauling up of the bottle by the dredge, the bottle *never once changed its position.* It has been proved, says he, that old shells never drift about the sea-bottom; there are no tides or currents there, but a profound stillness reigns as in chaos, though not lifeless. The deep sea-bottom is a place of eternal calm. Hereat he defiantly inverts the bottle again to remind us that there are no incrustations there, not even an abrasion of the smooth surface to show that after its deposition it ever once shifted from its place. The bottle evidently stood upright at the bottom, was undisturbed during the whole period of its submergence. The shells were already there, empty and decaying, in contact with its edge, and the cementing animals wrought between the angles of the contiguous surfaces, and soon cemented both together. We see no escape from these conclusions. Emilius is avowedly no naturalist, but he insists on logical deductions from all proven facts. We leave it to him to wind up the discourse, and he observes—

What a close analogy does this case afford to the method by which Nature appropriates the works of man on *terra firma.* The grass grows upon the rock or on the crumbling marble of the temple only after the surface has been prepared by successive colonies of confervæ, lichens, liverworts, and mosses. These form the foundations. As in the sea sponges and lepraliæ form a crust, so on the dry land the little liverworts form a stratum of soil which becomes a nidus for higher forms, and the humbler flowering plants follow and are succeeded by trees and shrubs. The 420 plants found by Dr. Deakin among the ruins of the Colosseum have an analogous position to the oysters and the serpulæ on our beautiful marine bottle. And to carry the analogy another step, when men build cities, they apportion to the humblest of their race, the miner, excavator, and mason, the task of forming the foundations on which noble forms of architecture are to be superimposed by skilful hands, and with all the aids of art and science. But in man's works the whole design is first prepared, the work of the miners and excavators is marked out as no less necessary, and as indeed the first essential for the erection of the fluted shaft and the capital, and when the city has ceased to be, Nature goes over *her* work in the old way, according to the vaster designs of the Great Architect, under whose guidance the meanest things perform services which are essential to the life of the noblest.

EFFECTS OF HASCHISCH.*

"Under the name of *Haschisch* is indicated the intoxicating preparations made from a species of hemp which bears the appellation of *Cannabis Indica.* The tops of the plants in flower, gathered before the maturity of the seeds, are employed in its production, but the details of the process are not known. It is prepared in two distinct forms—an extract shaped into slender cylinders more or less long, and thin tablets containing sugar, which have an agreeable and peculiar flavour. From the extract an alcoholic tincture is obtained, also *pastilles sucrées,* and several other preparations, in which fatty and aromatic substances enter. Sometimes the haschisch is smoked with tobacco, or it is mixed with coffee, tea, or other drinks.

"Haschisch is remarkable for a special action upon the human economy, which must not be confounded with that occasioned by alcoholic fluids, or by opium, and the general run of narcotics.

"Being desirous of testing its action on my own person, I seized, without hesitation, a favourable opportunity offered by one of my friends, who brought from the East a certain quantity of *haschisch* under the form of extract and *pâte sucrée.* I took two or three grammes of this paste with great indifference and doubt as to the marvellous effects it was alleged to produce. It was in the spring of 1854, about nine o'clock in the morning, and soon afterwards I repaired to the chemical laboratory of the College of France, and set to work as usual. In about a quarter of an hour I felt a peculiar movement in the extremities, which propagated itself towards the interior of the body. I felt as if something entered at the tips of my fingers and moved progressively, and without interruption, to my brain, without, however, producing the slightest derangement of the intellectual faculties, or the faintest impression of pain. I can only compare this sensation to that produced by nettles on the skin, or that occasioned by a great number of ants moving over the body, or that of a gentle titillation of the sole of the foot, or other delicate part of the skin. But all these comparisons are only approximations, and cannot convey a true idea of the effect produced by haschisch during the first period of its action. The movement I wish to describe has the peculiarity of being progressive, without intermittence, and without any pain.

"In this first period of the operation of *haschisch* I felt that I was in an abnormal state, and was contented. Nevertheless, I desired to continue the work I had begun, but was unable to do so, as my hands, affected by a peculiar nervous excitement,

* Note by M. S. de Luca, *Comptes Rendus*, 13th October, 1862.

refused to execute any movements that required delicacy or steadiness. I therefore determined to return home, but I had scarcely opened the doors of the grand court of the college than I beheld the houses as if they had been removed to a distance, while the voices that reached me were as weak as if they came from a remote place. All distances seemed very great, and I felt as if raised from the ground and walking through the air, whilst the persons in the streets touched the ground with their feet, as if they were my inferiors, and incapable of mounting above it as I had done. As I was hastening home the distances seemed to grow without end, and I thought I should never arrive. In the meantime I reasoned with myself and said, 'This is curious. The action of *haschisch* augments distances, weakens the voice, creates a sense of superiority over others, and the person under its influence believes himself lifted from the ground and walking in the air.' At length I reached the house, and at the place where my key was, I found and took possession of two letters bearing my address. The portress, who saw me return sooner than usual, said to her husband, 'M. Luca's rooms are not ready;' and when she heard me speak, she exclaimed, 'His voice has changed;' to which I hastened to reply, 'It is the effect of *haschisch.*' I proceeded to my lodging, opened the door, entered, and shut it, but left the key outside. My first desire was to open the two letters and read them, but the nervous movement which I have mentioned hindered me, and with all my efforts I only succeeded in passing them between my fingers and turning them about for two or three minutes. At last, seized with a supreme disdain for vulgar things, I flung the letters on the ground as if unworthy of my thoughts.

"A crowd of ideas came into my mind, and grew clear and precise; the nervous movement became more sensible, an agreeable feeling came over me, and I determined to go to bed, having taken off my clothes. I had scarcely got into bed before the clothes seemed to remove themselves to a certain distance from my body, as a sign of respect; and thus, without contact with them, I found myself in an atmosphere of pleasure and content. I saw at that moment, to my great satisfaction, all the events of my life pass before me; but my ideas changed so rapidly that I would not dwell upon a single one. At this time I said, 'If this state could last for ever, the dreams of poets would be realized, we should be all content, we should have nothing to desire, and we might pass our time in joyful contemplation!' The distinctness of my ideas was not diminished throughout this period of the action, and my mind sought to corroborate them by proofs, and to know them more completely. In fact, while I found myself in bed under this influence, I had my doubts, and said, 'You believe you are at home, and perhaps you are at work in the laboratory;' but this doubt passed off like lightning, as a thousand reasons occurred to convince me that I was really at home, and nowhere else, for I could get out of bed and walk—which I did; I could go back to bed—which I did also, having first examined my clothes, looked at the two letters on the floor, and noticed that the door was shut and the key outside. As soon as I got into bed the second time the clothes again removed themselves to a distance, and the same agreeable atmosphere surrounded me once more.

"This action lasted about four hours, and towards its close ideas succeeded with less rapidity, the distances diminished, and the bed-clothes respectfully approached me, the nervous movement disappeared, and all things gradually assumed their natural aspect, except that my lips were less moist than usual."

CARPENTER ON THE MICROSCOPE.

The appearance of a third edition of Dr. Carpenter's well known and valuable work* is an important event in the annals of microscopic literature, in which it still occupies a foremost place. It may be confidently stated that, as a scientific introduction to the use of the microscope as an instrument of research, and to the natural history and physiology of a very wide range of objects, no work equal to it has ever been produced. The present edition, by the introduction of much new matter, the revision and correction of many passages written in a less advanced stage of knowledge, and numerous additions to the illustrations, is brought very closely up to the requirements of the time. The first portion of *The Microscope and its Revelations*, as in former editions, is devoted to an explanation of the optical and mechanical arrangements of various kinds of instruments; but while the great makers, whose productions cannot be too highly praised, meet with ample justice, there is a deficiency of information concerning the merits of their imitators, whose productions, if less perfect, may be obtained at a largely diminished cost. The comparative merits of first and second class object-glasses is a very important question for the student. If rich, he would be unwise to grudge the price of the finest that are produced; but if his means are moderate, it is important that he should have some idea of the results

* *The Microscope and its Revelations*, by G. B. Carpenter, M.D., F.R.S., F.G.S., F.L.S., Registrar of the University of London, formerly President of the Microscopical Society of London, etc. Third Edition. Illustrated by ten plates, and nearly 400 wood engravings. Churchill.

afforded by the assemblage of instruments at the late Exhibition, or by any other means of instituting an extended comparison of the operation of instruments of different kinds.

The most important addition to the microscope since Dr. Carpenter last wrote, is undoubtedly the binocular arrangement of Mr. Wenham, which marked an enormous advance upon the earlier methods adopted by that gentleman, or upon those employed in the more complicated and less serviceable form adopted by Nachet. At first the new binoculars were the subjects of exaggerated praise, and their admirers appeared to fancy that no one had ever seen objects in relief without their aid. These notions have by this time sobered down, and the binocular takes its permanent place as an addition to, not a substitute for, monocular patterns. To some observers its utility is much greater than others; those whose eyes are the best matched in point of focus and power being the best suited; while other persons—some eminent naturalists amongst them—do not find it of the slightest use. Most people, however, will be helped by it for certain objects, and will agree with the modified eulogium pronounced by Dr. Carpenter, who observes: "It is requisite to bear in mind, that as the special purpose of the binocular microscope is to convey to the mind the notion of the *solid forms* of objects, of which some parts approximate to the objective more closely than others, the rays proceeding from the most projecting parts cannot be so nearly brought to the same focus with those from the mediary, as to produce even a tolerably distinct image of both at once; and it is moreover to be recollected, that when high powers are being employed, and especially such as are of large angular aperture, the smallest departure from exactitude in the focal adjustment gives indistinctness to the image. It seems to be only with objectives of comparatively low power and small angular aperture that images most suited for the production of stereoscopic effects will be produced; but for certain classes of objects this mode of exhibition is admirably adapted."

Without depreciating the "binocular," we may remark that a still greater boon to science would be the construction of a microscope adapted to take in a very large field, so as to facilitate the study of marine and fresh-water animals or vegetables in an aquarium, or large zoophyte trough. It is extremely difficult to determine many interesting points of development unless the objects can be watched under circumstances that make them quite at home; and although Mr. Warrington's portable microscope can be brought to bear upon any vessel, it has the defect of instruments intended for minute investigation, and the field is not one-third of the diameter that could be advantageously used.

The chapter on "Errors of Interpretation" is very important taken in connection with analagous remarks on the "Nature of Surface Marking of Diatomaceæ." Dr. Carpenter observes, "The most common error is that which is produced by the reversal of lights and shadows resulting from the refractive power of the object itself; thus the bi-concavity of the blood disks of human (and other mammalia) blood, occasions their centres to appear dark when in the focus of the microscope, through the dispersion of light which it occasions; but when they are brought a little within the focus by a slight approximation of the object-glass, the centres appear brighter than the principal part of the disks. The same reversal presents itself in the case of the markings of the Diatomaceæ; for these, when the surface is exactly in focus, are seen as light hexagonal spaces, separated by dark partitions, and yet when the surface is slightly beyond the focus, the hexagonal area are dark, and the intervening partitions light." While coinciding with the general reasoning, we would ask whether this passage does not require modification; cannot a hexagonal appearance be produced by illumination and focussing in objects in which it does not really exist?

Concerning these much disputed surface markings, Dr. Carpenter now says, that "There can now be no question as to the nature of the comparatively coarse areolation seen in the larger forms, such as Isthmia, Triceratium, and Biddulphia; in all of which the structure of the valve can be distinctly seen with a low magnifying power and ordinary light. In each of these instances we see a number of *areolæ,* rounded, oval, or hexagonal, with intervening spaces symmetrically disposed. . . . That the areolæ are really depressions is suggested by the appearances presented by the surface when the light is obliquely directed, and it may also be inferred from their aspect when viewed by the black ground illumination, since the areolæ are then less bright than the intervening spaces." After adducing other reasons, for the "depression" interpretation, the author passes to the consideration of the more delicate workings on minuter diatoms, and especially on those of the genus *Pleurosigma,* and he tells us when a *P. angulatum* is examined with an objective of one-twelfth of an inch focus, and an angular aperture of 170°, and a magnifying power of 1200 diameters, it presents a hexagonal areolation* somewhat resembling that of *Tricerstium.* We suppose other observers will still deny the accuracy of this hexagonal appearance, but the majority will probably coincide with Mr. Wenham's present opinion, and that now avowed by Dr. Carpenter, that the *Pleurosigma* areolæ "are minute tubercular elevations."

* There is some mistake here in the reference to Plate II.

There is another question on which microscopists would have been glad of somewhat more information. We allude to the practical value of such powers as Messrs. Powell and Lealand's 1-25th. Dr. Carpenter has only slightly modified the expressions previously applied to the 1-16th, that it is "questionable whether anything is really gained thereby," a dictum that is not confirmed by a subsequent statement that the 1-25th showed a certain movement in a plant cell not visible with other means. This power was likewise advantageously employed in the recent researches into the peripheral nerves made by Mr. Lionel Beale. The use of such high objectives must necessarily be very limited, and their employment without great judgment would only help to mislead. They may, however, be the means of explaining many particulars of extremely minute structure, and of elucidating the cause of movements like those of diatoms or the closterium, which yet remain a puzzle to be resolved.

Among the important additions to the present issue, we notice an account of M. Balbiani's discoveries on the reproduction of Infusoria—the first comprehensive view of which was given to the English reader in our own pages; a complete remodelling of the chapter on Diatoms, with explanations of the classification recommended by Mr. Ralfs; a collection of recently ascertained facts concerning the generation of the *Volvox globator,* showing that it forms no exception to the general rule, that bisexual propagation is a fact that occurs at some period of the history of an organized being. Moreover the account of the Rhizopoda has been re-written, and that of the Foraminifera enlarged and made to contain an exposition of the new views which have resulted from the labours of Dr. Carpenter, Mr. Parker, and Mr. Rupert Jones. There are also other additions of importance, including Mr. Rainey's remarkable discoveries of "Molecular Coalescence," of which drawings are given. These researches tend to connect purely physical with what are called vital processes, and Dr. Carpenter's remarks upon them will stimulate other inquirers to enter upon the path which has been so ably opened before them. Mr. Rainey brings about "a slow decomposition of the salts of lime contained in gum by the agency of sub-carbonate of potash. The result is the formation of spheroidal concretions of carbonate of lime, which progressively increase in diameter at the expense of an amorphous deposit which at first intervenes between them; two such spherules sometimes coalescing to produce dumb-bells, while the coalescence of a large number gives rise to a mulberry-like body." Similar concretionary spherules, Dr. Carpenter says, occur in the skin of the shrimp, in imperfect layers of the shell of mollusca, and they appear to form the deposits noticed by Professor Williamson in the scales of fishes; and it is "probable that by a further study of the relations between their structure and that of true bones and teeth, the principle of molecular coalescence will be found in some degree applicable to the special peculiarities of the latter."

Dr. Carpenter retains the opinions he has expressed on former occasions as to the distinction that separates the lower forms of animal and vegetable life, and considers we are "justified in laying it down as the most ready and certain differential character we are acquainted with, between those protophytes and protozoa which are apparently most closely related to each other in the simplification of their structure, that the former (with the exception of the fungi) decompose carbonic acid under the influence of light, and acquire a red or green colour from the new compounds which they form in the interior; whilst the latter, having no such power, receive animal and vegetable organisms, or particles of such, into the interior of their bodies, where they extract from them the ready-prepared nutriment they are fitted to yield." As we mentioned in our last number Dr. Wallich supplies some reasons for doubting the validity of this distinction as regards the deep sea Rhizopods, and the transformation of vegetable matter into the Amœboid condition seems to favour the opinion that no strict severance between the two kingdoms really exists. We must, however, wait before the full significance of the occurrence of vegetable Amœbæ can be ascertained. Dr. Hicks has not been able to give us a complete history of the Amœbæ formed from the protoplasmic contents of the roots of mosses, and Dr. Carpenter think that there is no sufficient evidence to confirm the statements of Dr. de Bary that the sporules of certain fungi (such as the *Æthalium septicum*) feed like Rhizopods, by taking in foreign substances, after they have assumed the Amœboid form.

We have spoken of Dr. Carpenter's book as an excellent introduction to the study of the various branches of microscopic investigation, but it must not be imagined by those who are unacquainted with the merits of former editions, that it bears any resemblance to that very unsatisfactory kind of literature which is usually described as "popular science." It is an admirable concentration of substantial learning and profound research, which could only have been made by an author whose own investigations had extended over an unusual range, and who possessed a rare acquaintance with the labours of other distinguished men. More than any book that could be named it will assist to form a class of genuine microscopic observers, and no intelligent person who can procure an instrument, need ever want objects to examine while its pages are at hand to indicate treasures that every locality can afford.

LASSELL ON AN ANNULAR NEBULA.

In a letter to M. Le Verrier, and by him communicated to the French Academy, M. Lassell gives the following interesting account:*—

"On directing my great telescope to the planetary nebula situated 20h. 56m., 101° 56′, its structure appeared to me so marvellous that I could not help sending you a drawing accompanied with a description.

"By employing two magnifications of 231 and 285, I saw, at first sight, an elliptical nebula of a clear blue, with a slight prolongation, or rather a very faint star, towards the extremity of its transverse axis. This aspect of the nebula resembled the appearance of the planet Saturn, when its ring is seen in a nearly full view. By employing still higher powers, magnifying respectively 760, 1060, and 1480 times, and under the most favourable circumstances, I discovered in the interior of the nebula, a brilliant elliptical ring, perfectly sharp, and without apparent connection with the surrounding nebula. This last is like a thin veil of vapour, and not confounded with the margin of the ring, whose splendour it diminishes very little. The nebulous envelope, a little more removed from the extremity of the conjugate axis than from the extremity of the transverse axis, is in reality very fully prolonged, and it is difficult to follow its traces amongst the stars that precede and follow it. There is a star near its northern border in the prolongation of its conjugate axis. The breadth or thickness of the ring differs from that of Saturn in being nearly uniform throughout. It appears, therefore, that if its form is really elliptical, we must see in a direction almost perpendicular to its plane; while if it is actually circular, it is presented to us a little foreshortened. A section passing through any portion of the space between its inner and outer sides would be circular. In other words, it is like a cylinder bent round till both ends meet.

"At first I was inclined to refer it to the same class as the annular nebula of Lyra, chiefly on account of its remarkable central star, which was, however, of greater brilliance; and, besides this, the resemblance is incomplete, for the ring is much more symmetrical, and better defined at its edges. It suggests the idea of a compact assemblage of brilliant stars, like the milky way. The brightness of the ring is not strictly uniform, the south preceding position being slightly more luminous. The transverse axis is inclined about 13° to the parallel of declination. A series of micrometrical measures of the length and breadth of the ellipse gives a mean of 26″·2 for the trans-

* *Comptes Rendus*, October 13th, 1862.

verse axis, and of 16″·6 for the conjugate axis." Mr. Lassell proceeds to remark that observations on this nebula are extremely difficult, and that it was only when the fine climate of Malta afforded him a night of unusual clearness, and permitted the employment of a power of 1480, that its details were revealed. He concludes thus: "I confess I was strongly impressed with the appearance of this marvel, situated, without doubt, at the extreme limit of the regions accessible to our investigation, and affording reason to believe that the heavens that are invisible to us are peopled with systems more splendid than any which we are permitted to contemplate."

LEECH-LORE.

BY THE REV. W. HOUGHTON, M.A., F.L.S.

Of the four orders which, according to Cuvier and Milne Edwards, form the extensive division know to naturalists by the term *Annelida*, that of the *Suctoriæ* most directly affects man either for good or evil. The various species that belong to the other three groups, viz., the *Dorsibranchiatæ*, the *Tubicolæ*, and the *Terricolæ* are only for the most part of indirect consequence to him, but with the leech, which belongs to the first-named group, man is directly concerned, and acknowledges this annelid either as a benefit or a pest; for while the medicinal leech has a strong claim upon our consideration on the grounds of the important services which it renders; there are others, such as the land-leech of Ceylon, and the horse-leech of Europe, which are often the cause of serious mischief.

Under the term leech is generally understood the animal of that name which is used in medicine, or rather, we should say, the two or three varieties thus employed; but the word is far more inclusive, and applies to other genera besides that to which the medicinal leech belongs.

Who was the discoverer of the useful art of bleeding by leeches? Themison, the founder of the ancient medical sect of the Methodici, and an eminent physician of Laodicea, in Syria (B.C. circ. 100), has the credit of being the first to make use of leeches.* The ancient Hebrews, and Orientals generally, do not appear to have been acquainted with the art, and even at this day the medicinal use of this annelid is unknown to the people of Syria; but that the art was practised by the later Greeks and Romans there is abundant evidence to show. We content ourselves, however, with one quotation from Oppian,

* Cæl. Aurel. *De Morb. Chron.* i. 1, p. 286.

who gives a very graphic description of the physician or surgeon applying leeches to an inflamed wound, the substance of which may be translated as follows :—

> "As when the surgeon, prompt and skilful in his art
> Has fixed a leech on some affected part,
> A leech, the slimy offspring of the pond,
> That sucks the black blood from each angry wound ;
> Nor stops, till satiated with the gore,
> It drops from off the skin, nor thirsts for more,
> But coils upon itself."*

There are two kinds of leeches generally employed in medicine, viz. the *Hirudo medicinalis,* the gray leech, and the *H. officinalis,* or the green leech. Another kind less used, as it is considered to be of an inferior quality, is the trout leech (*Hirudo troctina,* Johns.), so called from the orange-coloured spots with which its body is marked. These three kinds may be taken as affording certain typical characters, but there are numerous varieties which offer slight differences in colour, which it is supposed may be the result merely of the nature of their food, or of the water which they inhabit. Leeches are imported to this country from Spain, the south of France, Hungary, Algeria, etc. Many millions are annually brought to the dealers, who are sometimes guilty of fraud in the sale of them. M. Moquin-Tandon tells us that the merchants divide the leeches into *small, middle-sized,* and *large.* The small are called "threads," those just born "sprouts," the very large one "cows;" he adds that the dealers often gorge the leeches before selling them, with blood from the slaughter-house, and thus convert the small ones into middle-size, etc. The medicinal leech was once common enough in the lakes and pools of the north of England, though it is very rarely to be met with now in those parts. In Wordsworth's sonnet, *Resolution and Independence,* we are introduced to an old leech-gatherer in the following lines :—

> "He with a smile did then his words repeat,
> And said that gathering leeches far and wide
> He travelled ; stirring thus about his feet
> The waters of the pool where they abide.
> Once I could meet with them on every side.
> But they have dwindled long by slow decay ;
> Yet still I persevere and find them where I may."

Wordsworth's sonnet was written in 1807; when we consider

* "ὡς δ' ὅταν ἰητὴρ πολυμήχανος, ἕλκος ἀφύσσων
ὀιδαλέον, τῷ πολλὸν ἀνάρσιον ἔνδοθεν ἆιμα
ἐννέμεται διεράς τε γονάς κυανόχροα λίμνης
ἑρπετὰ τειρομένοιο κατὰ χροὸς εστήριξε
δαίνυσθαι μέλαν ἆιμα τὰ δ' ἀυτίκα γυρωθέντα
κυρτοῦνται, καὶ λύθρον ἐφέλκεται, ὀυδ' ἀνίησίν,
ἐισόκεν ἅιμοβαρῆ ζωρὸν ποτὸν αὖ ἐρύσαντα
ἐκ χροὸς ἀυτοκύλιστα πέσῃ."—*Hal.* ii. 599.

the immense numbers used in *therapeutics*, we shall not be surprised that native leeches have now become very scarce, and there is little doubt that the enormous demand for them, not only in England but on the Continent, would in time completely exhaust the natural supply, were it not that art here steps in and stops the drain. Hirudiniculture, M. Moquin-Tandon informs us, is now a most important branch of commerce, particularly in the Gironde and other districts of the southern departments. Large artificial marshes are formed, and the water is kept at a uniform level; a supply of clay and peat is made at the bottom and on the sides, and aquatic plants are provided for the two indispensable requisites of oxygenating the water, and of affording facilities for the leeches to free themselves of mucus, without which necessary cleansing they cannot long be kept in perfect health.

Almost every one is familiar with the little triradiate shaped mark left by the leech on the skin. This is effected by the three teeth of the animal thus deposited in its jaws; each tooth is provided with two sharp saw-like edges, worked by powerful muscles.

The leech produces two or three fibrous-coated cocoons, in which are seen a number of *vitelli*; this takes place not in deep water, but in moist holes or drains, at the spring of the year. The whole process is doubtless a most interesting spectacle to witness, and though we have not ourselves been spectators of the *modus parturiendi* in the genus *Hirudo*, we have been fortunate enough to observe it in the case of a closely allied genus, *Nephelis*, a most common leech, in every brook and pool in this country. Every one who has turned over stones and weeds, and especially the broad leaves of *Potamogeton natans*, *Persicaria*, *Sparganium*, etc., must have observed some oval-shaped, olive-coloured bodies, about one-third of an inch long and two lines broad. You find them in every brook and pond in great multitudes all through the summer, fixed to stones and leaves, and within the stems of *Sparganium* and other aquatic plants. What are these? If you are puzzled, you may have satisfaction in learning that so was the great Linneus! At first he took these capsules to be a species of insect, to which he gave the name of *coccus aquaticus*. It is recorded of the great Swede, that when he discovered the true nature of these capsules, which for a time had so much puzzled him, he exclaimed, "*Vidi et obstupui.*" Linneus, however, does not appear ever to have witnessed *Nephelis octoculata* in the act of producing and depositing the capsule. It is to the late Dr. Rawlins Johnson, of Bristol, to whom science is indebted for having been the first to record this extremely interesting and curious observation. (See *Philosophical Transactions for*

1817.) As we have witnessed this process we shall briefly describe it.

Some few years ago, in the month of July, we had alive in a glass vessel three or four specimens of this leech (it is the only British species of *Nephelis*). A few days after their capture we observed that one individual which had attached himself and herself—for the leeches combine both sexes in one person—to the sides of the glass, appeared very restive and uncomfortable, twisting and turning about in every direction; by and by a constriction was observed to take place on either side of the orifice from which the eggs proceed, the space between these two constrictions being much bulged out; around the circumference of this portion a slimy sloughing of the skin took place, while at the same time a number of minute globular bodies were emitted from the orifice, and inclosed within this mucus-like formation. Then the animal, with hinder sucker firmly affixed, drew back the front part of the body, and slipped its head out of the jelly-like mass; and now a still more curious scene presented itself. The leech turned round, and with its mouth moulded this viscid secretion into that oval form which the cocoon is destined to assume, and fixed it firmly to the sides of the glass, leaving it for a moment, and then returning to the work. This continued for the space of two or three minutes, when the leech left the cocoon with its inclosed vitelli to be matured into young specimens of Nephelis in due time by the surrounding water.

The *Monographie de la Famille des Hirudinees,* by M. Moquin-Tandon, is a work of great merit, and contains a vast amount of information on every department of leech-lore, useful alike to the naturalist and the doctor. It is accompanied with an atlas of several plates, many of which are coloured, and contain, for the most part, faithful representatives of the animals; their structure, mode of increase, the diseases to which the medicinal leeches are liable, their commercial value, particulars necessary to observe in their application, the descriptive characteristics of the species of the various genera which comprise this interesting group of Annelida are all carefully discussed.

The species or varieties of the medical leech have a wide geographical range, being found in nearly all parts of the world, in Europe, in different parts of Africa, in East and West Asia, in North and South America, and in the Indian Archipelago, in hot countries and in cold, in lowlands and high ground; a fact which furnishes evidence, when considered in addition to that which results from its structure and natural habitats, of the leech being an animal especially designed to serve to the good of mankind. "On contemplating," says Rymer Jones,*

* *The General Structure of the Animal Kingdom*, p. 262 (1155).

"the singular dental apparatus found in the medicinal leech, and considering the nature of the food upon which it usually lives, it is difficult to avoid arriving at the conclusion that such a structure is rather a provision intended to render these creatures subservient to the alleviation of human suffering than necessary to supply the wants of the animals themselves. In the streams and ponds which they usually dwell, any opportunity of meeting with a supply of the blood of warm-blooded vertebrata must be of rare occurrence, so that comparatively few are ever enabled to indulge the instinct that prompts them to gorge themselves so voraciously when allowed to obtain it. Neither does it appear that the blood which they swallow with so much avidity is a material properly suited to afford them nourishment; for although it is certainly true that it will remain for a considerable time in its stomach without becoming putrid, yet it is well known that most frequently the death of the leech is caused by such inordinate repletion, provided the greater portion of what is taken into the body is not speedily regurgitated through the mouth."

The enormous consumption of leeches may well convince us of their general value. M. Moquin-Tandon, in, 1846, estimated the annual demand in France to be from twenty to thirty million. Paris requiring three millions every year. It would be difficult to name any other creature so low in the scale of creation that possesses such high commercial importance. The prices paid for leeches are subject to variation. In 1806 they were worth at Paris from twelve to fifteen francs per thousand; in 1815 from thirty to thirty-six francs; in 1821, during the winter, they were worth from one hundred and fifty to two hundred and eighty francs per thousand. M. H. Cloquet affirms that in America and in India the price of a single leech has been known to be as high as three or five francs and even a guinea. It has already been stated that dealers frequently gorge the leeches; on this Dr. Christison remarks: "The gorging of leeches is a more common fraud than the substitution of spurious species; they are known by being less velvety in their coat, less flat when pressed, and by presenting a little tumour when squeezed between the fingers from the head to the tail. Leeches which have been used are often sold for unused or 'virgin' leeches. These are best known by putting them on a white cloth, and dusting their fore part with finely-powdered salt. In thirty seconds a little blood will be emitted, but not a particle if the leech be quite fresh."

Leeches are caught in various ways. People wade into the water inhabited by these worms, and the leeches clinging to their naked legs, are thus picked off. They are taken by the hand or in nets. Women and children are employed in their capture with great success. Sometimes portions of the bodies of animals are thrown into the water, and taken out after some hours with the adherent leeches; they are scooped out with ladles when the weather is rough, at which time they sink to the bottom, and hide in the mud. At Bonfarick, leeches are taken in great numbers by means of a wooden box, which is pierced on every side with a number of small openings sufficiently large to allow them to enter, but which are narrowed in the interior; this box is filled with moss and aquatic plants, and then, being attached by a cord, is thrown into the pond; the leeches collect in the plants. The spring is the season when the most leeches are taken, but the time varies according to climate. To prevent the complete exhaustion, the cocoons which contain the ova are carefully placed at the proper time in the reservoirs.

Leeches have enemies, and form no exception to the general law in the animal kingdom; various web-footed birds devour them, and herons, moles, shrew-mice, water-rats, and mole-crickets are also said to be their destroyers. It is related by Puymaurin that a certain dealer who had made 30,000 francs in four years by the sale of leeches, endeavoured to increase his number in a small pond, and when they amounted to about 200,000, a flock of wild ducks came, and in five hours destroyed them all. Besides these enemies above-mentioned, some kinds of fish, the larvæ of various aquatic insects, and even other kinds of leeches, such as *Aulastoma* and *Trochcta*, occasionally prey upon *Hirudo medicinalis*.

It has long been a subject of belief with some persons that leeches are so susceptible of atmospheric changes that they may be employed as useful barometers.*

A writer in *Hone's Every Day Book* (ii. 491) mentions the case of a gentleman who for several years kept a leech in a phial of water for the purpose of a weather-glass. If the weather was fine and calm, the leech lay motionless at the bottom of the vessel, and rolled together in a spiral form; if it rained, it crept up to the top of the glass; if wind was about to rise, "the poor prisoner galloped through its limpid habitation with amazing swiftness;" if a storm was at hand, the leech crawled up the glass and lodged out of the water, and "discovered great uneasiness in violent throes and convulsions."

On this subject M. Moquin-Tandon observes (213) that "on the eve of high wind, the leeches wander about their habitation with a surprising quickness; if the weather is cloudy they hide themselves in the mud; on the approach of storms they mount to the surface of the water, and fishermen profit by this circumstance to take them. These different movements are very far

* See *Inquire Within upon Everything*, No. 2180.

from being constant; if one observes a great quantity of leeches placed in a vessel, one would always perceive a number of these annelids remaining motionless at the bottom of the reservoir, and others rising to the surface of the water. However, a *curé* in the neighbourhood of Tours, announced in the public papers of 1774, that one could know every morning, by means of leeches, the weather of the next day. Briolët, Leroi, Toudouze and Valmont de Bomare, repeated these experiments and obtained no satisfactory results; Vitet was not more fortunate, and it has been the same with every one who has tried the employment of these pretended animal barometers. A modern author has therefore gone much too far when he has asserted that leeches replace with advantage the tube of Toricelli, and the opinion of the poet Cowper (as quoted by Johnson) is also exaggerated when he proclaims the instinct of leeches to be preferable to all the barometers in the world. It appears, however, that in Champagne, on the borders of the Lorraine, these clumsy instruments (*ces instruments grossiers*) had become common; a decanter, a small quantity of water, and five or six leeches being all that was necessary. Persons even carried their confidence in these indicators of the weather to the point of placing in the bottles a graduated wooden scale for the purpose of marking the different degrees of elevation to which the leeches attained. Charles Bonnet, who has perceived nothing regular or harmonious between the movements of the leeches and the variations of the atmosphere, has suspected that if these animals are not good barometers, they might serve as very sensitive thermometers; the assertion of the naturalist of Genoa is scarcely worthy of more serious consideration than the discovery of the *curé* of Tours." That leeches are, to some extent, affected by changes in the weather is a fact which we have witnessed ourselves, and where no other barometer can be had they can be employed in this respect by those who are not scrupulous about particulars or any amount of accuracy.

We all know how what is termed a *mania* in some particular subject breaks out from time to time, possessing the minds of multitudes with some epidemic. We all remember the Cochin China *mania*, the aquarium *mania*, for instance, but what will the fair sex say to the fact that in 1824 there existed in France a leech mania! The most enthusiastic admirer of Cochins, or of sea anemones, would never have thought of carrying her admiration for her pets so high as to wear on her dress representatives of these animals; but we learn from Fée that there might have been seen at that period elegant ladies wearing dresses *à la Broussais*, on the trimming of which were mitations of leeches! M. Broussais was a physician, no doubt the great patron of leeches, as Mr. Gosse is of sea-anemones.

The following extract from M. Moquin-Tandon's work, *Elements of Medical Zoology*,* may be read with advantage by those interested in checking the threatening scarcity of an animal whose preservation is of so much importance to all classes of society :—" M. Vayson has recently suggested a small domestic marsh (a *vaysonier*) which will be exceedingly useful to the pharmaceutist, and to persons who are desirous of raising *leeches* on a small scale. This apparatus consists of a common earthen vessel having the form of a truncated cone reversed. The lower part is perforated by a number of holes, but not so large as to allow of the leeches passing through them ; the vessel is then filled with peat earth, and a number of leeches are placed upon it which embed themselves in the earth; the upper opening of the vessel is then covered up with a piece of coarse canvas. When it is desired to send the leeches to a distance, the earth is made as damp as possible, and the vessel is packed in a box or wicker basket. When it is only wanted to preserve the animals, the lower part of the vessel is placed in water to the depth of about four inches, and the creatures are left to themselves. In consequence of the infiltration, the lower parts of the peat are soon saturated with water, while the upper portion is almost dry. The leeches know perfectly well how to choose between these two extremes the layer which is best adapted for them, and form in it galleries in which they live, grow, and produce their cocoons. The *vaysonier* will answer both for the preservation, the conveyance, and reproduction of leeches."

There are interesting particulars relating to many other genera of the leech family, such as the horse-leech, the land-leech of Ceylon, the incubating leech (*Glossiphonia*), but space forbids further remarks.

* Translated and Edited by R. T. Hulme. London. 1861.

THE STRUCTURE AND HABITS OF PHYSALIA.

BY G. C. WALLICH, M.D., F.L.S., F.G.S.

The last number of the Intellectual Observer contained a summary of the researches of the older writers on Physalia, from the time of Alexander when it was first noticed by Aristotle as occurring in the Mediterranean, to the year 1843, in which we find it described by M. Lesson in his *Histoire Naturelle des Acalephes.* But, although the more obvious portions of the Physalian structure had already been described at the date of the last-named memoir, it remained for our distinguished countryman Professor Huxley, to advance our previous knowledge of the Oceanic Hydrozoa generally, and to correct many of those erroneous views regarding their organization and morphological relations which were due to the statements of De Blainville, Lesson, and others.

It is the object of the present paper to adduce what further information has thus been rendered available, and, at the same time, to put the reader in possession of some apparently novel facts bearing on the history of Physalia which have fallen under the writer's immediate observation.

Professor Huxley's first memoir on Physalia was forwarded by him in 1847, from the Australian Seas, to the Linnean Society; the more detailed account appearing, however, in his admirable work on *The Oceanic Hydrozoa,* constituting the volume published by the Ray Society for the year 1858.

We find it there stated that "the body of every hydrozoon is essentially a sac, composed of two membranes," an external and an internal, which have respectively been called the "Ectoderm" and "Endoderm."* This sac contains the nutritive fluid which performs the functions of the blood in the higher animals, and is circulated by means of cilia which generally invest the inner as well as the outer membrane and, aided by the muscular contractility of the body, constitute the only circulatory and respiratory mechanism in the organisms under notice. The two membranes may readily be traced in every part of the structure. In the large bladder (which, by the way, closely resembles the swimming bladder of a medium sized haddock in dimension and general outline) they form an outer sac, or "pneumatophore" as it is technically termed, within which the true air-chamber, or "pneumatocyst," is enclosed; the latter being in reality a secondary introverted sac, having the same structure in its walls, and communicating with the outer world by a minute contractile orifice at the point at which the

* By Professor Allman.

inflexion of the pneumatophore or outer sac takes place. This point corresponds with the apex of the more elongated extremity of the pneumatophore. It will thus be seen that there is no communication between the cavity of the pneumatocyst and the general cavity of the organism; but, on the other hand, that a free communication does exist between the general, or "somatic" cavity as it is called, and the space existing between the walls of the pneumatocyst and pneumatophore.

According to Eichwald* and Von Olfers,† the crest is formed of a series of vertical cæcal folds of the pneumatocyst, invested exteriorly, in common with the rest of that body, by the two membranes of the pneumatophore. It is extremely doubtful whether the Physalidæ possess the power of expelling the air from the air-chamber as asserted by some writers. The only reliable evidence of this process is adduced by Eschscholtz,‡ who describes having seen the air voluntarily expelled from a young specimen of Physalia only five lines in length, so that it immediately sank to the bottom of the glass vessel in which it was placed for observation. In the nearly-allied families of Rhizophoridæ and Physophoridæ, in which the pneumatocyst consists only of a minute spherical or pyriform vesicle, I have repeatedly seen the creatures suddenly sink to the bottom of the glass on being irritated, but without any appearance of collapse of the air-cell. In the young Physalidæ the character of the air-cell ("pneumatocyst") is identical with that of the adult Physophora and Rhizophora, but no amount of irritation ever caused the specimens to contract the air-cell or sink, although their polypites and tentacles exhibited sensibility to the slightest touch, or even vibration of the glass, by becoming instantly coiled up close to the body.

During the long-continued calms at the equator, extending sometimes over several days, when the surface of the sea is literally as smooth as a mirror and as pellucid as crystal, I have had ample opportunity of watching Physalia, and have in no instance observed the float collapse, or the creature sink beneath the surface. Under the above conditions it becomes manifest that the creature is wholly devoid of power to move to and fro; the individuals remaining, as it were, fixed in the same spot, and evincing no signs of vitality beyond a partial collapse of the crest, occasional abrupt changes in the direction of the axis of the pneumatophore after the fashion recorded by M. de Quatrefages§ and Professor Huxley (*loc. cit*), a gentle dip over on one side—probably with a view to moisten the surface

* *Mem. de l'Acad. Imp. des Sciences de St. Petersbourg*, 1824.
† *Abhandlungen de Kön. Akad. de Wissenschaften zu Berlin*, 1831.
‡ *System du Acalephen*, 1829.
§ *Annales des Sciences Naturelles*, 1853.

which must become more or less parched by the fierce rays of the tropical sun,—or a few lazy oscillations in answer to the never-ceasing swell of the ocean. These are the only movements which present themselves during calms, but a far more remarkable phenomenon has repeatedly been noticed by me in moderate weather when the ship is passing along at a speed of not more than three or four knots an hour, and its impetus is sufficient to transmit delicate undulations for some distance along the surface of the water, although there is not sufficient wave-action to interrupt observation. Under these circumstances, each Physalia, as it comes abreast of the ship, even when at a distance of from thirty to sixty yards, gently inclines its pneumatophore and crest to one side so as to rest laterally on the water, and only regains its original posture when the ship has advanced far enough to prevent the transmission of the undulations. That the sensibility to the mechanical disturbance thus produced at the surface of the sea must be intensely acute is evident, inasmuch as the effect is visible far beyond the range of any surface disturbance observable by the eye. Hence it would seem to be aroused, not by the ordinary wave-action by which the creature happens to be surrounded, but by the subtle abnormal character imparted to that action by the passage of the ship. It is hardly necessary to state that, since no nervous system can be detected in the Physalidæ, there are, at present, no data even for speculation on the physiological aspect of this highly curious phenomenon; and it must be obvious that any attempt to account for it on the supposition that the acts in question are the result of direct mechanical irritation, is simply substituting one unexplained fact for another. At present, therefore, I have only to record the act of the "Portuguese man-of-war" as one of very frequent occurrence, leaving it to more imaginative minds to trace back the existing mode of salutation between vessels at sea designated "dipping the colours," to this primæval source.

According to my own experience, the Physalidæ never sink below the surface as has been asserted, but merely become lost to sight in the wave-disturbance when the weather is stormy; their peculiar colour and bubble-like aspect causing them to be undistinguishable from the element by which they are surrounded when at any distance from the observer's eye. This view derives confirmation, moreover, from the fact that they are frequently entrapped by the towing-net when not a single specimen can be seen, owing to the reason assigned.

The inclination to one side and re-erection of the pneumatophore, to which reference has been made, is slowly performed, (each operation occupying from three to five seconds) and would seem to be effected by the contraction of the muscular wall on the side towards which the inclination takes place. Besides this, the creature has the power of raising up, into a nearly vertical position at times, the free extremity of the pneumatophore. Even when taken out of the water, and placed on any hard surface, this portion of the creature continues to move, thus indicating that the act is due to muscular contractibility of the walls of the air-chamber, and not to the mere change of axis, alluded to by M. de Quatrefages, which is due to the sudden contraction of the tentacular appendages now about to be described.

On the inferior surface of Physalia there exists what appears, at first sight, to be only a confused mass of tentacular and suctorial organs. This mass consists of a duplicature of the general substance of the body, termed the cænosarc by Professor Huxley, from which three kinds of organs are given off, namely, the "Polypites," the "Tentacles," and the "Hydrocysts." The first are variable in number and size, and, according to the author just named, constitute the "principal organs of alimentation." In outline they are somewhat pyriform or flask-shaped, and during the life of the creature are in continual motion; the broad open discoidal end being that which is dependent, whilst the short pedunculate extremity is that by which they are attached to, and communicate with, the cavity of the cænosarc. Although these organs serve the purpose of stomachs, they also possess the prehensile power imputed to them, as may readily be seen in specimens placed in confinement. The interior of the polypite is furnished with villous projections, by means of which digestion and absorption are said to be effected, and the nutritive products conveyed into the general cavity of the body. The hydrocysts, which differ in no aspect from the polypites, save in being completely closed externally, have been regarded by Professor Huxley as "young stomachs."

The tentacles, in like manner with the polypites, are variable in number and length, one being, however, generally much longer than the rest. Each one is furnished at its point of attachment with a jelly-bag-shaped sac, the mouth of which communicates with the general cavity, and, along its upper half, with that tentacle to the side of which it is adherent. The tentacles in their contracted state are only a few inches in length, whilst, in their extended condition, they often attain a length of from four to six feet. They are formed of longitudinal highly contractible fibres, each of which averages from $\frac{1}{2500}$th to $\frac{1}{1700}$th of an inch in diameter; the united fibres, when extended, constituting a flattened band somewhat thicker on one side than on the other, along which are attached at intervals, crescentic masses composed almost wholly of thread capsules.

These masses do not embrace the entire circumference of the band, but only three sides as it were; the fourth being left free along its whole length. It is in the thread capsules that the peculiarly acute stinging power of the Physalidæ resides; although, as yet, both the chemical composition and the mode of secretion of the poisonous fluid with which the threads are embued, is altogether unknown. It is almost certain, however, that the extension and contraction of the tentacles is attributable to its own muscular structure, and not to the injection of the poisonous fluid supposed by Lesson and others to be a secretion of the basal saccular appendage already referred to.

The extensile quality of the tentacle is very remarkable. Thus I have repeatedly succeeded in winding it on a card by merely placing the animal on a board during the operation, and reeling off the thread, which, by this means, is reduced in thickness to that of fine silk, and may be continuously wound until it attains a length of eight or ten yards. This filament, when dried in the sun, will keep for any length of time, and forms a beautiful object for the microscope; the fibrillæ of the muscular band and the crescentic bundles of thread-cells being admirably seen, whilst their original colour is in nowise destroyed.

My endeavours to preserve the pneumatophore by drying in the sun, were invariably unsuccessful for, although it remained distended and its upper and lateral portions acquired the tough consistence of a dry membrane, the setting in of decomposition along the inferior fleshy portion always ended in its rupture. Small specimens of the allied family of Velella, however, which were preserved on glass slides by a similar process of drying, in 1857, are still in my possession, together with the delicate tentacles of Physalia just alluded to.

Although there cannot be a doubt that nutritive organisms, probably consisting of minute Entomostraca, Infusoria, or Rhizopoda, are seized after having been paralysed by the urticating organs of the tentacles and polypites (for these bodies also occur in the latter appendage), there is, I think, good reason to suspect that Mr. Bennett, who describes the process of fish capture by a Physalia, must have been misled as to the cause and effect of what he witnessed, for the following reasons: In a great number of cases the Physalia is accompanied by one or more small fishes, precisely in the same manner that the pilot-fish accompanies the shark. These fishes swim round and round and through the depending tentacles without inconvenience, and their association with Physalia is undoubtedly one of choice, being in all likelihood due to the quest of some kind of food which is attracted towards it, or furnished through its excretions. I have so repeatedly witnessed this association, and captured both Physalia and fish in the small hoop casting-net I was in the habit of using, that I can confidently state there is no hostility between them under ordinary circumstances, and that the mere contact of the fish with the tentacles of the former does not result in any observable inconvenience to either animal. The fish (according to Dr. Günther, who very kindly examined my sketch and favoured me with his opinion) is probably either a young form of one of the Scombridæ, or, if mature, a member of some unknown genus. It is curious, however, that the specimens captured by me over a wide area of the Atlantic, invariably belonged to the same species, and were, as nearly as possible, of one size; that is to say, from two to three inches in length; the colour on the back being a deep blue, identical with that of the cænosarc and body of the polypites of Physalia. Nor was this fish the only attendant on it; for, crawling about within the mass of polypites and tentacles, I as often found several Isopod crustaceans, from a quarter to three-quarters of an inch in length, evidently parasitic in this position. The same species was also observed by me frequently on the float of Ianthina, and on floating epiphytic Lepadidæ. Here, again, it is clear that the urticating organs are innocuous, inasmuch as partially devoured or dead specimens were never met with.

Lastly, I have not observed the marked iridescent quality which has been stated to accompany the brilliant tints of the Physalidæ. The colours themselves are extremely rich, the contrast afforded by the roseate pink of the upper margin of the crest, and the graduated tints of blue, commencing with the faintest opalescence on the upper surface of the pneumatophore, to the deep and almost full-toned indigo of the cænosarc and appendages, being very striking. Intermixed with these colours are the greenish streaks which mark the outlines of the cæcal chambers of the crest, and the root-like continuations of the velvety dark-coloured mass beneath. The minute mammiliform protuberance at one extremity of the pneumatophore is also of bluish green, whilst the walls of the air cavity itself, although almost colourless, reflect the images and tints of passing objects in the same manner as a soap-bubble, but without any greater amount of iridescence than is perceptible in ligament.

Of the mode of development of the embryo and of the air-chamber in the Physophoridæ generally, nothing is at present known; the young Physalia having only been seen when already so far advanced in growth as to constitute a nearly perfect, though comparatively minute, individual. In like manner we have still much to learn regarding the true basis of specific distinction in this class of organisms; the older authors having adopted distinctions which now-a-days would hardly be admissible as indicative of varieties.

These, then, are the more prominent characters of this remarkable and beautiful genus of Hydrozoa. They have been given somewhat in detail, with a view to incite "those who go down into the sea in ships" to extend our knowledge; and to prove that, at all times and under nearly all circumstances, the voyager may find ample food for the mind, and a far from exhaustible field for the instruction of his fellows.

PROFESSOR LAMONT'S NEW THEORY OF ATMOSPHERIC VAPOUR.

BY ALEXANDER S. HERSCHEL, B.A.

The experiments of Dr. Dalton on the pressure of vapour rising from the surface of water at different temperatures, in free space and in space enclosing air, led to conclusions which have since been received by the compilers of meteorological tables, but which are questioned by M. Lamont, and shown by his experiments to be in some degree fallacious. The vapour of boiling water, or of water at 100° centigrade, is familiarly known by the vibrations of the lid of a kettle, and by the formation of bubbles upon the surface of the heated water, to have the pressure of the incumbent atmosphere. The bubbles which rise to the surface of water boiling in an open vessel enclose within their pellicle a vapour whose tension or elastic force is exactly equal to that of the equally heated air which surrounds their envelope, and burst so soon as the quantity enclosed exceeds a capacity proportioned to the thickness of the film. The experiments of Dalton proved that the vapour so enclosed was lighter than the air surrounding, in very nearly the proportion of 2 to 3. It follows, by Mariotte's law of equable expansion of gases or vapours by heat, that such vapour and such air exposed to any superior equal temperature, will have to each other the same proportion, in density, of 2 to 3; but a further deduction from the experiments of Dalton is this, that water boiled in a partially exhausted receiver of air, will give rise to bubbles which enclose a vapour having equally a proportion in density of 2 to 3 to the adjacent air. In short, the vapour of water and common air, wherever these subsist at a common temperature and pressure, are always in the proportion in density of 2 to 3 one to the other. We here consider the case of water boiling in air. The pressure of the incumbent air being in this case the exact measure of the elastic force or tension of the vapour emitted by the water at boiling temperature, a table is readily constructed to exhibit the vapour tension of water of given temperature. Conceive a globe, completely exhausted of air, to contain a quantity of water, not too small, and to be raised to a certain temperature in the open air; this globe will have a tendency to explode or to collapse, according as the temperature is above or below 100° centigrade. If the atmospheric pressure about the globe be only one half of the ordinary pressure of the atmosphere at the sea level (as, for instance, on the summit of Mont Blanc), the globe will have similar tendencies according as its temperature is above or below 82° centigrade. And so for higher and lower pressures of the atmosphere without, there will be required higher or lower temperatures of the water globe to equilibrate from within the pressure from without. Such a table, expressing the pressure of pure vapour arising from water of given temperature, has been constructed with extreme accuracy by Mr. Regnault; and it results, that by exceedingly rapid methods of exhaustion, water may be made to freeze in the very act of boiling, ice or snow being forms of water which do not in the least interrupt the regular march of the numbers of the table.

Conceive again a sealed globe to enclose perfectly dry air of a given temperature and pressure, and likewise a vessel freely dilatable, including water in sufficient quantity. If the temperature of the globe be high, and the pressure of the air within it be small, the water so included will boil, and the temperature being exactly maintained, the vessel will enlarge until the incumbent air is so compressed in space, as to exert exactly the pressure of the vapour upon the external surface of the vessel. The pressure which now obtains within the globe is that due to the temperature of the water, according to the value assigned in the table before mentioned. M. Lamont assures us, from experiments, that the pressure will maintain this value if the walls of the including vessel be now removed. Dr. Dalton, however, deduced from his experiments a different rule. On removal of the partition supposed to separate the gaseous fluids, more aqueous vapour will be generated in proportion to the space occupied by the air, it will cross the boundary and fill that space *as if it were a vacuum,* the air at the same time will cross the boundary and expand into the space engaged by aqueous vapour *as if it were a vacuum,* and a pressure will result, the sum of that due to the temperature of the water and that of the air originally enclosed.

M. Lamont has found that a globe connected with an iced receiver by a tube one line in diameter may for two hours be occupied by water at a temperature of 100° Fahrenheit without signs of distillation taking place. Yet the pressure within the globe and receiver M. Lamont found to be compounded of that of the heated air and of the aqueous vapour with which the ærial space of the globe was saturated (by convection). This experiment is proof sufficient, in the opinion of M. Lamont, that the particles of vapour and of air are not, as in the theory of Dalton, indifferent one to another as grains of dust, but exert upon one another a mutual and permanent reaction. Whereas the aqueous particles are incapable, at low temperatures, to exert those pressures by which they might assume among the particles of air positions of equal and independent action, M. Lamont advocates a view that an atomic combination arises between these diverse particles, causing to the saturated air a character of humidity. This character he believes to be imparted to the air by actual contact only with the source of vapour, and not by any transfer of the particles of vapour among the particles of air.

DOUBLE STARS.—OCCULTATIONS.—THE EARTH IN OPPOSITION.

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

DOUBLE STARS.

We will return to the constellation *Cygnus*, before it passes away too far to the west, for the sake of a very inconspicuous object, but, at the same time, one of the most remarkable in the heavens—a double star, whose name, 61 *Cygni*, will ever be henceforth associated with a most memorable epoch in sidereal astronomy. The unusual amount of the common proper motion discovered by Piazzi, in this pair, 5″·2 in R. A. and 3″·2 in D. annually, or 1° in 700 years, induced the late eminent observer Bessel to suppose that it might be at a less impracticable distance from the earth than its neighbours, and might indicate that distance by a sensible parallax. He therefore undertook this most delicate and difficult investigation with the great heliometer* at Königsberg, measuring, at different seasons of the year, the interval between the pair and two smaller stars

* The instrument so called, or rather *mis*called, is an achromatic telescope, the object-glass of which, after its completion, is cut across into two halves, each so mounted that the straight edges are capable of sliding against one another, in obedience to a screw movement, the handle of which is brought within reach of the observer. So long as the two halves maintain the same position which they had before bisection, they produce a single image at the focus like an ordinary object-glass; but any lateral displacement has the immediate effect of converting this single image into two, whose distance can be varied at the pleasure of the observer; and in the same way the images of two distant objects in the same field can be made to coincide, and thus micrometrical measurements can be

in the neighbourhood, lying in different directions from it, and whose positions might be assumed as sensibly invariable. Had these measures proved identical at all times, after allowance had been made for the pair's proper motion, the inference would have been that all these four stars were at an equal distance from the earth, or, more correctly speaking, that the difference of their distances was inappreciable by this, or, in fact, any mode of measurement; while, on the contrary, any apparent shifting of place on the part of the brighter pair with respect to its minute neighbours, if it recurred at corresponding seasons of the year, could only be the result of a real motion in the spectator's eye, and would not merely indicate that the stars in question are near enough to change their apparent position when viewed from different points of the earth's orbit, but give the means of estimating their distance from the amount of that change. Sir W. Herschel had already attempted the parallax of the stars by looking out for annual variations in the apparent positions of close pairs; but while failing in one attempted discovery he, as is sometimes the case, stumbled upon another of not less importance connected with the cause of his failure; in trying to find a parallax, the result of one star's being widely removed in point of distance from the other, he detected an orbital motion, the effect of that mutual proximity which rendered parallax inappreciable; and thus his original object was reserved for another generation. Many years afterwards, Henderson, at the Cape of Good Hope, and Bessel, at Königsberg, undertook nearly simultaneously the same important investigation; Henderson attacking α *Centauri*, the most splendid double star in the whole heavens, but lying too far S. to be visible in our latitudes, for the same reason which determined Bessel's choice of 61 *Cygni*, namely, its great amount of proper motion. The priority of observation is undoubtedly due to Henderson in 1832, but to Bessel belonged the earlier announcement, by three weeks only, at the close of 1838, of the discovery of sidereal parallax. It must have been an anxious time for these observers, when they were repeating, night after night, and season after season, the questionings on which depended the first step of our knowledge of the dimensions of the universe; and it must have been an hour of

attained with a high degree of accuracy. These measurements are by no means applicable peculiarly to the Sun, as the very inappropriate name would imply, but are equally available for all objects in the same field. The principle of measurement by double focal images was discovered by Savery, in England, and Bouguer, in France, previously to the middle of the last century; Dollond devised the great improvement of halving the object-glass, and Frauenhofer constructed the first of any celebrity, that mentioned in the text, which has an aperture, I believe, of $6\frac{1}{3}$ inches. There is a still larger one, of $7\frac{2}{10}$ inches, by his successor Merz, at the Radcliffe Observatory, Oxford.

deep gratification when the starry height sent back the first answer ever vouchsafed to mortals—" Our distance is not unmeasurable; our position is not unapproachable; and, as far at least as we are concerned, the language of the book of Job receives a definite meaning for the first time since man was created upon the earth, 'Behold the height of the stars, how high they are!'" The quantities thus brought out were, however, very small, and subject, of course, to causes of error which would in some degree render them uncertain; but by the multiplication and comparison of observations, the limits of such errors can be ascertained, and it may be now stated, with perfect certainty, that the distance of 61 *Cygni* is measurable, and with much confidence that it amounts to about 52,000,000,000,000 miles. Figures thus marshalled speak an almost unintelligible language; and we may possibly aid our bewildered comprehension by stating that this distance is 550,900 times that of the sun from us, and that it would take a ray of light $8\frac{7}{10}$ *years* to traverse it,* while it occupies but $8\frac{1}{4}$ *minutes* in reaching us from the sun, at ninety-five millions of miles. And how strange is the impression following from this truth that we see not those stars, and much less others in their background, *as they are now.* We have not even any proof of their present existence! Had they been, eight years ago, blotted out of the roll of created things, we should still see them glittering in their accustomed place, by the stream of light which had left its source before their extinction; we view them as they were in the year 1853, without the slightest record or intimation of their subsequent history. At the same time, what an idea is given us, by the parallax discovered in this star, of the vast dimensions of that great universe in which we live, and how wonderfully does it, even in this one aspect, declare the Creator's power and Godhead! The sky is crowded with millions upon millions of stars; and of all that countless host, thousands, probably, for one, are at a distance incalculably greater than that of 61 Cygni!—It will require a little close attention to guide us to this remarkable pair, but our readers will probably not consider their trouble ill-bestowed. They must therefore imagine a line from γ *Cygni* to α, and draw a similar one parallel to it from ε (for these stars, see INTELLECTUAL OBSERVER for November, p. 304); this, at a distance equal to that of α from γ, will fall upon a minute object lying a little p, σ 4 mag. and τ, 5 mag.;† two stars near together, which

* These values were somewhat differently given at first; the above are the result of Peters's corrections, applied, according to Bessel's intention, after the latter's death.

† These are the magnitudes given in the larger star maps of the Society for the Diffusion of Useful Knowledge; but it is worthy of remark that at the present time τ *is the brighter of the two.*

will help to identify it; it is much fainter than those stars, but still steadily visible to a good eye. Its data are as follows:

61. 61 *Cygni.* 15″·6. 90°·5. (1830·81). 16″·3. 96°·3 (1839·69). 5½ and 6. Yellow and deeper yellow. Period more than 540 years, according to Bessel, who thinks that their joint mass may be about half the mass of our sun. Their orbit may possibly be 50 times as large as that of the earth. Secchi's measures, 1855·997, —17″·946 and 105°·93,—show its continued motion, contrary to W. Struve's opinion.

Our next object is at the tip of the Swan's E. wing. A line from γ to ϵ *Cygni,* prolonged as far again, but bent rather upwards, catches ζ *Cygni,* 3 mag.; if carried still onwards to the E. and a little to the S., somewhat further from ζ than ζ is from ϵ, it falls upon κ *Pegasi,* a 4 mag. star, a little N. of which is the following, of similar brightness:—

62. μ *Cygni.* 5″·4. 114°·3. 5 and 6. White and pale blue (1839·62, 1850·6). So W. Struve, 1831·63. Sestini made them yellow and more yellow, 1844·5. Dembowski gave "jaune rougeâtre" and "olivâtre," 1853, 1854; "blanc jaune clair" and "jaune cendré," 1855. I found the larger star yellow, 1850·69, 1851·81, while the other showed the curious effect, already mentioned in No. 29 of our list, of an undecided and changeable hue, blue and tawny. At present I see the principal star yellow. A third blue 7½ mag. star, at 3′ 36″·8, completes this beautiful group. Secchi, whose colours are here uncertain and variable, found, for the close pair, 1857·559, 4″·364 and 116°·10, and hence, and from the large value of its common proper motion, he considers that its physical connection is unquestionable.

A little E. of the galaxy, and *nf Altair,* lies a lozenge-shaped group of four moderate-sized stars, the lowermost with a companion close on its right, and another as a pendant to the whole. This is *Delphinus*; more appropriately named than is usually the case with these strangely devised configurations. The *nf,* or uppermost star of the lozenge is—

63. γ *Delphini.* 11″·8. 273°·3. 4 and 7. Golden yellow and flushed grey, 1850·7. Smyth had made the smaller star light emerald in 1839, corresponding more with Struve's *viridicœrulea.* Sir W. Herschel called them both white; whence, as he had a known bias for red tints, Struve infers the possibility of change. This, though without the interest, so far as we know, of physical connection, is a beautiful object, and within the reach of very small telescopes. Smyth commanded it with an aperture of two inches.

In tracing the galaxy from Cassiopea towards the NE. horizon, we soon come to a fine 2 mag. star involved in a lucid glow arising from the presence of a number of minute attendants.

This is *a Persei,* and it forms the starting-point of a remarkable sequence of 4 large stars, at nearly equal and considerable distances, ranging in a great curve towards the right beneath Cassiopea, without the intervention of any remarkable object. Beginning with *a Persei,* the others are γ, β, and *a Andromedæ,* often called respectively *Alamak, Mirach,* and *Alpherat.* We must look at the first of these three.

64. γ *Andromedæ.* 11″. 61°·6. $3\frac{1}{2}$ and $5\frac{1}{2}$. Deep yellow and sea-green. This, since its discovery by Christian Mayer in 1778, has been known as one of the most brilliant and beautiful instances of contrasted colour, as well as one of the easiest pairs in the heavens. There is no evidence of orbital revolution, but a fresh degree of interest has been attached to this object since Struve, senior, discovered with the Dorpat achromatic, twenty years ago, that the smaller star was itself an exceedingly close and difficult pair. The distance is given as under 0″·5, and it consequently forms a most severe test of defining power. Cooke's (of York) beautiful object-glasses of little more than 4 inches will elongate it, and Mr. Lockyer, of Wimbledon, has divided it with $6\frac{1}{4}$ inches by the same hand—a great triumph of optical skill. Secchi at Rome actually *measures* it, and calls it *easy!* with the Merz achromatic of $9\frac{1}{2}$ inches, and its division is "a broad dark space" with the new equatorial at Greenwich of $12\frac{3}{4}$ inches, also from Munich. One of the new silvered glass specula manufactured by Léon Foucault (a remarkable invention, of which we shall shortly hear more in England) has accomplished the separation with about the same aperture; but as much has been done by a metallic mirror of $9\frac{1}{4}$ inches, figured by Lassell. I have repeatedly elongated it with my $5\frac{1}{2}$-inch object-glass. The little discs are of unequal magnitude, the nearer to the great star being the larger. A difference of hue was noted by Secchi in 1856, who calls them *subviridis* and *violacea.* The late Sir W. K. Murray, of Ochtertyre, who had a 9-inch telescope by Cooke, discovered independently, in 1857, that they were yellow and blue. Dawes, with an 8-inch Alvan Clark object-glass, made the same observation; and Jacob, at Madras, with the Lerebours achromatic of $6\frac{1}{3}$ inches, though unable to divide them, found the larger end of the *wedge* yellowish, the other bluish. Few of our readers may hope to verify these details; yet it may interest them to know, when they gaze upon that minute speck, what other telescopes exhibit there.

a Andromedæ, already mentioned, stands at the left-hand upper corner of a rectangle of large stars, so fairly regular that the bottom line is sensibly horizontal, and the right side nearly vertical, when on the meridian. This is *the square of Pegasus,* marking the E. portion of that wide-spread constellation. At the other upper corner is β Pegasi or *Scheat;* the star beneath β is a, *Markab;* γ Pegasi occupies the left corner below. It may assist the student in acquiring the useful practice of estimating degrees, if he knows that the length of the bottom of the square is 17°, and of the right side is 13°, the top being about 16°, and the left side 14°. If from *a Pegasi* we draw a line back to our old acquaintance *Delphinus,* it will pass some way above a solitary star, the brightest in a considerable region. This is—

65. *ε Pegasi.* 2′ 18″·1. 324°·3. 2½ and 9. Bright yellow and blue lilac. A 14 mag. star at 1′ 25″ and 327° makes this a triple group with a sufficient aperture. The object is not in itself a remarkable one, but is inserted here as a striking example of a phenomenon which seems to have been first noticed by Sir J. Herschel. He found that when two unequal stars, as of 4 and 9 mag., are situated at a moderate distance (10″ to 60″ or 80″), nearly in a vertical line, on giving the telescope a swinging motion in a horizontal direction, the image of the small star will oscillate, like a ball hung by a string, through an arc greater in proportion to the difference of brightness; sometimes as much as 15° or 20° on each side of the vertical. This he thinks is owing to the longer time which may be required for a feebler light to affect the retina, whence the change of motion in a bright point may be more speedily perceived than in a faint one. *ε Pegasi* is an excellent instance of this optical deception: it will, however, be too late to see it well at the present season, as the position of the small star renders it vertical *before* passing the meridian, which it does at about 5h. in the beginning of December; but we shall remember it another year.

A diagonal of the square, from *a Andromedæ* through *a Pegasi,* bent a little downwards, points to a small "caltrop" or triangle of stars, with a fourth in its interior. This inner star is—

66. *ζ Aquarii.* 3″·5. 352°·4 (1838·04). 3″·2. 346°·9 (1852·81). 4 and 4½. Flushed white and creamy. There can be no doubt of the binary character of this beautiful pair, whose connection was discovered by Herschel I. in 1804. Its period may possibly be about 750 years; but an accurate determination is yet wanting. Secchi gives 3″·328 and 344°·03 (1856·835). It is within the reach of small apertures. I have seen it perfectly with 2¾ inches, and less would no doubt have sufficed.

A line from *ε Pegasi* through the last object, carried as far again, falls on a group of three small stars close together; the one to the right is—

67. *ψ^1 Aquarii.* 49″·5. 310°·5. 5½ and 9. Topaz yellow and cerulean blue. In fine contrast, but apparently stationary.

Struve, however, asserts a probable connection from common proper motion.

To find our next object we must suppose a line drawn from *Cassiopeia* between β and γ *Andromedæ;* this, at an equal distance beyond those stars, points out three stars lying near together, the two to the right being closest, and the small one being furthest in that direction, as well as lower than its neighbour. These form the head of *Aries*, and the small star is—

68. γ *Arietis*. 8″·8. 359°·8. 4½ and 5. Full white and faint blue. Piazzi Smyth made them both of the same colour, either white or light yellow, on the Peak of Teneriffe in 1856: W. Struve, "egregie albæ" in 1830: Dembowski, both white in 1852, 1854, and 1856. A fine pair, stationary, but, as it seems, moving together through space. Discovered by Hook in 1664 while following the comet of that year; "I took notice," he says, "that it consisted of two small stars very near together; a like instance to which I have not else met with in all the heavens." And in 1837, Struve had catalogued 2787, nearly all much more difficult! A very small telescope will bring it into view. Smyth found two inches of aperture sufficient for it.

Of the three stars already mentioned in the head of *Aries*, the brightest, *a*, stands to the left. A line from γ *Andromedæ* to this star will leave, a little to the left, and above its centre, two stars, β (4 mag.) and γ (5 mag.) *Trianguli*. Another line from γ, the smaller of these, to *a Arietis*, will pass, at ⅓ of the distance, the following pretty object, which, though visible to the naked eye, must be sought with some care in the telescope, as there are several other not much smaller stars near it:—

69. ι *Trianguli*. 3″·5. 78°·8. 5⅓ and 7. Topaz yellow and green. Secchi, who calls this "a most beautiful object," makes its colours white or yellow and blue. It is stationary.

OCCULTATIONS.

Of these, at convenient hours, the month contains only three. December 3rd, 40 *Arietis*, 6 mag., immerges at 4h. 53m. and emerges at 5h. 35m.; 9th, 5 *Cancri*, 6 mag., disappears at 9h. 30m. and reappears at 10h. 37m.; 23rd, τ^2 *Capricorni*, 5 mag., is concealed from 4h. 48m. to 5h. 52m. It may be well to remind our readers that there will be a total eclipse of the moon in the early morning of December 6, though the circumstances are unfavourable, as it begins about 4h. 32m., and the moon sets a little before 8h., just after the middle of the eclipse.

THE EARTH IN OPPOSITION.

It is a curious and a pleasant inquiry, what may be presumed to be the telescopic aspect of our globe from the planet Venus or Mercury; and though, of course, demonstrative certainty in the reply is not within our reach, we may be led to some interesting conclusions. We shall of course suppose the case of the nearest approach of either of those planets when they pass between ourselves and the sun. In such circumstances, as was explained in No. VIII. of the present work, an apparently retrograde motion will bring us up with a great broad disc into their midnight sky, and all our features will lie open before the distant observer's gaze. There can be little question that the distinction of our continents and oceans would be very perceptible, from the superior reflective power of the former as contrasted with the absorbent property of the latter, which, as is shown by experiments with the diving bell, soon extinguishes the solar rays. The general aspect of the land would no doubt be various from the effect of local colour where sufficiently extensive, and the vegetation of the prairies and pampas would be readily distinguishable from the sands of the Sahara; but diversities on a smaller scale would be merged by distance in a compound gray of the third order of colour: the appearance of the water would also be greatly contrasted in different parts, from its varying degrees of depth and consequent translucency. Islands would, of course, be in general perceptible in proportion to their size as brighter specks; but it may admit of a question whether an island, or, indeed, a line of coast, would be in all cases easily distinguished from an adjacent shallow sea.* The polar regions of ice and snow would of course be strongly marked, with their extension or contraction according to the time of year; but in consequence of the inclination of the earth's axis, their presentation would differ greatly at different seasons: if the supposed opposition of the earth should coincide with our European summer, the N. snows would alone be conspicuous, entering far into the visible hemisphere, but diminishing gradually with the continued action of the sun; if during our winter, the reverse would occur; in spring or autumn each pole would show its white segment at the edge of the disc; but in every case, as our poles of temperature are not coincident with our poles of rotation, and our continental are very different

* "At the eastern extremity of the island, where the rocks break off steeply some hundreds of feet, we saw every object of the port nearly beneath, and apparently within stone's throw. A novel sight to us was the bottom of the harbour, seen through the clear greenish water with considerable distinctness almost from end to end. Patches of sea-weed, dark rocks, and white gravel, seemed to be lying in the bottom of a shallow mirror, across which small fishes, large ones in reality, were wandering at their leisure. This was a picturesque revelation. Upon the surface of the harbour the depth of water very nearly shuts out all view of the bottom. I am beginning to think, that a few thousand feet above the ocean, in a bright day, would enable the eye to pierce it to an extraordinary depth."—Noble's *After Icebergs with a Painter*, pp. 182, 183.

from our insular climates,* the brightness of our arctic and antarctic regions would be unsymmetrical in extent, and their aspect would differ materially as different sides of our globe were brought round by our diurnal rotation. The frozen summits of such extensive ranges as the Himalaya or Andes would no doubt be perceptible with sufficient optical power; but the shadows of our mountains would of course be equally invisible with those in the full moon, and from the same cause; and it does not seem likely that even our largest river courses would have sufficient magnitude to be seen. As the rotation of our globe, combined with the inclination of its axis, would, in successive oppositions, bring the whole of the surface before the eye, it might at first be thought an easy task to map all its outlines with precision; but the atmosphere would in all likelihood interpose most serious difficulties. From its property of transmitting red light, as shown in our sunrise and sunset, and in the face of the totally eclipsed moon, it will probably communicate a slight ruddy tinge to our disc, like a faint wash of red passed over a drawing; but this hue would be very feeble, if at all apparent, in the centre, coming out chiefly from the oblique transit of the ray through the atmosphere towards the edges of the globe; and it would be immaterial compared with the confusion arising from the local condensation of its watery particles. There can be no doubt that Schröter was mistaken in thinking that accumulations of vapour would appear as dark spots upon a planetary disc; the worthy old Hanoverian (and a very worthy fellow he seems to have been) confounded the *interior* effect, or that produced upon an eye beneath them, which, of course, would be one of gloom from intercepted light, with the *exterior* aspect to a distant observer, which would be eminently luminous, few bodies reflecting a more intense white light than the upper surface of a densely compacted cloud: and hence those regions of the earth which are sometimes for months together overshadowed by a cloudy pall, must, to an external eye, present a peculiarly white and luminous appearance; while, for a like reason, the edges of the disc, where oblique vision would render vapour more perceptible, would possess not only the ruddier, as before suggested, but the more vivid light. And thus it is easy to see how baffling an impediment our atmospheric variations must interpose in the way of any accurate comprehension and delineation of the features of our globe, and how the configurations which a distant observer would at one time congratulate himself upon having satisfactorily traced, might, after a short interval, be wholly defaced and obliterated, or so intermingled with the

* See this fact admirably illustrated by Professor C. Piozzi Smyth, in his most interesting and pleasant book, *Three Cities in Russia.*

outlines of superjacent vaporous masses, as to produce a degree of entanglement requiring a long period for the extrication of anything like a reliable result.

Our readers will have easily perceived the bearing of these remarks upon the recent position and aspect of the planet Mars. How far a correspondence between the two globes may be made out, and where the analogy seems to escape us, is an interesting subject of inquiry, as to which, it may be hoped that some of them may have been providing themselves with materials for comparison and reflection.

THE HABITS OF THE AYE-AYE.

BY W. B. TEGETMEIER.

The opportune arrival of a living mature female Aye-aye at the Zoological Gardens, Regent's Park, has enabled observations to be made regarding its habits and food which tend to modify very considerably the suggestions which were thrown out by Dr. Sandwith and Professor Owen, and which were embodied in a paper published in the first volume of the Intellectual Observer.

For the greater number of the facts contained in the following short account of the habits of the animal as exhibited in confinement, I must express my obligations to Mr. Bartlett, the superintendent of the gardens, who is ever ready to impart information, and to afford every facility for the furtherance of zoological research.

For an account of the structure of this singular and anomalous animal, I must refer to the paper previously published, Vol. I. p. 130, where its singular combination of the squirrel-like gnawing teeth of a rodent with the grinders and extremities of a quadrumanous animal, are illustrated and described in detail.

In confinement the Aye-aye proves to be a nocturnal animal; during the day it sleeps curled up and covered by its bushy tail. In the night, however dark, Mr. Bartlett states that it moves about in its cage, and gnaws holes in the timber with its powerful rodent incisors. When undisturbed it not unfrequently hangs suspended by the hind claws, and uses the elongated probe-like finger of the hand for the purpose of cleaning and combing the tail, it being passed through the long hairs of that organ with great rapidity; this attenuated finger is also used for the purpose of picking the ears, eyes, and nose, the other fingers being partially closed. The supposed adaptation of this animal's peculiar organization to insectivorous habits, receives no confirmation from its proceedings as exhibited in confinement, where it has refused every variety of insect food, such as mealworms, grasshoppers, the larvæ of wasps, etc., etc., feeding solely upon thick sweet glutinous fluids, such as honey, or a mixture of milk and eggs; this food is taken by a very rapid movement of the hand, the left only being employed; during the process the fourth finger is thrust into the food, and passed rapidly backwards and forwards between the lips, depositing food at each movement, the tongue and lips being in full motion during the whole time of feeding. Sometimes, though rarely, the animal will lap the food in the manner of a cat.

The conclusion to which Mr. Bartlett inclines is, that the animal is not naturally insectivorous, but that with its large and powerful incisor teeth it excavates cavities in the trunks of such trees as possess a saccharine sap, and feeds upon the fluid that collects in these cavities; this appears the more probable as the Aye-aye is noticed to return repeatedly to the same cavity. It is obvious that we have still much to learn respecting the habits of this singular creature, and its possession must be regarded as a fortunate acquisition to our valuable and unrivalled collection of living animals.

It may be stated as a singular fact worthy of record, that the Aye-aye has not been heard to utter any vocal sound either during the day nor at night, when she seems to exhibit the greatest amount of activity and energy.

COMETS.

AN ACCOUNT OF ALL THE COMETS WHOSE ORBITS HAVE NOT BEEN CALCULATED.

BY G. CHAMBERS.

In the present day it rarely happens that a comet becomes visible without its being observed at any rate sufficiently long for some approximation to the elements of its orbit to be deduced. Such, however, was not the case in days gone by. Observers were few, and of observatories and instruments there were none; and so we are dependent for the information we possess on the writings of the historians and chroniclers, which seldom contain more than bare statements, with few or no details. Instruments and calculations did not come into general use till within the last two hundred years, before which period all accounts are more or less vague and uncertain.

The first who made any systematic attempt to put together the various allusions to comets in the old writers was the French astronomer Pingré, who, in 1783, published his celebrated

Cométographie ; ou Traité Historique et Théoretique des Comètes. This work, which for the industry and labour bestowed upon it, has few equals, has been the astronomer's text-book on the subject of cometary history from the period of its publication down to the present day. No attempt has ever been made to supersede it, the utmost that has been done having been to supplement it by the reproduction in Europe of certain Chinese accounts not accessible in the time of Pingré.

Our present catalogue is of course based upon Pingré's, but in the preparation of it much material assistance has been derived from Mr. Hind's scholarly catalogue, commenced in the *Companion to the Almanac* for 1859, but, unfortunately, since interrupted. Brevity being an essential pre-requisite, we have been obliged to omit much that was interesting, and to confine our attention to necessary facts and figures, only giving a limited number of references.

It may be convenient to make a few remarks on the Chinese observations to which such constant reference is made. They were originally Europeanized by MM. Couplet, Gaubil, and De Mailla, Jesuit priests at Pekin, who made very good use of their opportunities of benefiting science. De Mailla's MSS. were published at Paris in the last century, but the MSS. of Couplet and Gaubil are still unpublished. Within the last twenty years M. E. Biot has done some service by the translation of sundry Chinese catalogues of comets and meteors, and it is not impossible that, as our intercourse with that remarkable people becomes greater, further sources of information may be opened to us.

1770±. St. Augustine has preserved the following extract from Varro :—"There was seen a wonderful prodigy in the heavens, worthy to be compared with the brilliant star Venus, which Plautus and Homer, each in his own language, call the 'Evening Star.' Castor avers that this fine star changed colour, size, figure, and path; that it was never seen before, and has never been seen since. Adrastus of Cyzicus, and Dion the Neapolitan, refer the appearance of this prodigy to the reign of Ogyges."—(*De Civit.* xxi. 8.) This description, such as it is, may be presumed to be that of a comet, but no further particulars have been preserved.

1194±. On the fall of Troy, we are told by Hyginus, a contemporary of Ovid, that Electra, one of the Pleiads, quitted the company of her six sisters, and passed along the heavens towards the Arctic Pole, where she remained visible for a long time in tears and with dishevelled hair, to which the name of "comet" is applied.—(Fréret, *Acad. des Inscript.* x. 357.) What we are to understand by this is doubtful, but it may relate to a comet.

975±. "The Egyptians and the Æthiopians felt the dire effects of this comet, to which Typhon, who reigned then, gave his name. It appeared all on fire, and was twisted in the form of a spiral, and had a hideous aspect; it was not so much a star as a knot of fire."—(Plin. *Hist. Nat.* ii. 23.) *Date* very uncertain.

619 or 618. "We shall see in the west a star, such as is called a comet; it will announce to men war, famine, and the death of several distinguished leaders."—(*Sybill. Orac.* iii.) Though given as a prophecy, Pingré feels justified in citing this passage as a historical record.

612. In August a comet appeared amongst the seven stars of Ursa Major.—(Confucius, *Tchun-tsieou,* quoted by Ma-tuoan-lin.)

533. At the winter solstice, a comet appeared in Aquarius, and the tail of Capricornus.—(Gaubil; Ma-tuoan-lin gives, from Confucius, 531 as the date.)

524. In the winter a comet passed from Scorpio to the Milky Way.—(Gaubil; De Mailla, *Hist. Gén.* ii. 193.)

481. A comet appeared at the end of the year in the eastern part of the heavens. Its length was 2°, and it reached from the star *Yng* (?) to *α* Scorpii.—(Gaubil; Ma-tuoan-lin; De Mailla, ii. 222.)

479. At the time of the battle of Salamis, a comet in the shape of a horn was visible.—(Plin. ii. 23.)

465. + During a period of sixty-five days, an extraordinary object appeared in the sky, according to the testimony of several writers. It may have been a comet, but an Aurora Borealis would seem best to reconcile the various European statements. —(Damachus; Plin. ii. 59.) Ma-tuoan-lin speaks of a comet in 466, which Pingré considers identical with the "extraordinary object" of the European writers.

432. It is certain that a comet appeared in this year.—(Couplet; De Mailla, ii. 244; Ma-tuoan-lin.)

426 or 402. At the time of the winter solstice, during the archonship of Euclides, at Athens, a comet appeared near the North Pole.—(Aristot. *Meteor.* i. 6.) There were two archons of this name, so it is impossible to fix the year of this comet's apparition.

360. A comet was seen in China and Japan in the west.—(Couplet; De Mailla, ii. 267; Kaempfer. *Hist. Japon,* ii.)

345 (?) A comet in the form of a mane, which was afterwards changed into that of a spear.—(Plin. ii. 22.) Date very uncertain. Pliny gives the double date of the Olympiad, and A. U. C., which do not correspond, so one or other must be wrong. Our '345' is from Pingré.

344. "On the departure of the expedition of Timoleon from

Corinth for Sicily, the gods announced his success and future greatness by an extraordinary prodigy. A burning torch appeared in the heavens for an entire night, and went before the fleet to Sicily."—(Diod. Sic. *Hist.* xvi. 11; Plut. *Vit. Timol.*) Pingrê remarks—It is easy to see that the comet appeared in the West, and had a considerable north declination.

304. A comet was seen in China.—(Ma-tuoan-lin; De Mailla, ii. 306.)

302. A comet was seen in China.—(Ma-tuoan-lin; De Mailla, ii. 306.) The Chinese annalist expressly says there were two comets in two years.

295. A comet was seen in China.—(Ma-tuoan-lin.)

239. A comet was seen in China. It came from the East, and passed by the North and in the 5th Moon (June or July), it was seen during sixteen days in the West.—(Ma-tuoan-lin.)

237. In the 9th year of Chi-hoang-ti, a star appeared in the horizon. In May it was seen in the West; it appeared then in the North, and took eighty days to go from Sagittarius to the South.—(Ma-tuoan-lin.)

233. A comet was seen in China in February or March, in the East.—(Ma-tuoan-lin.)

213. A brilliant star was seen in China to come from the West.—(Ma-tuoan-lin; De Mailla, ii. 399.) Probably a comet.

203. A torch extended from East to West for ten days during the latter half of August, or the first half of September. It appeared near Arcturus (α Boötis).—(Jul. Obseq. *Prodig. Suppl.;* Ma-tuoan-lin.)

202. A burning torch was seen in the heavens.—(Jul. Obseq.)

171. A large comet with a tail was seen in China at the end of summer.—(Couplet; De Mailla, ii. 554.)

168. A torch was seen in the heavens.—(Jul. Obseq.)

166. A burning torch was seen in the heavens.—(Jul. Obseq.)

165. A torch was seen in the heavens.—(Jul. Obseq.) We are also told that at one place the sun was seen for several hours in the night, so that if this object was a comet it must have been an extremely brilliant one.

156. In October a comet 10° long appeared in the West. It was visible for twenty-one days, and traversed Aquarius, Equuleus, and Pegasus.—(Ma-tuoan-lin; De Mailla ii. 568.)

154 [i.] A comet came from the South-west in January.—(Ma-tuoan-lin; De Mailla ii. 569.)

154 [ii.] In September a comet appeared in the N.E.—(De Mailla ii. 569.)

(*To be continued.*)

PROCEEDINGS OF LEARNED SOCIETIES.

BY W. B. TEGETMEIER.

BRITISH ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.

Dr. Moffat read a very interesting paper "On the Luminosity of Phosphorus." If a piece of phosphorus be put under a bell-glass it will be found at times luminous, and at others non-luminous. When it is luminous, a stream of vapour rises from it, which sometimes terminates in an inverted cone of rings similar to those given off during the spontaneous combustion of phosphoretted hydrogen; and at others it forms a beautiful curve, with a descending limb equal in length to the ascending one. The vapour is attracted by a magnet and by heat, but it is repelled by cold. It renders steel needles magnetic, and it is perceived only when the phosphorus is luminous. Daily observations of the phosphorus for a period of eighteen months, show that the periods of luminosity or non-luminosity occur under opposite conditions of the atmosphere; the former being peculiar to the equatorial, while the latter to the polar current. By the catalytic action of phosphorus on atmospheric air, a gaseous body (superoxide of hydrogen) is formed, which is analogous to, or identical with, atmospheric ozone. The author has found that *phosphoric* ozone is developed only when the phosphorus is luminous, and that atmospheric ozone is produced only under these atmospheric conditions in which phosphorus is luminous. From observations extending over several years, it appears that 99 per cent. of luminous periods and 91 per cent. of ozone periods, commence with decreasing readings of the barometer and other conditions of the equatorial current; and that 94 per cent. and 66 per cent. terminate with increasing readings and the conditions of the polar current. Luminous periods commence and luminosity increases in brilliancy on the approach of storms and gales, and ozone periods commence and increase in quantity under similar conditions. There is, it would appear also from these observations, an intimate connection between the approach of storms, the commencement of luminous and ozone periods, and disorders of the nervous, muscular, and vascular systems. The author gave the dates of many storms and gales, and the occurrence of diseases of the above class, showing their coincidence; and in corroboration of what he had stated, he mentioned the fact that there was a concurrence in the issuing of Admiral FitzRoy's cautionary telegrams and these diseases. He also stated that he views the part performed by ozone in the atmosphere as being similar to that performed by protein in the blood; the latter giving oxygen for the disorganization of worn-out tissues in the animal economy—the former giving oxygen to the products of decomposition and putrefaction, and rendering them innocuous or salutary compounds. With these views the author had used ozone, artificially produced by the action of phosphorus, as a disinfectant in localities tainted with the products of putrefaction.

Dr. Daubeny read a paper "On the last Eruption of Vesuvius:" Vesuvius appears during the last few years to have entered upon a new phase of action. Its eruptions are more frequent but less violent than they were formerly; they proceed from a lower level than they did at an earlier period, and they give gaseous principles, such as the vapour of naphtha and light carburetted hydrogen, never before detected. The last eruption caused an elevation of the coast to the height of three feet seven inches above the level of the sea, which has not been observed on any preceding occasion. Dr. Daubeny suggested that Vesuvius was passing into the condition of a mud volcano, the products issuing from it being simply owing to the action of volcanic heat on the contiguous beds of Apennine limestone containing bituminous matters; hence the carbonic acid and carburetted hydrogen and naphtha vapour emitted, which were to be regarded as mere secondary products, to be distinguished from the muriatic and sulphurous vapours indicating primary volcanic action.

An interesting discussion took place "On Colour as a Test of the Races of Man," by Dr. Crawfurd. The author stated that he considered colour in different races to be a character imprinted upon them from the beginning, because, as far as our experience goes, neither time, climate, nor locality has produced any change. He contended that climate had no influence in determining colour in different races. Finns and Laps, though further north, are darker than the Swedes; and within the Arctic circle we find Esquimaux of the same colour and complexion as the Malays under the Equator. Yellow Hottentots and Bushmen live in the immediate neighbourhood of Black Caffres and negroes. Sir C. Nicholson opposed Mr. Crawfurd's conclusions. The variety of the human races, as they now are, had, doubtless, existed for a long time. Tombs of very great antiquity showed this. But there is now in India a race of Jews perfectly black;* and in China the Jews had long become the same in physiognomy as the Chinese, and the Jews never intermarry. Among the natives of America there was an evident approximation to the Red Indian in physiognomy; they were assuming the hatchet face and losing the beard. The same effect could be discerned among the European population of Australia.

Dr. Gray read a paper on the "Remarkable change of form of the Head which occurs during the growth of certain species of Crocodiles." It is found that when first hatched all the crocodiles have the front of the face shortened and rounded; even those in the adult state have an elongated beak. During growth the nose gradually lengthens and assumes the form characteristic of the particular species; and when the animal attains its adult size, the bones of the head dilate so as to be competent to the support of the large teeth the animal requires in its adult stage. This change of

* The black Jews of India are proselytes, not even claiming to be regarded of Hebrew origin.—Ed. I. O.

form is so considerable that naturalists have regarded the animals when in different stages as distinct species.

ENTOMOLOGICAL SOCIETY.—*Nov.* 3.

Destruction of Injurious Insects by Hard-billed Birds.—In the course of a debate on the destruction of insects injurious to cultivated vegetables, Mr. Mitford stated that, from repeated and careful observation, he had assured himself that the gooseberry and currant caterpillar, the larva of the *Nematus ventricosus*, so well known for its devastating action on the leaves, and consequently on the fruit of the gooseberry, etc., is devoured in great number by sparrows and chaffinches, especially during the period of their feeding their young, and also that this particular caterpillar does not appear to be preyed upon by the soft-billed birds, such as the warblers, etc.

GEOLOGICAL SOCIETY OF LONDON.—*Nov.* 5.

On a Deposit containing Diatomaceæ, Leaves, etc., in the Iron-ore Mines near Ulverston. By Miss E. Hodgson.—The object of this paper was to show that this deposit was deposited in a large cavern or chain of caverns by a subterranean stream, originating probably in a brook called the "Poaka Beck." The authoress first described in detail some of the various caverns and swallow-holes which abound in the limestone of the district, and then alluded to the current belief of their communication with each other, and with springs. Miss Hodgson also remarked that, prior to the year 1842, the Poaka Beck, after having become partially engulphed at Inman Gill, is said to have taken a subterranean course; since the above-named date, its course has been diverted. The paper concluded with a list of the *Diatomaceæ* found in the deposit, with notes on the places where they occur in the streams of the district, and with some remarks on the vegetable remains.

On the Association of Granite with the Tertiary Strata near Kingston. By J. G. Sawkins, Esq., F.G.S.—The occasion of this letter was the discovery by the author of a granitic formation traversing Jamaica in a direction from S.E. to N.W., being the same as that of the earthquake shocks. It pierces the carbonaceous series, and also the Tertiary strata, whence the author concludes that it is of Tertiary age. It usually contains copper-ores, and is often more or less decomposed.

ROYAL GEOGRAPHICAL SOCIETY.—*Nov.* 10.

Explorations in Australia.—Mr. Landsborough's and Captain Norman's expeditions from Moreton Bay to the Gulf of Carpentaria, and thence southwards across the continent to the River Darling, had resulted in the discovery of large tracts of country available for pastoral purposes. The climate was described as generally healthy; and the valleys of the Baren River and other districts were shown to possess all the elements for the support of a vast population. Sir Richard MacDonnell observed that the theories of vast deserts and inland seas of Australia were gradually disappearing; and he could testify, from personal experience, that although it was neither a rich nor a barren country, yet it possessed excellent materials for the development of pastoral wealth. He also said, that if cotton were to be grown in Australia, he believed the fittest spot for its cultivation would be found near the Victoria River. Sir Charles Nicholson, of New South Wales, agreed as to the adaptability of the soil and climate for the growth of cotton, and stated that 200 bales of cotton shipped at Moreton Bay were daily expected in England. Governor Kennedy, of Western Australia, exhibited two huge oyster-shells, which he was told were worth £140 per ton when imported into this country, a fact rendering that portion of Australia as valuable as the gold-producing ones.

ZOOLOGICAL SOCIETY.—*Nov.* 11.

Discovery of a New British Snake.—Mr. Frank Buckland described the capture, and exhibited living specimens of the *Coronella lævis*, a common European snake, but not hitherto ascertained to be a British species. Several specimens have been captured in Hampshire, etc. This snake is distinguished from the ordinary species, *Coluber natrix*, by the scales not having a raised keel or central elevated line; it is also viviparous, as has been demonstrated by one captured specimen that produced several living young.

CHEMICAL SOCIETY.—*Nov.* 20.

Spontaneously Inflammable Gaseous Compound of Silicon and Hydrogen.—Dr. Hoffmann made a communication to the members on the preparation of this highly-interesting compound, illustrating his remarks by a new and striking experiment. It is believed that silicon belongs to the same group of elements as carbon, but though the normal carburetted hydrogen, $C_2\ H_4$, has been long known, indications only of the existence of the corresponding silicon compound have been obtained, and these quite recently. Berzelius pointed out long ago the existence of a body which he believed to contain hydride of silicon—it was a solid, however, not a gas—and will probably turn out to be the hydrated oxide of silicon, since obtained by Wöhler. It is to the latter chemist that we owe the recognition of silicuretted hydrogen. In an experiment where water was being decomposed by a galvanic current, bubbles of a spontaneously inflammable gas were observed to rise from the aluminium electro-negative pole employed. Analysis proved the aluminium to contain a considerable quantity of silicon as an impurity. The conditions under which the new gas was formed still remained obscure, although Wöhler had done much to clear them up: quite lately, however, Dr. Martius had discovered a way of making silicuretted hydrogen in abundance. A mixture is made of

80 parts of chloride of magnesium.

20 parts of chlorides of potassium and sodium mixed in equivalents.

40 parts of sodium.

70 parts of silicofluoride of potassium.

The various salts, perfectly dry, are first intimately mixed together and then introduced into a wide-mouthed bottle; the sodium, cut into pieces the size of a small pea, is then added, and the whole contents of the bottle well agitated. A tall Hessian crucible having been heated to bright redness, the mixture is suddenly projected into it, and the cover placed upon the crucible. When the mass is fused the crucible is withdrawn from the furnace, broken, and the slag removed. This slag serves, by reason of the silicide of magnesium which it contains, for the preparation of the desired gas. It is necessary to break up the slag into fragments, and act upon them under water with strong hydrochloric acid. The gas, the composition of which seems to be Si_2, H_4, is at once liberated, and may be collected over water or mercury. If a bubble of the gas be allowed to escape into the air, it bursts into flame with explosive violence, a white, hollow, cylindrical ring of smoke ascends, rotating, undulating, and widening as it goes up, and distributing, when it breaks, a multitude of fine flakes of dry silica. All the appearances noticed remind the spectator forcibly of the phosphuretted hydrogen, but there is no offensive smell produced. When the gas is left long in contact with water, the curious hydrated oxide is formed, to which we have already alluded. This substance is white, and when dried and heated in a tube, scintillates just like the analogous substance obtained by the oxidation of graphite. This oxide of silicon has the formula $Si_2 H_2 O_5$.

ROYAL SOCIETY, *November* 20.

On the Fossil Bird from Solenhofen.—Professor Owen read an elaborate paper descriptive of the remarkable fossil bird, from the lithographic stone of Solenhofen, which is described in the article by Mr. Woodward. In the discussion that ensued, the Duke of Argyle and Mr. Gould expressed their belief, founded on the small size and peculiar character of the quill feathers of the wings, that the bird could not have possessed the power of flight. Professor Owen thought that the size of the furcula, or merry-thought, and the development of the ridges on the humerus, which served for the attachment of the pectoral muscles, proved the bird to have been capable of flight.

NOTES AND MEMORANDA.

Removing the Husk from Grain.—M. Lemoine adopts a chemical method for this purpose. For example, he places 100 kilogrammes of corn in a tub, and pours over it 15 kilogrammes of sulphuric acid at 66°, and stirs the mixture for fifteen or twenty minutes, then he adds 50 kilogrammes of water, which he decants after a few moments' contact and agitation. The fluid thus removed is reserved for a use he promises to explain. The acid is then neutralized by subcarbonate of soda or potash, and the grain thrown on a cloth with large meshes, and allowed to dry for an hour, after which its dessication is effected on fresh cloths, placed in an airy situation for several days.

Copper Paint.—The Abbé Moigno describes in *Cosmos* a new pigment used in the workshops of Mr. Oudry, of Auteuil. Its foundation depends upon the possibility of reducing electrolytic copper to an impalpable powder, which being combined with benzine, can be employed upon any surface as a paint. It possesses an agreeable lustre, and will take bronze tints by the usual chemical means. By reducing the quantity of copper, and adding bases of lead, zinc, or other metals, M. Oudry obtains a series of paints said to possess great advantages over those prepared with turpentine and ordinary oils.

Webster's Oxygen Process.—Mr. Pepper describes the new and cheap process for making oxygen in the *Chemical News*. Mr. Webster employs a furnace, containing a strong cast-iron vessel ten inches in diameter, and in this a smaller vessel seven inches in diameter is placed, open at the top, and provided with an orifice at its base, temporarily stopped with a piece of sheet-iron, so that when its contents are exhausted, this pot may be removed, and its contents knocked out with an iron bar. The outer vessel is connected by a pipe with a 30-gallon stone-ware vessel, containing half-a-gallon of water, and eight stone-ware colanders, on which 48 lbs. of the residue of a former experiment are placed, and which acts as a purifier. The inner pot is charged with 10 lbs. warm dry nitrate of soda, and 20 lbs. warm dry crude oxide of zinc, obtained from the so-called "galvanizing baths." A cover is then luted on, and the heat employed only sufficient to give a pasty character to the mass. Oxygen is speedily given off, accompanied by nitrous fumes, which the purifier absorbs. The end of the process is to obtain a large quantity of oxygen at a small cost; but it is mixed with nitrogen to the average extent of 41 per cent. It is expected that this mixture will prove useful to augment the illuminating power of coal-gas, and in various metallurgical processes.

Platino-cyanide of Magnesium.—This beautiful salt exhibits the phenomenon of dichroism. In one view it is ruby red, and in another emerald green; crystallized on a slide, it is a magnificent object when viewed with the Lieberkuhn, and dark well, or side silver reflector. With a little pains great variety of effect can be obtained. The crystals that form at the edges of a drop of its solution often make fan-shaped groups of prismatic needles, while the centre is occupied with smaller groups arranged in star patterns, or other ornamental shapes. The angle of the illumination should be changed while the object is under view.

Tooth of Orycteropus Capensis.—Mr. Baker, of Holborn, has furnished us with a little-known microscopic object of great beauty and interest, in the shape of a section of a tooth, which appears to belong to an animal often erroneously confounded with the ant-eaters, from which it differs by being furnished with grinders and flat nails that are strong and curved. It burrows with great facility, and feeds upon ants, which it catches with a long, strap-shaped, protrusile tongue, covered with a viscous fluid. The popular name of this creature is "ground pig;" the scientific appellation we have given above. It is three or four feet long from the snout to the tail, and stands low. Physiologically the teeth are beautiful examples of compound structure, resembling that of the Eagle Ray, figured in Dr. Carpenter's book, *The Microscope*, 3rd edit., p. 704. In man, and usually in the higher vertebrates, the centre of the tooth is excavated into a single cavity containing the pulp, but in the class of teeth to which that of the Orycteropus belongs, the cavities are many, and, as Dr. Carpenter observes, in his *Manual of Physiology*, "we may regard a tooth of this kind as repeating in each of the parts surrounding one of these canals the structure of the human tooth." Viewed as an opaque object, or when illuminated by the parabolic reflector, the horizontal section of the Orycteropus tooth presents a very elegant appearance, which we recommend to the attention of those engaged in ornamental design. Both in form and colour it suggests patterns for a tesselated pavement, or for fabrics of a fictile or textile kind.

The Acari of Solutions.—From a paper read by Mr. Shadbolt, and from observations made thereupon at a recent meeting of the Microscopical Society of London, it appears that the Acari which occurred in the electrical experiments of Mr. Cross and Mr. Weekes, and which have since been found in nitrate of silver baths, belong to a species widely diffused. Numbers have been discovered adhering to the walls of a room, and they make their way into any fluids that may be accessible. Thus the mystery of their origin is cleared up, as it might have been long ago, if philosophers had not fancied that their orthodoxy would be compromised by investigating any fact, that for the moment appeared to support the theory of spontaneous generation. It is still puzzling to know how they manage to exist in solutions of a caustic or poisonous kind, which, to all appearance, can contain nothing for them to eat. Mr. Richard Beck exhibited a fine specimen under a binocular microscope, and it closely resembled the *Acarus Crossii* figured in "Noad's Electricity."

Asbestos Paper.—*Cosmos* states that a considerable quantity of paper is made in the Northern States of America, containing one-third of amianthus, or fibrous asbestos, which is obtained at a very low price. This paper burns with flame, but leaves a white residue of the original shape, on which characters that were written with common ink can be read.

Imitation of the Human Voice.—"On the Boulevard de Magenta, Paris, a remarkable exhibition has been opened. It consists of an instrument which, especially in its upper notes, imitates the human voice so that it might be mistaken for it. This instrument, invented by M. Faber, formerly a Professor of Mathematics in Germany, represents a woman seated, having a larynx constructed of caoutchouc upon physiological principles. It has a range of two octaves, and sings any airs with the tone, pitch, and force of a woman's voice."—*Cosmos.*

75th Asteroid.—This body was discovered in September by Dr. Peters, of Hamilton College, New York. It looks like an 11 magnitude star.

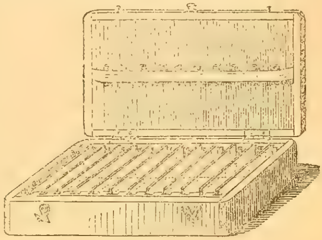
Circumpolar Planets.—M. Radau observes in *Cosmos* that, like Danae, the planet Niobe can become circumpolar in our latitudes, and that it was so, even for Rome, on the 27th October.

The Meteoric Stone of Chassigny.—M. Damour has analyzed the meteoric stone that fell at Chassigny on 3rd October, 1815, and finds it to be essentially composed of silica, magnesia, and protoxide of iron, thus bearing a strong resemblance to the precious stone called *peridot*, and especially to *hyalosiderite*, "which only differs from olivine in a somewhat smaller proportion of protoxide of iron, isomorphous with magnesia." In physical aspect the Chassigny stone is distinguished from other meteorites by its pale yellow tint; it appears composed of roundish grains, with a vitreous lustre, among which are others of a black tint. It scratches glass with difficulty, has a specific gravity of 3·57, contains no nickel nor iron in the metallic state, and it is not magnetic, except in the thin black crust that covers it. This latter circumstance M. Damour attributes to the fusion of the superficial layer having changed the protoxide of iron into $Fe\ O\ Fe_2\ O_3$. He remarks that peridot olivine is found in the meteoric iron brought from Siberia by Pallas, and in that from the desert of Atacama, in the form of vitreous grains. Further details will be found in *Comptes Rendus*, 13th October, 1862.

A Blue Bolide.—M. Eudes-Deslongchamps and his son were in their garden at Caen on the 19th September, when the darkness was suddenly lit up by an intensely blue bolide, the train of which was white. M. D. states that the blue colour was like that produced in fireworks by chloride of copper, and he asks in the paper, read before the French Academy, whether the bolide may not have contained that metal.

Zodiacal Light.—The French expedition to Mexico will devote attention to this curious appearance, and we notice amongst the papers upon it recently read before the French Academy, one from M. Heiss, of Munster, who says that his sight enables him to see it nearly all the year, and not only in mornings of March and evenings of September. He reminds M. Faye, to whom his communication is addressed, that he has observed with the naked eye 2000 more stars than Argelander includes in his *Uranometria Nova.*

ARRANGEMENT FOR CARRYING MICROSCOPIC OBJECTS.—The injury sustained by mounted microscopic objects in being conveyed from place to place, is familiar to all microscopists. The source of this injury arises chiefly from the loose manner in which the glass slides fit into the containing box, and the consequent shaking they receive in their transit from one place to another. To remedy this evil a very successful plan has been devised by Mr. A. H. Church; it is represented in the annexed engraving. Attached to the interior of the lid of the box, in which the slides are to be kept, are a number of small pieces of wood about half an inch long and one-eighth of an inch thick, fixed at regular intervals, corresponding to the spaces between the grooves in which the glasses rest. Inside the lid, and resting on the rounded tops of these little pieces of wood, a piece of silk-covered "elastic" is fastened, from end to end, without stretching. If the parts be properly adjusted, the slides will not shake when the lid is closed, as each slide presses the India-rubber elastic between two of the small studs on the lid, and in this manner is held steadily. The great recommendation of the contrivance is the fact that a single slide is as securely held as when the box is filled. Microscopists will readily appreciate the advantage of an arrangement which enables them to carry any number of objects without producing a continual rattling, and which precludes any liability to displacement or injury from concussion..



POTASH FROM THE ANIMAL KINGDOM.—The supply of potash has hitherto been solely derived from the vegetable kingdom. Recently, however, M. Maumené, a French chemist, has obtained it in considerable amount from animals. When sheep's wool is submitted to the action of cold soft water, a kind of greasy soap dissolves; this is a combination of certain fatty and oily acids with the alkali potash. It is found that by heating this soap to redness, a very pure carbonate of potash is obtained; this process is so productive that it is worked as a commercial speculation at Rheims, and samples of the various potash salts were shown in the International Exhibition.

NEW APPLICATIONS OF ALUMINIUM AND ITS ALLOYS. — Messrs. Bell Brothers, of Newcastle, have recently produced a new modification which they term "whitened aluminium," in which the unpleasant zinc-like hue of the metal is obviated. They have also formed keys of aluminium, alloyed with two per cent. of nickel to increase its hardness. Aluminium bronze is now made of three qualities, the first containing ten, the second seven and a-half, and the third five per cent. of aluminium, the residue being copper. These varieties of the bronze are scarcely to be distinguished in appearance from gold; their specific gravity, however, being rather less than that of copper (8·95), differs remarkably from that of the precious metal, the specific gravity of which, when pure, is as high as 19·5. From aluminium wire and foil the lighter weights used for chemical purposes, may be advantageously made, since occupying something like seven times the space of those of platinum, they are more easily adjusted and handled, and less likely to be lost. The finest aluminium wire, from its insignificant weight, advantageously serves to suspend from the beam of the balance, objects the specific gravity of which is being ascertained. MM. Collet, of Paris, have constructed a chemical balance in which, not the beam only, but every part, down to the milled head by which the beam is released, is made of aluminium.

THE REACTION OF IODINE.—At the September meeting of the *Société Helvetiques des Sciences Naturelles*, M. Schönbein pointed out that the proto-chloride of mercury, and other salts of that metal, had the property of preventing the coloration of starch by iodine, which, however, appeared on addition of chloride of sodium, sulphate of potash, hydrochloric, hydrobromic, or hydriodic acids.

The Foraminifera of the Alps.—At the same meeting, Professor Kauffmann stated that the foraminifera which were so abundant in the cretaceous rocks of the Alps, resembled those of the same formation in other countries. In order to see them well, it was necessary to polish the stone, heat it to a dark red with a blow-pipe, gently rub the surface with oil, and view with strong magnification. The effect of heating was to bring out the lines of the shells in contrast with the stone. When the shells were separated from the chalk, he mounted them in Balsam of Tolu, which does not harden, in preference to Canada Balsam.

Development of Tubularia.—At the same gathering, Professor Claparède gave a sketch of the development of hydroida belonging to the genus tubularia. On emerging from the egg the embryos resembled the simplest of the naked-eyed medusæ, although their digestive cavity was a simple sac, which did not give rise to gastric canals. They floated passively on the surface of the water, without the movements of contraction and expansion that characterized true medusæ. From the midst of a crown of tentacles sprung a *manubrium* (literally *handle*), as in the medusæ. This organ exhibited at its extremity a small opening which, by analogy, must be considered as a mouth. After the lapse of some days, the top of the umbrella elongated, and from its surface arose five little eminences surrounding a depression which grew deeper and deeper, and at last constituted a true opening, communicating between the digestive cavity and the external world. This was the true mouth, and the little eminences were the tentacles in an incipient state. At this time the little embryo fixed itself to some body by its manubrium, and gave up its wandering life. The manubrium elongated and constituted, the peduncle of the young tubularia. The primitive tentacles, which at first were directed downwards, as with the medusæ, reversed their position, pointed upwards, and formed the crown of the tubularia.

Formation of Raphides.—Dr. Reinsch, of Bâsle, laid before the same body his observations on the well-known crystalline deposits or raphides in the tissues of vegetables, and especially on those of the root of the *Convallaria multiflora*. He found that when he dissolved, by means of a re-agent, the crystals contained in a cell, there remained a membrane of exactly the same form. This membrane is coloured an intense yellow by iodine, and appears to have the same constitution as the primordial vesicle.

Velocity of Nerve Force.—M. Hirsch exhibited to the same Society an apparatus for determining what astronomers call the *personal equation* of time, or the difference which observers make from personal causes in the estimation of minute periods. He said, "We have now introduced the electric method into astronomical observation, and as the observer has only to shut off the current as soon as he sees the bisection of a star, the problem of personal equation consists in determining the time which is necessary for the astronomer to see and execute the necessary movement of his finger. This time, which we call physiological time, consists of three elements: 1. The time occupied in transmitting the impression to the brain. 2. The time taken by the brain to transform the sensation into a volition, and 3, that consumed in transmitting this volition through the nerves, and in the execution of the muscular movement." To ascertain these minute periods, M. Hirsch employs the Chronoscope of M. Hipp. A ball is so arranged that its fall interrupts an electric current, and thus sets free the motion of certain hands. As soon as an observer perceives the fall of the ball, he remakes the contact, and arrests the hands, whose motion in the interval gives the physiological time. By the use of this instrument M. Hirsch has come to the conclusion that nerves transmit their impressions at the rate of thirty-four metres a second. Mr. Heimholz estimated their velocity at 190 feet per second, but his experiments were on the motor nerves of frogs, and those of M. Hirsch on the sensitive nerves of man. We have condensed the four preceding paragraphs and this, from the *Archives des Sciences*, and, with reference to the experiments of M. Hirsch, we should imagine the rate at which nervous impressions travel would probably vary in different individuals, and in the same individual at different times.

Feet of Insects.

THE INTELLECTUAL OBSERVER.

JANUARY, 1863.

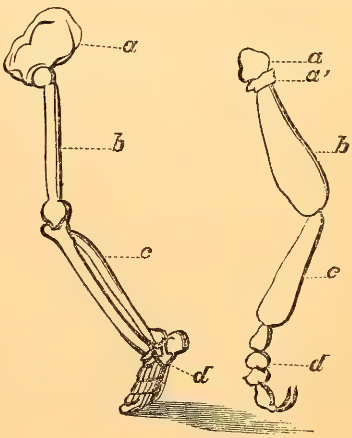
THE FEET OF INSECTS.

BY L. LANE CLARKE.

(*With a Tinted Plate.*)

It was suggested to me, some time ago, that a paper on the Feet of Insects might be acceptable to the readers of the Intellectual Observer; but, somewhat fearing that the subject was too well known, from the usual popular exhibitions of the foot of a fly or of a spider, I opened my collection of mounted insects, and began to look more carefully at their feet.

Small Coleoptera, Diptera, Hymenoptera, and Hemiptera were mounted whole, and parts of larger insects gave me several remarkable organs of motion. The feet, however, soon led the mind upward to the conclusion that, as the mechanism of the human hand or foot can only be understood by taking it in connection with the whole arm or leg, including the shoulder-blade and hip joint, so the feet of insects require an examination of the leg, and a knowledge of each joint, in order to appreciate the infinite variety, and perfect adaptation of every part to the wants and habits of these "living creatures."



I have said that the leg of an insect, and the vertebrate arm or leg have some resemblance in their composition; the leg is, perhaps, the best for comparison. They are both divided into four principal parts:—*a*, coxa, or hip; *b*, femur, or thigh; *c*, tibia, or shank; *d*, tarsus, or foot; *a** is an additional small joint,

* *Philos. Trans.* 1816, 325, t. xviii.

called a trochanter, which is so closely joined to the coxa as often to have no independent motion, and by some anatomists is considered merely as a part of that joint.

It is an interesting observation to make, that these joints have each been modified and varied, not only in the orders, but in the genera, and not in the genera only, but in the species, by shape and appendages that none but a careful naturalist can discover, but which, once observed, cannot fail to teach that pleasant lesson of the inexhaustible power, and infinite condescension of Him to whom indeed nothing is "little," no work too mean or lowly for a proper finish. In the larval, or imperfect state, insects have organs of locomotion, varied and curious enough to require a separate paper; the *apodous larvæ*, or those who walk without legs, have the most astonishing powers of progression, by muscular contraction and extension, by fleshy prominences, by anal hooks, or the use of mandibles, or by circles of spines round every segment of the body. The *pedate larvæ*, or those that move by means of legs, such as caterpillars and grubs of gnats, have spurious legs, tubercles armed with claws, retractile mamillæ; and the larvæ of water insects have organs appropriate to that element hereafter to be described.

Insects in their full development have six legs; the quasi-insects spiders, have eight; woodlice (*oniscidæ*) have fourteen; *Iulus maximus*, a great centipede has no less than 268; and it is a curious fact that a perfect centipede (*Iulus terrestris*) increases the number of its legs at every moult for two years: from twenty-six pairs, moulting, and obtaining thirty-six; moulting again, and possessing forty-three; until it prances along with 124 short but perfect legs, each terminating in a sharp claw.

Although I consider the whole leg of an insect worthy of minute attention, from the mere jointed appendage of a larva to the final form so helpful for many purposes—such as holding the insect's prey, cleansing its body, burrowing in the earth, building its habitation, or collecting its food—and although I cannot help drawing attention to its beautiful structure with all its complex machinery of muscles, nerves, and circulating fluid for the safe and swift movement of ball and socket joints, hinge joints, and rotatory articulation, yet as the last joint of the tarsi is usually considered the most interesting part, we shall confine our remarks as much as possible to the foot itself.

The fly, the spider, the cuckoo-spit, and water-beetles will furnish us with abundant illustrations of the subject.

FOOT OF THE FLY.

To study this part of our most common insect, and enter into the detail of its mechanism, we should possess a microscope of moderate power, and some prepared legs of either the *Scatophagus*, or dung-fly, or *Musca vomitoris*, or flesh-fly, and with a low power look at it as a whole. The tarsal joints are five, in all the Diptera; terminated in the fly by two black, strong claws and two Pulvilli, or white semi-transparent lobes, which are expansions of a membrane like parchment, apparently delicately fringed (fig. 1). These were formerly supposed to be suckers moveable in all directions, with a downy, convex surface and finely-granulated concave surface, which, being pressed closely to the plane of position, the air was supposed to be sufficiently expelled to produce the adhesion necessary to keep the fly from falling when walking upon glass, wall, or ceiling; the suckers contracting and dilating according to necessity.

Improvement in microscopes and a habit of careful investigation have led to a further discovery, first by Mr. Blackwall,* and then by Mr. Hepworth,* which proves this supposition to be an erroneous one.

They have ascertained that the delicate fringe of hair is itself the point of attachment, each hair being a minute tube, expanding at the tip into a disk or sucker, through which flows a viscid fluid, by means of which the fly's foot is attached to any dry surface so firmly as to require the action of those two strong claws to detach it again (fig. 1 *a*).

It was but a few days ago that I noticed a small house-fly jerking in a queer way upon the glass, as if in a fit of St. Vitus's dance, pulling up first one leg and then the other, but evidently unable to walk or detach itself from the glass. Upon a closer examination with a pocket-lens I saw from the appearance of certain white rings round the abdomen that the fly was really "very poorly," attacked with Empusa Muscæ—a disease to which they are very subject at this time of the year. This is an inward malady, arising from the growth of a fungus, which eventually consumes the whole viscera, and, doubtless, the muscles also, then breaks forth between the segments of the body, and the fly is seen sticking to the glass, surrounded by a halo of white dust—the spores of this fungus. The fly I was observing, weakened, doubtless, by the loss of some muscles, and the fluid continuing to flow from its suckers, it had no strength to contend with it.

The muscular power needful for the action of the claws must be considerable, when it is remembered that some flies run with such swiftness as to take 540 steps in a demi-second—equal to

* *Quarterly Journal of Microscopic Science*, 1854, vol. ii. p. 158.

the running of a man at the rate of twenty miles a minute. How astonishing, then, are the powers concealed within this tiny foot!

Nor is it the last joint of the tarsi only that accomplishes this feat; the flexor and extensor muscles, which are external to the bone in the claw of a cat, here lie within the crust of an insect's leg, and with their attendant nerves, and the life-giving circulation of vital fluid, attain their full development in the thickness of the femur, or thigh. Even as in the human arm or leg the fulness of elastic fibre denotes a strong-limbed man, so the shape of an insect's leg will give a pretty correct idea of its habits of leaping, or walking, or running; as, for instance, the remarkably *fast* fly, *Stenopteryx Hirundinis,* which infests our poor house-swallow. How robust are its thighs, and how strong are the toothed claws—no wonder it springs so deftly through, and clings so tightly to the downy feathers of the young bird. Beside this leg I have drawn one of the Tipulæ—long and slender, with small foot and hooked claw, such as is best adapted for an insect whose life is on the wing, or who only stalks along the grass to deposit its eggs. Observe, also, that the Stenopteryx has no large pulvillus; they would greatly impede this fly in its movements, therefore they are extremely small. Compare them with the long, large lobes of the house-fly, or *Asilus,* which have the habit of *resting* on walls or stems of trees (fig. 2); or with the foot of a *Leptis*—a pretty quiet fly, fond of repose in the sunshine of summer, where it is easily taken on the bark of forest trees; it has *three* lobes in each pulvillus, and by no means muscular legs (fig. 3).

The claws of Diptera have many modifications as well as the pulvillus. In the month of July, seeing our pony tormented by a very pretty little piebald fly (*Simulium elegans*) waving its white-banded fore-legs in an ecstasy of enjoyment as it refreshed itself with the warm blood of our "Black Prince," I caught one, and observed its variegated tibia, and that its claws were toothed with a small pulvillus, probably for running quickly over the horse and clinging to the hair (fig. 4).

Most of the Tipulæ, or gnat tribe, have toothed claws; they hang upon leaves, they rest upon grass and fern, and cling to water-plants or floating fragments on the water whenever they are commanded to deposit their eggs. The claw of the midge (*Ceratopogon*) is remarkably toothed and curved (figs. 10, 14, and 15). This is not the window midge (*Psychoda*), which requires, *and has,* a larger pulvillus and thicker legs for the hopping they indulge in, always zigzag, too, from right to left and left to right up the window pane.

The *Ceratopogon* are those beautiful but most annoying little gnats who dance in merry companies by river sides and on marshy ground. Some of them are carnivorous, and, like the *Dolichopus* and *Empis*, flies who prey upon smaller insects, have the thighs armed with spines, as in fig. 13, by which the struggles of its prisoner are soon ended. I need not say that in this tribe the pulvillus is always very small, and often altogether absent.

But whilst we are looking at the foot of a fly, let us not pass unheeded the variations in the tarsal joints. Here is the leg of a merry little fellow of the Empis family (*Hilara cilipes*, fig. 13); he feeds chiefly on the nectar of flowers, and is easily recognized by his dilated fore-metatarsi, but he also enjoys a small fly or two, and has a sharp little proboscis on which to spit them and leisurely suck their juices. These pretty little Hilara, I cannot help talking of them; they assemble in myriads over the running rivulets and the calm bright waters of the Cherwell, revolving in horizontal or oblique circles, crossing each other in a mazy dance, sweeping away quite suddenly, as if impelled or chased by fairy foes, anon returning to their merry sport in the summer sunshine. These dilated tarsi belong only to the male, and are given that he may restrain the movements of his volatile mate.

Fig. 8 is the leg of *Bibeo marci*, a very abundant heavy black fly, found in meadows round London during the month of May, with a remarkable prolongation of the fore-tibia into a sharp spine, with which it retains its prey. Another species has a perfect coronet of spines round its tibia.

Figs. 7 and 9 are legs of those flies called *Syrphidæ*, which resemble small wasps, and hover over flowers with a peculiar vibration of their wings; the curved and toothed femur is for some special purpose, I doubt not, but I cannot tell what it is; they are honey-loving insects, and difficult to catch, from *springing* sideways very quickly.

I must now conclude a paper that is, I fear, too long already, with the foot and leg of a flea. The *Pulex irritans* is ranked with the Diptera now, though wingless, because of its suctorial apparatus allying it to the Gnat family.

No pulvillus, indeed, does this restless little pest require, but it wants muscular power in no ordinary degree to leap 200 times its length without any aid from wings, and therefore look at the long, large coxa, the stout femur, the spiny tibia, and strong claws; not only lobed, and long, and sharp; but striated (fig. 12 *c*), and crenated, and for hitching in blankets, and creeping, and clinging, and tickling,—finished to perfection.

THE ECONOMIC PRODUCTION OF ARTIFICIAL HEAT.

BY J. W. M'GAULEY.

This subject is of considerable importance, both in a domestic and an industrial point of view, but particularly in the latter, since the success of a manufacture must be greatly affected by the cost at which heat—that is, motive power—is procured. The supremacy which Great Britain has attained, as a manufacturing country, is mainly due to the abundance and excellence of her fuel, and to a skilful application of the advantages it has conferred. We cannot enter into all the details of this very extensive inquiry; but we shall lay before our readers some of the most useful facts and most practical deductions connected with it.

The purposes for which artificial heat is required may be conveniently divided into two classes: one of them relating to domestic economy, and having for its object the preservation or production of a proper temperature in apartments, and the preparation of food; and the other to the requirements of the arts and manufactures. Few climates are so genial as, at no part of the year, to demand artificial modes of warming habitations; none are altogether independent of heat for culinary purposes; and all civilized nations are desirous of promoting manufactures, which, when carried on extensively, must, to a greater or less extent, depend on the effect derived from heat. For, with the steam-engine, heat is really the moving power, the water being but a carrier of the forces developed by combustion, and the steam but the most convenient medium for obtaining them. Such an investigation as the present includes also a consideration of the different species of fuel, and their most effective application to practical purposes: these various points, therefore, shall more or less be kept in view in what we are to say.

Fuel: *Wood.*—Though a great variety of substances have been used at various times, and in different places, as fuel, those almost universally employed are reducible to wood, peat, and coal, with their modifications, charcoal and coke. Wood, on account of its very general diffusion, and its convenience as a heat-giving material, has been always used for the production of artificial heat; and, for some purposes, it continues to be more suitable than anything else: thus its freedom from sulphur, etc., confers upon it superior excellence in the reduction and manufacture of iron. In *new* countries wood is usually, at first, cheap and abundant, from the necessity of clearing the forest; but its price is soon augmented, since the labour required to fell it is expensive, and the difficulty of transportation is often so great, that it is burned or allowed to rot after having been cut down. Hence, the writer has seen in Canada localities surrounded by forests, and yet supplied with coal, brought from the United States by lake and rail, almost as economically, as with wood. In *old* countries, from the great value of land, and often from the abundance of coal, the supply of wood is very limited. But it might be grown for constructive and engineering purposes, very abundantly in Great Britain and still more so in Ireland, if the vast extent of mountain and other unproductive land were devoted to it. Not only would a large amount of profit be thus secured to the owners, but the appearance of the country would be improved, and (on account of the changes produced in the atmosphere by growing plants) its healthfulness would be augmented. The value of wood, where nothing else can be profitably cultivated, and its effect in beautifying wild scenery, are not as much remembered as they should be. On the continent of Europe, where it is grown in large quantities, the most romantic views derive their interest from picturesque and extensive forests.

Many and valuable experiments have been made on the heating powers of the various kinds of fuel; but they can be looked upon merely as approximations, since not only the various species, but the various specimens of the same species, differ greatly from each other. The heat-giving power of fuel depends on the nature and proportions of its constituents. Though it is intimately connected with the quantity of oxygen which enters into combination during combustion, it would be incorrect to assert that a pound of that supporter will cause the same amount of heat to be evolved, whatever the substance with which it unites; for something depends also on the nature of the combustible, since the quantities of heat obtained from different subtances, with an equal absorption of oxygen, are not the same. Thus, hydrogen, during combustion, gives out four times as much heat as an equal weight of carbon, though it unites with only three times as much oxygen; and fourteen times as much heat as an equal weight of sulphur, though it unites with only eight times as much oxygen. Wood, and other kinds of fuel, owe their heating capabilities to carbon, or to carbon and hydrogen. But the highest duty of a pound of carbon may be considered as about fifteen pounds of water evaporated, after having been raised to a temperature of 212°; and of a pound of hydrogen, as about sixty-two and a half pounds. These quantities suppose that all the heat is carried off by the waste steam; but, if the heat of the latter is utilized in any way, the theoretical amount of duty is increased. Any oxygen present in fuel diminishes the effect derived from the hydrogen, since the heat obtained from it is lessened by any portion of it being *already* in combination with the supporter. One pound of ordinary wood, in a proper condition for burning, will raise about twenty-six pounds of water from 0° to 212°, or will evaporate four and three-quarter pounds of boiling water; but much depends on its hygrometric state.

Peat.—From the comparatively limited supply of this substance, and other circumstances, it might almost be neglected in treating of fuels. Its efficiency depends, in a great degree, on its compactness and its freedom from earthy matters. The former is sometimes artificially increased by pressure: but its elasticity is an obstacle to its compression, and the cost of condensing it is considerable; if, however, its density is sufficient, it is applicable to many important processes. The qualities of peat are so variable, that while one pound of some kinds will raise sixty pounds of water from the freezing to the boiling point, one pound of other kinds will not raise twenty pounds of water through the same number of degrees; and its calorific power when dry is only about half that of the same weight of coal. But much depends on the locality in which it is obtained: good Irish peat is twice as effective as the best kinds found in France.

Coal.—Notwithstanding the enormous quantities of coal with which this country is so happily furnished, the period at which it superseded wood is not very remote. It is universally admitted to be of vegetable origin, but the forms of vegetation of which it consists are so imperfectly known, that they afford little information as to the state of the earth at the time they were produced. In peat, the vegetable matter exists in various stages of decomposition: lignite is evidently the carbonaceous residue of forest-trees; brown coal is vegetable matter in a state intermediate between that of wood and bituminous coal; semi-bituminous, or "steam coal," is that which is in a state intermediate between bituminous coal and anthracite; and the latter is bituminous coal from which the gaseous constituents have been expelled, most probably by heat, so that many specimens of it contain only a small amount of oxygen, and little or no hydrogen. The following are, on an average, the chief constituents of the substances just mentioned:—

	Carbon.	Hydrogen.	Oxygen.	Nitrogen.
Beech	48·89	6·07	43·11	0·93
Oak	50·64	6·03	42·05	1·28
Lignite	62·80	5·03	23·27	0·00
Brown Coal	69·74	7·07	9·24	0·14
Bituminous Coal	81·60	5·27	7·91	0·39
Steam Coal	85·57	4·64	2·18	1·03
Anthracite	89·21	2·48	0·20	0·17

The chief heat-giving constituent of coal is its carbon, which, in the bituminous kinds, varies from sixty-five to ninety-five per cent. One pound of good coal will raise about sixty pounds of water from the freezing to the boiling point; but small coal of the same kind will raise only about forty-five pounds through the same number of degrees. Watt was able, on an average, to evaporate seven and a-half pounds of water with one pound of coal; and with ordinary boilers, there has not been much change in this respect since his time. A cylindrical boiler will evaporate only seven pounds; but a "Cornish" boiler, ten and a-quarter pounds; and a locomotive boiler, with one pound of coke, from eight to nine and a-half pounds. If the full effect of one pound of coal were obtained, it should evaporate about sixteen pounds; but a large portion of the heat usually passes off into the chimney.

Charcoal.—As might be expected, equal weights of dry charcoal afford equal amounts of heat, at whatever temperature it is burned, provided it is changed into carbonic acid by union with a sufficient amount of oxygen. One pound of wood charcoal will raise about seventy pounds of water from zero to the boiling-point: and a cubic foot of charcoal from soft wood weighs about eight and a-half pounds, but from hard wood about twelve and a-half. One pound of peat charcoal will raise upwards of sixty pounds of water from zero to the boiling-point.

Coke.—This substance is of very different qualities, according to the coal from which it is made, and the mode of its manufacture; oven coke is far the best, gas coke being mere cinder. The density of coke, its most important quality, depends on the quantity manufactured at once—since, the greater this is, the greater the pressure, and therefore the greater the compactness of the result; on the temperature at which it is manufactured—since if this is high enough, the bicarburetted hydrogen evolved will deposit half its carbon on the coke; and on the time during which it is kept in the oven—since continued heat causes it to contract. One pound of good coke will raise sixty-five pounds of water from zero to the boiling-point, while one pound of the coal from which it is made will raise only sixty pounds through the same number of degrees.

HEAT. *Production of heat from fuel.*—Open fire-places, or stoves, are most usually employed for the purpose of heating apartments; the former are more agreeable, the latter more economical. When an open fire-place is properly constructed, the effect obtainable from it is sufficient, under ordinary circumstances: but, in cold regions, such as a large portion of North America, it would be very ineffective for heating or culinary processes; and hence the almost exclusive use of stoves through so great an extent of the New World. They are generally placed far out in the apartments, and their flues are so arranged as to traverse a considerable space before entering the chimney, that the products of combustion may part with as much heat as possible previous to their escape; for, after the gaseous current has ceased to be applied to heating purposes, the heat it contains is totally lost. The whole heating power of the fuel, therefore, is not obtained, unless the temperature of its gaseous products is lowered to that of the atmosphere; this is impossible when it is burned in the ordinary way, but the nearer we approximate to it the better. The heating of rooms, in very cold countries, by stoves, is not only economical and convenient, but productive of a pleasing temperature with great ease when their management is understood. All disagreeable smell, and other inconveniences—unless the heat is allowed to become immoderate—are prevented, by placing on each stove a vessel of water for evaporation. Stoves are, however, more suited to the use of wood than of coal: the combustion of the latter is not so easily regulated, and the soot which it produces is more troublesome, though not so inflammable. When reasonable care is taken, they are not found very liable to cause accidents by fire; nor would insurance companies, in the countries where they are used, consider their absence an additional security. For culinary purposes, at least with wood, they are extremely effective, convenient, and economical: and, however employed, they consume much less fuel, for a given heating power, than an open fire-place. In the application of heat to the objects of the manufacturer, all the discoveries which science has made with regard to combustion have been brought into operation. The conditions required for perfect combustion are few and simple, but they are of the highest importance: a proper supply of the supporter must be provided, and it must be mixed with the combustible at a sufficiently high temperature. If either of these is imperfectly fulfilled, a waste of fuel and the want of a proper temperature will be the inevitable consequences.

It will be useful to notice briefly the chief sources of a waste of heat during combustion. Of these, not the least common is the presence of *hygrometric water* in the fuel. This must cause a loss of heat, since, as it will certainly be evaporated, its amount is to be deducted from that of the water which otherwise would be converted into steam; or the heat it absorbs must be considered as diminishing that which should be applied to the object in view. Newly-felled wood often contains fifty per cent. of water; and so much of the heat given off by the remaining fifty per cent. is consumed in evaporating it, that scarcely any useful heat remains. After twelve months, wood may contain twenty-five per cent. water: and, if it is kept in a dry place, ten per cent, which, if expelled artificially, will be re-absorbed from the atmosphere. Beech contains the least, and fir the most moisture. The peat of commerce frequently contains twenty-five per cent. water, and when carefully dried, at least ten per cent. Coal usually contains one or two per cent., but very much more if exposed to the atmosphere and rain, particularly when it is in dust or small pieces. By exposure to the air, charcoal absorbs at least ten per cent. water, which causes flame during its combustion, the water being decomposed, and carburetted hydrogen formed. In wet weather coke will absorb seven per cent. of water. It is clear that, in purchasiug fuel by weight, its hygrometric water may seriously affect the quantity in reality obtained, and therefore its commercial value.

Primage and *leakage* cause heat to be wasted. The former, which consists in water being mechanically suspended in the steam—not to speak of its other inconveniences—involves a loss of the heat expended in raising such water from the temperature of the feed to that of the issuing steam. The less pure the water in the boiler, on account of mud or greasy matter, the more rapid the evaporation, the greater the loss from this source: and hence the primage is greater with locomotive than with fixed boilers. Keeping the boiler clean, and allowing the steam a sufficient space for deposition of the water, reduce the waste, from this cause, almost to nothing. Leakage of water or steam leads to a waste of all the heat carried off by the water or steam which escapes.

The heat required to produce a *draught* in the chimney is another source of loss, the amount of which depends on the quantity of gaseous matter passing off, and the temperature at which it is emitted. The minimum of quantity is the transmission of just so much air through the furnace as will burn the fuel; and the minimum of temperature is that which exceeds, by only a few degrees, the temperature of the water, which is being converted into steam of the required pressure. The temperature at which the products of combustion cease to act on the boiler, or other body to be heated, is a matter of considerable importance: and any loss arising from it is dependent on the elevation of temperature of the waste products, and on their weight and specific heat. It is not unusual for these to pass off at a temperature of 600°; and this, with twice as much draught as is necessary, would cause a loss of nearly twenty-seven per cent. of the whole heat. A diminished draught, by raising the temperature of the products of combustion, increases the heat of the escape current also; and therefore a diminution of the draught to a nearer correspondence with what theoretically may be required, does not economize the heat as much as might at first be supposed. But the loss from this latter cause does not counterbalance the advantage, since the higher the temperature of a body, the more capable it is of heating another; the capacity, therefore, of that other for heat is practically increased. When the capacity of a boiler for absorbing heat is augmented, its size may be diminished; and hence, a proper draught will render a smaller boiler sufficient, or will leave more of a larger to take up the residue of the heat after its first violence is expended. For, one square foot of boiling-heating surface, with a suitable draught, will produce as much effect as five square feet of equally efficient surface, when the draught is four times what it should be. The difference between the heating effect of a well-regulated and an excessive draught is very great; for, while the one will produce a temperature of 3000° and upwards, the other may not afford one of 2000°: a little seeming waste, in producing the former is, therefore, real economy. The draught may, however, be so violent, as not to allow time for the heat to be imparted to the boiler; or it may be so languid as, in certain cases, to be attended with inconvenience, and even danger. Thus, if the temperature of a chimney or flue is not sufficiently high, the carbonic acid which is formed by combustion, and which is one and a-half times as heavy as common air, will flow backwards. By a certain arrangement of an American stove, a small quantity of wood may be kept smouldering for the whole night: this is a convenient way of maintaining a moderate temperature without any trouble or attendance; but in sleeping apartments it is not unaccompanied by danger.

Conduction of heat, from the boiler to the surrounding solids, and *radiation* from its surface, are also causes of heat being wasted. Locomotive boilers are particularly subject to these inconveniences; and the evil is much greater when the cylinders are outside. The excellence of what is termed a "Cornish" boiler, consists, almost exclusively, in the care with which it is insulated by felt, brick, and other non-conductors of heat.

Finally, heat is lost by the passing off of *uncombined fuel*. This may occur mechanically, from fuel being dropped among the ashes, which must happen if the coal is small, or if the distance between the bars is too great: they must not, however, be so close as to prevent a proper supply of air. Some kinds of coal break down with great rapidity during transmission, and even in the very steamers in which they are used; and some, from the water which is chemically combined with them, split up and fall to powder when heated. Waste from uncombined fuel may occur also from the production of *smoke;* that is, from incomplete combustion. The prevention of visible smoke has for a long time occupied the attention of men of science. It is indispensable to the economical application of fuel; because smoke consists of carbon and other matters, which are a most effective portion of the combustible, and which, if allowed to escape into the atmosphere, are totally wasted. When the combustion is imperfect soot will be formed with a part of the carbon, and, instead of carbonic acid, carbonic oxide may be evolved. The hydrogen also, in place of being burned, may form hydrocarbons, such as carry vapours, and pass off; or it may escape without having entered into any combination. In all these cases a large amount of the heat which should be derived from the fuel is lost. Smoke is not only a loss to the manufacturer, but an injury and an annoyance to the neighbourhood, by rendering it less healthy and less agreeable; hence, the manufacturer is obliged, by Act of Parliament, to "burn his smoke." Burning it, is enough to prevent inconvenience to others; but preventing it, would be more advantageous to himself, since carbonaceous matters combine with oxygen much more readily when they are in the *nascent state*. Smoke will certainly be consumed, if its constituents are mixed with oxygen in proper quantities, and at a proper temperature. Atmospheric air contains, by weight, twenty-three per cent. oxygen; and sixty cubic feet may be considered to afford one pound of it. Hydrogen requires for combustion eight times its weight of oxygen; and carbon two and two-third times its weight. One pound of hydrogen, therefore, absorbs the oxygen of four hundred and eighty cubic feet of atmospheric air; and one pound of carbon, that of one hundred and sixty cubic feet. The carbon is believed to be capable of giving to the products of combustion a temperature of 4400° Fahr. if its combustion is perfect, and some of the heat is not carried away by excessive draught.

Since the compounds of carbon and hydrogen are found to afford the same amount of heat as their constituents, it is not necessary, in examining the effects which ought to be expected from hydrocarbons, to consider each of them separately; it is enough if the nature and amount of the elements of which their aggregates consists, are ascertained. Compounds of carbon and hydrogen are usually decomposed by the high temperature, before they are burned; then, hydrogen having the greatest affinity for oxygen, first combines with it, liberating the carbon; the carbon, if there is enough of oxygen, with a sufficiently high temperature, afterwards forms carbonic acid; but if there is a deficient supply of oxygen, the carbonic acid takes up another atom of carbon, becoming carbonic oxide: in which case as much heat per pound of carbon, is carried off as would raise 10,100 lbs. of water one degree Fahr. The blue flame which surrounds the opening, and plays over the fuel, when the door of a locomotive furnace is opened, arises from the extra supply of air changing what was passing off as carbonic oxide into carbonic acid; and the flame seen at the top of a chimney is due to the same cause. Perforating the furnace door partially prevents this waste. Since the elements of coal, coke, etc., exist in the solid form, in changing to the gaseous state they absorb a large amount of the heat derived from previous combustion; and the gaseous products of combustion carry off so much heat, that it is believed their volatilization consumes as much of it as is given out by their combustion: hence, there is reason to doubt that the effect of any coal containing hydrogen is greater than that of its carbon; and it has been found that coal containing the smallest quantity of gases, is, practically, the most effective as a heat-producer. When coal contains hydrogen, the resulting water forms double its volume of steam.

We may err by having too great as well as too small a supply of air. If the latter is in excess, the heat being dispersed through a greater quantity of matter, the temperature obtained is less than it should be. When twice the proper quantity of air is admitted, the temperature of the products of combustion will be only about 2300°, or little more than half what might be expected; yet five, and even ten times the proper amount is often supplied to the fuel. We must not, however, confine ourselves to the theoretical quantity, since only about two-thirds of what is sent into the furnace comes in contact with the combustibles.

Various means have been devised for the consumption of smoke. It is not enough to increase the height of the chimney: this would indeed augment the draught, but would produce little other effect than the diffusion of the nuisance over a wider space. Among the most effective means that have been employed, is mixing air with the smoke. When fuel is put on the *dead plate*, so that it may be coked, and its volatile constituents mixed with air may pass over the fuel which is at a high temperature, air is required *above* the fuel. If this is cold, on account of being drawn directly from the atmosphere, not only is the bottom of the boiler lowered in temperature, and the generation of steam in consequence diminished, but the smoke is not all destroyed. It has been attempted to obviate these inconveniences by supplying the required air through tubes passing down within the chimney; but this, by cooling the contents of the latter, diminishes the draught, and thus affects the supply of the supporter of combustion. When, as with coke, or cinders of any kind, the combustion is confined to the fuel on the grate, air is not required above; yet such is the neglect, not unfrequently observed, that the same draught may be sometimes found with every kind and quantity of fuel.

When the waste steam was first thrown into the chimney of locomotives, it was found that the draught was enormously increased. This principle, in a modified form, has been applied to the consumption of smoke: for which purpose a small quantity of steam is thrown into the forepart of the furnace, above the fuel, by a fan-shaped distributor, having a few small apertures; and the instant the steam is turned on through the flame and smoke, the latter disappears. The cause of this extraordinary effect is not certainly known. Some consider that the steam merely carries the air mechanically to the fuel; others, that the steam is decomposed by the carbonaceous matter of the smoke at a high temperature, carbonic oxide and hydrogen being produced; and that the combustion of these augments the amount of heat evolved. The latter supposition is apparently confirmed, by the fact that more water is sometimes evaporated than can well be ascribed to the fuel: in which case, it would seem reasonable to attribute some of the effect to combustion of the hydrogen; but whatever heat is given out by the burning hydrogen must have been first obtained from the fuel itself, since exactly the same amount of heat is required to decompose water, as is afterwards evolved during the recomposition of its elements. The steam increases the draught to such a degree, that its force must be diminished by side openings in the chimney, or other means; and hence, supplying air for combustion by tubes passing down through the chimney ceases to be injurious; and the chimney may be made smaller and lower. Since with this contrivance no air passes through the ash-pit, combustion takes place altogether on the surface of the fuel; and the absence of smoke causes the heat to be radiated more directly, and, therefore, more effectually, on the bottom of the boiler.

We have now briefly alluded to the best modes of using the more ordinary kinds of fuel; and, from the great difference between the amount of heat obtained in practice and that which theory would lead us to expect, it can easily be imagined how much yet remains to be done in this department of practical science. The separate condensation of steam, invented by Watt, and the application of the principle of expansion, by Woolf and Hornblower, greatly augmented the dynamical value of fuel; and yet the mechanical effect obtained from even the best condensing expansive engine is many times less than it would be if, according to the received "mechanical equivalent of heat," the whole heat were changed into work. The locomotive, from its peculiar position, is, perhaps, least favourably circumstanced, so far as relates to the economy of fuel; yet, with all the sources of waste to which it is exposed, it will do as much work with one pound of coke as a good non-expansive condensing engine with a pound of coal, and more than twice as much as a good high-pressure stationary engine with the same. Theoretical and practical results will, it is true, never entirely correspond, but they should be much more nearly alike than they ever yet have been. Whatever improvements have at any time been effected in the economy of fuel, have originated in a careful and rational application of the physical laws which relate to combustion, and of those on which the doctrine of heat is founded. Apparent trifles, such, for instance, as insulation of the boiler by non-conductors of heat, accommodation of the draught to the nature and quantity of the fuel, etc., have been the cause of very important saving on the item of fuel; and whatever good shall be hereafter effected in the same direction, will be due to a like judicious application of the practical knowledge with which experience and research shall have furnished us.

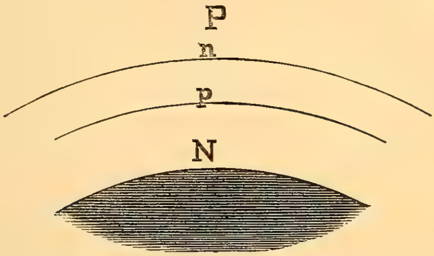
QUETELET ON THE ELECTRICITY OF THE AIR.

In his important work, *Sur la Physique du Globe,* M. Quetelet gives a voluminous account of the electrical observations made under his superintendence at Brussels, and devotes one section to an explanation of the distribution of the electricity of the air, which cannot fail to interest our readers, and which we therefore present to them in a condensed form.

M. Quetelet remarks, that were it not for the existence of other bodies in celestial space, the terrestrial atmosphere would scarcely experience any electrical changes. He further tells us that the sun must be regarded as the chief exciting and disturbing cause. He regards our atmosphere as divided into two layers; the upper one, *n.p.*, "nearly immoveable in all its parts, the lower one, *p.n.*, constantly traversed and stirred up by winds." The upper layer he considers is also divided into two portions: the one negative, *n.*, equilibrates the positive electricity, P., of the sun, and of the surrounding space;* and the other positive, *p.*, acts through the lower stratum of air, and equilibrates the negative electricity of the earth, N. The positive and negative electricities of the upper regions of the atmosphere are kept apart by the extreme dryness which must prevail

† M. Quetelet adds in a note, "If it is objected that the electricity of the sun traverses the void without resistance, and that its fluid ought to unite with the fluid of the opposite nature which we suppose to exist in the exterior layer of the atmosphere, we might without difficulty admit this hypothesis, and our explanation would be simplified. There would, in fact, remain only the positive electricity below the superior envelope of our atmosphere, which would paralyze on one side the negative electricity of the sun, and on the other would act through the inferior envelope and paralyze the negative electricity on the surface of the globe. We must then admit that the electricity of the sun and the earth are of the same kind.

there. In the lower stratum absolute dryness does not exist. It is more or less moist, constantly disturbed, and traversed, although with considerable difficulty, by the positive electricity which can at times unite with the opposite electricity of the earth; but these never exist in intimate connection. The action is like that of two conductors charged with opposite electricities and placed at a distance: "the opposite fluids tend to unite through the more or less moist air that is interposed, but their charges remain the same. If the losses are constantly renewed, the positive fluid of the upper layer gives rise to all the electrical phenomena that we observe upon our globe.



Being partially retained by the dryness and relative immobility of the stratum in which it finds itself, it operates through the lower stratum, which is always agitated and always more or less humid, and partially paralyzes the electricity indicated by our instruments on the surface of the globe."

In our northern hemisphere, the electricity is stronger in winter than in summer. The layer of the atmosphere that is constantly disturbed is not so thick at this season, and thus we are closer to the upper layer. In the course of a year, this augmentation of electricity and diminution of height becomes very apparent; between June and January, or December, the variation is as much as 1 to 10. Nor is the diurnal variation less noticeable, "the electricity becomes stronger towards the approach of night, and its minimum occurs a little after the hours of strongest heat during the day. It is towards three o'clock P.M. in the summer time, that the electrified layer which acts upon our instruments appears to be furthest removed from the earth." It should also be remembered that as heat augments, and the air becomes drier, its conducting power is diminished. During the night the solar action is insensible, and the variation is much less, and that which occurs appears to be the result of changes in the opposite atmosphere.

M. Quetelet observes that we have no precise ideas of the *absolute force of electricity*, and that we do not know whether its intensity is greater in the north than in the south, although if the upper stratum of the air is not so high, the electricity must be stronger, as seems to be shown by the auroras. "The earth is generally regarded as solid throughout all its extent, although many physicists consider that it is only solid in its exterior portion. They say, and as we think with reason, that the interior portion, in a state of greater or less fluidity, may have its own movements, which may occasion magnetic variations, and also the electric variations that are intimately connected with them."

The great laws of the distribution of atmospheric electricity are often masked by secondary causes. Thus, especially during the summer, we notice the formation of strata of clouds carrying an electricity which M. Quetelet denominates *accidental*, and which gives rise to storms. "These clouds may be the origin of hail, which finds itself attracted and repelled by the upper stratum of the air, until it falls by force of gravity," or there may be a direct electrical action upon the earth in the shape of storms. Negative electricity is more frequent in the atmosphere during the summer, the space between the earth and the stationary portion of the atmosphere being then greater, and also being drier and better able to accommodate clouds which assume "a supplementary electricity." The tranquil passage of electricity towards the earth is more frequent in winter, but in the summer, by reason of the greater dryness, it is less continuous and more violent. Thunder-storms are more common in summer than in winter, but those of the latter season are often extremely dangerous. One, for example, in the winter of 1860, struck twenty clock towers within the limits of Belgium, and in the course of a few hours; and in the night of April 14th, 1718, twenty-four towers were struck in France, along the coasts of Brittany. Summer storms are usually less destructive on the surface of the earth, and their action limited to a smaller space. Winter storms act over a wider range.

M. Quetelet gives numerous details of the great storm of the 19th February, 1860, to which allusion has just been made, and which surpassed in violence any ever known to have occurred in Belgium. It began on the evening of the Sunday in question, and followed the route usually taken by such scourges in that country. About seven o'clock it burst over Rolleghem and Courtroy; an hour afterwards it reached Ghent, Brussels, and the neighbourhood of Antwerp; and by nine it was at Liege, carrying devastation as it went, and increasing in force. Hail, rain, and snow fell at various places during its passage, several of the churches upon which the lightning fell were set on fire; the wind was tempestuous, and the thunder-peals extremely loud. The barometer was strongly depressed, and the thermometer experienced considerable oscillations. M. Duprez, commenting on this alarming visitation, states that fourteen out of twenty-two cases of buildings being struck resulted in fires, and that the only edifice which was provided with a lightning-conductor suffered no damage. M. Quetelet adds that, in his statistics of buildings or vessels struck by lightning, he found that out of a hundred and sixty-eight cases in which lightning-conductors had been struck, only twenty-seven, by reason of grave defects in their formation, had failed to exercise a preservative power.

The average annual allowance of thunder-storms for Belgium is fifteen or sixteen, and they are twenty-one times more numerous in summer than in winter. The annual number for a particular locality will vary considerably, being four times as many in some years as in others, while fifteen or twenty leagues away, the average has not been changed. In our northern countries winter storms, while the sun is below the equator, are usually formed between the clouds and the earth; those in summer, when the sun is above the equator, are formed in a higher region between the clouds and the stationary layer of the atmosphere, and they have less tendency to strike elevated objects. Their region of action is often very limited, extending over only a few leagues. The velocity of the movement of thunder-storms equals that of the most rapid winds.

THE SEA LAMPREY

(*Petromyzon marinus*).

BY JONATHAN COUCH, F.L.S.

(*With a Coloured Plate.*)

The large Sea Lamprey is one of the most remarkable of fishes, both as regards its organization and habits; and as such, without appearing to have done so, it has obtained special notice, as well among the ancients as moderns. But as actual and close observance of the forms of the inhabitants of the ocean for the purpose of scientific distinction was not much practised in ancient times, some curious mistakes were committed about it by writers of remote date; most of whom, at least those whose works have come down to us, must have written from the imperfect information which they had gathered from common sources; and in doing this they appear to have felt the greater readiness to receive it in the proportion that it was strange and mysterious.

It was commonly believed that there was a fish called the

Naucrates, Remora, or Echeneis, which, when it pleased, laid hold of a ship, and by means of a magical power which it possessed, and which was inscrutable by human intellect, and therefore above being reasoned on, it was able to arrest its progress in the midst of its most onward course, and thus fix it stationary in the middle of the ocean. Ordinary observation had shown that the lamprey was in the habit of laying hold of a ship so firmly as not to be easily separated from it; and without attending to the difference in the mode of acting, by what seemed a natural process of reasoning they drew the conclusion that where the action was so much alike the fishes themselves must be the same. These dissimilar fishes, therefore, the Remora and Lamprey, became confounded together, and that, indeed, to such an extent, that when taken in the sea there is reason to believe that the lamprey lost, if it ever possessed, a specific name; which circumstance will help to explain how it happens that there does not appear to be any direct mention of it in the natural history of Pliny, although the fish itself is common in the Tiber. The fact, however, of the knowledge of this fish by the ancients, with the uncertainty arising from confounding it with the Remora, Naucrates, or Echeneis, appears with little doubt, from the description which Oppian gives of the last named species. His reference to its teeth is decisive in this respect, for these organs in the Naucrates are scarcely perceptible, and certainly are not employed in the action which rendered this fish so famous:—

> "Slender his shape, his length a cubit ends;
> No beauteous spot the gloomy race commends;
> An eel-like clinging kind, of dusky looks;
> His jaws display tenacious rows of hooks.
> But in strange power the puny fish excels,
> Beyond the boasted art of magic spells.—
> The sucking fish beneath with secret chains
> Clung to the keel the swiftest ship detains."

When, however, the lamprey had come under the notice of another class of observers in its yearly migration into fresh water, its marine practices were forgotten or unknown, and it assumed a name according to the likeness it was supposed to bear to some more familiarly-known fish. Ray, in his little work, *Nomenclætor Classicus*, very properly finds fault with those English writers, especially the poets, who translated the Latin name of the fish Muræna, by the English term Lamprey, which John Jones, the translator of Oppian, always does, although these fishes are different in every respect. But we have already remarked that scientific differences were little thought of by the generality of the ancients. It was sufficient for them that there was some, although a distant resemblance; and in the present instance of the Muræna this resemblance, as regarded the shape, was thought sufficiently close to warrant the transfer, with some little qualification, of the name of one of these fishes to the other. Rondeletius is sufficient authority for saying, that the sea lamprey was sometimes called Muræna simply, or *Murœna fluviatilis*, the River Muræna, which he distinguishes by an anatomical difference in the head from the Muræna of the sea; and he thinks the comparison of one with the other not amiss. There is much probability also in the opinion that it is the lamprey which is mentioned by Ausonius, under the name of Mustellax, although Cuvier has said that the Burbolt is the species intended by this Roman poet. The important fact, however, of its migrating habit from salt water, which he refers to, and which is not a character of the Burbolt, and the description of its colour, appear sufficient to decide the question:—

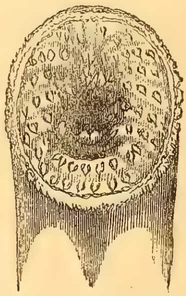
> "All through the ponds of Ister's double name,
> Frothing the surface, the Mustella came;
> Watched by observant eyes it holds its way,
> And safely shelters in our favoured bay;
> Bringing new riches to the wide Moselle;
> And its bright beauties who can paint or tell?
> On breadth of heavenly blue are dots of black,
> Each circled yellow through the luscious track
> Along the slippery surface of its back.
> From head to vent it suits the nicest taste,
> But all behind is dry, and thrown to waste."
>
> *Ausonius's Moselle.*

The fact that the Burbolt is still called Motella in some parts of France will weigh but little when we call to mind how common it is for different sorts of fishes to bear the same name, as also that the same fish is known by several names in different parts of the same country.

This species of lamprey is often taken in the sea, but always under peculiar circumstances, which have reference to remarkable instinctive habits; and these, again, are worthy of notice as offering explanation of the use of the curious structure of its mouth, and of the organization which serves it for the purpose of breathing. This remarkable structure we shall by and by describe, but at present it is sufficient to say, that the mouth, when open, forms an expanded disk, round the deepest portion of which there is an arrangement of rasping teeth; and these the fish has the power, however difficult it may appear, of bringing into contact with any surface on which it chooses to lay hold. By an exhausting action through which the air and water are removed, a vacuum is produced; and thus the fish becomes fixed without any further exercise of muscular action. The bottom of a ship or boat is frequently the object to which it attaches itself, and it becomes a question what is the intention kept in view in thus affixing itself; which it does so firmly, indeed, that the utmost strength of a man is often unequal to the task of removing it. The object may be no greater than to relieve itself from further exertion in swimming, and, as in the instance of the true Remora, to be conveyed to a longer distance with the least expenditure of strength. It may also be with the hope of feeding on the flesh of an animal, for which it has mistaken the ship, according to what we know of its propensities under other circumstances; but it is affirmed by Rondeletius that it is also with the intention of devouring the pitch with which the ship has been *payed*, or coated, and for which it has been supposed to feel an appetite. Such was the opinion, at least, formerly entertained by the fishermen of Marseilles; and strange as it may appear, a similar opinion has been expressed in England by a witness in an inquiry by a parliamentary commission on the salmon fisheries, in the year 1861. It was then shown that under peculiar circumstances, not only salmon, but lampreys also, tasted strongly of tar. The witness said, "We asked the fishermen about it, and they told us that there was a little ripple of tar coming down into the Severn, and that must have been the reason (with the salmon). We were rather angry with the fishermen, and then thought they had put these salmon into a boat where tar had been emptied; but they said no, the tar in the river must have been the reason. We had two lampreys returned that tasted very badly of tar; we found out the reason of that. Lampreys have mouths like suckers, and live by suction; and they will suck tightly to anything. The boats had been newly tarred, and these lampreys sucked on to the boat, and from that they were all tar. I am quite certain that the lampreys did not get the tar out of the water, but out of the boat. These tarred fish were confined to one year."

It is not so certain, however, that the vegetable tar attracts these fish as that coal tar drives them away; and accordingly it has been noticed that since the sea-going boats have employed the latter no lampreys have laid hold upon them.

But there is another use to which the mouth is applied, concerning which no doubt can exist, and by which the singular situation and armature of the teeth are to be explained. The whole of the interior arch of the mouth is studded with rows of teeth, each one of which, on a broad base, is furnished with one or two apparently reversed points; and these teeth which are most remote and concealed are larger than others, and more effectually crowded with these points. For simply biting they are useless; but when the breadth of the mouth is brought into contact with the surface of a fish on which the lamprey has laid hold, by producing a vacuum these roughly-pointed teeth are brought forward so as to be able to act on it by a circular motion; and a limited space of the captive prey is thus rasped into a pulp and swallowed, until a hole is made which may perhaps penetrate to the bones, and from the torture of which the most strenuous exertion of the victim cannot deliver it. The most active fishes are subject to this infliction, and on none have I found it more frequent than on the mackerel, although the gurnard, coal-fish (*Rauning Pollack*), cod, and haddock, have been also the subjects of attack. It might be supposed that death would be the inevitable fate of fishes which have been thus dealt with; but I have seen some that have borne the mark of having been thus fed on, which after having perhaps satisfied the appetite of their foe have survived to have the wound healed, although not without an enduring mark. In repeated instances a lamprey which did not exceed six or seven inches in length has been caught while still adhering firmly to the body of a mackerel; a circumstance which happens most frequently in the spring of the year. It is in the spring, and with us about April and May, that the lamprey is ready to deposit its spawn, for which purpose it seeks the fresh water of the deepest of our rivers. I have had it brought to me from the sea with the roe enlarged on the 11th of April, and also in the middle of May; but in Holland, Ruysch says it is so early as February, and in Scotland Sir William Jardine assigns it to June, and thenceforward so late as to the end of August. It is at this its first entry into the rivers that the fishery is entered upon for taking it. The Severn has long been celebrated for this fishery, and for the excellency of the lampreys taken in it. Indeed, it is not known that this fish is much sought after in any other river; and even there so fluctuating is the taste of epicurism, that within a few years the sale of it has much declined. They are fished for mostly in the night, and from thirty to forty are regarded as a successful adventure, at the price of a shilling to eighteenpence for each fish. But it was held of higher value in remote times, and an often quoted instance in English History is a proof that it was once deemed a favourite dish at the table of a king. The death of Henry I. was caused by his having indulged too freely in a dish of potted lampreys. The value set on the lamprey is also shown by the fact that it was thought a not unfitting present to be sent by the king to a subject of high rank. King John sent one lamprey to the Earl



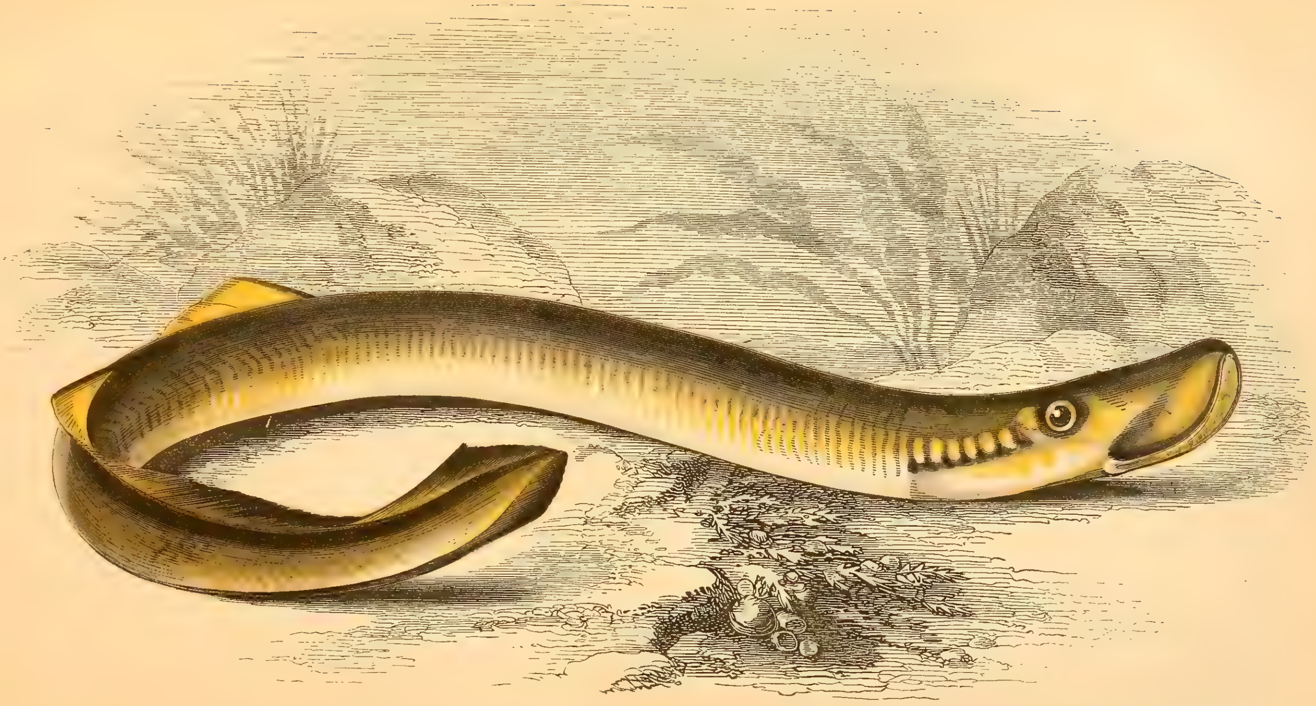
The Mouth of the Petromyzon marinus.

of Chester, and the honour of the gift was acknowledged by the present of a good palfrey in return. It was an old custom for the Corporation of the City of Gloucester to present to the reigning sovereign a pie of lampreys yearly, but it appears that this custom has ceased to exist; an end probably having been put to it on the occasion of the passing of the Reform Bill. In the last century also a lamprey-pie was sent by the Corporation of the same city to the Prince of Wales. As this kind of lamprey enters rivers for the purpose of spawning in the spring, so this is also the season of its highest perfection; but immediately after the discharge of the roe, so great a change in this respect takes place, that they are not only weakened and emaciated, but it has been believed they are so far from recovering their former condition that even death is the result. In the sea this fish is said to be worthless for the table. However, that this last supposition is not correct appears from the fact, that while in May, twelve months perhaps from their birth, they are often found not to exceed six or eight inches in length, some examples are met with which measure more than thirty inches, and which therefore we may conclude to have experienced the growths of several seasons, and consequently to have passed through more than one or two of those in which the spawn is deposited.

The mode of proceeding by which a procreant bed is prepared for the reception of this treasure affords an insight into another use to which the sucking faculty of the mouth can be applied. Both sexes unite in preparing the ground; and as in the process of doing this it may happen that stones of comparatively considerable size are in the way, the mouth is a principal instrument employed in the labour of removing them, so that the grains of roe may be covered by only a lighter sand. The mouth is applied to the surface of a stone, and by a strenuous effort it is carried to a distance until every difficulty of this sort is removed out of the way. Soon after spawning the parent fish return to the sea.

This fish inhabits a variety of climates except the very warm; being found in the Mediterranean, where those of the Tiber are said to be of large size; and in the north of Europe, where it is mentioned by Nilsson as common in the Baltic and North Sea. It is said also to be met with in North America. It is retentive of life, and so may be carried alive to a considerable distance if sometimes dipped in water.

The genus *Petromyzon*, to which the lamprey belongs, is distinguished by having the mouth formed of a wide opening without distinct jaws; an aperture on the top of the head which communicates with the gills, the spiracles or outlets of which are seven in number. Pectoral and ventral fins none.



SEA LAMPREY.

The sea lamprey (*Petromyzon marinus*) is specifically distinguished by having the second dorsal fin separate from the tail, although sometimes in only a small degree.

The body is long and round, slightly compressed, but more so near the tail, and thus not unlike an eel. When the mouth is closed, the part before the eyes appears somewhat lengthened; but when open it is circular and terminal, so that the fish appears as if the head had been cut off. The rim of what may be termed the under jaw is a little curved, forming a ridge which is edged with sharp points; on the tongue there is a more solid and firm bed of three teeth, having sharp points; and above, there is an arch of nine bifid teeth, the middle one lower than the others—in all there are ten bifid teeth; the remainder of the mouth is covered with teeth having sharp points, which stand in rows that pass off in curved radii from the throat; the lower ones small: altogether a formidable arrangement. These teeth are deciduous, the new ones thrusting off the old and taking their place. The mode of arrangement is a specific character of this fish, and I have found the renewal occurring in May; but it does not appear to observe a regular recurrence. The mouth is fringed with fibres. Eye moderate, lively; vent far behind. First dorsal fin behind the middle of the body, lower and shorter than the second; the caudal fin separate, and surrounding the tail. The colour is often variegated and beautiful, as it is referred to by Ausonius; but sometimes it is plain and almost uniform; and this difference appears to belong to the district in which the individual is found; but on the whole the tendency is to blue or green, with yellow on the sides and belly. The manner in which the process of breathing is conducted is deserving of notice. Under ordinary circumstances, when the mouth is open, the water probably enters by it and passes out by the openings of the gills; as it does also when the mouth is held above the water, and water is seen to be drawn in by the opening on the head. But on some occasions when wholly immersed it was discharged by that opening as well as by the gills; but it was never seen to enter by the gills of one side, as has been supposed, to be discharged by the orifices on the other side. This family of fishes has usually been arranged with cartilaginous fishes, which certainly is not its place. They bear a closer affinity to the annelid or worm tribe. Professor Owen says that in their fully ossified skeleton there is only one and a-half of earthy salt per cent.; and the remainder is mucus, not gelatine.

GAUTIER ON NEBULÆ.

The *Bibliothèque Universelle et Revue Suisse* has an interesting article by Professor Gautier on Nebulæ, of which the following is a condensed account:—

The author begins by stating that his purpose is to give "a slight idea" of a wonderful class of objects which have been specially studied by the two Herschels, Messier, Lord Rosse, Vico, Secchi, Lamont, Lassell, and Bond, and of which fifty-three have been accurately placed in M. Langier's catalogue, published in the *Comptes Rendus* of 12th December, 1853. This list gives the positions of the nebulæ with great nicety, and thus lays a foundation for deciding whether they are really situated beyond the fixed stars that are visible to us.

The Orion nebula formed the subject of a paper presented through M. Struve to the St. Petersburg Academy in 1856, and which detailed the results of four years' investigations, conducted by M. Liapounoff (Director of the Kasan Observatory), with an equatoreal telescope, equal to that of Dorpat, and a meridian circle of Repsold. M. Liapounoff noted down the position of every star he could distinguish in this nebula, and in comparing his accounts with those of Sir J. Herschel and Messrs. Lamont and Bond, M. Struve came to the conclusion that it must be subject to changes of form, and of the relative brightness of its different parts.

At Poulkova M. Otto Struve continued the work of M. Liapounoff, as recorded in the Monthly Notices of the Astronomical Society for 1857. M. Struve pointed out the variable light of divers little stars, and he observed: "The existence of so many variable stars in so small a space of the central part of the most curious nebula in the heavens, naturally induces us to suppose that these phenomena are intimately connected with the mysterious nature of this body. . . . . In admitting that the rapid changes of light observed in these little stars, whether in the region called *Huyghens* or that termed *Subnebulosa,* are connected with the nature of the nebula, we may presume that we should equally observe changes in the appearance of the nebula, and in the distribution of the nebulous matter; but observations of this kind are subject to so many illusions that we cannot be too cautious." Among causes of discrepancy between different observations, he enumerated the power of the telescope, the state of the atmosphere, the eye of the observer, and his experience in producing graphic delineations of this kind of object; which, taken altogether, precluded any certain discovery of changes of a progressive character that might occur in short spaces of time. It is, therefore, towards rapid changes that attention should be directed, and they can be better noted by attending to certain prominent portions of the nebula than by watching it as a whole. Following this rule, M. Struve thought he detected considerable alterations in a single winter, and he mentioned four parts of the nebula in which they seemed to have occurred. The first is a bay extending from the Strait of Le Gentil in the direction of the trapezium of stars situated towards the middle of the nebula. This bay sometimes appeared to him dark like the strait; at others full of nebulosity, and little inferior in light to the parts surrounding the region of Huyghens. Dr. Lamont was the first to describe this bay, which was not seen by Sir J. Herschel. The second is a nebulous bridge traversing the Great Strait, and exhibiting towards its centre a luminous point. In the winter M. Struve saw it as represented by Herschel and by Liapounoff, with much more concentration of light, but always much more extended than it appeared to these two astronomers, and closely approaching the southern limit of the Great Strait. M. Lamont had only indicated the faintest traces of it, and M. Bond had not seen it at all. The third is a nebulosity surrounding star 75 of Herschel's catalogue, and which appeared to M. Struve subject to great changes of light. The fourth is a sort of narrow channel (*canal étroit*) connecting in a straight line the dark space situated about stars 76, 80, 84 of Herschel's catalogue, with the northern margin of the Great Strait. This channel, not figured by any former observer, was distinctly seen by M. Struve on the 24th March, 1857, but on other occasions he could not discover the least sign of it. He thus arrived at the conclusion that the centre of the Orion nebula is in a state of constant change, but he considered that, except under favourable circumstances, no achromatic telescope of less than ten inches aperture would enable them to be perceived.

In 1861 the Monthly Notice of the Astronomical Society contained a report by Mr. G. Bond, of Harvard College, on the "Spiral Structure of the Great Nebula in Orion." Mr. Bond, senior, in 1848 noticed a disposition in the light of this nebula to radiate from the south side, starting from the vicinity of the trapezium of stars situated towards the middle." Mr. G. Bond began, in 1857, to form a catalogue of stars, comprised within a square of 40 minutes, having θ (theta) in its centre. He selected 121 brilliant stars as points of reference for the smaller stars which were of too feeble light to remain visible when his micrometer threads were illuminated. He placed in his first sketch 262 stars. The form and disposition of the elongated luminous tufts, alternating with darker spaces, proceeding from the neighbourhood of the trapezium, were determined by two independent proceedings, the nebula being first sketched as a light object on a dark ground, and then as a dark object upon a light ground.

The general aspect of the greater part of the nebula as thus depicted, was that of an assemblage of tufts or curved bunches of luminous matter emanating from the brilliant masses near the trapezium, extending towards the south on each side of an axis, passing by the top of the region of Huyghens, and whose angle of position is nearly 180°. Twenty of these circumvolutions were distinctly traced, while others, producing the same impression, are too faint or too complicated to be described with precision. Thus the nebula of Orion belongs to the spiral class.

Mr. Bond noticed many cases in which masses of nebulous matter were associated with stars, frequently under the form of little tufts extending from the south side. He likewise cites two remarkable instances of a deficit of luminous matter close to tolerably brilliant stars. The first occurs in the trapezium itself, the dark centre of which has been noticed by many observers, and the other belongs to the star ι (iota). Mr. Bond inclined to the idea that there was a physical connection between the stars and the nebulosity. The spiral form accorded with the notion of a stellar arrangement, as shown in a mass of stars, properly so called, in the constellation Hercules, which have evidently a curvilinear disposition.

In 1860, Mr. Norman Pogson observed a change in the nebula or mass of stars in Scorpio (No. 80 in Messier's catalogue). On the 9th May, this nebula had its ordinary aspect, without any stellar appearance, and on the 28th of the same month, he noticed in it a star of 7th or 8th mag., which was also seen on the 21st at Königsberg by MM. Luther and Auwers, and estimated by them as below the 7th mag. On the 10th of June following, under a power of 66, the star appearance was almost invisible, but the nebula glowed with more than ordinary lustre, and with a well-marked central condensation. Mr. Pogson did not attribute this variation to a change in the nebula itself, but thought it singular that a new variable star, the third comprised in the same field of vision, should be found situated exactly in the centre of this nebula.

More recently, M. Chacornac has observed the annular nebula in Lyra with the great Foucault telescope, and he has confirmed its resolution into a mass of minute stars, the most brilliant occupying the extremities of the inner axis. This nebula looked like a hollow cylinder seen in a direction nearly parallel to its axis, with its centre, as described by Lord Rosse, veiled by a curtain of nebulous matter which was transformed into a thin layer of little stars. When all other light was excluded, M. Chacornac found that the scintillation of this multitude of luminous points produced a singular effect of giddiness.

M. Gautier then proceeds to speak of the labours of M. d'Arrest, first with a $4\frac{1}{2}$ inch telescope, at Leipsic, and since then with an 11 inch achromatic at Copenhagen, which has enabled him to discover more than 100 new nebulæ. With regard to variable nebulæ he thinks much caution needed. He confirms Struve's observations on the nebula of Orion, and finds Mr. Hind's little nebula in Taurus to be also variable.* The nebula which Sir J. Herschel thought had disappeared, has been seen by M. Chacornac with the Foucault telescope, and by M. d'Arrest with his great reflector.

Sir J. Herschel, in his great paper on nebulæ (published in *Phil. Trans.*, 1833), remarked that the number of nebulæ physically united, is probably larger in comparison with the total number of nebulæ, than that of double stars when compared with the entire number of known stars; and taking 5′ as the maximum distance of double nebulæ, M. d'Arrest has already arranged fifty under that category, and he estimates that there are two or three hundred of this sort out of about three thousand nebulæ visible in our hemisphere.

M. d'Arrest mentions a triple nebula, but only in one instance has he been able to observe noticeable changes indicating a common revolution. The interesting object has a Right Ascension of 109° 12′, and N. Declination 20° 45′. It is represented by M. Lassell, in the engraving accompanying his memoir, in vol. xxiii. of the Astronomical Society. Its two components are distinct, being only separated by 28′, but they are difficult to see when the micrometer threads are illuminated. A very small star is seen between them, exactly where M. Lassell observed it ten years ago.

Finally, M. d'Arrest reports a small number of instances in which a slight change of distance and position has been noticed after the lapse of a certain time, between particular nebulæ and small adjacent stars.

We may remark that, if it can be shown that two or more nebulæ, each probably a system of thousands of suns arranged in a particular order, and at great distances from each other, really revolve about one another, or about a common centre, not only will some of the grandest views of creation be opened, but fresh speculations will arise concerning the nature of the force by which such mighty movements are compelled.

* See Intellectual Observer, vol. ii., page 310.

M. Auwers has published some observations made by him at Göttingen and Königsberg, to show that the two last variable nebulæ of M. d'Arrest have not really altered in luminosity. With regard to the nebula of Mr. Hind, which is the only one whose periodic variation has been proved, the same astronomer states that he saw it perfectly in March, 1858, but that it was feebler than in 1856. M. Chacornac could not find it in 1858, and erroneously thought it had disappeared.

MAGNIFICENT METEOR SEEN ON THE 27TH OF NOVEMBER, 1862.

BY E. J. LOWE, F.R.A.S., F.L.S., ETC.

Another of those curious strangers that now and then make their appearance to astonish and puzzle us, was seen on the 27th of November.

Before describing this phenomenon, it will perhaps be desirable to say a few words, *en passant,* on meteors in general.

These bodies vary considerably in size, shape, velocity, and appearance: some are so small as scarcely to be visible to the naked eye; others, on the contrary, are two or three times the apparent diameter of the moon. Some are visible and gone again almost instantaneously, others lasting a number of seconds. Respecting their shape, they are oval, circular, kite-shaped, sharp and well-defined, or a confused mass of light—occasionally assuming extraordinary forms.

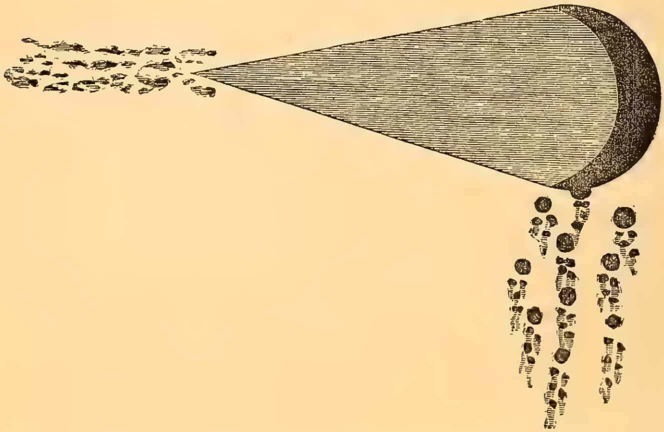
Nearly all the large meteors give the impression of being within a few hundred yards of the observer, showing how fallacious our estimate frequently is as to the distance and size of bright bodies; and this remark may also apply with equal truth to dark bodies. In a total eclipse of the sun, the dark surface of the moon has been seen apparently within two or three hundred feet of the earth, and yet it was, in reality, thousands of miles away. The meteor that has just occurred was thought to be within a few hundred yards of an observer near London, and equally near to others who viewed it from Grantham. At the latter place a gentleman was certain that it was on this side of the Wood-hill Tunnel, until it was pointed out that were this the case, there must have been a line of brighter light along its path reflected on the ground. The distance, however, had no increase of light, and the darkness caused by a steep hill on this side of both the moon and meteor was not diminished; clearly showing that it must have been far beyond this hill. From the appearance and position, as seen from Dover (150 miles S.E.), it seems to have been at least three or four hundred miles distant from Grantham. As regards size, this is also fallacious; an incandescent body of a known size does not decrease in its apparent dimensions by removal to a greater or less distance: for in some experiments it was found that the source of light appeared greater at a quarter of a mile away than it did at a hundred yards. A row of lamps in a street is not seen to decrease by distance in the same manner when lighted at night as when viewed in the daytime.

Occasionally these large bodies are seen to burst, a noise as of distant thunder is heard, and the meteor itself, or fragments, appears to fall to the ground—the actual bursting taking place at some miles' elevation above the surface of the earth.

There are several distinct features in the light emitted from these large bodies: 1*st*, there is the light of the meteor itself; 2*nd*, a train of sparks or continuous streak left in its path; and 3*rd*, a discharge of balls from the head of the meteor. As regards the first case there seems to be great differences of opinion. From my own observations I greatly doubt the self-luminosity of a meteor; the intense light always comes from the front edge of the body, as if caused by becoming ignited, or igniting something in the region through which it passes. The great difficulty is to imagine what that something can be on the confines of the air, if not actually above the atmosphere. Aurora borealis at the same height exhibits a flame: it must, therefore, be a light-bearing region, perhaps magnetic. The friction produced by the velocity of a large body may cause the ignition. Our ordinary flame is not bright enough to produce the intense light of a meteor; the brightness of electrical light would be nearer the truth.

With regard to the train of sparks, or continuous line or streak of light often left after the meteor itself has vanished, and which in the case of a train of sparks only lasts a second or two, whilst as a streak or line of light it has been known to last upwards of a quarter of an hour—this more closely resembles a phosphorescent luminosity, that when once luminous it is with difficulty extinguished. I have seen it as a long line that has been gradually bent into a wavy line by currents. I have also seen the two ends of a straight line of this light actually unite and form a circle with stars shining within the inclosed ring. The meteor which produced the phenomenon had departed in one direction, whilst this phosphorescent luminosity was borne along at right angles to the meteor's path. The velocity is so very different; a meteor, when recorded as moving slowly, moves many times more rapidly than is the case with this luminosity—the latter is always *very sluggish* in its movements. The balls projected from the head of the meteor, usually (but I think erroneously) considered the bursting, always fall perpendicularly. The impression given is, that fragments are split from the outer edge of the body, which fall, by the law of gravitation, to the earth. The appearance of these balls is not confined to the bursting of the meteor—*i.e.*, immediately before its disappearance they are seen to be emitted as showers, sometimes at frequent intervals along its path; and these displays were of frequent occurrence with the meteor of November 27th.

The accounts given of these almost instantaneous appearances require to be taken with caution. With those unused to observation there is certain to be a want of steadiness; amazement bewilders the brain and frequently exaggerates the appearance; then, again, the want of proper words and terms of description, and also of the knowledge of the various features to be examined—all operate against a faithful account. This is to be regretted, because each meteor puts on a different appearance, according to the position of the observer; and this will be apparent when examining the accounts of the late meteor as seen from Grantham and Dover—two places 150 miles from each other.



METEOR AND FORMATION OF ROCKET-LIKE SHOWERS.

The meteor of 27th November was seen by myself on the platform of the railway station at Grantham under the most favourable circumstances—so much so, that there cannot be an error of five seconds in time, nor of one minute in space.

Hour of appearance.—5h. 46m. 57s. P.M., G.M.T.

Hour of disappearance.—5h. 47m. 5s. P.M., G.M.T.

Motion.—Slow.

Duration.—8 seconds.

Greatest diameter (*i.e.*, width across the head).—0° 31′ 0″.

Length longitudinally.—1° 17′ 0″.

Colour.—Blue.

Form.—Kite-shaped.

Position near β Ceti.—Æ. 0h. 36m. 39s.; S. Dec. 18° 45′ 0″.

Position near Fomalhaut.—Æ. 22h. 50m. 1s.; S. Dec. 30° 20′ 59″.

The meteor was somewhat kite-shaped, being nearly equal to the moon in breadth, and above twice her apparent diameter in length. (This estimate being taken by looking at the meteor and the moon at the same time.)

The light was an intense blue, but only intensely bright in the front, mostly as a crescent, but occasionally expanding to almost a circle ; the remaining portion *milky-white,* and dim in comparison.

A train of sparks was left in its path, yet these only lasted from one to two seconds ; balls of a blue colour, of large size (almost equal to the apparent diameter of Mars), also fell from the head of the meteor, perpendicularly downwards, not continuously but at frequent intervals (more especially between β Ceti and Fomalhaut). These balls threw out other smaller balls, which burst into star-like sparks of a yellowish colour, not unlike the shower seen from a rocket at a distance, but infinitely more beautiful.

The meteor gradually increased in size, but not uniformly ; an occasional decrease in size and brightness taking place. It vanished at its maximum brightness, not bursting, but as if going behind some opaque body.

I did not see the commencement, owing to a building ; but from the testimony of the Grantham stationmaster (who was on the other side) it must have commenced very near to where I first saw it : if the path were produced backwards, it would almost cross the Pleiades. My view commenced near *α Ceti,* and after progressing some distance the meteor passed almost over *β Ceti,* and then immediately above *Fomalhaut,* vanishing 4° beyond this star, and about 5° above my horizon.

This meteor gave a very strong impression that it was a *non-luminous* body—the light being produced by the *friction of its velocity on the air.*

Mr. H. P. Finlayson saw this meteor from Sandgate, near Dover, and his remarks add great interest to this appearance. They are—

"Hour of first appearance.—5h. 47m. 5s. P.M., G.M.T.

Duration.—Not more than 4s. or 5s.

Motion.—Slow.

Greatest diameter.—0° 13′.

Greatest length.—0° 26′.

Colour.—White, but reflected light bluish.

Form.—Kite-shaped, or what are called 'Prince Rupert's Drops.'

Position of appearance.—R.A. 23h. ; S. Dec. 7°.

Position of explosion or disappearance.—R.A. 20h. 40m. ; S. Dec. about 25°.

"Although the moon was extremely bright and clear its light was lessened by that of the meteor; and I have little hesitation in saying that if a transit had occurred the meteor would have been seen as a bright body on the moon. There were no coloured balls seen to fall from its head, but a train of red sparks was left in its path.

"Had its path been continued backwards, it would pass about midway between the moon and the planet Mars; and if a line touching the horns of the moon and produced till it intersected the path of the meteor, it would have been nearly at right angles with it."

It will thus be seen that near Dover the meteor first came into view at the point where it disappeared at Grantham; that it was *white* instead of *blue;* that it was not nearly so large, but apparently quite as bright, and that no coloured balls fell from its head.

The Rev. John Burdor saw the formation of the meteor from English Bicknor, in the Forest of Dean, Gloucestershire; he saw a stream of sparks for an instant, which gathered, as it were, into the meteor—one or two solitary sparks at first, increasing to a stream until the meteor was formed, and then the meteor itself increasing in glory and volume until it vanished. The colour most intense blue. The height above the horizon was guessed to be 60°.

At Streatham Hill, London, it had the appearance of being in a state of incandescence, surpassing the electric light in brilliancy, if possible. It disappeared without any apparent explosion about 5° beyond, where it became invisible at Grantham.

At Sutton Courtney, near Abingdon, Mr. John Kent says there was a slight explosion similar to that of a percussion-cap, and this attracted his attention to it; he considered it remarkable how suddenly it disappeared, there being apparently no obstacle to hide it. Mr. J. Seeley, who saw it from Hazeby Heath, Hants, was also struck with the suddenness of its disappearance.

At Bridport, in Dorset, Mr. Charles Walker saw it rise in the N.E., move horizontally, and disappear in S.E. We estimated its greatest height at about 20°; its shape conical, with a circular base, the latter moving foremost. The apparent length was rather greater than the diameter of the full moon, and the greatest breadth about half its length.

Mr. Philip Barrington saw the meteor from near Bray, county Wicklow. It appeared almost due E., and moved rapidly to about due S.E., lasting only a few seconds. It seemed about four times the diameter of the moon in length, and half its diameter in breadth at the head, tapering down to the extremity of the tail. It moved nearly horizontally at an altitude of 5° or 6°. A number of sparks were left behind in its progress, and just before its disappearance it threw out the most brilliant light, blue and green, like the explosion of an enormous rocket.

Mr. A. P. Falconer, of Lymington, Hants, saw a great light issue from the sky, and increase in size as it approached him. He says, "I was then standing in a line due S. with the needle rocks; as it advanced to this line, suddenly it cast off sparks in the same way as is seen to fly off from the blows of the smith's hammer off a piece of hot iron; on its N.E. limb and under it these lumps of fire and flame flew off in curls, some falling down whilst part formed a broad expanse of light behind it, *crimson-red* interlined above with *greenish-blue,* and below *bright yellow.* The ball of light was *bright blue,* and it was like a Roman candle. I fancied as it cast off these sparks it seemed impeded in its course, and apparently to *forge* its way along. Its size increased as it approached me; I feared these sparks, discharged so abundantly, would set fire to my hay and straw ricks; these ceased, it turned more southerly, then quickly whirled to the S. (*due*), between the earth and the moon (which was then over it), and vanished away."

The meteor, as Mr. Falconer observes, was impeded in its course; there was at Grantham a momentary check in its velocity each time it discharged a shower of balls.

THE EYE AND THE MICROSCOPE.

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

(Member of the Microscopical Society of London).

It is a common, but fortunately an erroneous opinion, that the use of the microscope is necessarily followed by injury to the eyes. It is no doubt true that those organs are often fatigued by looking through the optical arrangements by which the minute world is made known to us; but the inconvenience generally results from causes capable of removal; and it is not too much to affirm that very few miscroscopic studies, whether pursued in the day-time, by the help of natural illumination, or of an evening, by the aid of appropriate lamps, have any inevitable tendency to debilitate the sight. Experienced observers are well aware of this fact, and unless their researches have demanded unusual exertion, they can report, after ten or twenty years' labour, that their visual apparatus has not deteriorated any faster, if so fast, as that of their neighbours, which has never been employed in seeking the information which lenses are able to afford.

In the earlier days of optical science, it was impossible to imitate the natural conditions of good and pleasant sight, either with the microscope or the telescope. The eye possessed advantages which no artist was then able to reproduce in optical combinations; and hence every attempt to extend its powers involved the necessity of putting up with serious defects. These unfavourable circumstances have been so far changed, that it is now possible to make telescopic, or microscopic, vision almost as clear and as easy as if no instrument intervened. To do so, however, requires a close copy of the natural conditions of satisfactory sight. We see objects most agreeably and correctly at a certain distance, with a certain quantity and a particular direction of light; and it is also necessary that they should be, or appear to be, of a sufficient size. To stare at a white house in the full glare of sunlight, to strain every nerve in order to make out dim outlines faintly and uncertainly looming through a fog—these are things which everybody knows are painful and mischievous; and if we make our microscopic experiments under a similar blaze, or in a similar mist, we shall easily produce an analogous effect. If, on the other hand, the light falls softly, and in right quantity, upon or through our object—if the power employed is sufficient to make the details clear, and the whole arrangement is good—the sensation will bear so close a resemblance to that of the normal vision, that little or no fatigue will be felt.

This question is important, because on the one hand many persons hesitate to become microscopists from a fear that their eyes will not bear the strain; and, on the other hand, scores of people who have purchased instruments, give up their use because they do not succeed in seeing through them with satisfaction and ease. The first essential requisite is to obtain a microscope free from important defects, and unless it is convenient to spend a large sum of money at once, it is better to have only two powers, and a sufficient quantity of apparatus to use these with the best effect. Furnished with a microscope having a body about ten inches long, or if shorter with a Kelner eye-piece—which to some extent remedies the want of length—and two objectives of one inch, or two-thirds, and one-quarter, or one-fifth focal lengths, and with two or three eye-pieces, the student can verify the majority of observations of general interest in the animal and vegetable kingdoms, and he can examine for himself all the objects he is likely to collect. A greater array of powers is often convenient, and even indispensable for special purposes; but it is of far more consequence to use those mentioned well, and they must, under any circumstances, form the staple instruments of research. The lowest of these powers, the inch, or two-thirds, should have a perfectly flat field, and evince no sensible defects if made to give four times its ordinary magnification by a higher eye-piece and a few inches of the draw-tube. A well-made section of an echinus' spine is a good test for flatness of field—the margin and the centre should come in and go out of focus together. That elegant Diatom, the *Arachnoidiscus Ehrenbergii,* will likewise supply a fair but by no means a difficult test of defining power. Let us imagine a beginner trying to show these two objects. In the first place, let him take the echinus' spine, the inch or two-thirds object-glass, and the first eye-piece. Having got the spine in focus, the mode of illumination will decide whether it can be seen without wearying the eye. The microscope ought to have the mirror below the stage so mounted as to move up and down, and right and left, and to assume a position at any angle with the plane in which the object lies. Candles should be avoided as a source of light. They are too unsteady and continually vary in height. Discard them, therefore, and buy a small paraffin lamp for a shilling or eighteenpence.* It will be high enough for many purposes, and can be raised when required by a block of mahogany or a book. As a general rule, the source of light is required at two elevations only—one suited for transparent illumination with the mirror under the stage, and the other to enable the bull's-eye to condense the rays upon any substance to be seen by the light which it reflects. The lamp should, except in some special case, be placed on the left of the observer, a few inches from the microscope; and to prevent his eye being distracted by its glare, a shade should be employed. This is made of various patterns to suit different fancies, but the simplest plan is to take a piece of *thin* flexible cardboard, about nine inches by six, cover it with black cotton velvet, which has no lustre, and make a hole in it through which the tube of the microscope, immediately below the eye-piece, can be introduced. Supplied with this screen, both eyes should be kept open, and the object steadily viewed as soon as the focus has been accurately arranged. Then take the mirror, which we will suppose to have been turned so as to throw some light through the echinus' spine, and observe the effect of slight changes in its position. The whole field should be equally lit, or fatigue will ensue from some portions being seen worse than others. There should

* Many observers will prefer a superior lamp, and they should inspect the elegant and excellent pattern devised by Mr. Pillischer, the optician. In addition to being good for the microscope, it is one of the best reading-lamps yet introduced.

be no glare. With a naked lamp this can be avoided by regulating the quantity of the light, and paying attention to the angle—a little obliquity having a softening effect. A ground glass globe gives a pleasant repose, and the same, or a better effect may be obtained by melting a bit of spermaceti on thin paper, and cutting a disk of the preparation thus made, which may, according to its size, be dropt over the largest hole of the diaphragm, or placed on the flat side of the bull's-eye lens. The latter is the best plan, as it causes no interference with an oblique direction given to the light by turning the mirror. The student must not imagine he has illuminated the echinus' spine properly until every portion is clear; no part being enough in the shade to diminish its distinctness, and none too bright to be seen without pain.

Having thoroughly succeeded in illuminating the echinus' spine as a transparent object on a light ground, so that it can be seen as comfortably as a willow-pattern plate one foot from the eye, let the mirror be thrown out of the plane of the instrument, and at such an angle that none of its light can fall directly upon the object-glass. If this be accomplished, the ground will be dark, and the object will stand out in strong relief seen by the light it is able to refract, or bend back to the plane of the instrument. This produces a beautiful effect, and is sometimes superior to the dark ground illumination afforded by the parabola or spotted lens. What has been previously said about uniform distribution of light should still be attended to, as the want of this uniformity is a frequent cause of distress to the eye.

It is customary to treat the parabolic illuminator as if it were a difficult instrument to manage, but after a month or two's practice with the stage mirror at various angles, it may be advantageously employed, and has an admirable effect, not only in giving beauty to a large range of objects which possess the necessary refractive power, but in rendering visible points of structure which other modes of illumination do not readily disclose. For example, the red eyes of rotifers gleam like rubies in its light. The action of the parabolic illuminator is to throw through an object a cone of rays at such an angle that none shall enter the objective until refracted by the substance under view, which, if suited to the purpose, stands out with great brilliance on a black ground. The stop with which it is provided should usually be pulled back and a strong light thrown up the instrument from the stage mirror, which should receive a good supply of light from the bull's-eye or condensing lens, having in this case its flat side to the lamp. It is usual to recommend the use of the *plane* mirror, but the concave one generally answers best. The parabola should be gently moved backwards or forwards till the best condensation of light is obtained.

The lesson with the echinus' spine is not yet over. It should be seen as an opaque body, with the bull's-eye lens, with the lieberkuhn and dark well, and with the side silver reflector. If the bull's-eye is intended to give a strong spot of light, its *convex* side may be turned towards the lamp; but when employed to increase the quantity of light which falls upon the mirror, its flat side should occupy that position. The lieberkuhn is very easily used, and if a few shillings do not matter, it is better to get a set of dark wells from the optician than to make shift with spots of velvet or lamp-black upon a glass slide. The side silver reflector cannot be recommended to a mere beginner, but after a few months work has given some skill in manipulation, it is a valuable aid. It is best mounted on a stand like a little bull's-eye, and should have motions in all directions, including the means of changing its height. When it is to be used, place the lamp on the *right* hand, the bull's-eye in front of it, and the silver reflector on the left, so that it may catch the light, which will be thrown across the stage. Thus arranged this piece of apparatus has several advantages. It gives light with one reflection from a single surface, which has no tendency to become chromatic, and it affords great facilities for oblique illumination. With such an object as the elytron of the diamond beetle it has a gorgeous effect, and, at the same time, brings out fine lines which an equal amount of light less judiciously applied would efface. It will not do so well with the echinus' spine, as the method of dark-ground illumination already described; but the student should try this, and other objects, in every possible way, and will thus acquire manipulative skill and judgment concerning the best plan to employ.

Having gone through a set of illuminating experiments with the echinus' spine, repeat them with the slide of arachnoidiscus, and specially note the beautiful appearance which these diatoms present when the parabola is used. They then resemble the exquisite filagree-work which the Maltese execute in silver; and if the parabola is suddenly removed, and light from the mirror under the stage sent through the object a great change will be noticed in the disposition of the light, and dark lines. The markings of the arachnoidiscus must be displayed as they are shown in good drawings whatever mode of illumination be employed, and it is well to select a slide containing, in addition to one or two arachnoidisci, some other large diatoms, such as *Triceratium, Biddulphia,* etc., which can be displayed with the same power.

The objects recommended for the first lesson in such a use of the microscope as will not injure the eyes, may be varied at the pleasure of the student, but it is well to begin with those that can be shown with a low power, and which, either singly or in groups, occupy all the field. Another class of objects do not want more magnification for their efficient display, but are not big enough to occupy so large a space. The tarsal joints of the feet of many insects, their spiracles and mandibles, belong to this category. Now, if such objects are surrounded by a flood of bright light, they will not be distinctly shown, and the eye of the observer will be uncomfortably affected. In these cases the object should be arranged exactly in the centre of the field, as a symmetrical appearance is more agreeable and less fatiguing than the aspect of anything that looks askew. In the next place, the light must be moderated by obliquity, by the spermaceti paper, or by some other mode. The least troublesome of these methods is the spermaceti paper, or a piece of semi-transparent white glass made for the purpose. If the object needs a very strong light to make it sufficiently transparent, the best plan is to use an achromatic condenser and allow a sharp pencil of light to reach it through one of the smaller stops. The value of the achromatic condenser for showing difficult objects is well known, but its advantage in saving the eyes is less recognised than it deserves. Many things, such as portions of insects, can be seen distinctly without it, though with a fatigue which is avoided by its use. When employed with low powers the usual plan is to remove the upper part of the combination so as to bring its focal length below that of the objective employed. In many cases, however, it is better to use the whole, which we will suppose to be a quarter-inch power, and to throw it out of focus, so that the rays will cross before reaching the object. This plan, with the use of one of the smaller holes or stops, gives enough light for many purposes and prevents over excitement of the eye.

No student who wishes to work efficiently with a quarter-inch, a fifth, or a higher power, should begin with either of them; but first learn to use an inch or two-thirds with the various methods of illumination which we have indicated. If premature efforts are made to obtain considerable magnification, disappointment will inevitably result, and so far as what Dr. Kitchener termed the "economy of the eyes" is concerned, it should be remembered that every increase of power augments the difficulties of obtaining a clear and pleasant view. An experienced manipulator will show a properly selected and prepared object with the highest objectives without any sacrifice of convenience or distinctness; but it is only after considerable practice that a beginner will be really successful with a quarter-inch. The popular notion of the necessity for magnification is quite wrong, and the common exclamation, "That must be a very powerful microscope," is a frequent indication of this mistake. High powers are needed to exhibit details that can have no meaning, and often no beauty, for those whose minds have not been previously prepared to appreciate them by a broader acquaintance with the complete structure of which they form a part. Thus the same steps which the microscopist should take for the preservation of his eyes, lay the best foundation for the more difficult operations, in which the employment of higher objectives and of niceties of illumination become indispensable.

When a good set of experiments have been made with an inch or two-thirds objective, and the difficulties of microscopic vision have been sufficiently conquered, a similar course should be commenced with a quarter or a fifth object-glass. Objects that are severe tests of the perfection of such glasses should be avoided until those which are easier have been successfully displayed. The scales of the *Vanessa urticœ*, and that pretty diatom the *Pleurosigma hippocampus*, will do admirably for a beginning, taking them in the order mentioned. The butterfly scales require a clear, steady light sent through with little obliquity, and the mirror must be turned so that the illumination leaves their edges clear all round. If one side appears shadowy, there is some fault in the angle at which the light falls; and if the unoccupied part of the field is too brilliant, either the light must be reduced by turning the lamp a little lower, or the distance of the mirror from the stage must be altered, or the spermaceti screen interposed.

The *Pleurosigma hippocampus* will give good practice in regulating the obliquity of the rays from the mirror. It is a very easy object for a good manipulator, but a beginner must not be surprised if he makes a hundred trials before he can quickly and readily show the two sets of lines as plainly as he can see the pattern of an engine-turned watch. As a rule, no more light should be used in displaying any object than would be sufficient to imitate the brightness of a larger object of the same kind as seen in the diffused illumination of a fine day, and it is often desirable not to exceed that of a shady room in the summer time. When the lamp and optical contrivances have been judiciously arranged, an increase or decrease of light can be obtained by turning the wick a little higher or lower, and if an observation is prolonged, less light will suffice than for a temporary glance, as the eye is more willing to accommodate itself to a moderate illumination than to grow accustomed to anything like a glare.

A magnification of two hundred linear or upwards can only afford easy vision with objects that are very flat, as slight inequalities of surface inevitably throw the salient, or retreating, portions, as the case may be, out of focus. As a general rule, the larger the angle of aperture of the object-glass, and the more oblique the rays it can receive from the surface of the object, the more cloudy will be any parts that are not focussed to a nicety, and hence, for ordinary use, it is well that a quarter-inch power should not exceed about 80 or 90 angular aperture, and a fifth a little more. The impossibility of making any high power work well on uneven objects indicates a practical restriction of their use; and when they must be employed upon things which they can only show in part, no attention should be paid to what is indistinct. This habit is easily formed by concentrating attention upon that which is seen well; and if this is accomplished, a fertile source of optical discomfort is removed.

Let one more hint be given on the avoidance of injury to the eye. Secure steadiness in the instrument, the table, and the place of observation. It is extremely fatiguing, and taxes the brain as well as the eye, to try to make out the details of objects that are fidgetting about. Slides merely require a good instrument, a table which no one shakes, and a room in which no one runs or stamps about; but live things must be restrained by slight compression, or by a loop of thread, which when pressed down in the live box, forms a sort of cage, the whole of which can be taken in by the power employed.

It would be easy to prolong these hints on the eye and the microscope; but if, the student can be set to work in the right manner, he will soon be able to profit by the labours of well-known writers; and if, during the first three months of his engaging in microscopic pursuits, he will determine never to be satisfied unless his objects are seen as easily and as plainly as the furniture of the room, he will not, in any subsequent portion of his career, complain that the employment of the most fascinating of optical instruments has injured his sight.

EXPERIENCES OF HASCHISCH.

BY SHIRLEY HIBBERD.

The translation of a note by M. S. de Luca, on Haschisch, which appeared in the December number of the Intellectual Observer (page 346), recalled to my memory some experiences of my own in the use of Haschisch. These experiences might not be worth recording were it not a matter of some interest to the medical profession whether or not Haschisch can be exhibited as a therapeutic agent, a matter to be determined very much by a comparison of its effects on persons of various habit and constitution. It may be right to preface these remarks by stating that I am of middling height, spare habit, sanguine-nervous temperament, not robust, but have always enjoyed sound health, have great powers of endurance, and possess altogether a vigorous constitution.

The publication, in 1845, of a work on Haschisch, by Dr. Moreau,* occasioned between myself and a friend, who was then preparing for the medical profession, some conversations on this and other narcotics, the result of which was that we several times smoked and swallowed opium, and resolved also to possess ourselves of some Haschisch. We made application to Messrs. Battley and Watts, the druggists, of Fore Street, without success, and, after other fruitless efforts, gave up the hope of ever tasting the fascinating compound of *Cannabis Indica*. In 1849 my friend was sent to Paris, and he soon after wrote to me to say that the students at the Medical Schools were all indulging in the intoxication of Haschisch, and by the next post he would forward me a sample. In due time I received a small brown slab, resembling a refined sample of Cavendish tobacco, and with it instructions to take not more than one drachm at a time. I was so eager to make acquaintance with it that I could have taken the whole at once. It weighed about half an ounce; it emitted an agreeable odour when broken, and felt sticky between the fingers. I trembled with joy as I turned it over and over in my hand, and I thought the odour affected me so as to produce a sense of inward satisfaction, like that of the first few whiffs of a good cigar. I retired to my study, it was then growing dusk, the season July, and I had been up two nights in succession reading Jacob Behmen. I remember feeling quite fatigued and low, yet in perfect health, and in the mood for any wild freak which might promise a sensation agreeable to the imagination. I sat down at the window, broke off a piece of the cake as near a drachm as I could guess, and swallowed it. I put away the remainder, that

* "*Du Haschisch et de l'Alienation Mentale Etudes Psychologiques.*"

I might not be tempted to take a second dose, and waited anxiously to feel its effects.

I soon became conscious of a sense of disappointment. I said "That was not Haschisch, but some preparation of chocolate." I took my pen to write an indignant letter to my friend, that he might know I had not become an easy dupe to his plan for deceiving me. I was at a loss how to begin the letter, though otherwise always ready at writing, even when fatigued. For a moment I paused, considering, and then the parietal bones of my head expanded widely, as if parting at the sutures, and again collapsed with a sort of shuffling sound. I said, "This is the result of fatigue; I have read too hard, I will go to bed." As I rose from my table I became conscious of an agreeable state of warmth and lightness; I felt as if I had taken Scotch whisky. The room seemed larger than usual, and getting larger and larger still; some skulls of animals on the walls acquired colossal proportions, and the conviction entered my mind that I had realized an old dream of living in the midst of the monsters of the Oolitic period, and that I had been awe-struck for years, immoveable, paralyzed, and with every faculty benumbed, except the faculty of wonder. I caught sight of my watch hanging in front of some papers on the wall, it at once dispelled the illusion. I calmly looked at it, and found it was just twenty minutes since I swallowed the Haschisch. Immediately the watch expanded to vast dimensions, and its ticking sounded through my head like the pulsation of a world. I knew now for the first time that I was under the influence of the drug, and began to make a few notes in pencil. Suddenly my limbs seemed benumbed, my toes shrunk within my slippers, my fingers became like the long legs of a convulsed spider, I dropped the pencil, and walked to the window. The landscape was so sublime that I forgot the cause of the illusion in my admiration of the magical scene. The horizon was removed to an infinite distance, but was still discernible, and the sunset had marked it out with myriads of fiery circles all revolving, mingling together, expanding and then changing to an aurora, which shot up to the zenith, and fell down in sparks and splashes among the trees, which at once became illuminated, and the whole scene was grand beyond description, with fires of every conceivable colour.

All this time the landscape continued to expand, everything grew as I looked on to greater and greater proportions. Trees shot up higher and higher; their branches overspread the sky; they met together, and became a confused mass; the lights, which just before had glowed on every hand, changed to a general purple haze, a sense of twitching in every limb, coupled with a feeling of weariness and depression, caused me to turn aside and sit down. The twitching changed to a sharp pricking sensation, most violent in the extremities, and for a moment the thought crossed my mind that I had been poisoned by strychnine. I opened a drawer to find an emetic, but the drawer had gone, and in its place sat one of my antediluvian monsters grinning at me—a real icthyosaurus, with a red cap on its head, and with drum and pandean pipes. For about six weeks —so at the time I determined the period—it played a monotonous tune, while I sat on the ground laughing and enjoying the idea of my toes and fingers being elongated into claws, when suddenly the thought seized me that I would destroy the illusion by an effort. I dashed at the monster, and my hand fell on the handle of the drawer. The dream was dissolved, and I could clearly understand that the ticking of my watch and the singing of a bird in the garden, were the real sounds which my fancy had changed to the drum and pipes of my Oolitic companion. I once more looked at my watch, and though years seemed to have elapsed since the spell began, I found the real period to be but twenty-five minutes.

This last act of observing the time threw me again off my balance. I said, "Twenty-five minutes, twenty-five days, twenty-five months, twenty-five years, twenty-five centuries, twenty-five eons. Now I know it all; I am the alchemist who discovered the elixir of life in the dark ages, and I shall live for ever; what is time to me? Yes, that was the elixir I took twenty-five minutes ago to experience a sensation, and there it goes round the room." It made me giddy to see it whirl like a wheel of which I was the centre. There was a bust of Milton on the shelf which had changed to the face of Jacob Behmen, and it sat on one of the spokes of the wheel, and smiled upon me with such a smile of peace and satisfaction that I shouted "Ha, ha!" The wheel revolved; it became brilliant with fiery corruscations, and by degrees the centre where I sat became the circumference, and I was whirled with it, my head opening and shutting, so that I could feel the cold air upon my brain; my breath getting short and difficult, my chest falling in as if crushed by a weight, and my stomach gnawed by rats. This went on for ages, yet I knew all the while where I was, and how the whole thing had happened; and actually got up, rang the bell, and ordered some coffee, though not for an instant did the illusion cease, nor, so far as I ever learnt, did the servant who answered me discover any signs of my aberration. I thought of the coffee as likely to relieve the sense of oppression and disorder, which was now fast dispelling the illusion by its reality. I felt my pulse, and tried to count it; I knew afterwards that it was full and rapid, but at the time the throbs were like the heaving of mountains, and the numbers would multiply themselves; so that as I counted "one, two, three," they became "one, two, three years, centuries, ages," and I literally shrieked with the overpowering thought that I had lived *from* all eternity, and should live *to* all eternity in a palace of coloured stalactites, supported by shafts of emerald, resting on a sea of liquid gold, for this was now the appearance of things; and the gnawing at my stomach suggested the idea that I should be starved to death and yet live, the deformed wreck of a deluded man.

At this moment there was a tap at the door, and the servant entered with the coffee. It was in a huge tankard chased all over with dragons that extended all round the world, and I saw the odour of it play round her in circles of light, and for at least an hour she stood smiling and hesitating where to place it, because my table was covered with papers. I very calmly removed a few of the papers, and heaved a sigh that dissipated the dragons, made the odours fall in a shower of rain, and she put down the tray with a crash that made every bone in my body vibrate as if struck by ten thousand hammers. I know not whether she was alarmed at my appearance, but she stood apparently aghast, and her rosy face expanded to the size of a balloon, and away she went with the rapidity of lightning, with Mr. Green in the car, and I stood applauding in the midst of thousands of lamps, which I had time to note—as the scene continued during a period which seemed indefinite—were all glow-worms, which I could touch, and they communicated to my fingers phosphorescent sparks, as if they had been rubbed with lucifer matches.* But I knew this was unreal; and I drank the coffee with the most perfect composure, though I felt it difficult to pour it out without spilling it, and the cup came to my lips as if it were the rim of a cauldron seething with a stew of spices and nepenthe, and amid the steam I could see the fierceness and tartness and prima materia of Jacob Behmen, all displayed, so that there was an end of the mystery, and I could see into his brain, as he now seemed to be looking into mine.

The moment I sipped the coffee it darted through me, and caused sensations of insupportable heat. The gnawing sensation of the stomach and contraction of the chest gave way to a sense of pricking, most violent in my fingers and toes, and yet, though painful, this was all pleasant; and though I could now collectedly observe the objects around me, yet they would transport themselves to immeasurable distances, and keep con-

* Only a few days before I had found some glow-worms in the garden, and on handling them found my fingers tipped with a dull phosphoric glow. This probably gave rise to the illusion. In fact, I afterwards traced many of my sensations during the paroxysm to previous events, and I almost believe the illusions are the result of abnormal memory.

tinually dilating in size; and though I looked at my watch, and saw that only forty minutes had elapsed, yet there was a secret persuasion in my mind that a period of at least forty centuries had gone by since I broke off a fragment of the cake, and committed myself to this dream.

There seemed to be now only one effect of the drug remaining, and that was a sense of warmth all over the body and a tendency in my head to expand and fill the room. But my arms dropped down; I could not keep them up without great and painful effort. I finished the coffee, experienced less of the pricking sensation than at first, and then rose and went to bed. I could walk without difficulty, though my legs were immensely long, and felt as if they would presently be cramped, so that I should cry out. As I undressed myself, my clothes would fly from me far away into boundless space, and become wandering stars, the buttons of my vest glittered in the firmament like Orion, but much more vast and splendid. I did not dare to look out of the window; I endeavoured to control myself, for I began to feel a sense of dread. As I got into bed, the bed extended; as I lay down at full length I myself extended, and as soon as I shut my eyes I felt that I covered the space of the whole earth. I had a sense of indescribable pain all over me; my skin seemed to move to and fro upon my flesh, my head swelled to awful dimensions, and I parted in two from head to foot; became two persons, each throbbing, breathing hard, sighing loudly, and lost in a commixture of ethereal yet agonizing colours and sounds. These seemed to continue for ages; but I was really asleep, and I never could call to mind at what time I went to bed, or at what point of the illusion sleep came upon me, but I always supposed it to be when I felt myself parted in twain, and immersed in light and music.

The next day I was awake early, and seemingly unrefreshed. I lay some hours pondering on the strange effects the drug had produced, and found it difficult for some time to prevent the intrusion of some broken fragments of the visions from taking possession of me; but when I had dressed and breakfasted, I felt as well as usual, and experienced no sensation whatever, which I could attribute to the effects of the drug.

In a second experiment, when unaffected by fatigue, I noticed that every physical and mental power seemed intensified. The illusions were more agreeable, and more ridiculous. I was the subject of a thousand different moods in the course of a few seconds, which, as in the former cases, seemed ages, and these moods were nearly always swallowed up in some strange vision of walls receding, landscapes rolling away to an horizon they never reached; skies opening to views of boundless space, and sudden flashes before the eye of visible odours, sounds, and ideas. The most remarkable feature of this paroxysm was a feeling that my soul was too large for my body, and must expand it to suitable dimensions. This pained me. I gasped for my breath, and felt my skin stretch and crack, and my joints fly like the snapping of huge beams of timber. These illusions became instantly the foundations of others. The cracking of my skin became suddenly a display of fireworks; and the snapping of my joints, the beating of gongs. Still pleasurable sensations prevailed; old memories were revived as pictures, and in many respects the effects resembled those of opium. But with opium there is a more entire and settled acquiescence in the illusions, and the ideas are more connected and continuous. With Haschisch there is a rapid succession of new scenes and startling combinations. When there is no pain the mind is literally whirled away in a succession of ravishing delights, and is yet all the while conscious that the whole affair is a deception. This paroxysm was soon over. It ended in a joyous feeling, in which life seemed lengthened out beyond the natural term, and all around me were objects of transcendant beauty, which I had the power of resolving into realities by an effort of the will; and it seemed that by successively using this effort the spell was broken, and the effect of the drug entirely destroyed.

The third dose was the last. I took it at mid-day, when in my usual health and spirits. Thinking that at the second experiment I did not take enough, I now weighed out four scruples. I at once went out, and proceeded across Finsbury Square, in the direction of the city. It seemed that about a quarter of an hour elapsed, during which I had felt a comfortable sense of warmth, and an increasing tendency to open my mouth for air, though I was not aware of any difficulty of breathing. "Now," said I, "this is pleasant. I shall have a glorious time of it." Immediately a voice shouted "There he goes; he's always inflated!" I was at once conscious that I was observed by passers-by to be expanding rapidly; and I felt myself rise from the ground, and walk above it. I halted, and by an effort of the mind collected myself, and found that the voice was that of a man selling some wares in Moorgate Street, who had not even noticed me, nor had any one else. But the thought occurred immediately, "This is a delusion, I *am* expanding, and cannot touch the ground." For a moment it might be, but it seemed an indefinite period, I saw the whole of the city spread out before me as a diorama. The church bells rang joyously; the houses were illuminated; the horses had gold and silver trappings; the people were waltzing, singing, laughing, and playing with fireworks. I again exerted my will, and felt a disgust at the meanness of such a performance, so far short did it come of my own sense of sublimity; for I felt exalted, and had the utmost consciousness that I was able to separate the false from the true, though I really could not. I retraced my steps, and was accompanied home with triumphal bands of music, shouts of triumph, running footmen, carrying coloured flambeaux; and I gradually quickened my pace till I ran too, only touching the ground at intervals, but for the most part swimming through the air; yet knowing that I walked as other people, and knowing too, that the ordinary sounds and scenes of the streets were the foundations of the whole delusion.

I reached home, and went to my study with a sense of satisfaction that I was now in a safer position than in the streets under such an influence. I sat down, and began to fill a pipe with Turkey tobacco. The pipe would lengthen out so that I could not reach the bowl, yet I did reach it, and in like manner the tobacco jar seemed deep enough to serve for one of those used in "Ali Baba, or the Forty Thieves!" and it suddenly became a row of jars, and out of them leaped the forty thieves, with monkey's faces and red jackets on.* I lighted my pipe, and as the cloud rose, I saw the party had all lighted their pipes, and were all proper Arabs, and I was in the midst, about to tell them a tale.

By some strange freak they all suddenly collapsed and became the double of myself, and yet they continued smoking. I now saw in the stomach of my double a huge cake of Haschisch, which presently shot up into his brain, and I felt a hot throbbing of the head, and the thought occurred, "Why, if he has the Haschisch, have I the burning, and how can that shadow smoke so calmly with a mass of poison in his brain?" I rose and propounded to my double a problem, "How, in the end, matter and spirit would be completely identified and made as one?" I was assured, in reply, that a sense of lightness would accomplish all, and I became light as a feather; I swayed to and fro, I was lifted up, sparks flashed in my eyes, fire was emitted from my fingers, my head, my stomach; and presently there was an awful crash, and I came to myself with the thought that I was going mad. I saw the pipe in fragments at my feet, and the burning tobacco on the hearthrug. I coolly picked it up with my hand, took another pipe, dropped the smoking tobacco into it, and saw my double again. This time he was the body and I was the shadow. I felt myself to be nothing; I was the soul, and beside me was the body. I thought I had now solved the problem of matter and spirit. I

* I had seen a monkey on a barrel organ during my walk, and tested my sanity by noting all its zoological features, in order to determine its species; but I lost it suddenly.

said, "They are only two forms of the same fact," and I laughed aloud, and they all laughed with me—the umbrellas, I mean—for my umbrella hung on a hat rail, and it peopled the room with offspring, and away went the furniture and ornaments and books, all carrying umbrellas, dancing, whistling, and splashing the water from the pools upon me till I stamped my foot and smothered myself with sparks, and planets, and auroras, and sank back with a pain in the head that literally dispelled the delusions, and created a momentary alarm. I was now beset with prickings; I seemed to swell; I had a difficulty in breathing—and yet it was a pleasant one. I put the tobacco away, inspected everything about me, and thought of trying the effects of reading aloud, and of attempting to sing; but I found my strength gone, I was spell-bound, so light I could not govern my movements, and by degrees I began to discover that the illusion was over, that it had left me tremulous, and with a low pulse, and requiring refreshment for my recovery. The first act on fairly reviewing the case was to seize the fragment of Haschisch that remained and fling it up the chimney. It went up, and did not even return again; I saw it go into the sky and become a bird, for the chimney was glass, and I could see through all its windings. I now felt that madness had really come upon me, and I began to bathe my temples and drink soda-water, and soon discovered that I had had a second paroxysm, for there lay the Haschisch among the shavings in the fire-place. I applied a match, there was a glorious blaze, and I now saw it dissolve into a grand procession of coloured lights, that died away and left me quietly and collectedly reflecting on the whole affair. This was the third paroxysm. There was yet one more, but of a trivial nature, and I had now done with Haschisch.

Having at that same period of my life frequently indulged in the use of opium, I can compare its effects with those of Haschisch, and I notice this great distinction as regards my own experiences:—With opium the mind and body become alike contented. Pain soon ceases after commencing to smoke a pipe in which a fragment of opium is mixed with the tobacco. On the other hand, Haschisch causes pain, and many unpleasant sensations are mingled with the most delightful of the visions it presents. Another distinction is that opium always causes some amount of nausea when its pleasurable effects are over. Haschisch leaves a slight depression, but the stomach does not appear to be affected; but this might be different if the use of Haschisch became habitual. Another distinction is, that the mind can pursue a train of thought logically while influenced by opium, but Haschisch causes so many alternations of feeling, that sequence is destroyed.

Some readers of this may associate the subject with the recollection of an act of discourtesy on my part. On the 12th and 19th of June, 1850, I delivered two lectures at the London Mechanics' Institution, in the course of which I gave an account of the effects of Haschisch on myself. Something like a Haschisch society was formed there immediately afterwards, and I was requested to furnish the material for gratifying the wish of the young men to understand Haschisch at first-hand. A readiness to oblige led me astray; I consented. I obtained a large cube of Haschisch from Paris, and was about to send it on to the gentleman who had corresponded with me on the subject. I felt that I might be the author of incalculable mischief, so I destroyed the cake, and purposely sent no word of explanation or apology. I thought if I now refused they would get it by some other means; but if I remained silent, the enthusiasm for Haschisch would die out in disappointment. I know not if my discretion at last was equal to my folly at first; but if any of those persons read this, I wish them to understand that it was for their good I adopted such a method of disappointing them.

THE FLYING LIZARDS OF THE SECONDARY ROCKS.

BY HENRY WOODWARD, F.Z.S.

(*With an Illustration.*)

THE discovery of the remarkable fossil animal in the Lithographic Limestone of Solenhofen, which was described in the INTELLECTUAL OBSERVER for December last, has naturally awakened great interest in all inquirers into Zoology.

This interest has been still more strongly excited by the statement of the high authorities, Drs. A. Wagner and H. Von Meyer, that this creature *was not a bird,* but a long-tailed flying lizard furnished with feathers. Having, in our description of the *Archæopteryx* (as it is now definitely named), informed our readers of the positive reasons for regarding it as a bird, we are happy now to be able to show, on the other hand, that it is not a reptile. Since that description was in print, another instalment of Dr. Häberlein's magnificent collection has been received at the British Museum, and in it are two most instructive specimens of the very genus of long-tailed Pterodactyles, or *Rhamphorhynchus,* with which our fossil bird has been compared. These admirable specimens, the first ever brought to this country, have, together with the two slabs containing the *Archæopteryx,* been placed in the glass cases of the Geological Gallery, so that they are now within view of all who desire to see them.

The reading of Professor Owen's paper before the Royal Society being deferred until the 20th November, we were unable to use his valuable anatomical observations and comparisons in our article. It is with pleasure, therefore, that we now record that, in deference to H. Von Meyer (who had a year before described and named a single feather from the same quarry which furnished the fossil bird), Professor Owen has withdrawn his MS. name and adopted H. Von Meyer's, *Archæopteryx;* giving it, however, the specific name of *A. macrurus.* The structural peculiarity of the fossil bird, in which it differs essentially from all known examples of the class *Aves,* is in the apparent possession of two unguicular digits, armed with hooked claws, attached to the carpal bones of each fore-arm. These, we suggested, might be *analogous* to the spurs on the wing of the "Screamer" and "Spur-winged goose;" but might more probably *correspond* with the prehensile thumb on the wing of the bat, or the small fingers of the Pterodactyle.

Professor Owen considers the long tail to indicate a *more generalized* type than is seen in recent birds, which are *specialized* by a form of tail which may be regarded as characteristic of the class. He cited instances of the changes which the vertebræ undergo in the embryo of recent birds as illustrative of their affinity with *Archæopteryx.* Thus, in the embryo of the rook twelve free caudal vertebræ are found; but before maturity five or six of these have coalesced to form the sacrum, and three to make the terminal joint of the tail. In the embryo ostrich eighteen to twenty free vertebræ occur, but seven or eight unite in the sacrum, and two or three in the last joint. This arrangement is also found in the embryonal development of the class of Fishes; for all fishes are *Heterocercal* (odd or uneven-tailed) in the embryo, although most modern fishes are *Homocercal* (even-tailed) afterwards. Again, in the *Reptilia* we have many familiar instances of this general type of structure. In our common fresh-water *Tritons,* or newts, the full-grown animal retains the long larval tail; but the long-tailed aquatic tadpole of the frog is gradually transformed into a tailless air-breathing animal, exhibiting probably the highest form of reptilian structure.

The Solenhofen bird furnishes a fresh exemplification of Von Baer's law of archetypal forms,* and illustrates in a very striking manner that essential similarity of anatomical structure in all animals, which is, perhaps, the most convincing evidence of unity of creative design that can be presented to our minds.

But we must not dwell upon this inviting subject, having to speak of those singular extinct creatures—*reptiles* in all their

* *Taylor's Scientific Memoirs,* 1853.

characteristics except the possession of the means of aërial locomotion—the Pterodactyles.

Amongst the *Vertebrata* the power of flight was formerly considered to belong especially and almost exclusively to birds. In the auks and penguins, however, we find birds whose wings are useless for flight, but serve admirably for swimming; and the ostrich, cassowary, emu, apteryx, etc., have *no wings* (properly so called) at all.

We are all familiar with the Mammalian type of flying animals, the bats, in which the finger-bones and membrane of the fore-hand are modified, so as to form organs fitted for the purposes of sustained and rapid flight. In the *Galeopithecus* and certain squirrels we have instances of other mammals imperfectly adapted for flight by a wide expansion of the skin on both sides of the body, from the neck to the hinder extremities, which serves as a parachute. Short flights are likewise performed by some fishes (as the *Dactylopterus*, for instance), which have their pectoral fins enormously enlarged, and capable of sustaining the body for a brief interval when they leap out of the water into the air; but their respiratory arrangements preclude a long absence from their native element.

In the Reptilian class we also have an illustration of imperfect flight in the little *Draco volans*, a lizard, which has an expanded membrane on each side of its body, and supported by the horizontal extension of the first six pairs of false ribs. It is, however, incapable of motion, and only sufficient to buoy up the creature in springing from bough to bough in pursuit of insects. That this capability of flight, which attains its highest development in birds whose respiration and circulation is the most active of all "warm-blooded" animals, should be assumed by certain mammals may seem remarkable, but that we should discover it exercised in a high degree of perfection among reptiles—a class so sluggish in the respiratory functions that they have been designated "cold-blooded"—seems at first incredible; indeed, the fossil remains of these curious creatures when first discovered gave rise to the wildest speculations. In 1784, Collini, an eminent German naturalist, attributed them to *Unbekanntes Seethier* (*unknown sea-beasts*); Hermann, to a creature "between a mammal and a bird;" Blumenbach, to a "water-bird;" Spix, to a species of vampire bat.

It is to the illustrious author of the *Ossemens Fossiles* that we are indebted for the first true determination of the place in nature which these flying Saurians held. It was Cuvier who, in 1801, described the "Reptile volant" from the lithographic stone, and in 1809* he gave it the appropriate

* *Ann. du Muséum*, xiii. p. 424, t. 31.

PTERODACTYLES, FROM THE LITHOGRAPHIC LIMESTONE.

name of "Pterodactyle" (*wing-finger*), by which the group of extinct winged lizards is still called.

Although by far the most perfect specimens of the order *Pterosauria* have hitherto been obtained from the Upper Oolite of Germany, its remains occur in various strata from the Upper Keuper to the Chalk—proving its existence through that great period of geological time represented by the entire Secondary rocks—and in many localities both in this country and in Germany.

Both the examples figured in the accompanying woodcut are from the Lithographic Limestone near Eichstatt, in Bavaria, and are selected as illustrating two extreme forms of Pterodactyles in structure and size from that place. Fig. 1 is among the most perfect, as well as the smallest specimen known—*P. brevirostris,* Sömm., and also nearly the first discovered species. It is represented of the *natural size!**

Fig. 2 is the almost perfect skeleton of *Rhamphorhynchus Gemmingii,* Meyer, reduced to one-third the natural size (t.IX. f. 1), from H. Von Meyer's magnificent work on the Reptiles of the Lithographic Stone of Germany and France, containing twenty-one double folio plates, published in 1860. This specimen was discovered in 1854. Fig. 3 is a conjectural restoration of fig. 2.

The specimens of *Rhamphorhynchus* in the British Museum consist of one, in which the lower jaw, the long wing-fingers, and the hind limbs attached to the pelvis, with the perfect tail, are beautifully exhibited; and a larger individual, having the head, tail, fingers, and both feet very well preserved. Numerous *portions* of Pterodactyles have been found in Germany and elsewhere, but the two first discovered, *P. longirostris*† and *P. crassirostris,*‡ Goldf., being almost entire skeletons, may still be considered among the most important specimens. We have in the National Collection casts of both these, besides the actual remains of Pterodactyles from the Lias of Lyme Regis, the Stonesfield Slate and Cambridge Greensand, etc., and those lately acquired from Solenhofen, and it is to be hoped we shall have, when sufficient space is allotted for Palæontology, copies of all the remarkable specimens of this class which can be procured. Without entering unnecessarily into anatomical details, we can easily perceive many striking peculiarities of structure in the skeletons before us. The dissimilarity of the skulls of figs. 1 and 2 is very noticeable, and may be regarded as indicative of differences of habit in respect of food, and the method of obtaining it, as is the

* Sömmerring, Munich Acad., 1820. Cuvier, *Oss. Foss.*, 1836, pl. 251, f. 7. Buckland's *Bridgewater Treatise*, vol. ii., pl. 22, f. O.

† Cuvier, *Oss. Foss.*, p. 359, t. 23. f. 1.

‡ Goldfuss, in *Leopold Akad.*, xv. p. 63, t. 7—9.

case with analogous modifications in the form and strength of the beaks of birds, and in the jaws and teeth of animals.

Professor Owen* suggests that *P. brevirostris* and another species (*P. Meyeri*) were probably immature Pterodactyles, as they show the large cranium, short jaws, and unossified sternum, characteristic of the early period of life in crocodiles of the present day.†

But we find in this order such singular modifications, both in the dentition and the form and length of the jaws, as to lead to the supposition that it might include (like the Bats) genera with insectivorous, carnivorous, and possibly even frugivorous habits. The head, however, has always a more or less elongated form, and is lightened by large vacuities interposed between the nostril and the orbit. The vertebræ of the neck are about seven in number, and united by ball and socket joints, the hollow being in front. In almost all known specimens the neck vertebræ are the *largest*, and the entire series gradually diminishes to the sacrum, and terminates with a more or less long and slender tail.

The fore-arm consists of a short humerus, a radius and ulna of nearly equal size, and placed closely together; carpal and metacarpal bones, supporting four fingers, armed with claws, and a fifth or outermost digit (consisting of four joints), which is elongated like the four digits in the bat, and serves to sustain the membranous wing upon which the animal was upborne in flight.

The head of the humerus was supported by the union of the coracoid and scapula; and although the *furculum*, or "merry-thought" (so characteristic a bone in birds), is absent, we often find the sternum more or less perfectly preserved, and furnished with a very deep keel for the attachment of strong pectoral muscles by which the expansive wings of the Pterodactyle were moved.

"It is almost superfluous to remark that the evidence of the fore limbs had shown the Pterodactyle to have been a flying animal long before anything was precisely known as to its sternum. The development of the keel of the sternum in the Pterodactyle exceeds that of any of the bat tribe; and it may be confidently concluded that the flight of the winged reptile might have been at least as swift and of as long continuance as in the *Pteropi*. But, viewing the lightness of the bones of the Pterodactyle, and the relatively greater development of the interpectoral crest of the sternum, Professor Owen‡ believes it to have been a creature of more extensive, continuous, and power-

* *Palæontology*, second edition, 1861, p. 274.
† Gray, *On Skulls of Young Garhial and Crocodile.* British Association, 1862.
‡ Palæontl. Society, Suppt. No. iii., *Fossil Reptilia Cretaceous Formation*, p. 11.

ful flight than is now enjoyed by any bat; and the Pterodactyles may at least have been as capable of migration as the great frugiverous *Chiroptera*.

"The structural affinities, however, of the Pterodactyles to the cold-blooded air-breathers, and their analogy in wing structure to the bats, indicate that they might have possessed the faculty of becoming torpid, and of so existing during a period when their food in a given locality was not attainable."

In the smaller species (as fig. 1) the weakness of the posterior extremities is less apparent, but in larger ones (as fig. 2) the increase in length of the fore-arms is not followed by a proportionate strengthening of the hind limbs; on the contrary, they seem to become attenuated as if from disuse. The pelvis in Pterodactyles is very feeble, and (as in recent sauria) seems to be anchylosed to not more than three sacral vertebræ.

The leg is composed of femur and tibia (with traces of a fibula?). The tarsus can also be made out in some specimens. The hind foot seems composed, in some species, of four toes only, not five,* supported upon long and slender metatarsals, and numbering 1, 2, 3, and 4 joints respectively, as in the digits of the forehand.

In *Rhamphorhynchus* (fig. 2) the false ribs are extended as if for the attachment of the wing membrane, for which the feeble pelvis and hind limbs seem but ill adapted.

We have presented to us in this genus probably the most remarkable form of all the Pterodactyles, one furnished with a long *stiff tail,* exceeding the entire length of its body. It is impossible to examine this singular prolongation of the caudal vertebræ, which is embedded in a compact mass of minute ossified fibres (as shown in our figure of the natural size), without being at once impressed with the conviction that its use was analogous to the long tail-feathers of the frigate bird, acting not only as a powerful rudder (especially if it was furnished with a crested fold of membrane, as in the tails of many recent sauria), but also as an equipoise to the long and pointed wings, which in life must have measured more than four feet from tip to tip. The *Rhamphorhynchus,* when seated with closely folded wings, would probably have presented a very similar appearance with that of this ocean wanderer.

Beside the tiny Pterodactyle (fig. 1) there is another almost equally small (*P. Meyeri),* which, amongst other interesting characteristics, possesses the circle of sclerotic eye-plates. These bony plates occur in certain other reptilia, as the *Enaliosauria,* or sea lizards, and in turtles; and are also found in many birds. Their use appears to be "to vary the sphere of distinct vision,

* In the restoration given of *P. crassirostris* by Goldfuss in *Akad. der Wiss* (*loc. cit.*) he attributes five toes to the hind limb.

in order to descry their prey at long or short distances. These bony plates also assist to maintain the prominent position of the front of the eye, which is so remarkable in birds."*

The oldest known Pterodactylous remains appear to have been obtained from the Upper Keuper of Wurtemberg, but they are of only a fragmentary nature. The *Dimorphodon (Pterodactylus) macronyx*, Buckld., from the Lias of Lyme-Regis, is the oldest found in this country. In this species there is an unusual provision for giving support and movement to a large head at the extremity of a long neck, by the occurrence of bony tendons running parallel to the cervical vertebræ, like the tendons that pass along the backs of many birds, and those figured in the tail of *Rhamphorhynchus*. The expanse of the wings of this creature equalled those of the *Rhamphorhynchus*, but its jaws were eight inches long, and it is not supposed to have had a long tail. Beside a few large, long, and sharp-pointed teeth at the fore part of the jaws, it was furnished with a close-set row of short, compressed, very small, lancet-shaped teeth.

Fragmentary remains of Pterodactyles also occur in the Stonesfield slate of this country (one of the Oolitic series), and there is evidence of the existence of the same genus in the Wealden strata, but the species must have been of a larger size.

It is in the cretaceous series of England that the most gigantic specimens of flying lizards have been met with.

We are indebted to Lucas Barrett, Esq., F.G.S., the present director of the Geological Survey of the West Indies, and Jas. Carter, Esq., M.R.C.S., of Cambridge, for the discovery of remains of Pterodactyles in the Cambridge Greensand.

These bones, which always occur detached and much broken and water-worn, present, in the restorations of Professor Owen, proportions so gigantic that I cannot do better than quote his own calculations upon the subject, extracted from No. 1 Supplement to Palæontological Society's Memoirs for 1859, "Fossil Reptilia of Cretaceous Formation."

Dimensions of *Pterodactylus Sedgwickii*, Owen, Greensand, Cambridge :—

	Feet.	Inches.
"Humerus	1	0
Radius	1	4
Metacarpus	1	8
1st Phalanx	2	3
2nd ,, ...	1	9
3rd ,, ...	1	5
4th ,, ...	1	1
Total of one wing .	10	6

* Yarrel *On the Anatomy of Birds of Prey. Zool. Journal*, vol. iii., p. 181.

"Supposing the breadth of the Pterodactyle between the two shoulder-joints to be eight inches, and allowing two inches for the carpus and the cartilages of the joints of the different bones in each wing, we may then calculate that a large *P. Sedgwickii* would be upborne on an expanse of wings not less than 22 feet from tip to tip."

In the Palæontographical Society's Publications, Supplement No. 3, already referred to, Professor Owen says, "I am now enabled to adduce, from more recently acquired additions to the Woodwardian Museum at Cambridge, evidences of a much larger Pterodactyle, distinct from any previously known, and which must have acquired at least double the dimensions of *P. Sedgwickii*."

Professor Owen describes and figures remains of two other species of chalk Pterodactyles, *P. Cuvieri* and *P. compressirostris*, larger than *P. giganteus* of Bowerbank. This, however, still belongs to the race of the giants.

Evidence of a long tail in the Chalk species has not yet been met with; but from the number of detached caudal vertebræ found in the Cambridge Greensand, Professor Owen believes the *P. Sedgwickii* "had a long but moveable tail."

When looking at the skeleton of the Pterodactyle one is apt to fancy, for an instant, "here is a reptile trying to become a bird;" and the first glance at the *Archæopteryx* might suggest the notion that *here* it had succeeded in the attempt; but a more careful consideration of the subject will not fail to convince us that the Pterodactyle bird and bat are no less essentially members of distinct classes of animals because they are gifted with the common faculty of flight.

Thirty-seven species of flying lizards are known and described; how many individuals have been discovered it is impossible to say. There is every reason, however, to believe, from the frequent occurrence of their remains, that they were very abundant in the Mesozoic period.

We are not justified, however, in considering that they *altogether* took the place of birds; on the contrary, the discovery of the *Archæopteryx* proves them to have been contemporaneous races so far back as the upper Oolitic age.

All the mammals we are acquainted with in rocks of the Secondary period belonged to small animals obscurely resembling the lowest of existing quadrupeds. Their place in nature appears to have been filled by orders of reptiles, some of them now extinct. The gigantic Dinosaurians represented the land quadrupeds; Enaliosaurians took the place of whales, and the Pterodactyles of bats, and *partially* of birds, thus realizing Dr. Mantell's vision of an "Age of Reptiles."

PERUVIAN-BARK TREES AND THEIR TRANSPLANTATION.

BY BERTHOLD SEEMANN, F.L.S., F.R.G.S.

Many years before the Irish famine William Cobbett predicted that calamity, and many years before the present cotton distress, far-seeing minds foretold that catastrophe. Nothing could be more sound than the principles upon which these unheeded warnings were based—the uncertainty always attendant on a *single source of supply*. Cobbett knew that potatoes, like all other organisms, are subject to occasional attacks of diseases and wide-spread epidemics; and that a whole people, like the Irish, relying for their staple food upon these roots, must sooner or later share the fate of the product upon which they have placed their main dependence, and with the fortunes of which they have intimately associated themselves. It was the same with cotton. Far-seeing men could perceive the political thunderstorm gathering in the United States; and knowing that all Lancashire, all England —in fact, all the world—relied upon this one source of supply for cotton, they denounced the recklessness of such improvidence in the strongest terms, formed associations for obtaining the raw material from other countries than the United States, and in speech and print did all in their power to arouse public attention. Yet as long as the mills were busy, and millions of bales were coming in without interruption, no notice was taken of their endeavours to stave off the fearful doom to which our manufacturing population was drifting. Now that the calamity has at length overtaken us, and thousands upon thousands of pounds are spent in keeping the workpeople from actual starvation, everybody remembers hearing Cassandra's voice. If but a hundredth part of what is now required to feed the hungry spinners had been devoted to encouraging the growth of cotton in the various tropical and subtropical possessions of Great Britain, Lancashire distress would never have been heard of, and manufacturers would have gradually relied upon the produce of free labour instead of paying a premium to slavery.

Mankind is threatened by a third danger, which may prove equally great, equally fatal in its consequences. Most men are probably not aware of the vast benefits they owe to the discovery of the Peruvian bark, the produce of various species of *Chinchona*, and the alkaloids, quinine and chinchonine, embedded in it. History takes no notice of the death of countless mediocrities from fever and ague, but fails not to record that Alexander the Great died of the common remittent fever at Babylon, and that Oliver Cromwell was carried off by ague. A few doses of quinine might have saved their lives, and compelled Clio to make very different entries in her diary than she has done. The whole Walcheren expedition was saved from destruction by a Yankee skipper arriving just in the nick of time with a supply of this medicine. In order to hold many important tropical possessions it is not only necessary for our race to keep the powder dry, but also take care not to let the quinine run too low. In fact the drug is almost as indispensable to mankind as air itself, and aided by this silent agent Europeans have been able to establish happy homes, busy factories, and flourishing colonies in districts which, without this invaluable aid, would have simply become their graveyards. Our only wonder is how we could ever have done without it, and what would become of us if the supply should ever fail. And the supply does begin to fail, fail rapidly. It is known that 1,200,000 lbs. of Peruvian bark (meaning by that term all medicinal barks produced by Chinchona trees) are annually imported into England; and it is estimated that no less than 3,000,000 lbs., and probably a much greater quantity, are consumed every year throughout the world. The demand is daily increasing, and the drain upon the South American forests, including those of New Granada, Ecuador, Peru, and Bolivia, has now been going on for more than two centuries, though not to such an extent as at present. The better kinds, those yielding the largest quantity of alkaloids, are very local in their geographical range at present, often limited to very circumscribed districts; and though we speak of Chinchona forests, it is absolute delusion to fancy that these trees, like our pines and oaks, form entire woods by themselves. On the contrary, they are intermingled with other trees, and generally occur in isolated specimens. The bark is collected by ignorant Indians, who, improvident of the future, strip the tree anyhow, and in most instances without properly felling it, so that it begins to rot after being robbed of its produce, and has no power to put forth new shoots from the root. Thus, what with the excessive and unceasing demand for bark, and the reckless manner of collecting it, large tracts of country, formerly famous for their abundant yield, are now entirely denuded of almost every trace of Chinchona vegetation. The neighbourhood of Loxa in Ecuador was at no very remote period one of the principal localities for several of our best barks; but when, in 1847, Captain Pim and I visited the place, we had to go a considerable distance from the town before we obtained even the sight of a single specimen. Stimulated by the present high prices the bark collectors have penetrated the remotest districts, explored wilds probably never trodden by the foot of the white man; and if by any chance they are lost, or their provisions fall short, death is their inevitable doom. Dr. Weddell describes a poor fellow who thus had ended his days, far away from home and friends. His corpse was nearly naked, and covered with myriads of insects, the stings of which had tormented his last moments. Close by was a hastily-constructed hut, his clothes, his knife, and an earthen pot, showing the remnants of the last meal of a man in search of medicine which was to save the life of others.

The Indians, though at present the best *cascarilleros*, or bark collectors, and intimately acquainted with the names and commercial value of the different sorts, are supposed by some to have been formerly ignorant of the great therapeutic qualities of these drugs. They called the Loxa bark "Quinaquina" (bark of barks); and Markham has well shown that in the Quichua language, to which the term belongs, a doubling of a name is an indication that the plant to which it applies possesses, in the estimation of the Indians, some medicinal virtue. Now, we know of no other use of the Loxa bark except that derived from its febrifuge properties, and in my mind there is little doubt that it was to this the doubling of the name must be attributed. Those who have had practical experience in gathering information about medicinal plants from the lips of barbarous people, as I have had, will not be surprised at the secresy with which the knowledge of the use of Quinaquina was preserved. As a rule, the most sovereign remedies are never revealed to a stranger, nor known to the people at large, and no bribe will induce the "medical profession" amongst the Indians to be otherwise than reserved when questioned by Europeans. Madame de Genlis, in her "Zuma," builds the plot of her charming little story on a conspiracy of the Indians, the object of which was to allow the climate to destroy their Spanish enemy by withholding the knowledge of the bark when fever attacked them. I am aware that this is not history, but I have always thought, considering the Indian character, and the strong desire of the aboriginal population to get rid of their foreign oppressors, that Madame de Genlis had here hit upon the true solution of the question why so many years elapsed before Europeans became acquainted with this bark of barks.

It is not until the year 1630, that Don Juan Lopez de Canizares, the Spanish Corregidor of Loxa, being ill of intermittent fever, an Indian is said to have revealed to him the virtues of the bark, and instructed him in the proper way of administering it. About eight years later the wife of the fourth Count of Chinchon, Viceroy of Peru, was suffering from the same complaint, when the Loxa Corregidor forwarded a parcel of powdered quinaquina as a sovereign and never-failing remedy for "tertiana." It effected a complete cure, and the particular plant which had this honour, and yields the true and original Peruvian bark is, as Howard justly concludes, the *Chahuarguera* variety of *Chinchona Condaminea*, a kind containing a large percentage of *Chinchonidine* (the importance of which is just beginning to be recognized). It is therefore not to quinine,

CHINCHONA CONDAMINEA, VAR. CHAHUARGUERA (*reduced one-half*).

but to *Chinchonidine* that the countess's cure was due. That lady on returning to Spain in 1640, took with her a quantity of the healing bark, and was thus the first to introduce this invaluable medicine into Europe. Hence it was sometimes called Countess's bark, or Countess's powder; and hence, to commemorate the event, Linnæus named the genus of plants producing these barks, *Chinchona*. By some accident, not isolated in his nomenclature, he mis-spelt the name, writing

Cinchona, and until a recent period no attempt was made to correct it.

The Jesuits in their wanderings through South America became well acquainted with bark, and in 1670 they sent parcels of it to Rome, whence it was distributed by Cardinal de Lugo amongst the members of their society throughout Europe, and obtained the name of Jesuit's bark, or Cardinal's bark. It was in consequence of this patronage that bigoted Protestants refused to avail themselves of a medicine favoured by the Roman Catholics, just as staunch Catholics objected to the use of beer, an infusion of barley flavoured with hop, instead of sweet gale, and other herbs, as in the case of *ale*, because, as an old song has it, "with this same beer came in heresy here." At the time of Cromwell's death from ague, the use of Peruvian bark was actually known in London. In 1678 Louis XIV. bought the secret of preparing quinaquina from Sir Robert Talbot, an English physician, for two thousand louis d'ors, a title, and a large pension, and from that time downwards, the use of this medicine, though often and violently opposed by practitioners, gradually made its way into every country and all circles of society. The only people who now entertain any prejudice against its administration are the natives of those very countries from which we obtain our supplies. The medical men of Guayaquil, for instance, must call it by some other name in their prescriptions, or else patients object to taking it. The Spanish people throughout America have a deeply-rooted theory that all diseases are referable to the influence of either heat or cold, and, confounding cause and effect, they pronounce all fevers to proceed from heat. Bark they justly believe to be very heating, and hence their prejudice against its application in fever—a prejudice which seems to have communicated itself even to the Indians.

Until the present century Peruvian bark was administered in its crude state; and it was not until 1816 that a Portuguese surgeon, Dr. Gomez, succeeded in isolating the febrifugal principle, hinted at by Dr. Duncan at Edinburgh, and named by the former Chinchonine. But the final discovery of quinine is due to two French chemists, Pelletier and Caventou, in 1820, who considered it a vegetable alkaloid analogous to morphine and strychnine, and they afterwards found that the febrifugal principle was seated in two alkaloids, quinine and chinchonine, separate or together. In 1829 Pelletier discovered a third alkaloid, aricine, derived from *Chinchona pubescens*, and at present of no known medicinal value. The different organic constituents of *Chinchona* bark are :—

Quina . .	Kinovic acid.
Chinchonia .	Chinchona red.

Aricina .	. A yellow colouring matter.
Quinidia .	. A green fatty matter.
Chinchonidia	. Starch.
Quinic acid	. Gum.
Tannic acid	. Lignin.

Quinine is a white substance, without smell, bitter, fusible, crystallized, with the property of left-handed rotatory polarization. The salts of quinine are soluble in water, alcohol, and ether. Chinchonidine differs from quinine in being less soluble in water, altogether insoluble in ether, and having the property of right-handed rotatory polarization, agreeing in the latter respect with quininine, a substance which forms salts like those of quinine, and becomes green by successive additions of chlorine and ammonia. In this changing of colour it differs essentially from chinchonidine, which has not the property of turning green, and forms a sulphate almost exactly like that of quinine.

In many distant parts quinine is equal in value to gold, and there is hardly a chemist of eminence who has not tried his hand at producing these alkaloids artificially. We have of late years obtained so many wonderful results in the laboratory that we should not treat their endeavours as aiming at any thing beyond their reach. There is just a possibility that one day the dreams of alchemists may be realized by the baser metals being converted into gold, and the artificial production of quinine ranks in the same category. But these alkaloids are such complex atoms that there is very little probability of their ever being obtained from any sources save Nature's own workshop. Such being the present aspect of this question, it becomes a matter of the highest interest to mankind that the even flow of their source should not be interrupted.

The genus *Chinchona* of Linnæus belongs to the Chinchonaceæ, the same natural order which embraces the Coffee, Ipecacuanha, and many other important productions. All the species, and there are a great number, are either trees or large shrubs, and their general aspect may be compared to our beech, whilst a flowering branch might be likened to that of a lilac. The bark is smooth, or in the older trees more or less rugged, often covered with various lichens, which at one time were thought to be excellent marks for distinguishing the different sorts of barks, but which are now accounted of little value in pharmacological determination. The wood is at first white, but afterwards assumes a yellowish tinge; it is of beautiful grain, and takes a ready polish. The leaves are opposite, entire, either glabrous, or more or less covered with hair, and on the under side, in the axils of the veins, either covered with *scrobiculœ* or destitute of them. A theory had gained ground that the absence of these *scrobiculœ* proved the worthlessness of a species for all febrifugal purposes, but this theory has of late been demolished, some utterly worthless species having *scrobiculœ,* and some really valuable ones, for instance, *Chinchona succirubra,* the Red bark, not having them. The petiole is rather long, and supported by stipules. The flowers, arranged in cymose panicles, are white, pink, or purple, and often sweetly scented. The calyx is five-toothed. The corolla hypocrateriform, five-lobed, and having inside five stamens. The capsule is ovate, oblong, or linear-lanceolate, crowned with the remnant of the calyx—two-celled, many-seeded and opening from the base to the apex. This latter technicality was first pointed out by Linnæus in his tenth edition of his *Genera Plantarum;* but in consequence of information, probably received from Mutis of Bogota, that the capsules opened sometimes from the top to the base, as well as from the base to the top, the character was disregarded until restored by Endlicher and Klotzsch; Dr. Karsten has called its validity once more in question, but many botanists are inclined to think that the exceptional cases brought forward in support of his opinion may be explained away by regarding them as the result of mechanical, rather than organic dehiscence. Commercially, this technical point (by which Chinchonas principally differ from Ladenbergias) is of the utmost value, as all the Chinchonaceous plants, the capsules of which open from the apex to the base, may, in a practical point of view, according to Howard's investigation, be considered as not producing alkaloids. The seeds are flat, winged, and so light that one would fancy that a breath of wind could disperse them over large tracts of country, and that by means of these peculiarities the different species of *Chinchona* enjoyed a very wide geographical range, while exactly the contrary is the case, all the species being extremely local.

The Chinchona trees range from the 19th degree of S. to the 10th degree of N. latitude, following the almost semicircular curve of the Cordillera of the Andes over 1740 miles of latitude. The most favourable conditions of their growth are, as Markham has summed them up, a continuous vegetation; a mean temperature, varying according to species, from 60° to 70° Fahr., an almost constant supply of moisture, and an elevation of from 5000 to 8000 ft.; some species, however, descending below 2500, and some ascending to 9000 ft. Their favourite haunts are ravines and valleys, or slopes of mountains. There they grow, surrounded by the most magnificent scenery in the world, midst tree-ferns, arborescent passion-flowers, *Melastomaceœ,* and allied Chinchonaceous genera.

There are five principal regions from which our present supply of bark is derived, viz., the New Granada region, the Red-bark region on the western slopes of Chimborazo, the

Crown-bark region in the province of Loxa (Ecuador), the Grey-bark region of Huanuco in Northern Peru, and the Calisaya region in Southern Peru and Bolivia. The species inhabiting most of these regions have lately been studied with more than usual accuracy and minuteness. Those of New Granada have been investigated for many years by Mr. Lindig, and the results have been made known by Dr. Karsten in his *Flora Columbiana.* The Red-bark region has been visited by Messrs. Spruce and Cross, both of whom wrote excellent reports on it. Southern Ecuador and Northern Peru have been most ably handled by Mr. J. E. Howard in his *Illustrations of the Nueva Quinologia of Pavon,* a work originally embracing some of the results of the Spanish expedition to South America under Ruiz, Pavon, and Tafalla, but left unpublished until Mr. Howard took them in hand, embellished them with splendid plates, and gave them to the world with a long series of annotations such as only a perfect master of the subject could supply. The Caravaya region in Bolivia and Southern Peru, first explored by Hænke, has lately been visited by Mr. Markham, whose investigations have been published in his *Travels in Peru and India,* a volume full of the latest and soundest information on everything connected with the history, conditions of growth, and cultivation of Chinchonas. Dr. Weddell, an English botanist, residing in France, had previously given us a monograph principally on the Bolivian species, which he has studied during his extensive travels in their native country. The literature relating to Chinchonas is an extremely rich one; even when, in 1826, Bergen published his monograph, his catalogue of all written on the subject extended over seventy-two pages, and included 670 different publications. Since then numberless additions have been made, but none of them exceed in value those of Karsten, Markham, Howard, and Weddell.

The constant drain for Chinchona bark upon South America has already been pointed out, and the exhaustion of the forests is proceeding at so rapid a rate that the utter annihilation of the trees, local as many species are, is merely a matter of time. Indeed, the days are fast approaching when the poor fever-stricken patient will sigh in vain for the only remedy that can afford a speedy and certain relief. The Republics in whose dominion Nature has placed these invaluable forests are too weak and ignorant to pass or enforce laws for their proper protection and administration, and too indolent to make plantations which would ensure our future supplies of bark. Under such circumstances German, Dutch, and English men of science—I shall not discuss the question of who was the first—have for years advocated the necessity of introducing the bark trees into the higher mountains of the East and West Indies, but for a long time their memoirs were shelved by men in office. In 1852, however, the Dutch government was induced by Mr. Pahud, then Minister of the Colonies, to send Dr. Hasskarl, a German botanist, to Peru in order to obtain seeds and plants of the Chinchonas for transplantation to the Upper mountains of Java. Unfortunately Dr. Hasskarl got hold of a species which he believed to be a valuable one, but which, after millions of it had been raised in Java, proved to be *Chinchona Pahudiana,* utterly useless for all practical purposes. The really valuable species the Dutch did not succeed, and have not succeeded to this day, in propagating to any extent, though under skilful treatment they may be multiplied rapidly, even the leaf-buds striking readily. But considering that the whole cultivation was necessarily an experiment, their progress was sufficiently encouraging to back the proposal which first Dr. Royle, and afterwards with better success of being accepted, Mr. Markham made to the British government to introduce the Chinchona trees to India, Ceylon, and Jamaica. In 1859 the Secretary of State for India charged Mr. Markham, who was thoroughly familiar with South America and the Spanish and Quichua languages, with the duty of superintending the introduction. The latter at once submitted a plan which, if carried out in its integrity, would have been productive of the best results. It was to send a competent botanist to every one of the five great Chinchona regions, and have a swift steamer on the coast of South America to receive the seeds and plants collected, and convey them direct to the East Indies, where about £40,000 are annually spent to purchase quinine for the troops and officials. A false system of economy induced the India office to withhold its sanction, not only to the exploration of the New Granada and Loxa regions, but also to the use of a steamer, the most important part of the whole plan. Messrs. Spruce and Cross undertook to forward the product of the Red-bark region, Mr. Pritchett those of the Huanuco district, whilst Mr. Markham himself penetrated into Caravaya, far beyond the boundaries of even Spanish civilization. Though the utmost secresy was observed, the real object of these explorations soon spread about, and the narrow-minded South American governments passed laws prohibiting the exportation of seeds or plants. Mr. Markham had just collected a sufficient number of the *Chinchona Calisaya* and other valuable species, when the jealousy of the municipal Juntas compelled him to beat a hasty retreat, and, avoiding the regular roads, make the best of his way over the frozen summits of the Cordilleras to the port of Islay.

Though Mr. Markham's well-conceived plan was but partially carried out, there are now fine plantations of Chinchonas, including the most valuable species, in the East Indies, Ceylon, and

Jamaica, and so rapid is their extension that, in all human probability, there will be a supply of Peruvian bark from these sources at the very time South American forests are approaching exhaustion. Other countries with climates suitable might try the cultivation, which, in order to be of real benefit to mankind, ought to be as general as that of the spices, and conducted by private enterprise. The first plantations in Java were made in the open clearings, but afterwards this system was given up, and avenues were cut through the virgin forest, in which the Chinchonas were set, thus going to the other extreme, and allowing them no sun whatever. The latter is the system still pursued in Java, whilst the former, with some modification, has been adopted on some of the most important plantations in India, and is expected to lead to more speedy and profitable results.

THE MOON.

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

The student who feels disposed to carry into effect the suggestions contained in a previous paper, will have to bear in mind that, notwithstanding the peculiar accessibility of our satellite in point of distance, its frequent visibility, and the powerful grasp upon it possessed even by moderate sized instruments, certain conditions are requisite for the accurate comprehension and delineation of its minute details; and not even keenness of sight, or accuracy of pencil, can adequately compensate for entire ignorance of perspective, or of the laws of light and shade. The surface which we have to interpret and represent may probably be composed of materials not dissimilar to those of our globe, and their arrangement is not so wholly different as might be supposed in the judgment of an uninstructed eye; but they are exhibited to us in a way so very unlike any views that we ever obtain of the surface on which we stand, that it requires some attention to discover their real configuration. We look upon a hemisphere which presents its details to us under every possible angle between $0°$ and $90°$; and the partial or total concealment of one object behind another, and the effect technically called "foreshortening," by which length is contrasted when viewed end ways, and height diminished when regarded from above, and circles are transformed into ellipses, and right angles become obtuse or acute, ought to be understood and allowed for. A general idea also of what is termed "relief," is equally as important as one of perspective. The laws of light and shade produce effects the reason of which is not always apparent, except to the careful observer, and which are perhaps not always fully attended to, even by artists, who ought to be especially scrupulous in this respect, but which show their fullest development in the moon. There it is clearly seen how small a relation the actual amount of elevation bears to the extent of shadow which it occasions in the nearly horizontal illumination of the beginning or close of the lunar day, and how slight a resemblance there often is, under such circumstances, between the outline of the substance and the shadow. Every little insulated hillock will betray itself in this position by so disproportioned a shade, that Schröter considered that elevations of not more than eighty feet might thus be clearly distinguished near the "terminator," or general boundary of light and darkness, even at our distance of nearly a quarter of a million of miles. The shadow of a rounded summit will be projected out into a long spire, so sharpened at the point as to deceive the unwary spectator into the impression of its falling from a tapering pinnacle; inconsiderable ridges near the terminator will bring in great encroaching notches or bays of darkness; the rings of craters will increase strongly in apparent breadth; the long gentle slopes which usually incline upwards to the foot of the wall, like a broad "glacis," in military language, and pass unnoticed under a higher sun, being thrown up from the surrounding level to swell the general mass, while the interior cavity seems also to open wider as the lower slopes and terraces of its precipitous sides disappear one after another in the advancing shade. Nor are these more familiar appearances all that the observer will have to account for. He must seek in the same laws of illumination the explanation of less ordinary effects; he may find a tapering spire of shadow distorted from its regular outline by the uneven ground which it traverses, or squared off suddenly before reaching its termination, because it is traversed at right angles by a comparatively inconsiderable ridge; he may perceive that the shade cast by a peaked but broad-shouldered summit loses its sharpness with the advance of the lunar forenoon, and at length disappears, from becoming entangled among its own inferior buttresses, while these alone project a black outline of an entirely altered character upon the plain at their feet. The same results of the unchanging laws of illumination, it need not be said, occur equally upon the earth; but here we are little sensible of them. Surrounded by them, and enveloped in them, we are not in a position to comprehend their full proportions, or to judge intuitively how the relief of our landscape would appear in a bird's-eye view at the distance of a quarter of a million of miles. And besides this important difference, we can never see in terrestrial effects those sharp and vehement contrasts of light and shade which strike us so much in the moon. The presence of a highly reflective atmosphere, even when unvaried by clouds, which diffuse much light, modifies the depth of our shadows, in proportion as it illuminates and colours what would otherwise be the blackness of our sky. On the moon that vaporous envelope is, if not altogether wanting, far too rare to produce any such result.

Here much general light is interwoven with our darkness, and the direct sunshine is not the only medium of illumination; air-tints and reflections soften all our shadows by day, and twilight encroaches far upon the regions of night: there (save only when the keen eye of Dawes, sheltered by his own contracted eye-piece, detects in the black interior of some colossal crater a feeble reverberation from its illuminated wall) everything not in direct sunshine is involved in absolute midnight. Half-tones, the cause of so much beauty upon the earth, do not exist upon the moon, excepting where a narrow dusky fringe along the terminator, or the fainter beam that first breaks in upon the floor of a crater, or touches some mountain's peak amidst the darkness of the night-side, shows that a portion of the solar disc alone is visible. But the student who has mastered these peculiar characteristics has still a task remaining—to allow for the difference of aspect introduced by what is called "libration." Were the moon to travel round us with a perfectly equable velocity, in an orbit coincident with the ecliptic, revolving at the same time on an axis perpendicular to its orbit, we should always see exactly the same hemisphere, with an invariable arrangement of the spots relatively to the centre and the edges of the disc; and precisely the same effects of light and shade would recur at corresponding periods in every lunation. But none of these conditions are fulfilled. The moon's orbit is an ellipse, a form necessarily involving inequality of speed in its different parts; and since her rotation upon her axis is perfectly equable, this alternate acceleration and retardation in her orbit, urging her beyond, or keeping her behind, the place in the sky which she would have occupied with an equable motion, has the effect of making her spots appear to "librate," or swing to and fro, alternately in advance of and behind their mean position. This motion from E. to W., and from W. to E., is called the "libration in longitude." The inclination of the moon's orbit to the ecliptic, and of her axis to her orbit, combine to produce another kind of libration, "in latitude," which shifts the spots in a similar way upwards and downwards; and as in the previous case we see alternately a little way round the mean E. or W. limb, so in this, we catch a little more of the regions beyond the arctic or antarctic pole.

These changes, it is true, are of no great extent, never exceeding 7° 55′ from E. to W., or 6° 47′ from N. to S.,* and their influence is not important upon the central parts of the disc; but they keep the limb in an unsettled state, and are continually altering the perspective of the parts adjacent to it, so that in this situation a region will have an entirely different aspect at the same age of the moon in different lunations. The libration in latitude may also sometimes occasion a slight deviation in the direction of the shadows, which may not be unimportant in the case of objects lying E. and W., and assuming an altered appearance as the shadow falls on the N. or S. side. The larger features, indeed, are liable to no misapprehension, keeping, under all circumstances, their own determinate character; but as to minuter details, it would hardly be supposed, except from actual experience, how great an amount of apparent change may sometimes depend upon very small deviations in the angles of incident and reflected light. The landscape artist, however, who has delineated the same subject repeatedly from slightly altered points of view, and in the varying light of successive hours, will require no further or closer illustration of these transformations. Such are the difficulties which beset the study of the moon, though not without some degree of compensation, since, if these discrepancies at one time perplex us, at another time they unravel perplexities; and the play of light and shade which may occasionally bring a familiar object before us in "a questionable shape," will now and then clear up, beyond a question, the nature of one previously doubtful.

The subject will be resumed in a future number. A pressure on our space compels the postponement of our list of "Double Stars."

OCCULTATIONS.

There will be only four occultations during this month at convenient hours. Jan. 1st., κ^1 *Tauri*, 5½ mag. (one of the components of a wide double star) will disappear at 10h. 3m., and reappear at 11h. 8m.—Jan. 9th, 55 *Leonis*, 6 mag., occulted when the moon rises, will emerge at 10h. 12m.—Jan. 26th, 27 *Arietis*, 6 mag., will be hidden from 11h. 31m. till 12h. 8m.—Jan. 27th, δ *Arietis*, 4½ mag., will disappear at 5h. 10m., and reappear at 6h. 28m.

* These quantities are somewhat variously given; the value here adopted is from Beer and Mädler.

There is a third kind of libration called the *parallactic*, arising from the different position of the point of view upon the surface of the earth, and varying with the moon's altitude above the horizon, but it never exceeds 1° 1′ 30″.

PROCEEDINGS OF LEARNED SOCIETIES.

BY W. B. TEGETMEIER.

ROYAL ASTRONOMICAL SOCIETY.

At the first meeting of the present session, on the 14th Nov., the Astronomer Royal called attention to the efforts which have been lately made to improve our knowledge of the measure of the earth and of the heavens, his discourse being illustrated by a map showing the triangulation of Europe as it stands at present, and rendering evident that from the Danube to the North Cape on the N., and to Valentia on the W., very little is left to be desired.

Mindful of the past labours of the French and ourselves on the measures of arcs of *meridian*, the illustrious Struve, the originator of the recent operations, suggested that an arc of *parallel* should be measured, extending from Valentia, using the present triangulation as far as it reaches, and extending it to the town of Orsk, on the Oural, thus comprising nearly seventy degrees of longitude, an arc of such a length, that, as remarked by the Astronomer Royal, it is scarcely probable that a longer will ever be measured by man.

For the measure of the earth, then, it was first necessary to find by some lineal measure *the length of this arc;* in other words, to find the distance in yards (our standard of measurement) between Valentia and Orsk; and secondly to find the *difference in time* between the two places.

First, as to the length of the arc. The British part of it required little attention, as thanks to the admirable work of our Ordnance surveyors, and subsequent investigations by means of chronometers, the actual distance from Valentia to Dover is known to within a few yards.

Unfortunately the continuation of this line to Paris, which has been effected with equal accuracy, dips too much to the south to be available for the present purpose. It became necessary, therefore, to effect a junction between Dover and Belgium to fill up the gap that there exists between the English and continental systems of triangulation. This has been admirably done by Sir H. James during the present year, and the whole distance from Valentia to some point pretty well advanced, is by this time computed, while the triangulation itself is fast progressing towards Orsk.

Secondly, as to the difference of local time at the extremities of this arc. This must be determined from those observed at intermediate places on the arc; as, for instance, between Valentia and Greenwich, and Greenwich and Brussels, and in this determination telegraphs and railways will be freely used. A complete circuit between the first-named points were placed at Mr. Airy's disposal by Sir Charles Bright, after the Atlantic cable (which "took sea" at Valentia) proved a failure. The difference of time obtained by the electric current (which took 1-10th of a second to traverse the 800 miles of wire) agreed exactly with that formerly derived from the transit of chronometers between the two places.

The recent experiments of Foucault with the turning mirror, and the parallax observations of the planet Mars which have been made during the past three months in both N. and S. hemispheres, were alluded to, as bearing upon the distance of the sun, which is the basis of all measures of the heavens.

The smaller velocity of light deduced by Foucault, linked to the sun's distance by its aberration, was shown to be supported by some of M. le Verrier's recent investigations, while the extreme doubtfulness of some of the most important observations of the transit of Venus on 1769, on which the received distance of the sun depends, renders the success of the observations of Mars doubly desirable. And although the distance of Mars, and not of the sun, will, in the first instance, be obtained by this method, they are bound together by a proportion which has been accurately known since the days of Copernicus and Tycho.

Professor Selwyn communicated a note relative to an apparent notch in the sun's limb, observed by him some little time ago. From the note we learn that he now ascribes the appearance to the low power employed, as the complete limb was observed on the same day by the Rev. W. R. Dawes, in his larger instrument.

Several other papers, among them a valuable one on eye-pieces, by the distinguished observer we have just named, and on the diameters of Mars, by the Rev. R. Main, were communicated to the Society.

The latter paper was accompanied by some drawings of Mars, from observations made in the Oxford heliometer. Another series of thirteen drawings, chosen from twenty-five made during the past opposition of the planet, and embracing a complete rotation, was exhibited by Mr. Lockyer.

This latter series, the result of observations made by an equatoreally mounted refractor of $6\frac{1}{4}$ inches aperture, the workmanship of Messrs. Cooke and Sons, of York, was remarkable not only on account of the details of the planet shown, but also of the exact agreement of the broad features of the drawings with a similar series taken by Beer and Mädler, in 1830.

CHEMICAL SOCIETY, *December 4th.*

Recent Formation of Rocks.—A paper was read by Mr. A. H. Church on "Certain Processes of Rock Formation now in Action." The author's attention was directed in the summer of 1860 to an instance, at Bude-Haven, in Cornwall, of the consolidation of sea-sand by means of land-springs, and he endeavoured to trace the chemical causes of the phenomenon. From numerous analyses of the loose and of the consolidated sand, and also of the water of the district, the author came to the conclusion that the cementing action was often due to the reprecipitation, between the sandy particles of carbonate of lime—this substance being originally derived from the shelly *débris* of the sand itself, and being held in temporary solution by carbonated water. The absence of marine salts from the consolidated sand supports this hypothesis. Mr.

Church then proceeded to describe the formation of travertine in several localities in England, noting more especially the rapidity of the process, the organic substances, occurring sometimes most abundantly, in the deposits, and the physical characteristics of the formation. As to this last point, the author pointed out the remarkable similarity in construction between the discoidal concretions of carbonate of lime in travertine and Rainey's globular lime-crystals, pearls, and the minerals pisolite and oolite.

The latter portion of the paper was partly devoted to a brief notice of the consolidation of various materials into rocky or mineral substances by means of silica, oxide of iron, etc., and partly to the peculiar processes by which certain mineral and metallic veins are gradually formed by the elimination of the constituents from the surrounding masses of mixed matters. Mr. Church noticed the construction of the geodes of iron-ore, containing nuclei of ochre or clay, found in the ochre pit on Shotover Hill, near Oxford; the formation still going on* of magnesiam limestone at the upper part of Bullingdon Marsh, in the same neighbourhood; the occurrence in clay of calcareous concretions, and in chalk of silicious nodules; and the production, at the present time, in the chalk, of such minerals as allophane and collyrite, in which forms much of the silica and alumina† of the chalk becomes, as it were, concentrated.

In the interesting discussion which followed, Mr. Church supported his views of the modern formation of silicious minerals by the case of the silicified basket of eggs found in an abandoned chalk-pit, near Winchester, many years ago.

CHEMICAL SOCIETY.—*December* 18.

Artificially Formed Alcohols.—A communication was read from Professor Wurtz, in which he pointed out, among other novel facts, certain hitherto unobserved differences between ordinary alcohols as obtained by fermentation, and those artificially produced by synthesis from the corresponding olefiant. The former may be viewed as water in which one equivalent of hydrogen has been replaced by ethyle, or its homologues, the latter as water plus ethylene or other olefiants. This is shown by the formulæ

$\left.\begin{matrix} C_{10}\,H_{11} \\ H \end{matrix}\right\} O_2$	Normal amylic alcohol.
$C_{10}\,H_{10},\,H_2\,O_2$	Amylic alcohol formed by synthesis from amylene.

Chinoline Blue.—Dr. Hofmann gave a most interesting oral account to the Society of his experiments on the constitution of this beautiful but fugitive dye, discovered some years ago by Greville Williams. A prize of 20,000 francs has been recently offered in France to any one who will devise a way of rendering this dye permanent, and the material is now manufactured on a

* This modern deposit has been worked for magnesia commercially.

† Mr. Church displayed numerous illustrative specimens of the products referred to, including crystals of sulphate of lime, and of sulphate of baryta, found in septaria, in the London clay.

large scale in Paris. It occurs in magnificent square prismatic crystals of brilliant metallic lustre, and which, if made from pure chinoline ($C_{18} H_7 N$) by the successive action of iodide of amyle ($C_{10} H_{11} J$) and potash (KO, HO), have the constitution expressed by the formula—

$$C_{56} H_{35} N_2 I.$$

This substance contains the elements of two equivalents of chinoline—one of iodide of amyle, and one of amylene. It yields a magnificent series of salts. Analogous substances may also be obtained by taking lepidine ($C_{20} H_9 N$) instead of chinoline, and iodide of ethyle instead of the amyle compound.

LINNEAN SOCIETY.—*December* 18*th.*

The first paper read was by Mr. A. H. Church, "On the Form of the Vascular Fasciculi in certain British Ferns." The author pointed out the general characteristics of the vascular bundles in the majority of the British species of Lastrea, noting two remarkable exceptions in *L. oreopteris*, the mountain fern, and *L. thelypteris*, the marsh fern. In these latter plants there are only two vascular fasciculi in the stipes of the frond, and these ultimately unite. The scalariform ducts are arranged in these two species in the form of the Greek letter Σ, while in other Lastreas the prevalent form is that of an oval with a small incurved process. Mr. Church pointed out the vascular arrangement in several other British species as compared with certain foreign forms and British varieties, having derived his conclusions from several hundred examinations of the living plants. In these researches he made use of perchloride of iron, which revealed the secondary deposits and ducts containing tannin, by striking a blue-black colour with them.

ROYAL GEOGRAPHICAL SOCIETY.—*December* 8*th.*

Overland Route from Pekin.—Dr. Norton Shaw read a paper descriptive of Mr. Grant's important and adventurous overland journey from Pekin to European Russia. Mr. Grant, having obtained a passport for Mongolia from Prince Kung, started from Pekin on March 26th, 1862. On the 1st of April he arrived at Kalgan, the most important commercial town in the north of China. On the 9th of May he reached Ouga, the capital of Mongolia, having traversed the desert of Gobi entirely unattended. Remaining twenty days at Kiachta, he started for Irkutsk, the capital of Eastern Siberia. After stopping here for a short time, he set out for Tomsk, whence he took a steamer to Tumen, calling at Tobolsk, the ancient capital of Siberia, from whence he passed through Ekaterinburgh to the Ural Mountains, and arrived at Tagill, where there are valuable mines belonging to the Demidoff family. These mines last year gave employment to upwards of 60,000 persons.

Mr. Grant stated that by this route communication might be made between London and Pekin in twenty-one days, the present route requiring upwards of fifty. He also praised most warmly the universal kindness and hospitality of the Russians.

Mr. Lay, the Chinese Commissioner, stated that an expedition was being organised in England to assist the Chinese government: Prince Kung having expressed a wish to avail himself of the assistance of Englishmen in suppressing the Taeping rebellion. This expedition is to be placed under the command of Captain Sherard Osborn. In connection with this movement it was proposed to organize a system of emigration, by which the surplus population of China could be located in some of the islands of the Indian Archipelago.

NOTES AND MEMORANDA.

Magnetic Perturbations and Auroras.—The epochs of the appearance of the Aurora borealis, and those of magnetic perturbations, coincide pretty closely. Rarely are auroras exhibited without magnetic disturbances occurring at the same time, and the agitation of the magnetic needle indicates the approach of an aurora. The causes of the two phenomena appear to operate simultaneously, and they are often accompanied by earthquakes in countries exposed to that class of action. Magnetic perturbations, however, operate over a much wider range than auroras.—*Quetelet, Physique du Globe.*

Vegetation and Temperature.—M. Quetelet says that careful observations have convinced him that a plant develops much more rapidly during a mean temperature, when this temperature varies, than when it is uniform, provided that it does not fall below freezing. He is also of opinion that the effect produced is equal to the squares of the temperatures. Thus, if the effect of an uniform temperature of 10° Cent. be considered as 100, that of an average or mean temperature equal to 10°, but varying between 6° and 14,° will be equal to 116.

$$\frac{6 \times 6 + 14 \times 14}{2} = 116.$$

Growth of Cotton in France.—*Cosmos* states that M. Arnaud, of Remoulins, has demonstrated that cotton can be grown in the south of France. The expense, beginning with the preparation of the soil, and ending with cleaning and warehousing the cotton, is 800 frs. per *hectare*, which is equal to 24,711 acres. In Algeria the return is 500 or 600 kilogrammes, each of which is rather more than 2½ lb.; and supposing 300 lb. could be obtained in France, it would yield, at 6 frs. per kilogramme, 1800 frs., half of which would suffice for a good profit. The great objection is, in the south of France the plant does not become quite ripe, and the capsules, after being gathered in a closed state, require to be kept in a warm, dry place, until they open of their own accord.

76th Asteroid.—M. d'Arrest has discovered this body, which resembles a 12 magnitude star. He proposes to call it Freya. It is the first object of its kind that has been discovered at Copenhagen.

The Supposed Satellite of Venus.—We learn from *Cosmos* that M. Haase, of Hanover, called the attention of astronomers, by circular, to the advisability of watching the solar disk towards the end of November and the beginning of December, as he believes the body conjectured to be a satellite of Venus may be a small planet revolving in an orbit, not differing much from that of the great one. When sufficient time has expired to collect the various observations, some new light may be thrown on this curious subject.

Age of the Pyramids.—M. Radau states that Mahmoud Bey, Astronomer to the Viceroy of Egypt, has investigated the structure of the Pyramids, with a view to discover the object of their erection. He finds the average slope of the Great Pyramid, and of six others at Memphis, to be 52°, and the variation from this mean to be slight. Moreover, the pyramids and funeral monuments which surround them, are placed so as to correspond exactly with the four cardinal points. Now it is observed when Sirius passes the meridian of Gizeh its rays strike upon the south side of the Pyramid, and 3300 years B.C. they must have fallen perpendicularly upon it, and thus, according to astrological speculation, must have exerted their greatest influence. He therefore conjectures that the pyramids were built so as to receive the most complete illumination from the brightest star in our heavens, which was consecrated to Sothis, the celestial dog and judge of the dead. The date of 3300 years B.C. corresponds with Bunsen's calculation, according to which the pyramids were built in the reign of Cheops, in the 34th century before our era, and it also coincides with the Arab tradition that they were constructed three or four centuries before the Deluge, in the year 3716, before the Hegira.

Ozone produced by Plants.—Mr. C. Kosman has communicated to the French Academy a series of observations, from which he draws the following conclusions:—1. Plants evolve ozonized oxygen from their leaves and green parts. 2. They disengage during the day ozonized oxygen in a greater ponderable quantity than exists in the circumambient air. 3. During the night the difference between the ozone produced in the plants, and that contained in the air, becomes *nil* in the case of isolated vegetation, but where the plants grow thickly and vigorously, this ozone is more abundant than that of the air. 4. Plants in the country evolve more ozone during the day than town plants. 5. From this cause country air is more exhilarating than town air. 6. In the midst of towns, and of a dense population, the night air exhibits more ozone than that of the day, but in proportion as the animal population diminishes, and the vegetable kingdom predominates, the diurnal ozone increases until it exceeds that of the night. 7. The interior of the corollas of plants do not evolve ozone. 8. Inhabited rooms do not usually contain ozonized oxygen.

Oxygenized Water.—M. Chevreul finds that this preparation destroys colours of an organic origin, just as chlorine does, but more slowly.

Size of Microscopic Printing and Writing.—Mr. Webb addresses us a note, in which he says he has measured the first *i* in "shilling," as it appears in one of the microscopic cards supplied to our readers, and he finds it "to be approximately the $\frac{1}{500} \times \frac{1}{1000} = \frac{1}{500000}$ of an inch." The specimen which he engraved for us was by no means intended to represent the limit of perfection to which he has brought this curious art, but such as could be easily read with a moderate power by persons of ordinary sight. He sends us the "Lord's Prayer," beautifully printed from copper, in which he states the letters are $\frac{1}{1100} \times \frac{1}{1100} = \frac{1}{2110000}$ of an inch, and he observes in his note, "startling as the above numbers appear at first sight, yet the letters are very large when compared with those which have been cut upon glass, some of which are only the forty millionth of an inch." He adds, "In your September number you mentioned my chapter of St. John. That specimen has been measured by several gentlemen, who all agree in stating it to be the $\frac{1}{31} \times \frac{1}{34}$, or $\frac{1}{1054}$ of an inch. The 4137 letters in that specimen, multiplied by 1054, give 4,360,398 letters to the square inch, while the whole of the Bible and Testament are said to contain only 3,566,400 letters, thus showing that at the rate in which the chapter of St. John is written, the whole Bible and Testament, and more than three-quarters of a million ad ditional letters, would come into the square inch" Mr. Webb also calls attention to the extreme minuteness of the particles of blacklead with which the lines of the finest writing on glass are filled by the gentleman who mounts his specimens. Their size, he says, would require at least ten figures to express it, and such figures are probably only a tenth of the number required to state the dimensions of Dr. Faraday's ruby gold.

Bolides.—On the 26th November, about 5 P.M., a large meteor was seen described "as big as two fists," and lighting up a lane near Chiselhurst. On the same date, but at 6 P.M., a gentleman near Broxbourne saw a large meteor apparently 400 or 500 yards above the ground, first blue, then red, and emitted numerous sparks. The same body appears to have been seen at Peckham, Bath, etc. *Cosmos* states that a few minutes before six this bolide passed over Havre with astonishing rapidity from N. to S., leaving a luminous track behind it. It was also seen at Bolbec, Ivetot, and Rouen; observers at the latter place fancying it fell by the Church of St. Vivien. At Strasburg it was seen about five minutes to five.

Pseudopodia of the Rhizopoda.—The *Annals of Natural History*, No. 60, contains a translation of Professor Reichert's observations on the pseudopodia of *Miliola and Rotalia*, which he obtained alive at Trieste. He states that the pseudopodia, when fully extended, measure six or eight times the diameter af the body, and terminate in filaments so fine that "a perceptible thickening scarcely appears when two or three filaments come together, and apparently pass into one, or when the magnifying power of the instrument is raised from 450 to 700 diameters." He denies the fact of the so-called movement of granules in these organs, and explains it by a "contraction wave formed by a loop advancing along the filament, produced in consequence of contractile movements of the substance invisible to us." He denies that the pseudopodia coalesce or amalgamate on touching each other, although they readily adhere, and ascribes the appearance of a "sarcode net" to apparent anastamoses arising from adhesion.

The Animal and Float of Ianthina.—Mr. A. Adams, writing in *Annals of Natural History*, describes the beautiful *Ianthina*, or ocean snail, as quite blind, and having the large horny mandibles, and the rounded extremity of the tongue, furnished with sharp, curved, slender teeth. It chiefly feeds on Physalia Porpitæ and Velellæ. The Ianthina is remarkable for floating shell downwards in the water, and Mr. Adams tells us that the anterior part of the foot forms a "shallow cup which embraces the smooth anterior rounded end of the float. When the animal wishes to bring its head to the surface of the water, this part of the foot is made to glide over the back of the float. Thus the animal can raise and lower itself at pleasure by means of its own float." The floats are formed of a mucous film containing air, and when cut with scissors the animal descended to the bottom of the vessel in which it was confined, and did not make a new one.

The Supposed Minute Vertebrate.—Mr. Spence Bate points out the probability of the supposed minute jaw found by Dr. Wallich in St. Helena mud being the last joint of the leg of a small crustacean, and Dr. Wallich sends a fresh letter to the *Annals of Natural History*, giving reasons for thinking it—as Mr. Busk conjectures—a valve of a pedicellaria from an echinus.

Mr. Hincks on the Medusæ of Hydroid Polyps.—The Rev. Thomas Hincks gives two drawings, with descriptions, in the *Annals of Natural History*, showing that the medusa, or "*gonozoid*," as he prefers to call it, "of the *Stauridia producta*, is identical with that of the *Coryne eximia, a member of a distinct genus*." The reader who is not acquainted with the curious modes of reproduction and development belonging to these creatures, is referred to our article on the "Origin and Transformation of Animals" (September No., p. 95).

De Candolle on Species.—In an article on the *Cupuliferæ* in the *Bibliothèque Universel*, M. Alphonse de Candolle observes, "hereditariness is an attribute of races as well as of species, to cite an evident example, the Jewish people have a certain hereditary configuration, which they preserve under all climates and influences of nutrition, without any one pretending that they constitute a species. Non-hereditariness may overthrow a pretended species, but hereditariness, even when it appears to be indefinite, does not prove the existence of a species."

Secchi on the 2nd Comet of 1862.—In a letter to M. Elie de Beaumont, M. Secchi gives an interesting account of this comet, which may be taken in conjunction with that already furnished to our readers by Mr. Webb and Mrs. Ward. He says the opposite directions taken by the sheaf-like streams of luminous matter, indicated two fixed centres of eruption. "The tail was simple until the two reversed jets were well developed, so that no doubt could remain that it was really these nebulosities which, in reversing themselves, produced the tail." The periodicity of the jets at first suggested a rotation of the comet about an axis, but the idea was not confirmed by observation. The light of the nucleus and of the *aigrettes* was only polarized once, on the last day on which such an observation was possible, and then very feebly. The nebulosities, on the contrary, were always strongly polarized. These facts indicate a different molecular condition, and M. Secchi suggests that the nucleus and the aigrettes may have been formed of vapour analogous to our clouds, which do not polarize, while the nebulosities had passed into a state of gas which polarizes like our atmosphere. He adds, "We might also admit that the nucleus and the aigrettes were incandescent, but the supposition is a little difficult. After the perihelion passage there appeared vestiges of paraboloid surfaces enveloping the sheaves of light, as if the matter was being deposited in layers as the comet cooled."

Secchi on Mars.—In 1858, M. Secchi found the appearance of Mars differ considerably from the drawings of Maedler and other astronomers. Now, the planet has returned to its former aspect, and, instead of exhibiting large complicated solar spots, showed them to be reduced to a small circle, as in Maedler. The great spots had given place to rose-coloured surfaces, traversed by blue canals, as represented in Secchi's picture of 1858. From these changes he thinks no doubt can remain that the polar spots consist of snow, or condensed clouds, which the summer heat of the planet melts. The red surface he regards as land, and the blue canals as water.—*Comptes Rendus.*

Volcanic Hair.—M. Rambosson communicates to the French Academy some facts relating to the volcano in the Isle of Reunion, and states that in the eruption of 1860 as in that of 1812, it poured forth a shower of dark cinders and of long flexible filaments of glass-like golden hair. Similar filaments were seen by Sir W. Hamilton emitted by Vesuvius in 1779.

Analysis of Air.—In his pamphlet on "Air and Water," Mr. Condy points out the facility with which air may be tested for organic impurities by placing in the required spot four or more small white saucers, each containing an ounce of distilled water, and severally one, two, three, four, or more drops of his Patent Ozonized Water, or Disinfecting Fluid, reduced by addition of two parts of water. The rate at which the pink colour of the permanganate disappears, indicates the proportion of impurity present. If during a night or day the colour vanishes in the saucer containing four drops, he states that the impurity verges on positive pollution.

New Use of Diamonds.—It was proposed some time ago in *Cosmos* to employ rough dark diamonds in the perforation of rocks, and that journal now states that M. Leschot has used a perforator formed of a tube terminating in a crown of these diamonds, and succeeded in making a hole in granite in one hour which would have taken two miners two days. The diamonds were not injured in the process.

Experiment with Sulphuretted Hydrogen.—*Cosmos* says, "Bring some drops of bromine in contact with sulphuretted hydrogen, and you will see the volume of the gas doubled at the moment the sulphur is deposited."

A Fowl with Black Periosteum.—Dr. Miche, dining with some friends on a Cochin China fowl, noticed that the covering of its bones was quite black. He accordingly sent the skeleton to M. Flourens, who was able to exhibit to the Academy a similar skeleton of a common fowl. The bones themselves were white. Six chickens out of twelve having the same parents exhibited this peculiarity, and the flesh of the only one killed was dark and ill-flavoured.

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