THE

POPULAR SCIENCE REVIEW.

A QUARTERLY MISCELLANY OF
ENTERTAINING AND INSTRUCTIVE ARTICLES ON
SCIENTIFIC SUBJECTS.

EDITED BY HENRY LAWSON, M.D.

VOLUME V.

LONDON:
ROBERT HARDWICKE, 192, PICCADILLY;
AND ALL BOOKSELLERS.

1866.

COX AND WYMAN,
ORIENTAL, CLASSICAL, AND GENERAL PRINTERS,
GREAT QUEEN STREET, W.C.

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Some insects injurious to Turnips.

POPULAR SCIENCE REVIEW.

INSECTS INJURIOUS TO THE TURNIP CROPS.

BY REV. W. HOUGHTON, M.A., F.L.S.

"WHAT thou owest, O Rome, to the Neroes," says Horace, in one of the most sublime of his Odes, "the River Metaurus and vanquished Hasdrubal are witnesses;" and he had good reason for saying so, for the victory of Claudius Nero over Hannibal's troops was a decisive one. The tide of conquest was turned; and when the great Carthaginian General saw the decapitated head of his unfortunate brother thrown into his camp, he was compelled to exclaim, "*Agnosco fortunam Carthaginis*,"—"I acknowledge the fate of Carthage." We may borrow the above-named words of the bard of Venusium, and say, "What thou owest, O Agriculturist, to the turnip crops, the whole science of farming, and the cattle, *not* 'on a thousand hills,' but in a thousand stalls, bear witness." For what should we do without turnips? What is the main support of our stalled oxen during the winter months? We may certainly use oil-cake and other fattening substances with great advantage; but still we must have our turnips, whose succulent nature is necessary to counteract the too stimulating and heating effects of oil-cake, barley meal, and other such like food. "Without the turnip," a writer in Morton's "Cyclopædia of Agriculture" remarks, "rotations of crops would have been still limited to weedy corn and foul pastures, the production of butcher's meat would have depended on pasturage, and consequently the great mass of the population must still have been condemned to a farinaceous diet or salted rations in winter. Under such circumstances it is easy to conjecture what must have been the result. The cultivation of the potato would have increased to such an extent, that the whole of Britain must now have been what Ireland lately was." Without acknowledging as an undoubted *sequitur* the above conclusion, we must all agree that the turnip has played, and will continue to play, a very important part in British agriculture; and his name is worthy to descend to posterity who first introduced to British field cultivation the variety of the *Brassica campestris,* which we believe to be the origin of our Swedish turnip.*

Probably there is no plant which has more enemies in the insect form than the turnip. The late lamented John Curtis, whose entomological knowledge is widely known, and greatly appreciated, enumerates nearly forty species of insects, besides scolopendræ, slugs and snails, which, in a greater or less degree, at certain times are found to injure the turnip crops. The ants run off with the seed as soon as it is sown; that which is spared by the ants is attacked the moment the tender leaves appear above the surface by one of the most formidable, albeit diminutive, enemies of all—namely, the little flea-beetle, popularly known throughout England as "the fly." Should the crop weather this storm, another blasting influence occasionally attacks it, in the shape of the "nigger" caterpillars of the turnip saw-fly *(Athalia spinarum)*, and the larvæ of the white butterflies; these soon make skeletons of the leaves, and defile them by their excrements. Beneath the cuticles of the leaves the larvæ of different kinds of two-winged flies excavate their winding tunnels; other dipterous larvæ riddle the turnip bulbs with innumerable mines, while the smother-fly, in two or three of its species (*Aphis*), entirely destroys the leaves. Fat grubs—bad luck to them!—the larvæ of certain moths, bite off the young root, and sever it from the green portion; wireworms,—*i.e.*, the larvæ of various click beetles (*Elateridæ*) (all vermiform creeping things of the earth are wireworms in the farmer's zoology!), centipedes, and weevil beetles must be added to the long catalogue of turnip enemies.

When we reflect on this formidable list of destructive agents in the form of insects, and add to it various fungi, which live parasitically upon the leaves (such as *Peronospora parasitica,* a species allied to the potato mould, and a kind of *Oïdium* [*Erysiphe*], which covers the leaves with its innumerable interlacements, looking like delicate threads of frosted silver under the microscope), it would seem almost to be a matter of

* Some writers suppose that the Swede is the hybrid with turnip and rape. Professor Buckman ("How to Grow Good Roots," p. 15) says this is doubtless the origin. Has the point, however, I would ask, ever been satisfactorily established?

wonder that turnips ever come to perfection at all in this country. But the especial object of this paper is to bring before the reader's notice some account of the insects which have been the cause of the complete failure of the turnip crops in Shropshire during the year 1865. Look where you will, the crops are in many instances utterly destroyed; in others so deteriorated in quality, as to render them, comparatively speaking, valueless, if not, it is to be feared, absolutely injurious as an article of food. To the ordinary observer, no doubt, the bulbs (I am speaking of the Swedes), though small, appear sound externally; but only let us cut into the root, and five out of six specimens we shall find to hold numerous little maggots. These I shall speak of by and by.

The first serious damage from insects is caused by the "fly," a small beetle about the size of a flea, and which, like that irritating little brute, is possessed of wonderful leaping powers. The muscles of the last pair of legs are enormously developed; by means of these the insect is able to take its tremendous jumps. The insect in question is not a fly properly so-called, but a beetle; and were we not guided by the old proverb, that "handsome is that handsome does," I have no doubt we should be inclined to allow him a claim to beauty. The elytra are greenish black, with a distinct broad longitudinal line or band of yellow down each; the body is black, antennæ and legs testaceous. The name of this insect is *Haltĭca nemorum*, *i.e.*, the "Leaper of the Groves," the specific name having reference to the localities frequented by the animal before turnips were as common as they are now. The injury the countless hosts of these little beetles do to the turnips, just as they show their two cotyledonous leaves above the ground, is too well known to need repetition: with their sharp mandibles they bite through the succulent leaves and riddle them through and through. It is the perfect insect or *imago* alone that does this damage. It was long before naturalists became acquainted with the economy of *Haltica nemorum*; various theories were promulgated, and most of them were false. It was supposed that the minute white spots occasionally seen upon the seeds were the eggs of the beetle: accordingly turnip-seed steeped in briny and other solutions was sold in the London seed-shops in order to ensure a crop. This may seem strange to us who refer every minute organism to the revelations of the microscope, which will tell us at once whether our preconceived theories be true. The whole history of this little pest, however, has been made known by the careful investigations of Mr. Le Keux; and though, now that we have become acquainted with the habits of the turnip fly, we are still unable to supply a remedy against its attacks, yet it is obvious that every attempt to provide against the ravages of any insect is little likely to prove efficacious until the economy of that insect is made known. We must first be sure of the disease before we can apply the remedy. And here let me remark that this department of Agricultural Science is eminently indebted to the late Mr. John Curtis, who has studied through a long period of years the habits and life-history of a vast number of insects injurious to our field crops. The results of these valuable investigations have been published in the "Transactions of the Entomological Society" and the "Quarterly Journal of Agriculture," and conveniently methodized in his beautiful work on "Farm Insects," published by Blackie & Sons in 1860. To what Mr. Curtis has written on the subject of insects injurious to our turnip crops, I have on the present occasion nothing new to record, but the naturalist takes delight in verifying by personal observation the investigation of his predecessors.

To the unobserving, the apparently sudden appearance of myriads of insects is unaccountable; hence people sometimes call in the direct agency of the east wind, and attribute to that much-abused quarter the power to engender, by some mysterious influence, whole hosts of countless myriads of flies. This is termed *a blight*,—a term which expresses in vague language nothing clearly intelligible, so far as relates to the direct cause of the mischief that ensues. Now the *Haltica nemorum* is probably known to, and seen by, farmers only at the time when the turnips are putting forth their smooth leaves. He has not noticed them at other seasons of the year, and wonders where in the world they could all have come from so suddenly, with destruction on their wings. But the naturalist notices them even as late as November, sitting with hind legs bent under their bodies ready for a spring, upon the leaves of the plants. He notices, too, the various holes made in the fully-developed leaf, and witnesses the little enemy busy at work, in the very act of making them. But we must tell the short history of their lives in a few words. The sexes pair from April to September. According to the investigations of Mr. Le Keux, the eggs, which are laid about one each day, are deposited on the under side of the rough leaves of the turnips. They are hatched in ten days, when a small maggot, of a yellow colour, appears. He immediately begins to eat his passage between the cuticles of the leaf, then hides himself in the ground, and changes in about six days to a chrysalis, the perfect insect emerging in about a fortnight afterwards. This little pest is widely distributed over the whole country, and is abundant in

Germany, Sweden, and other parts of the Continent. In this country, says Mr. Curtis, it is probable that every bank and meadow harbours them to a greater or less extent. They have been found on grass lands which had not been ploughed for many years, and where there were no turnips within half a mile. The strength of this little animal's jaws may be proved by the fact that some specimens which Mr. Curtis put in a quill with a cork stopper, "soon reduced the inside of the cork stopper to powder." The beetles hybernate during the winter, hiding in the bark of trees, under stones and leaves, ready to be called into active life by the first sunny days in the early part of the year. Although, as a rule, the turnips suffer only from the depredations of this insect while they are in the smooth cotyledonous leaves, yet instances are on record, it is said, of the autumnal crops having been destroyed by these enemies. Cruciferous plants form the principal food of the turnip-beetle; the white turnip seems to be preferred to the Swede; charlock or kedlock is a very favourite diet. A farmer told me the other day that he attributed the immunity of his Swedes from the attacks of this insect, in 1865, to the presence of a quantity of charlock amongst the turnips, the fly choosing this latter plant in preference to the turnip. Various recommendations to get rid of this scourge have from time to time been suggested, but for the most part they are unsuccessful. One method was to soak the turnip-seed in brine, brimstone, milk, and other solutions. This plan is as old as Columella, who recommends a solution of soot. I may here remark that the turnip-beetle, either *Haltica nemorum* or other species of the genus, was known to the Greeks in the time of Theophrastus under the name of *Psylla* (ψύλλα). The Roman agriculturists were well aware of the injury this little insect caused to plants of the cabbage family.

"Whoever will sow," says Columella, "*rapa* and *napus* in summer must take care lest by reason of the drought, the flea (*pulex*) consume the tender leaves just as they come out; in order to prevent this let him collect the dust from the ceilings, or the soot that adheres to the roofs above the fireplaces, and mix this with the seed, sprinkling water upon it the day before sowing, in order that the seed, by being steeped, may imbibe the liquid; the following day you may sow. Certain ancient authors, as Democritus, recommend the seeds to be steeped in the juice of the herb *sedum*, as a remedy against the attacks of these creatures, which from experience I have found to be useful; but because this plant is not readily procurable, I generally use soot and dust, and have saved my plants from injury."—(Columella, *de Re Rust.*, XI., iii., 60, 61.)

Modern agriculturists have made use of soot and dust, though not exactly in the way directed by the Roman writer.

"We learn that Mr. Dickson has perfectly succeeded in saving his crop by a very simple dressing. He took some road dust, some soot, and a little guano, and mixing these together, sowed them along the rows in the middle of the day. In a short time he found that the crowd of flies had altogether disappeared."—(Curtis's "Farm Insects," p. 31.)

Nets to catch the insects, newly painted or tarred boards to be drawn over the turnips, fumigation by "burning stubble and weeds to windward of the field, so that the smoke drives along the ground," watering the plants with brine, are all mentioned as remedies against the ravages of the turnip fly; but although some of these may be efficacious in themselves, the practical application of them on a large scale renders them for the most part unavailable. The problem may be rather solved by considering *not* how we can put the fly out of the reach of the turnip, but how we can put the turnip out of the reach of the fly. "Rapid growth of the plant is the best security." The farmer must watch his opportunity: let him have his ground ready for the seed by the end of April. Should the weather be showery let the seed be put into the ground, but if there is appearance of continued dry weather, let him wait.

The vegetation of the seed may be accelerated by steeping it in water for twenty-four hours, and the surest way to obtain a strong crop is to sow seed of the same age, otherwise the plants do not come up simultaneously, and the fly will attack and destroy the crop in detail; for it is ascertained that young seed vegetates quicker than old: this year's seed will therefore have the start of two or three years old, by as many weeks.*

But we will suppose that our turnips have survived the attacks of the turnip-beetle, and are growing and looking well for some seven or eight weeks; but what ails them once again now, we will suppose, about the end of July? The leaves look sickly; in a month's time after this, the whole crop may be said to be destroyed. What is our enemy here? Let us pull up a few plants by the roots; why they are actually cut in two just beneath the surface of the soil; the tap root remains in the soil, the broken stem and withered leaves alone we hold in our hands. And here we find the enemy in the shape of an ugly fat caterpillar, though he is not yet fully grown. These caterpillars vary slightly in colour, being generally of a pale, dirty, greyish-green, with a number of black spots along the back. The position of these is shown in Pl. I. fig. 3 *b*. Most formidable enemies are these caterpillars to the turnip crops. Here, in

* "Farm Insects," p. 26. How necessary it is to sow *new* seed has been experimentally proved by Professor Buckman, who has shown that seeds that have been kept three years generally fail to the extent of about 38 per cent. "Science and Practice in Farm Cultivation," No. 1, p. 38 (Hardwicke).

Shropshire, they have destroyed three or four consecutive sowings on several farms in this neighbourhood, during the summer of 1865. The enemy is the larva of a very beautiful moth, the *Agrotis exclamationis,* or "the heart and dart moth," the male and female of which are figured in the accompanying plate. The Latin specific name was given to this moth on account of the markings on the anterior wings, which bear some faint resemblance to the note of exclamation (!). The English name is somewhat more appropriate, so far as the form of the marks is concerned (the heart and dart being very distinct in the wings of the male figure in the drawing), (fig. 4); but both Latin and English names are highly appropriate, so far as relates to the dreadful damage these moths cause to the turnips. Is not this insect rightly called *exclamationis?* for alas (!) for the hopes of the farmer where it abounds; and people fond of symbolic representation may discern in the markings of the wings the farmer's heart about to be pierced by the dart of destruction. Nor is it turnips alone that these grubs devastate; they are very fond of lettuces, as I know to my cost, for they destroy a great number of plants in my garden every year by biting the root, and separating it from the stem.

These caterpillars are to be found abundantly in the ground as late as the middle of November; they change to pupæ in the winter, and appear as moths about June. Another species, very similar to the last, namely the *Agrotis segetum,* is also a destructive enemy to the turnip crops. As to the means to be employed to get rid of this destructive caterpillar, I believe we must depend upon the rooks, starlings, peewits, and other birds. It is said that soot is particularly obnoxious to them, but for field crops it would be difficult to obtain it in sufficient quantity; in gardens, doubtless, soot may be used to advantage. If a crop has been destroyed by these caterpillars in the month of August, the prospect of securing a second sowing is but small; for the grubs are still in the ground, and being larger are able to do more mischief. Perhaps deep-ploughing, so as to bury the enemy, might be of service; but the best friends of the farmer are, undoubtedly, the rooks and starlings. Let the rook be as sacred to the agriculturist as the owl to Athene and the stag to Artemis; let rookeries be everywhere protected, and the birds encouraged; let rook-shooting be deemed an offence of the gravest kind—those poor cawing young ones, over whose untimely fate the sorrowful parents, wheeling round high above the reach of gun-shot, are bewailing in such pitiable strains, are worthy of a more honourable treatment than to be stuffed in a pie! How long will the farmers have to be told, that by killing the rooks they are destroying their friends! Let them learn the following easy distich, which I improvise for the occasion:—

Oh! farmer, spare that bird,
Touch not a single quill!
The rook is thy true friend;
Requite him not with ill.

Instead of the last verse, a little variety may be introduced by reading:—

Of grubs he eats his fill.

The choice of reading must be left to the poetic taste of the bucolic mind.

The smother-fly, or plant louse *(Aphis)* must be enumerated as a very injurious insect to the turnip crops. The effects of its destructive work throughout a large portion of Shropshire, last August and September, were most remarkable. Crops that had survived the turnip-beetle and the caterpillars of *Agrotis segetum* and *exclamationis,* and seemed to be thriving, were suddenly attacked by myriads of *Aphis,* chiefly of the species *A. brassicæ.* In a few days, that which promised so well was hopelessly blighted. The leaves first curled and puckered inwards, then withered and died; and the smell arising therefrom completely tainted the air with a peculiarly offensive odour. Hardly a green turnip-field was to be seen for miles around; nothing but dead leaves, which, in the distance, gave to the field rather the appearance of a brown fallow than a crop of turnips.

As an illustration of the desirability of cultivating some knowledge of Natural History, and especially the economy of insects, I will mention that two farmers in this neighbourhood imagined that the lady-bird beetles (*Coccinella septem-punctata*), of which in some fields I observed prodigious numbers, were the cause of much of the injury, and therefore slew as many as they could. "What!" I exclaimed, "kill your friends! don't you know that the lady-bird, both in its larval and adult condition, is a notorious consumer of aphis flesh?" Oh, no, of course neither the one nor the other had ever heard of such a thing. "Well, then," I said, "look here, on this leaf," and I showed my friend the little beetle engaged in the very act of dining off an aphis.

The coccinellæ are unquestionably very useful in this way, and it is a great mistake to destroy them; but so innumerable were the armies of aphides in the autumn of 1865, that their well-meant endeavours to lessen the swarms were inappreciable.

Of far greater benefit to the agriculturist than either the lady-bird, or the larvæ of the Syrphidæ and lace-winged flies, is a minute hymenopterous insect, about $1\frac{1}{4}$ lines long and 2 lines in expanse of wing. Towards the middle of October, the turnip-fields swarmed with this useful insect; your clothes would be quite covered with them; of course, they were not distinguished by an ordinary observer from the aphis—this was the *Ichneumon aphidum* of Linnæus, the *Aphidius* (*Trionyx*) *rapæ* of Curtis. I dare say some of my readers have noticed on the under sides of the leaves of almost any plant affected by the aphis, some dry, puffed-out skins, generally of a light brown colour. These bodies are evidently those of an aphis; you see his legs, head, and the anal tubes; there can be no mistake about his aphis character; he is, however, quite motionless. By a careful inspection of these occupants of your leaf, you will notice in some cases a small round hole opening out from the back of the bodies (see fig. 6). Out of this *back door* the little parasite has emerged. The *Aphidius* belongs to the *Ichneumonidæ*, and the female had deposited, after the manner of that family of insects, an egg in the soft body of the *Aphis*, which turning into a maggot lived on the vitals of the plant-louse, changed into a nympha, and then into the perfect insect. About the end of October, the farmers' hopes brightened; the cold and rain had annihilated the "smother-fly," and the turnips, though small, showed signs of vitality, by putting forth from the crown a few fresh green leaves. The crops would grow now, it was supposed, and though the bulbs would not attain to any size, it was at least expected that they would be sound. But, alas! as formidable an enemy as either grub or smother-fly was stealthily doing his work of destruction underground. We take a turnip up, the upper part seems externally sound enough; the soil which attaches itself to the root prevents our seeing the injury I am next going to notice. Let us brush the soil away—and now we see brown erosions and portions of the tap root quite rotten; let us slice away, and we find a whitish maggot, about four lines long, with a pointed head, out of which he protrudes a curious organ furnished with two black hooks (by means of which he scrapes tunnels in the bulb), and a truncated tail end, having in the centre two projecting brown spiracles, from which proceed along the back a pair of silvery tracheæ; the truncated end is surrounded with about a dozen serratures. Hardly a turnip is free from some of these maggots; most of the turnips contain numbers; some,—and these have not put forth any fresh leaves,—are completely riddled through and through, and quite rotten; the decomposition has been evidently caused by the maggots (see fig. 7 *a* and *b*). If we examine the soil near the root, we find the pupæ, brown semi-cylindrical bodies, showing through the hardened integument the black hooked organ so prominent in the larva, and the serrated teeth at the posterior extremity (figs. 12 *a* & *b*). These pupæ change into two-winged flies of the genus *Anthomyia* of Meigen. The species to which this maggot belongs is the *Anthomyia brassicæ* of Bouché. I have pupæ now in my possession, but have no personal acquaintance with the perfect insect. The figure in plate (fig. 13) is copied from Curtis's "Farm Insects." It is the male of a closely related species, named by Bouché *Anthomyia radicum,* whose larva is said to be very similar to the last named, and to be, like it, injurious to the turnip roots. Of all the numerous enemies to the turnip crops, I suspect that this, as in 1865, will prove itself the most to be dreaded. The maggots boring their way into the bulbs are there as fixtures until they wish to assume the pupa form, when they quit the turnip and bury themselves in the ground.

A curious parasitic insect, one of the useful *Ichneumonides,* named by Bouché *Alysia Manducator,* lives as a larva within the bodies of the Anthomyia pupæ, and keeps them in check. I am not at present acquainted with it. The problem to solve, in order to prevent the fly from laying its eggs near the turnips, is to discover some preparation obnoxious to the insect and not hurtful to the plant, which might be put upon the soil. Lye of ashes, into which cabbage plants on being transplanted are dipped, is said to preserve them; but, as Curtis has well remarked, "It often happens that good specifics which may be successfully employed in the garden, cannot conveniently be extended to the field." I suspect that gas-tar might be used with great advantage.

The larva of the *Anthomyia brassicæ* has a pair of curious branchiæ between the second and third segment of the anterior extremity. These are connected with delicate branching tracheæ (figs. 10 and 11).

All the maggots which I noticed in the turnip bulbs appeared to belong to the same species of fly; but Mr. Curtis enumerates two or three other kinds, which, either in this country or on the Continent, are known to affect the crops, and adds, "my own opinion is, that nothing can be more likely to encourage the maggots of the cabbage and turnip flies than fresh dung, in which it seems they luxuriate; and such being the case, by spreading it in a raw state, an entire field may at once be inoculated with the disease." As far as my own experience goes, I have not found the maggot that has proved so destructive to the bulbs in dung, but a closely related one I have noticed in abundance in farmyard manure.

I suspect that the aphis was not primarily the cause of the injury to the Swedes, but that its attacks were induced by the previous unhealthiness of the plants, which had been caused by the maggots of the above-named fly already beginning their excavations.

EXPLANATION OF PLATE.

Fig. 1. Section of portion of turnip bulb affected by the larvæ of *Anthomyia brassicæ.*

„ 2. The Earth-flea beetle (*Haltica nemorum*) magnified.

„ 3. Larva of *Agrotis exclamationis*—(*a*) nat. size; (*b*) portion of ditto magnified.

„ 4, 5. Imago of above—(4) male, (5) female.

„ 6. Indurated skin of *Aphis brassicæ*, showing at the posterior extremity the opening through which the parasite *Aphidius rapæ* has emerged.

„ 7. Larva of *Anthomyia brassicæ*—(*a*) magnified, (*b*) nat. size.

„ 8. Portion of anterior extremity of ditto, showing position of hook-shaped organ and lateral branchiæ (magnified).

„ 9. Side view of hooked organ (magnified).

„ 10. Portion of anterior extremity, showing position of branchiæ and their connection with the tracheal vessels (magnified).

„ 11. Digitiform branchia, more highly magnified.

„ 12. Pupa of *Anthomyia*—(*b*) nat. size, (*a*) magnified.

„ 13. Perfect insect of *Anthomyia radicum* (magnified).

All the above figures have been drawn for me by my kind friend R. S. Chattock, Esq., of Solihull, from specimens, with the exception of figures 2 and 13, which have been copied from Curtis's "Farm Insects."

COFFEE.

BY BARON LIEBIG.

WHEN a boy I had lessons in French of a Frenchwoman, whose husband was confectioner in the grand ducal kitchen at Darmstadt. One of the sons—he became afterwards a brave and distinguished officer—was a great crony of mine, and with him I often paid a visit to the said ducal kitchen, which for me was not merely a source of material enjoyment.

The steaming, roasting, and boiling which were going on there, excited in me the greatest interest, and I could uninterruptedly watch the process of roasting a joint from the first when it was put raw on the spit, till that consummating moment when the fire had imparted to it a rich brown covering and of sweetest savour.

I observed how the roast-veal was sprinkled with salt, the capons wrapped in slices of bacon; nothing escaped my eager boyish attention.

Hence I have retained a taste for cooking, and in leisure hours occupy myself with the mysteries of the kitchen; with the preparation of articles of human food, and all thereto belonging; in which are not unfrequently included matters of which chemistry knows next to nothing.

Young chemists do not devote their attention to such things inasmuch as they are little fitted to afford proof of their skill and ingenuity, or to found a claim to recognition in the domain of science. It therefore is left for the older ones to do so.

On the best method of preparing our common beverage, coffee, the opinions both of cooks and connoisseurs considerably diverge; and the difficulty of a decision cannot fail to be appreciated by him who knows that our tinmen and other artificers are yearly adding to the improvement of the half-hundred biggins or coffee-pots which we already possess.

As my recipe for the preparation of coffee threatens to make all these inventions unnecessary, I risk, of course, making all manufacturers as such my adversaries.

I appeal, however, to the impartiality of those who drink my coffee, all of whom I hope to have on my side.

So much has already been written about the mental influence of tea and coffee upon our modern society and civilization, that it is useless to dwell on it more particularly here.

But this is certain, that Anne Boleyn must have risen from a breakfast of half-a-pound of bacon and a quart of beer (mentioned by her in one of her letters) with very different sensations as well as sentiments, from those she would have had, if the meal had consisted only of a cup of coffee or tea with some bread and butter and an egg.

I also pass over unnoticed the national economical importance of coffee, and will merely say a few words on the influence which coffee has had on modern warfare.

In the first Schleswig-Holstein and the last Italian campaign the introduction of coffee very materially contributed to improve the general health of the German and French soldier; and I am assured (by Captain Pfeufer, of the Sanitary Commission in the Bavarian Army) that since the use of coffee in the Bavarian army as beverage for the men, the numbers of soldiers on a march unable to proceed has, in comparison with formerly, very considerably diminished,—so much so, indeed, that sometimes not a man is ill; and this too when the distances have been great and the weather unfavourable.

And Julius Froebel relates ("Seven Years in Central America," p. 226), that for the men accompanying the great trading caravans in Central America, coffee is an indispensable necessity:—"Brandy is only taken as a medicine, but coffee, on the contrary, is an indispensable article, and is drunk twice a day, and in large quantities. The refreshing and strengthening effect of the drink under great toil in heat and in cold, in rain or dry, is extraordinary."

As is well known the English are masters in the preparation of tea. In preparing coffee, the Germans are, so they assert, greater adepts. It is certain that more coffee is drunk in Germany than tea.

The German *savant* especially prefers coffee to tea, which, perhaps, is because of his habits and of the different effect of the two beverages on the body.

Tea acts directly on the stomach, whose movements sometimes can be so much augmented by it, that strong tea, if taken fasting, inclines to vomiting.

Coffee, on the contrary, furthers the peristaltic movement downwards; and, therefore, the German man of letters, more accustomed to a sitting life, looks on a cup of coffee, without milk and assisted by a cigar, as a very acceptable means of assisting certain organic processes.

For the same reason, so it is said, Russian ladies have become patronesses of coffee and tobacco.

These remarks prove sufficiently that the preparation of a beverage possessing in the highest degree the above valuable qualities, cannot be without interest.

I was originally led to my attempts in this matter by the intention to obtain an extract of coffee, which might be useful for travellers and for armies on a march; and on this occasion I became aware of the influence which the atmosphere, or the oxygen in the atmosphere, exercises on coffee, by which its qualities are very materially deteriorated. I have found that a watery hot extract of roasted coffee, which, when fresh, is perfectly enjoyable—if allowed to evaporate, quickly or slowly, in a high or low temperature, loses by degrees its agreeable flavour from coming in contact with the air; a black mass remains that cannot be entirely redissolved in cold water, and which on account of its bad taste cannot be used.

Be the method of preparing coffee what it may, it is first requisite to sort the berries. Foreign substances are frequently found among them, bits of wood, feathers, and usually a number of black mouldy berries, which must be taken away; for our sense of taste is so delicate that the smallest admixture cannot escape notice.

Berries of dark or green hue are generally dyed; and these must first be washed in a little water and afterwards dried with a warm linen cloth; with those of a pale colour this is unnecessary.

The next operation is the *roasting*. On this depends the good quality of the coffee. In reality the berries should only be roasted until they have lost their horny condition, so that they may be ground, or, as is done in the East, pounded to a fine powder.

Coffee contains a crystalline substance, named *caffeine* or *theine*, because it is also a component part of tea.

This matter is volatile, and every care must be taken to retain it in the coffee. For this purpose the berries should be roasted till they are of a pale-brown colour; in those which are too dark there is no caffeine; if they are black the essential parts of the berries are entirely destroyed, and the beverage prepared from these does not deserve the name of coffee.

The berries of coffee, once roasted, lose every hour somewhat of their aroma, in consequence of the influence of the oxygen of the air, which, owing to the porosity of the roasted berries, can easily penetrate.

This pernicious change may best be avoided by strewing over the berries, when the roasting is completed, and while the vessel in which it has been done is still hot, some powdered white or brown sugar (half-an-ounce to one pound of coffee is sufficient). The sugar melts immediately, and by well shaking or turning the roaster quickly, it spreads over all the berries, and gives each one a fine glaze, impervious to the atmosphere. They have then a shining appearance, as though covered with a varnish, and they in consequence lose their smell entirely, which, however, returns in a high degree as soon as they are ground.

After this operation, they are to be shaken out rapidly from the roaster and spread on a cold plate of iron, so that they may cool as soon as possible. If the hot berries are allowed to remain heaped together, they begin to sweat, and when the quantity is large the heating process, by the influence of air, increases to such a degree that at last they take fire spontaneously. The roasted and glazed berries should be kept in a dry place, because the covering of sugar attracts moisture.

If the raw berries are boiled in water, from 23 to 24 per cent. of soluble matter is extracted. On being roasted till they assume a pale-chestnut colour, they lose 15 to 16 per cent., and the extract obtained from these by means of boiling water is 20 to 21 per cent. of the weight of the unroasted berries. The loss in weight of the extract is much larger when the roasting process is carried on till the colour of the berries is dark-brown or black. At the same time that the berries lose in weight by roasting they gain in volume by swelling; 100 volume of green berries give, after roasting, a volume of 150 to 160; or two pint measures of unroasted berries give three pints when roasted.

The usual methods of preparing coffee are, 1st, by *filtration;* 2nd, by *infusion;* 3rd, by *boiling.*

Filtration gives often, but not always, a good cup of coffee. When the pouring the boiling water over the ground coffee is done slowly, the drops in passing come in contact with too much air, whose oxygen works a change in the aromatic particles, and often destroys them entirely. The extraction, moreover, is incomplete. Instead of 20 to 21 per cent. the water dissolves only 11 to 15 per cent., and 7 to 10 per cent. is lost.

Infusion is accomplished by making the water boil, and then putting in the ground coffee; the vessel being immediately taken off the fire and allowed to stand quietly for about ten minutes. The coffee is ready for use when the powder swimming on the surface falls to the bottom on slightly stirring it. This method gives a very aromatic coffee, but one containing little extract.

Boiling, as is the custom in the East, yields excellent coffee. The powder is put on the fire in cold water, which is allowed merely to boil up a few seconds. The fine particles of coffee are drunk with the beverage. If boiled long, the aromatic parts are volatilized, and the coffee is then rich in extract, but poor in aroma.

As the best method, I adopt the following, which is a union of the 2nd and the 3rd:—

The usual quantities both of coffee and water are to be retained; a tin measure containing half an ounce of green berries, when filled with roasted ones, is generally sufficient for two small cups of coffee of moderate strength, or one, so called, large breakfast-cup (one pound of green berries, equal to 16 ounces, yielding after roasting 24 tin measures [of ½ ounce] for 48 small cups of coffee).

With three-fourths of the coffee to be employed, after being ground, the water is made to boil for 10 or 15 minutes. The one quarter of the coffee which has been kept back is then flung in, and the vessel immediately withdrawn from the fire, covered over, and allowed to stand for 5 or 6 minutes. In order that the powder on the surface may fall to the bottom, it is stirred round; the deposit takes place, and the coffee poured off is ready for use. In order to separate the dregs more completely, the coffee may be passed through a clean cloth; but generally this is not necessary, and often prejudicial to the pure flavour of the beverage.

The first boiling gives the strength, the second addition the flavour. The water does not dissolve of the aromatic substances more than the fourth part contained in the roasted coffee.

The beverage when ready ought to be of a brown-black colour; untransparent it always is, somewhat like chocolate thinned with water; and this want of clearness in coffee so prepared does not come from the fine grounds, but from a peculiar fat resembling butter, about 12 per cent. of which the berries contain, and which, if over-roasted, is partly destroyed.

In the other methods of making coffee, more than the half of the valuable parts of the berries remains in the "grounds," and is lost.

To judge as favourably of my coffee as I do myself, its taste is not to be compared with that of the ordinary beverage, but rather the good effects might be taken into consideration which my coffee has on the organism. Many persons, too, who connect the idea of strength or concentration with a dark or black colour, fancy my coffee to be thin and weak, but these were at once inclined more favourably directly I gave it a dark colour by means of burnt sugar, or by adding some substitute.

The real flavour of coffee is so little known to most persons that many who drank my coffee for the first time doubted of its goodness, because it tasted of the berries. A coffee, however, which has not the flavour of the berry is no coffee, but an artificial beverage, for which many other things may be substituted at pleasure. Hence it comes that if to the decoction made from roasted chicory, carrots, or beetroot, the slightest quantity of coffee be added, few persons detect the difference. This accounts for the great diffusion of each such substitute. A dark mixture, with an empyreumatical taste, most people fancy to be coffee. For tea there are no substitutes, because everybody knows what real tea is like.

Heating qualities have generally been attributed to coffee, and for this reason it is avoided by many people: however, these heating qualities belong to the volatile products called forth by the destruction of the soluble parts of the berries in the process of roasting. Coffee prepared in my manner is not heating, and I have found that it may be taken after dinner without disturbing the digestion; a circumstance which, with me at least, always takes place after the enjoyment of strongly-roasted coffee.

For special cases, such as journeys and marches, where it is impossible to be burdened with the necessary machines for roasting and grinding, coffee may be carried in a powdered form, and its aromatic properties preserved by the following process:—One pound of the roasted berries are reduced to powder and immediately wetted with a syrup of sugar, obtained by pouring on three ounces of sugar two ounces of water, and letting them stand a few minutes. When the powder is thoroughly wetted with the syrup, two ounces of finely-powdered sugar are to be added, mixed well with it, and the whole is then to be spread out in the air to dry. The sugar locks up the volatile parts of the coffee, so that when it is dry they cannot escape. If coffee is now to be made, cold water is to be poured over a certain quantity of the powder and made to boil. Ground coffee prepared in this way, and which lay exposed to the air for one month, yielded, on being boiled, as good a beverage as one made of freshly-roasted berries.

AUSTRALIA AND EUROPE FORMERLY ONE CONTINENT.

BY BERTHOLD SEEMANN, Ph.D., F.L.S., V.P.A.S.

TO our forefathers it must have had a wonderful fascination when some astrologer of note proclaimed the great events that were to happen in the world, or uttered solemn words of warning that sent a thrill of horror through the believing multitude. Our practical age, by its unbelief, has deprived itself of all the pleasure resulting from that pastime. True, there have been some modern attempts in that direction, but they have invariably resulted in failure. We no sooner hear of some popular preacher having predicted the end of the world to occur within three years' time, than we read in the newspapers that the prophet has rudely destroyed our nascent belief by taking a new lease of his house for a series of years. Modern science, which dispelled so many delusions, has laid it down as one of its dogmas, that it is absolutely useless to attempt lifting the veil which separates the living present from the unborn future; and mankind has no sooner mastered this dogma than it makes right-about-face, and throws itself, with all the ardour of a youthful lover, into the arms of the past. Not content with such history as is written in books, it compels the hieroglyphics of Egypt and the picture-writings of America to give evidence. Rude implements are put in the witness-box, and every stone or bone touched by the hand of extinct human races becomes an object of interest. The fainter the stream of history runs, the greater the interest it inspires. But at last a point is reached where all human history, as far as present investigation goes, apparently comes to an end. Even if we assume the correctness of M. Desnoyer's observation, man's existence upon earth has, as yet, not been traced farther back than to the Pleiocene formation. But it would be premature to say, because no evidence has as yet been adduced, that man may not have existed in the Eocene, especially as it can be shown that a race of men, the lowest we know of, co-exists with that remnant of the Eocene Flora which still survives on the continent and islands of Australia.

With the entire cessation of data for human history, our

Fossil European Plants, and their Analogous Living Species.

interest in the good and evil periods through which our planet has passed does not abate; but we go on inquiring into the nature and formation of the tertiary, secondary, and primary rocks, because the history of the one helps to explain that of the other, and imparts an irresistible force to the dicta of modern investigation. After we shall have made greater advance in these investigations, and accumulated more facts, we shall be in a fair position to reconstruct, with a tolerable degree of accuracy, the whole surface of our globe as it existed at the various geological periods, show the boundaries of the continents and islands, clothe them with extinct forms of vegetation, and recal to life races of animals and men long passed away. Unger's ideal landscapes of primitive nature* foreshadowed the results which the united labours of geologists, botanists, zoologists, and anthropologists, are busy to bring about. It cannot be said that at present they are pursuing their labours in concert; on the contrary, every one is too busily engaged in his own workshop to trouble himself much about the doings of others; but there is no harm in that course when so much preliminary work has still to be got through. It is perhaps all the better that up to a certain point every one should work independently, merely contenting himself with letting the general public know the principal results at which he has arrived.

The facts which botanists have accumulated for reconstructing these lost maps of the globe are rather comprehensive; and they have not been backward in demonstrating the former existence of several large tracts of solid land in parts now occupied by great oceans. The many striking points of contact between the present floras of the United States and Eastern Asia induced them to assume, that during the present order of things there existed a continental connection between South Eastern Asia and Western America. The singular correspondence of the present flora of the Southern United States with that of the lignite flora of Europe induces them to believe that, in the Miocene period, Europe and America were connected by a land passage, of which Iceland, Madeira, and the other Atlantic islands, are remnants; that, in fact, the story of Atlantis, which an Egyptian priest told to Solon, is not purely fictitious, but rests upon a solid historical basis. Again, the existence of certain Iberian plants in Ireland they explain by having once more recourse to a former continental connection between the Iberian peninsula and that island. An hypothesis even bolder than any of these has been advanced

* Ideal Views of the Primitive World in its Geological and Palæontological Phases. London: Robert Hardwicke, 192, Picadilly.

by Dr. Unger, of Vienna, one of the most distinguished and cautious of leading botanical palæontologists, to account for the similarity, not to say identity, of vegetable forms existing in the Eocene beds of Europe and the present flora of Australia. Dr. Unger employs, in his essay on this subject (*Journal of Botany, British and Foreign*, vol. iii. pp. 39-70), the same method by which he proved so satisfactorily the former existence of the island of Atlantis (*Journal of Botany*, iii. p. 12), and it may be interesting to give here the result of his labours, adding such observations as may suggest themselves.

New Holland and the neighbouring islands are characterized by a vegetation at present not met with in other parts of the world. Several natural orders and genera of plants are there found in such overwhelming majority that the vegetation derives from them its distinguishing character. There are, for instance, certain Myrtaceous plants—*Eucalypti*, or gum-trees—diffused over New Holland in such numerous species, and the species represented by such innumerable individuals, that they alone determine the character and the condition of the forests. The same remark applies to a countless multitude of those heath-like plants, the *Epacrids*, which are to New Holland what the *Ericas* are to the Cape of Good Hope. The peculiarity of these trees and shrubs, and their abundance, have induced botanical geographers to designate the extra-tropical part of New Holland "the region of gum-trees and *Epacrids*." But these are not the only types characteristic of this part of the globe: the *Proteaceæ, Santaleæ, Monimiaceæ,* and *Antholobeæ,* are equally prominent. True, some of them have sent outposts to other continents, but their principal army is stationed in New Holland and the adjacent islands; the *Proteaceæ* especially are spread over the whole continent of Australia in numerous genera and species. Nor must we omit to mention several genera of *Leguminosæ* and *Coniferæ.* There are also the *Acacias,* with numerous species, and curious enlarged leafstalks, peculiar to the Australian types; and amongst the *Coniferæ,* the genera *Araucaria, Podocarpus,* and partly *Callitris.*

Let us now see how far these characteristic plants of New Holland are represented in our European Eocene formation. Not only do we meet with the polymorphous order *Myrtaceæ,* but it is plain the genus *Eucalyptus* itself is represented amongst the fossils. Of several species the peculiar leaves as well as the fruit have been found. The same is the case with the *Epacrids.* But much more stress has been laid upon the *Proteaceæ,* as the characteristic plants of the Eocene period, than the *Myrtaceæ* and *Epacrids.* We have found of them different leaves, fruit, and seed, and are in a position to make out even certain genera, such as *Banksia* (fig. 13), *Dryandra*, *Hakea*, *Embothrium* (fig. 12), *Grevillea* (fig. 10), *Lomatia*, *Persoonia*, *Petrophyllum*, &c. Thus it would appear that the *Proteaceæ* now constituting the bulk of the New Holland vegetation played a similar part during a former geological epoch of Europe. Greater stress has, however, to be laid—because the character of New Holland and the Southern Hemisphere is more especially determined by them—upon the presence of the *Santalaceæ*, *Anthoboleæ*, and *Monimiaceæ*, particularly the genus *Leptomeria*, of which several species have been discovered in the Tyrol and in the lignite deposits of the lower Rhine. Closely related to these leafless shrubs is the Australian Cherry (*Exocarpus*, fig. 9), which, strange to mention, is found amongst the fossils at Nadoboj (fig. 8). Nor must we omit to enumerate the genus *Laurelia*, which is peculiar to New Zealand and the mountains of Southern Chili. All these fragments make it evident that the flora of the Eocene period bore the character of the present Australian vegetation. But what are we to add about the *Coniferæ*, *Cupuliferæ*, *Casuarineæ*, *Araliaceæ*, *Leguminosæ*, &c.? Amongst the most common fossils of Sotzka and Häring are the branches of a coniferous plant which has its exact counterpart in the genus *Araucaria*; and the latter, as it is well known, belongs exclusively to the Southern Hemisphere, New Holland and Norfolk Island possessing five species. *Podocarpus*, *Libocedrus*, and *Callitris*, may also be named as natives of the same hemisphere, and fragments of them are found in nearly all localities of the Eocene formation. Who does not know the *Casuarineæ* of our greenhouses, and that those leafless, equisetum-like trees are almost exclusively met with in New Holland? They also seem to have been represented in pre-historic ages. It is also worthy of remark that amongst the numerous fossil-oaks of the Eocene period, there is one with the type peculiar to the Javanese ones of the existing vegetation; and that the dwarf Beeches of Tierra del Fuego, Chili, Van Diemen's Land, &c., of the present day (figs. 2, 3, 4, 6, and 7) probably also existed formerly (figs. 1 and 5). Many more instances could be cited, but we may content ourselves with casting a look upon the widely-diffused and polymorphous class of *Leguminosæ*. As is well known, it is divided into several tribes, every one of which, preferring a certain climate, has selected this or that country as its principal dwelling-place. Amongst those with pea-flowers the *Dalbergieæ* and *Cæsalpineæ* are only met with in the tropics; whilst the *Mimoseæ* form a considerable portion of the tree-vegetation of New Holland. Amongst the fossils of the Eocene formation we have corresponding with them the genera *Pterocarpus, Drepanocarpus, Centrolobium, Dalbergia, Cassia, Cæsalpinia, Bauhinia, Copaifera, Entada, Acacia, Mimosa,* and *Inga*—*Acacia* being, perhaps, most numerously represented.

Seeing what a considerable portion of the Australian and Polynesian flora was represented by characteristic types in the Eocene period, we can no longer entertain any doubt that *Europe stood in some kind of connection with New Holland.* But what was the exact nature of this connection? Let us hear Dr. Unger's answer. Wherever similar or the same effects in natural phenomena are perceived, we are justified in ascribing them to similar or the same causes. A vegetation in Europe bearing the same character as that of New Holland and the adjacent islands of the present day compels us to admit that, at the Eocene period, a set of conditions prevailed in our continent similar to those under which the Australian flora at present exists. It is not conceivable that when our forests were formed by Araucarias, instead of Pines, and our underwood of *Proteaceæ, Santaleæ,* &c., instead of Rhammi, Privets, and Hazels, the climate and soil should have been the same as they are now. We know but too well what peculiar conditions of temperature, light, moisture, &c., certain plants require, and how slavishly we are tied to certain rules in our cultivation of foreign plants. True, *Araucarias, Proteaceæ,* and *Epacrideæ* grow, at present, exceedingly well in Europe, but only when protected by glass, in a certain artificial temperature and light, and a well-prepared soil—calculated to approximate the exceptional conditions under which they are grown to those of their native country. We may, therefore, conclude with good reason that the conditions which we produce artificially, in order to grow these plants, existed in the whole of Europe ; in short that, *at the Eocene period, Europe must have had a climate like that of New Holland at the present day.*

But by thus determining the climate of Europe during the Eocene period, we have not proved more than that our part of the world could formerly support a vegetation which required a much milder climate. It is more important to ascertain how the vegetation of a continent situated at our very antipodes could find its way hither. It is comparatively easy to account for the spreading of the plants of an adjacent milder climate to our northern zone, or how the plants of a northern subtropical region came to us; but the occurrence of representatives of the southern hemisphere in the northern certainly demands a very peculiar set of conditions. In trying to solve this problem we shall have to learn a little geography—pre-historic geography though it be —by the assistance of botany. The principal questions that meet us at the very outset are: Has a continental connection between these two quarters of the globe been possible or probable? Are there any proofs similar to those by which is supported the former connection between Europe and America? None whatever; moreover, the geological investigations respecting this point are still so unsatisfactory that we gain no support from them to account for a contemporaneous and homologous vegetation in these two extreme corners of the globe. Nothing remains save to assume either the existence of several centres of creation, or the transmission from one locality to the other of the greater number of these plants over land and sea. By adopting the first alternative, we should have to assume that, at the same geological period, New Holland as well as Europe produced the germs of identical, or very nearly identical plants. An identity of climate—which, under any circumstances, must be granted—would seem to settle the question, by the adoption of this hypothesis, in the most simple manner. And why should not similar, or even perfectly identical plants originate in two or several parts of the globe, provided external circumstances are favourable? Theoretically speaking, there is, indeed, nothing to oppose to this, provided that the origin of species is brought about exclusively by external circumstances. But we are led to quite an opposite view by what we know of the distribution of existing plants. We know that every species was originally confined to a more or less circumscribed space, whence it spread centrifugally. However extensive the range of certain plants may be, it has always a well-defined limit, beyond which the species seldom ventures in isolated patches. Wherever we do meet with such exceptional cases, similar to those of the enclaves in the distribution of languages, we have no difficulty in recognizing in them intruders, or as parts cut off from the principal stock, and geology has already in some respects accounted for the cause of this dismemberment. But not a single species has as yet been found occupying two distinct territories which are evidently the result of two centres of creation. These facts justify us in rejecting the proposition of a contemporaneous origin of identical or nearly identical species in two countries widely separated from each other, and nothing remains but to assume that either the New Holland plants emigrated to Europe, or (what is less probable) the former European plants, which had an Australian character, passed from Europe to New Holland.

Wandering is the destiny of mortals. If man or beast are compelled to leave their native place, their organization, and the nature of surrounding circumstances, easily supply us with an intelligible reason for the act. But it is more difficult to account for the migration of plants, intimately connected as they are with the soil; and if, nevertheless, we find these effecting a migration from one continent to the other, it can only be the result of a tendency belonging less to the individual than to the whole species struggling for existence. If it be interesting to trace the migrations of different races of men and animals, it is not the less so to watch the distribution of plants. At present a considerable number of European plants grow in New Holland, and many of them existed there even before that continent was discovered by us. If these could find their way thither across the equator, New Holland plants could pass to us before vessels began to navigate between the two continents. What currents, winds, and migratory animals, can effect in this respect has been substantiated by superabundant evidence. Long ago, Nature established a telegraphic intercourse over the globe, by means of which she not only makes known her decrees, but effects her necessary postal communications; and if amongst the cosmopolitan plants there are so many lower Cryptogams propagated by minute light spores, we cannot long remain in doubt about the agents that lent a helping hand to these colonists. But even this, as everything else in this world, has its limit; and it would be unphilosophical to think that by these means alone we could explain the whole distribution of plants. Oceans and large basins of water offer, indeed, great obstacles to the spreading of terrestrial plants, though they may be instrumental in carrying fruits and seeds. But experience has taught that the transportation effected by waves and currents is, at best, confined to only a limited number of plants which can bear the ill effects of water without losing their vitality, and which, on their arrival on foreign shores, meet with such conditions as are essential to their existence. It is evident that amongst the numerous species composing the flora of a country there can only be very few which are able to overleap the boundaries of their natural range.

But all this does not explain how the peculiarities of a whole flora can reappear in far distant countries. If, therefore, we find in the Eocene flora of Europe principally plants bearing the characters of those of Australia and Polynesia, we can hardly believe that the whole of them could have passed uninjured across Torres Strait to New Guinea, the Moluccas, &c., to Asia, and thence to Europe. On the contrary, to render this singular fact somewhat intelligible we shall be compelled not only to assume a closer connection of the different Polynesian islands with Australia, but also a continental connection of them with Asia by way of the Moluccas. It is, therefore, by means of a continental highway that the *Araucarias*, *Proteaceæ*, *Santaleæ*, and numerous other arboreous and herbaceous plants, reached our continent, where, after myriads of years, they are still preserved as fossils. But supposing that the highway had been sufficiently practicable to permit masses of plants to reach Europe, the problem still remains, how did it come to pass that they could make so difficult a journey, extending over thousands of years, without obtaining on foreign Asiatic soil conditions favourable to their existence? Unfortunately, the geological investigations of that continent do, as yet, not enable us to make even a surmise, but we know for certain the ranks of these Australian emigrants were increased in Asia by a number of species which continued with them their onward march to Europe,—at that time, it should be remembered, not a cold country.

But Europe of the Eocene period received the plants which spread over mountains and plains, valleys and river-banks, neither exclusively from the south nor from the east. The west also furnished additions, and if at that period these were rather meagre, they show, at all events, that the bridge was already building which, at a later period, was to facilitate communication between the two continents in such a remarkable manner. At that time some plants of the western continent began to reach Europe by means of the island of Atlantis, then probably just rising above the ocean. The numerous Hickories, Maples, Oaks, Poplars, *Nyssaceæ* and *Papilionaceæ*, &c., can have reached us only from a western centre of creation. Europe thus became, in all probability, the farthest limit attained by the outposts and colonists of three great centres of creation, situated at about equal distances from each other, and the place where they met and amalgamated. Europe, without being a centre of creation, thus received the impress of the peculiarities of three great continents.

Australia, on account of its isolated geographical position, strange productions, curious physical character, and the low degree of development attained by its flora and fauna, must not be regarded as a newly-born island, but, on the contrary, as a country in its senility, which from time immemorial had retained its character unchanged. New Holland may be likened to an old man, rather than to a child; it does not begin to breathe and to live; on the contrary, it has lived and toiled, and is tottering towards the grave. This is indicated, not only by its flora and fauna, but also by geological peculiarities of the country. None of the newer formations, so widely diffused over Europe, cover its extensive primitive rocks; and its older deposits, principally consisting of layers of carboniferous sandstone and porphyry, are horizontal and undisturbed. No revolutions have passed over the surface since it rose from the ocean; and for that reason the greater portion of the country still looks most like the bottom of the sea. On the other hand, there is a phenomenon plainly indicating that the country has done playing its part, and must now prepare for vast changes. The whole of New Holland is surrounded by coral reefs, those buildings of sinister Naiades which slowly but surely drag their victims to their watery habitation. It is known that these reef-building corals grow only in considerable masses where the ground is gradually sinking. If there were no other sign, these coral banks surrounding the continent and islands would point to changes in the level; and, from what the smaller Polynesian islands have already undergone, the future New Holland—viz. a dissolution of the continent into groups of islands—might be predicted. But the entire condition of the country, the desert-like character of the interior, the great number of salt-lakes, the rivers terminating in swamps, &c., indicate an approaching geological change, which, however—let our colonists take comfort—may not take place for some thousands of years. As soon as New Holland shall have been broken up into islands, we may expect its vegetation to assume the same aspect as that now presented by the Polynesian islands. The bulk of the plants, adapted as they are to the peculiar dry climate of the extratropical parts, would perish as soon as the climate became insular, and the Asiatic flora, which even now presses hard upon the northern parts of New Holland, would get the upper hand, as has been the case in the Pacific after the dissolution of its continent into those innumerable islands now called Polynesia. Plants with dry leathery leaves would be superseded by those having a more luxuriant but weedy look; for that I take to be the principal physiognomic difference between the floras of extratropical Australia and tropical Asia.

It must be evident that the inquiry Unger has set on foot cannot stop here. The abundance of the most typical forms of Australian mammals — the marsupials (opossum and kangaroo)—in tertiary European deposits, will doubtless tempt some comprehensive mind to treat the subject from a zoological point of view. It is most important to ascertain whether the present fauna of Australia was always associated with the present flora. I do not know of any reason why it should not; but a closer examination of all the facts may possibly point to a different conclusion. It will probably turn out that in the Australian native population we behold the oldest as well as the lowest race of men—a race in many instances without any religion whatever, and incapable of mastering any religious teaching,—a race unfitted for civilization, and so near the brute creation that it might be appropriately classed with it, if it was not for its power of language and the only ingenious thing in its possession—the boomerang. The reason why New Holland could not make any great strides in civilization, conceding even that the natives as a race were capable of it, are easily found in the nature of the country. It wants moisture and nutritious plants for man and beast. It requires immense tracts of land to feed even a flock of sheep, wild animals are scarce; and whilst every other part of the globe has added edible plants to our table, we have not received a single addition from New Holland; indeed, Europeans who should have to rely for their food upon what Australian vegetation can supply, would share the melancholy fate of Burke and Wills when they tried to eke out their existence by eating the wretched nardoo fruits of Australian swamps. There could be no flocking together of men as long as these conditions were not remedied, no permanent interest in property, and no improvement. All was hopeless stagnation

But if, under these unfavourable conditions, man has existed, at least as far as we *historically* know, for several centuries,* we may conclude that he *could* exist in Europe, even during the Eocene period; when the same, or a closely similar climate, vegetation, and perhaps fauna, prevailed there. We may also be sure that, with such surroundings, whatever his race may have been, he could not have arrived at a much higher degree of civilization than the wretched aborigines who are now disappearing in Australia.

Bearing in mind that, at one period of the earth's history, there flourished in Europe a vegetation very similar to that still beheld in Australia; but that the whole of it has been swept away, to make room for other vegetable forms, leaving no trace behind except what is recorded in the great stone-book of nature, New Holland is highly instructive. It is a faithful picture of what the aspect of our flora must have been ages ago; and on paying a visit to Australia we are, as it were, transporting ourselves back to ante-historical periods. The

* I am fully aware that some anthropologists regard (perhaps with justice) the Australian and Papuan races as identical; but I have avoided complicating the question here discussed by the introduction of that subject. The most northern country occupied by Papuans are the Andaman islands, and I have shown, some years ago, in the *Athenæum*, that they were visited about 1000 years back by Sindbad the Sailor (the popular version of whose narratives is familiar to us through the "Arabian Nights' Entertainment"), and that the inhabitants were at that time as wild as they are at the present day, though in contact with the civilization of Asia.

effect which such an inspection produces on the mind is very singular. It kindles in us (and I speak from personal experience) feelings of curiosity, but no sympathy. We delight in bright green foliage, sweet-smelling flowers, and fruits with some kind of taste in them. But we have here none of all these. The leaves are of a dull, often brownish, green, and without any lustre, the flowers do not smell, and the fruits, without any exception, are tasteless and insipid. Is the whole of this vegetation, and the animals depending upon it for support, to disappear before the continent becomes a fit abode for the white man?

Plates 2 and 3 represent a few specimens of the fossil species found in Europe, and their corresponding living types, the former illustrated by woodcuts, the latter by nature-printing. Fig. 1, *Fagus pygmæa*, and fig. 5, *Fagus Chamæphegos*, two fossil species; figs. 2, 3, and 4, *Fagus obliqua;* fig. 6, *Fagus betuloides* and *Fagus Cunninghami*, three existing species; fig. 8, the fossil *Exocarpus Radobojana*, and fig. 9, the existing *Exocarpus cupressiformis;* fig. 10, the fossil *Grevillea Kymmeana*, and fig. 11, the existing *Lomatia linearis;* fig. 13, the extinct *Banksia Solonis*, and fig. 14, the existing *Banksia serrata.*

Fig. 13.

Fig. 14.

Fossil European Plants, and their Analogous Living Species.

ON OZONE IN RELATION TO HEALTH AND DISEASE.

BY B. W. RICHARDSON, M.A., M.D., F.R.C.P.

I HAVE undertaken to write a few pages for the POPULAR SCIENCE REVIEW on the subject of Ozone in relation to disease. The subject is all novelty and all interest, so that those who have studied it, as I and some few others have studied it, are sure of a hearing when they communicate what they know in intelligible language. But for the very reason that the subject is both novel and interesting, it is necessary to approach it with caution, and certainly without enthusiasm. The cold philosopher whom Bulwer Lytton has so marvellously depicted in "Zanoni," Zanoni's own guide and counsellor, would not himself have been too frigid in his philosophy to deal with this topic. Since the day when the word Ozone first became known in this country, I have made the subject before us a careful study, and eleven years ago a conjoint paper by Dr. Moffatt and myself was read at the Epidemiological Society, the key-note of which paper was "Ozone and disease." But I confess that as yet I know very little about the matter—very little that can be called real and demonstrative. I feel as one of the crew of Columbus might have felt when, nearing the western islands of the Indies, he saw floating towards him remnants of trees and broken paddles and canoes, with flights of birds above head, and other indications that land must be near, but with no land in sight. I feel that there are many indications of the near approach of some great truth connected with discoveries on Ozone; but the truth is either not visible as yet, or, being visible, is so dimly seen as to be indefinable.

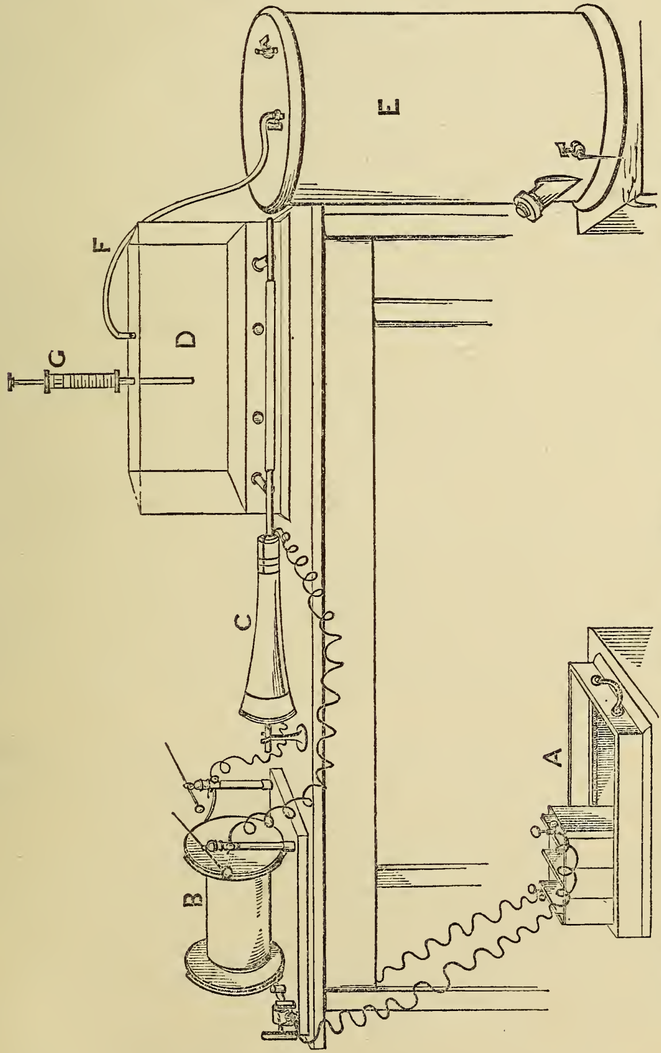
It is fair, reader, that I should give you this warning, and having made so clear a confession, I will ask you to trust me as a guide without hesitation or fear. I will direct the light I hold boldly on paths that are known, and if at any time it shall fall on paths that are obscure, the *fact* shall be stated, and no artificial path shall be described.

The chemists have held a sharp contest respecting the true nature of Ozone. In general terms the word refers to a gaseous substance possessing a peculiar odour: it is a negative word, conveying no accurate idea of the composition of the substance—and perhaps this is an advantage to science rather than the contrary, at least for the present time; the word, that is to say, is meaningless, and might, from its derivation "οζω, to smell," apply to any gas that is odorous; but because it is meaningless as a definition, it pledges itself to no theory or hypothesis as to the elementary constitution of the substance it designates. When that constitution is discovered, and all chemists shake hands over it in cordial agreement, it will be good time to change the name, if that be desirable, and make the designation define the substance as it really is in its essence.

The circumstances under which Ozone may be presented are, to a considerable extent, known. When an electrical machine —a common frictional machine—is set in motion, and sparks or flashes are taken from the positive conductor, Ozone is developed, and its characteristic odour is readily detected. When water is decomposed by electricity, Ozone appears, with oxygen, at the positive pole; in fact, according to one view, the oxygen is simply in an active state, ozonized. If oxygen, nitrous oxide gas, or carbonic acid gas, be placed in a glass jar, and electrical sparks be passed through the gas, Ozone is developed, and the same has been stated in respect to nitrogen, but Dr. Wood and I were unable by experiment to sustain this last assertion. Ozone may also be obtained by heating one end of a glass rod gently, and then immersing the said end in a jar through which rectified ether is diffused in vapour.

A ready way of making Ozone is to take sticks of common phosphorus, scrape them until they have a metallic lustre, place them, in this condition, in a large bell jar, and half cover them with water. The air in the bell jar is soon charged with Ozone, and a large room can readily be supplied with air in the ozonized state by this process.

To make Ozone on a large scale an apparatus invented by Siemens is the best. A cylinder of glass is covered neatly on its outer surface with tinfoil in the same manner as a Leyden jar. Then within this cylinder a smaller cylinder, also coated with tinfoil, is introduced and fixed with cork. The two free ends of the large cylinder are closed with corks well coated with sealing-wax varnish, and each cork is perforated so that a small wooden or glass tube may be inserted. There is thus formed a chamber of glass, lined with tinfoil, and if a bellows be attached to one of the small tubes, and air be driven from the bellows, it passes through this chamber and can be collected as it escapes at the opposite end. To ozonize the air that may be sent through this chamber, it is now only necessary to discharge electrical sparks through the chamber while the current of air is making its way. To effect this, the coating of tinfoil on the inner and the coating of tinfoil on the outer cylinder are each armed with a fine platinum wire. These



A. Battery; B. Induction Coil; C. Ozone generator; D. Chamber for receiving ozonized air; E. Gas-holder for reserved ozonized air G. Pump for extracting air.

wires are connected by their free ends with the poles, one wire to one pole, the other to the opposite pole,—of a large induction coil. The coil being set in action by the power derived from three or four cells of a Grove's battery, electrical discharges are freely made in the chamber of the cylinder, and the air is richly ozonized. In the diagram herewith supplied, the apparatus, as it is set up ready for action, is well depicted by Mr. Orrin Smith.

By means of this apparatus I have produced an air which is irrespirable except for a brief period, and so active in its destructive power that gutta-percha and india-rubber tubings are destroyed by merely conveying it. To obviate the mechanical difficulties arising from this cause Dr. Wood has very ingeniously devised a tube of quills, which answers every purpose: the quills are held together with sealing-wax varnish, the narrow end of one quill being inserted into the wider end of another, and so on in a line.

Such are the various methods by which Ozone is produced, and however produced it appears to have the same properties: it is, therefore, assumed to be the same substance as derived from all these sources, but what it is,—that is still a disputed question.

I shall not trouble the reader with any argument on this great subject—it suffices for the physiologist to know that there is an active agent, which he may call Ozone, and which he can produce at will,—but I may state, in one or two words, that, in respect to composition, one class of theorists hold Ozone to be simply oxygen in an active state, while others maintain that it is a combination of oxygen with hydrogen, a peroxide of hydrogen. According to my light I should say that those who hold for the active oxygen theory have the best of the disputation; but I will not press the point further, because the object of this paper is not to discuss what Ozone is, but what it does in one particular course of action.

By operating with Siemens's apparatus, we may discover with great rapidity and by frequently repeated experiment, the influence of Ozone on both dead and living organic animal matter. We may follow these lines usefully.

On dead matter that has become putrid Ozone acts with great vehemence as a deodorizer or purifier. This it effects by decomposing the products which emanate from the putrifying body, and the effects are the same in the most offensive compounds. I could illustrate these facts by numerous experiments, but one will be sufficient.

In the year 1854, I placed a pint of blood derived from an ox, in a large, wide-mouthed bottle. The blood had coagulated when it was placed in the bottle, and consisted of two parts clot and serum. It was left in this state, exposed to the air, until it was quite putrid and the clot was softening: then the clot was gently stirred from time to time, until it had entirely redissolved as a result of alkaline decomposition. At the close of the year, the whole mass was as fluid as port wine, and was most offensive to the sense of smell. The stopper was placed in the bottle, and the bottle itself was put aside. In the year 1862, the bottle was taken from its hiding-place, and an ounce of the blood was withdrawn. The fluid was so offensive as to produce nausea when the gases evolved from it were inhaled. It was subjected by Dr. Wood and myself to a current of Ozone from Siemens's cylinder. For a few minutes the odour of Ozone was destroyed by the odour of the gases from the blood; gradually the offensive smell passed away; then the fluid mass became quite sweet, and at last a faint odour of Ozone was detected, whereupon the current was stopped. The blood was thus entirely deodorized, but another and most singular phenomenon was observed. The dead blood coagulated as the products of decomposition were removed, and this so perfectly, that from the new clot that was formed serum exuded. Before the experiment commenced, I had predicted on theoretical grounds that the phenomenon of secondary coagulation must follow upon purification, and this experiment, as well as several others afterwards performed, verified the truth of the prediction.

We gather from this experiment, then, the first fundamental fact I would like to impress, that the substance called Ozone energetically destroys the putrid emanations of decomposing animal substances, and, even after they are long dead, restores to the dead matter certain of its properties which, though in truth they are always physical, are vulgarly called vital. We might turn this fact to some great account in the matter of decomposing animal food. If the butcher were a scientific man, he could at little expense restore to wholesome freshness and purity the greater portion of the decomposing carcases, which now, at bad seasons of the year for preservation, he is obliged to cast away as a nuisance.

I have put forward these effects produced on dead matter by Ozone in its concentrate form that the facts may impress the mind forcibly and sharply, for the light we possess leaves no obscurity here; and now we may venture a step further, and show the same series of effects as progressing on the largest scale, not artificially or by human experiment, but universally, with nature herself as the experimentalist. By some grand process Ozone is produced in the atmospheric sea which surrounds our planet. It is estimated to exist naturally in the proportion of one part of Ozone to ten thousand parts of air. I cannot vouch for the entire accuracy of this computation, because the amount, according to our present mode of estimating it, seems to fluctuate, and no sufficient number of experiments have been made in different portions of the world to allow of a correct average being determined: we must take one part in ten thousand as an approximative, not an actual value.

The natural process leading to the production of Ozone in the atmospheric sea is not as yet understood. At first, electrical storms were conceived to be the means of production; then Professor Dove advanced the idea that the Ozone is generated in the upper equatorial currents of air, and is by these diffused over the planetary surface with the north and south winds; and again Dr. Moffatt, whose labours in this department of science cannot be over-estimated, considers that Ozone is connected with the phenomenon of phosphorescence, and that, in short, it is produced in nature at large as we have seen it produced in the laboratory as a result of phosphorous oxidation. Of all these theories, that of Dr. Moffatt is the most simple, and is best supported by observation.

When we know the two facts that Ozone purifies decomposing organic substances, by breaking up the offensive deleterious products of decomposition, and that it exists naturally in the air we breathe, we might infer that it fulfilled some useful purpose in the universe, without speculating rashly. But we have no occasion to speculate at all, for we find as a positive fact, sustained by the most perfect evidence, that Ozone *is* usefully employed, and that in truth it is the great purifier of the impure air of city and town. It is now proved that the Ozone in air, after it is diffused through town and city, is no longer to be detected there by the most delicate tests for its presence. Hence it is said to be lost in towns; in other words, it is used up in the process of destroying those exhaled substances which pass from the bodies of men and animals, and which escape from the organic *débris* that necessarily accumulate in and about every human habitation.

Were the formation of Ozone to cease in nature, I doubt if life could exist on this globe, according to the present constitution of terrestrial laws.

Turn we now to the effects produced by Ozone on living animals. The light rests steadily here on some facts of great interest. By means of Siemens's apparatus, I have been able to determine with accuracy the action of this remarkable body in its concentrate form on healthy living organisms.

When air containing an excess of Ozone is breathed for some minutes, it produces, first, a sense of irritation of the nose and throat, with sneezing, and soon a dull heavy pain in the head, and headache more or less severe. After a time there is watery discharge from the nostrils, and free secretion from the back of the throat. When the inhalation is over, the symptoms gradually subside, and I have never known any bad effects follow, although the headache will remain for five or six hours. These symptoms are very decided, and have been experienced by Schönbein, Scoutetten, Wood, myself, and many other observers. As a class of symptoms they are without doubt identical with those which characterize nasal catarrh, or common cold. I do not believe that any of my learned *confrères* in physic would hesitate for a moment in pronouncing a person who was suffering from Ozone catarrh as being affected with common cold, premising that the cause was withheld from his knowledge.

The inference, therefore, has been drawn that when common cold is the prevailing disease, there is an excess of Ozone in the air, and that the symptoms are due to such excess of Ozone.

On this particular point the light we have shines doubtfully: the inference is fair and reasonable, but the actual proofs are not as yet afforded. The position is as follows:—

A disease identical with catarrh can be excited by the inhalation of an air containing an excess of Ozone.

It has been shown, specially by Moffatt, that catarrh is common during what are called the Ozone periods.

But catarrh is sometimes present in a general form when, by the ordinary tests, Ozone cannot be shown to be present in excess.

The theory, therefore, is not perfect in all its parts. It may be imperfect because our present tests for Ozone are not sufficiently accurate; it may be, *the* test we always employ is sometimes interfered with in its action by the presence of other bodies foreign to the atmospheric air. The test itself consists of a paper saturated with solution of iodide of potassium and starch. When this paper is exposed to ordinary air it undergoes no change; when it is exposed to ozonized air, the potassium is oxidized, and the iodine being set free combines with the starch, forming iodide of starch. The iodide of starch strikes a dark blue colour, and the depth of the colour struck on the paper gives the theoretical degree of Ozone present in the air. Schönbein and Moffatt each prepare Ozone test papers, with scales, for comparing degrees of intensity.

The test being made more accurate, it is possible, and indeed probable, that in time Ozone will be proved to stand to catarrh in the position of cause to effect. Nay, I have thought that local currents of Ozone may probably be generated from the friction of air in its passage, with violence, through narrow channels, as when there is produced what is commonly called draught; and certainly an Ozone paper colours more quickly in a draught than it does in a calm air. But, after all, these facts bearing on the connection of Ozone with catarrh may be singular coincidences only; it is hard to think so lightly of them, but it would be unsafe to think more.

Speculation as to the influence of Ozone in the production of disease has been carried much further by some authors. It has been argued that croup, diphtheria, quinsy, bronchitis, inflammation of the lungs, and pneumonia, stand to Ozone in the position of effect to cause. Presuming that common cold is really a product of excess of Ozone in the air, there can be nothing more reasonable, or more fairly inferential, than that these other allied disorders follow upon the same cause; and again, there can be no doubt that the disorders are most common and most fatal during the Ozone periods —*i.e.*, periods when Ozone is most active; but for the same reasons as were given in regard to common cold, the evidence is not decisive. The evidence that has been accumulated ought never to be forgotten by the man of science, and no opportunity for extending it and improving it ought to be let slip; but it cannot be accepted in any positive sense at this moment.

We are assisted to some knowledge in relation to the possible effects of Ozone, as a disease-producing agent, by experiments, with excess of Ozone, on living animals. I have studied this point with some care, and have arrived at certain results exceedingly interesting to the man of science, and to all, indeed, who would know something of disease and its possible causation. In these experiments I charged air with Ozone until it was painful to breathe, and then filling a chamber with this air, and keeping the chamber supplied with it by means of a free current, the effect of a continued inhalation of the air was observed on animals of an inferior order.

Without entering into details, I may state the facts that were thus elicited.

In the first place, all the symptoms of nasal catarrh and of irritation of the mucous membranes of the nose, the mouth, and the throat, are rapidly induced. Then follow free secretion of saliva and profuse action of the skin,—perspiration. The breathing is greatly quickened, and the action of the heart is increased in proportion. Carried to an extreme degree, congestion of the lungs succeeds, and a well-known disease, which we physicians call "congestive bronchitis," is set up. The examination of the chest by the stethescope yields every physical sign of this disease, and the appearances of the lungs, if the induced malady be allowed to run to a fatal termination, leave no particle of evidence wanting to indicate the nature of the malady. The mucous membrane of the bronchial tubes is coated with a tenacious secretion, the lungs are congested in points, and the extreme terminations of the bronchial tubes are filled with a frothy, pearl-like mucus.

The blood is changed in physical quality under Ozone. It is not altered materially in colour, but it undergoes rapid coagulation, and its corpuscles run together with unusual force, forming into close masses or groups. I believe, also, that the fibrine, or plastic matter of the blood, is increased in quantity, either actually or relatively; but on this point I am not as yet positively informed by experimental investigation. It is worthy of remark that these effects of Ozone, administered by inhalation, are more readily developed in carnivorous than they are in herbivorous animals. It is much easier, for instance, to bring rats under the influence of Ozone than rabbits.

From the series of facts relative to the effects produced by excess of Ozone—and they are facts which any one who chooses to go to a little trouble can learn for himself—it is no difficult task to arrive at the conjecture that congestive bronchitis and inflammation of the lungs in man and animals, are produced by the respiration of Ozone in the air: the difficulty, in fact, is to avoid coming to that conclusion too hastily, the phenomena of the artificial and the phenomena of the natural disease being so closely allied as to admit of no clear distinction. Why, then, should we hesitate to accept the conjecture? If it be faithfully true, it makes dark places illuminate, and the most crooked paths straight; it reveals a new era in medicine, and in one vast department puts the physician side by side with the pure physicist in the circle of the fixed sciences; if it be true, the physician will only have to wait for a little further advance on the part of the meteorologist to be able to predict the advent of diseases—a sure proof that a degree of fixed science has been actually attained.

At the last meeting of the British Association for the Advancement of Science, my distinguished friend, Dr. Moffatt, did, indeed, somewhat more than anticipate these successes. In a paper read by him, and entitled, "Phosphorescence in connection with Storms and Disease," he exhibited tables to show that the atmospheric conditions under which the luminosity of phosphorus took place were those of the south or equatorial current of air, namely, a minimum of atmospheric pressure, and maximum of temperature and humidity; and that those under which non-luminosity takes place are the conditions of the north or Polar current, namely, maximum of pressure and minimum of temperature and humidity. The atmospheric conditions of Ozone and non-Ozone periods are the same as those of the luminosity and non-luminosity of phosphorus. Phosphorus becomes luminous and Ozone periods commence on the approach of storms, and if a storm sets in during a luminous or Ozone period, the luminosity increases in brilliancy and the Ozone in quantity. He also showed tables he had prepared from observations on the luminosity of phosphorus, Ozone, and the prevalence of diseases in connection with the system of meteorological telegraphy, instituted by the late Admiral Fitzroy. From these it appeared that all the periods of luminosity commenced with the setting in of the atmospheric conditions, of the approach of which cautionary telegrams gave warning. Of diseases, 80 per cent. of apoplexy, epilepsy, and sudden death occurred on the days on which phosphorus became luminous. The atmospheric conditions which lead to those storms, of which the telegram gave warning, are invariably accompanied by diseases of the nervous, vascular, and muscular systems. During the two years in which those telegrams were sent, 143 cases of those diseases came under his notice; of which 54·5 per cent. took place on telegram days, and 45·5 per cent. on other days similar in a meteorological sense to those on which the telegrams were issued, differing only in degree, as the tables showed. Although storms are accompanied by diseases of some kinds, they are nevertheless, he maintained, of great benefit in a sanitary sense. They carry with them a supply of nature's deodorizing and disinfecting agent—Ozone. As far as he had had opportunities of observing, he had come to the conclusion that cholera disappears with the setting in of the equatorial or ozoniferous current, as was the case at Newcastle in 1853, and in the London epidemic. During a cholera epidemic the barometer readings are high, a calm prevails, and there is no Ozone. In conclusion, Dr. Moffatt asked whether, seeing the intimate connection there is between periods of the luminosity of phosphorus and Ozone periods, and of non-luminosity and non-ozone periods, and knowing that Ozone is formed by the action of phosphorus on moist air, we might not reasonably look to phosphorescence for the chief source of atmospheric Ozone? It was a question whether we might not find phosphorus a useful disinfectant by using it as a producer of artificial Ozone? He had himself used phosphorus as a disinfectant for four years.

Must these suggested and suggestive triumphs of science be checked even by a doubt? Alas! the stern truth stands out, *they must.*

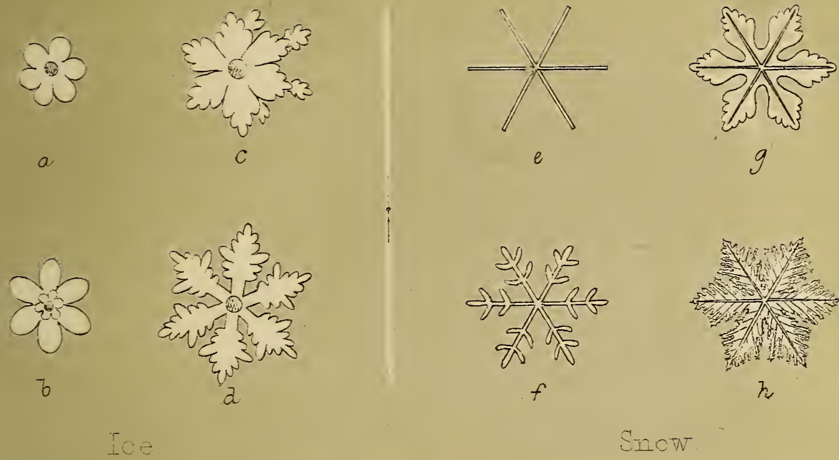
They must stand at the bar and wait for the verdict, not because they are necessarily untrue,—not because they may not be all true,—but because they fall short of perfect demonstration. We must yield that Ozone in excess, as we produce it in the laboratory, induces certain symptoms of disease; but as yet we know of no instance in which an excess sufficient to produce the same symptoms exists in nature. An air so charged with Ozone as to produce these symptoms, would require no chemical test to prove the presence of an injurious agent. It would be an irrespirable air, and it would affect with varying intensity all who breathed it. In order, therefore, to sustain these conjectures in their entirety, we must assume two positions, each of which is yet unproven: firstly, that Ozone may exist in intensity in the air, although not detectable by the present recognized tests or by the senses; and, secondly, that there are local currents of Ozone which cross the path of one person and injure him, while others escape. Both these positions are possible, but they are not proven. They will be approached by steady work at oxygen, a body which we once thought the immortal Priestley had divined and defined, but regarding the nature of which we stand as yet like little children, who, thinking they detect form and colour and beauty in a soap-bubble, suddenly are perplexed by seeing it resolve itself into the, to them, invisible and unknown.

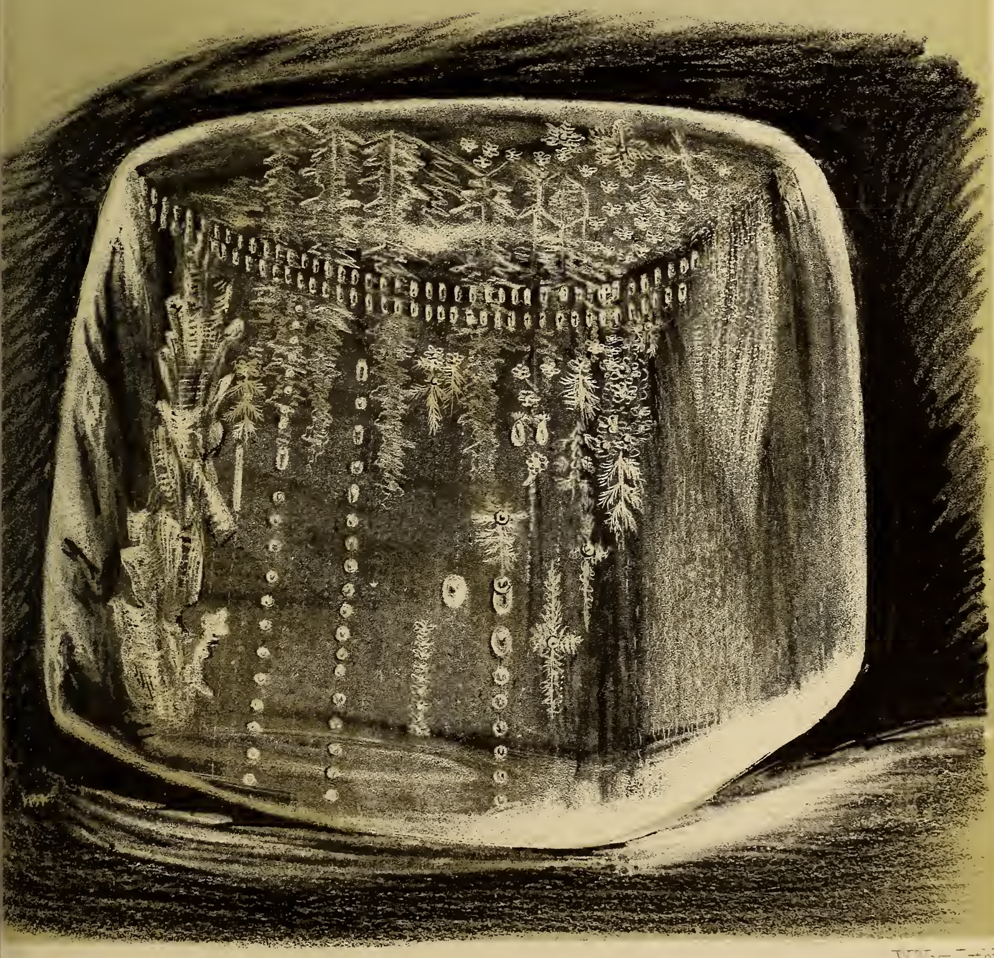
Reader, I fear you are weary, and I too tire. I have only one or two things more to say on the text I have taken, and "cito" shall be the motto. Firstly, then, let me add in regard to active oxygen, Ozone, that as it is the great purifier of the dead earth, so perchance it is the physical purificator of the living animal. The light shines doubtfully here, but the direction of it is to show that when oxygen gas is brought into contact with the blood in the living lungs, it is in part transformed into Ozone, and that the subtle, active agent is doing its work more secretly but not less certainly, within the tissues of the organism, than in the world without. Secondly, I would mention that the special physiological effects of Ozone are destroyed by heat, and are obscured or prevented by extreme cold. In experiments to show the effects of Ozone on animal respiration, a temperature not lower than 65 deg. Fahr., and not higher than 75 deg., should be sustained. Thirdly, I would state that there is a condition of atmospheric oxygen in which that gas exhibits an opposite condition to the ozonised state. Oxygen in this opposite or negative condition is called antozone. There are different methods of producing antozone which I have not space to describe; but I must note that in some experiments on the re-inhalation of air many times over I was able to reduce oxygen to such negative state that it failed to support life. The act of purifying such oxygen from carbonic acid and other tangible impurities had no effect in rendering it better fitted for the support of healthy life; but Ozone at once restored to it active power. In this negative oxygen animals die as if under the influence of a narcotic; in it the destruction of the products of organic decomposition is greatly impeded, and the presence of such products speedily renders it intolerably offensive; dead animal tissue in it rapidly putrifies, and wounds in the bodies of living animals become sanious, dark, and unwholesome.

Lastly, we gather from what has gone before a few facts bearing on hygienic measures, general and special. We may learn that as Ozone is used up in crowded localities, and as its presence is essential for the removal of the products arising from decomposing organic remains, no mere attention to ventilation, however important that may be, can suffice to make the air efficient for supporting healthy life unless the air be rendered active by the presence of Ozone. Hence it is an absurdity of the worst description to build hospitals for the sick in the midst of the crowded localities of the poor, and to ventilate them with air that has swept its way over a sea of ammoniacal compounds derived from the living and the dead. Hence, human dwellings built on the borders of lakes or pools charged with organic *débris*, or built near manure heaps, or over sewers, or on ground saturated with putrefying substances, become necessarily the centres of the fever type of disease; not by necessity, as is vulgarly supposed, because the inhabitants are conscious of "smell," but because the air they breathe is reduced in active power, and poisons are being generated around them to which they are constantly exposed, and before which they fall a ready prey.

The lecture is over: I have dealt with a subject that is in some sense a paradox, abstruse yet simple, unpractical and yet of all subjects the most practical when it is well known. In time there will be no paradox, but the hard and most mysterious labours of the scientific investigator will resolve themselves into a few easy propositions which all will understand. Then we shall take care to conserve Ozone where it should be conserved, to supply it like light in places where it cannot be always secured naturally; and to neutralize it if, like the Roman centurion's soldiers, it comes when we do not want it. In Ozone another generation may actually see an article of commerce, and even now an "Ozone Company" might prove itself not merely a useful, but, as a sequence, a paying concern. Such a company could bleach, deodorize, disinfect, preserve meat and vegetables, and give sea air to every household that required it; its "supply" could be as manageable as gas, and as cheap as water; and with due precaution the lieges might make use of the agent as safely in their households as I and other men of science make use of it in the laboratory.

Plate IV.





Liquefaction of Ice

GLACIERS AND ICE.

BY W. F. BARRETT,

ASSISTANT IN THE PHYSICAL LABORATORY OF THE ROYAL INSTITUTION.

THERE is perhaps nothing that excites the admiration of the student of nature more than the stability which is seen throughout the universe; and his admiration passes into emotion when a closer examination reveals the fact that permanency is upheld by incessant change. This unresting repose is shown by the heavenly bodies, and is found among the atoms of matter; for the actions of law, unlike our own, remain untrammelled by the element of size. Could we, therefore, take our stand in space, and be omniscient spectators of the workings of the universe, we should find a thrill of ceaseless movement passing from limit to limit, and carried on from age to age. Streaming from every orb, and spreading far and wide, crossing and recrossing, without irregularity or jostling, there would be the wave-like motion of light and heat, keeping up most literally an unending strain of ethereal music. On the surfaces of the worlds rolling beneath us, such air and water as they possess would be seen pulsing from equator to pole, or locked and unlocked by changes in their nature, and all the while the very particles of both would be swinging to and fro in regular cadence. It is the perfect harmony which reigns in every part that sustains this eternal motion. There is no confusion, no noise; the parts are "fitly joined together," and work in concord; moreover, by the juxtaposition and blending of their movements, they become subservient to the wants of man. The reverence to an unseen Ruler which these facts awaken, is not, indeed, denied, but confirmed by every other teaching of physical science.

This wonderful *roll* of nature, which secures unity whilst abolishing uniformity, is strikingly manifest in the distillation of water which occurs on so grand a scale over the globe. Seas are lifted by the sun as vapour, and, condensing, fall to the earth as rain or snow, thus forming our lakes and rivers, whose waters at last return to the ocean. But how, it may be asked, is this circulation maintained, when the congealed vapours add themselves to that mantle of snow which for ever enwraps the higher mountain peaks? Up to a certain point the summer's heat annually removes the winter's snow,—the gain on the one hand and the loss on the other are evenly balanced; but beyond this point, as we rise into colder regions, the gain exceeds the loss, and a residuum of unmelted snow is added to the yearly fall. We have passed the so-called *snow-line*, above which increasing quantities of snow would, in this way, yearly accumulate. Let this action continue unchecked for centuries, and nothing but the reaching of a superior snow-line, where the dryness of the upper air forbids the formation of snow, would prevent the transference of our oceans from their beds to mountain summits. "Supposing, at a particular point above the line referred to, a layer of three feet a year is added to the mass; this deposit, accumulating even through the brief period of the Christian era, would produce an elevation of 5,580 feet. And did such accumulations continue throughout geologic instead of historic ages, we cannot estimate the height to which the snows would pile themselves."* But our mountains do not thus perceptibly grow higher; what is it takes their increasing burden away, and enables the rhythm of nature to flow on here as elsewhere? It is the *glacier* which removes the annual load of snow from the mountain sides, and, by its liquefaction, finally restores to the ocean water which may have been lifted from it some centuries before. Concerning this an eminent man of science has recently said, "Is it not very remarkable that ice, by special properties which belong exclusively to it, has a movement which probably is the only one slow enough to remove in a continuous manner, without entirely ceasing, the surcharged reservoirs of snow heaped upon the summits and plateaux of high mountains? At the same time the ice itself descends into cultivated valleys, without producing there periodic cataclysms, but, on the contrary, originating those rivers that the heat of summer enlarges, and which carry freshness and fertility into the plain. How admirable a combination of the forces of nature, that a superior Intelligence could alone co-ordinate with a determinate end in view! But even this is only a feeble scintillation of transformations, as grand as they are innumerable, continually taking place in the laboratory of nature, of which God alone is the master, but into the mysteries of which man is permitted to glimpse."

But the snow on the mountain summits is a dry, white powder, whilst the glacier is composed of clear, solid ice. How can the one be transformed into the other?

* Tyndall's "Heat," 2nd edition, p. 186.

To answer this question let us trace the history of the glacier itself from its birth-place in the snow-fields above, to its dissolution in the valleys below. The surface of the snow-field is melted by the daily action of the sun, but being subsequently refrozen, a crust is produced sufficiently strong, before the sun melts it, to bear the weight of the climber. Below this platform the snow is dry and incoherent; it will not "bind" when squeezed together; it is like so much white dust or flour: nevertheless this is the material, which, by the unceasing action of directed force, is fashioned into a glacier. It is by the repetition of the sun's action just described, that the first change is wrought. The liquefaction of the superficial portions of the snow-crust creates little rivulets, which, piercing into the under snow, deliver their warmth to the mass around as they themselves become frozen. In this way the external heat is conveyed to the interior of the snow, in the end elevating its temperature to 32° Fahr., the freezing point of water. If the snow be now examined it can be rolled or squeezed into a coherent mass; in fact, we have here discovered what every schoolboy knows, that snowballs can only be made when a thaw sets in. As the snow lies on the sides of the mountain the action of gravity tends to pull the mass downward. The pressure thus developed acts like the squeeze of our hands on a snowball, it binds together the snow-slope in those parts where the temperature is not below 32°, and throughout the whole it brings the particles of snow into closer contact, gradually ejecting the air which lies between the granules.

Snow is white, not by itself, but from its state of division; sugar and salt are white from the same reason. Pound a transparent lump of sugar-candy or rock-salt, and the powder is opaque and white like snow. The transparency of the solid is due to its particles being in perfect contact; the opacity of the powder is caused by the breaking up of this continuity. In the former case the light readily glides through; in the latter, from a well-known optical law, a little light is pitched back to the eye as it passes and emerges from particle to particle. A luminous beam is thus unable to struggle through the entanglement of air and solid, for though each alone is transparent, their intermixture becomes opaque from the incessant "echoing" of light that is aroused. From this cause when glass, alum, or ice is crushed, an opaque white powder results; and conversely, when sugar, spermaceti, stearine, or snow is melted or powerfully squeezed together, a translucent substance is produced.

The mountain-snow *is* thus squeezed by the superjacent portions; it yields, and as some of the air entrapped in the snow escapes, a compact mass is formed, half snow and half ice, technically termed *névé*. By the force of gravity, the *névé* is slowly dragged downwards, moving partly by the upper layers slipping over the lower ones, and partly by the sliding of its whole mass bodily down the plateau. As warmer regions are entered, the *névé* gathers into the valleys, and becoming more and more consolidated, it passes by insensible degrees into the *glacier*. Still urged downwards the glacier continues to move by sliding and yielding, grinding down the rocks over which it passes, or grooving and scratching them in the direction of its motion. It is the long continuance of this action which has led many eminent men to believe that the glacier scoops out for itself the valley through which it moves; but though this view has been opposed, it certainly appears probable that, if it cannot originate, the glacier may enlarge and condition its bed.

Whatever erosive power the glacier may possess, it is greatly assisted by that disintegration to which mountains are especially subject. Frost, storms, and avalanches are all active, so that as the glacier moves along, its borders become laden with the *débris* of falling rocks, giving rise to the so-called *moraines*, seen as longitudinal streaks on the glaciers shown in fig. 1. The edges of the glacier are in this way lined with ridges of stones, which to a large extent prevent the sun melting the ice beneath them. The consequence of this is that as the other portions of the glacier not thus screened melt away, the moraines relatively rise to a considerable height, until in some places, as at the upper portion of the Mer de Glace near Mont Tacul, through the moraines the marginal ice is elevated nearly fifty feet above the level of the surrounding glacier. Pushing far below the limits of perpetual snow, indeed correctly commencing only where the snow-line ends, the glacier reaches warm and cultivated regions, where its soiled substratum and weather-beaten surface are continuously melted, forming numerous turbid streams, which finally discharge themselves into the ocean. Measuring from their end or *snout* to their origin, the glaciers of the Alps on an average are from ten to twenty miles long, and in the main about half a mile wide. Their depth has not been well ascertained, but in some places they have been bored 216 feet without reaching their bottom. Large as are these ice-streams, they are surpassed in other countries; and even those are but pigmies compared to what must formerly have existed during a pre-historic age.

The velocity with which the glacier moves along its bed has been the subject of careful study ever since the year 1841, when M. Agassiz, by exact and laborious observations, established the fact of a continued motion. But it is chiefly from the repeated examinations of Principal Forbes, who has devoted many years to a critical survey of the glaciers of

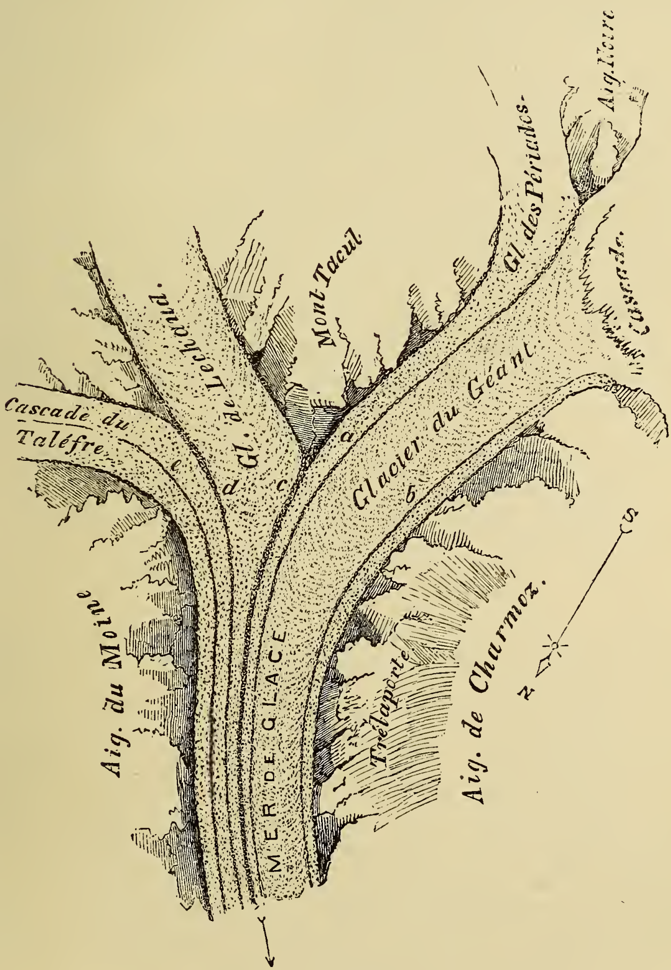


Fig. 1.*

Norway and the Alps, and the intrepid observations of Professor Tyndall, that the movement of glaciers was found to be subject to certain laws which have been sought out and

* This and the following woodcut are taken from the "Glaciers of the Alps,"—published by Murray.

established. The rate at which the glacier moves, depends on the angle of the slope on which it rests, or the width of its channel, and on its own depth. As the two first conditions change from the progress of the glacier, the last continually alters, the glacier thus undergoing the diversities to be found in a river—massing itself in the gorges and moving like rapids, or spreading itself out in the plains, where it stagnates into water, or sluggishly creeps along.

This enables us to understand the analogy that has so often been suggested between a glacier and a river. The comparison is in every respect true, for the glacier is fed by tributaries, bends round a corner, accommodates itself to the shape and size of its channel, and is retarded by the friction it encounters against its bed. In fig. 1, four glaciers are seen to pour into a single channel, where they are welded into the Mer-de-Glace. The channel through which the united mass is urged, is seen to be extremely narrow. Professor Tyndall has determined the width of the three main tributaries just before their point of junction. They are as follows :

Glacier du Géant	1134 yards
Glacier du Lechaud	825 „
Glacier du Taléfre	638 „
Making a total of	2597 „

At Trélaporte the united stream was measured, and found to be a channel only 893 yards wide.* Right through this narrow gateway the entire quantity of ice, which was previously contained in a bed nearly three times as wide, is continually being forced. This fact is surely one of the most impressive in the whole of glacial phenomena. It reveals at once the enormous pressure to which the glacier must be subject, in order to thrust a solid body like ice through such a gorge. But it is only the shape of the glacier which changes; its volume is not materially affected by this compression. Just as would occur with a river similarly circumstanced, the depth and velocity of the trunk glacier at Trélaporte becomes greater than before existed in any of its tributaries.

The union of several glaciers is marked by the transference of a corresponding number of moraines, *minus one*, from the sides to the centre of the glacier. In other words, at the junction of every two glaciers, two *lateral* moraines pass into one *medial* moraine. This will become clear by again referring

* "Glaciers of the Alps," p. 287.

to fig. 1, where *a b c d e* indicate medial moraines formed by the union of one more than a corresponding number of glaciers.

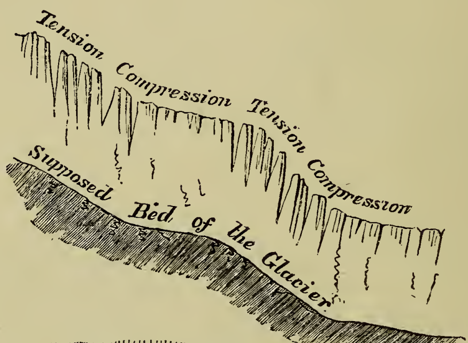
Like a river, where the glacier rubs along its bed, its motion is impeded; hence it moves with different velocities at different points on its surface. A row of stones lying straight across the glacier to-day, will not be in the same position to-morrow; the central ones will have crept forward some 20 to 30 inches, the marginal ones but 5 to 10 inches, and the others in proportion. The first reference to the speedier motion of the central parts of the glacier was made in the writings of a Bishop of Savoy, M. Rendu; a year later, in 1842, Principal Forbes definitely established the fact, whilst immediately afterwards M. Agassiz demonstrated it by observations which then embraced a year's motion of the different parts of the glacier of the Aar. These results, confirmed by subsequent observers, are in exact accordance with the flow of rivers which are found to move fastest at their central superficial parts. Indeed, as already noticed, the strictness of the analogy between a glacier and a river is remarkable. When a current rounds a curve, its point of swiftest motion shoots for a while beyond the centre, regaining its central position if the river continues straight, but passing again to the opposite extreme if it turns in a contrary direction—its course resembling the path taken by a dog pursuing a hare, which swerves from side to side, a figure usually shown in natural philosophy diagrams to illustrate the influence of inertia. Just in the same manner does the glacier behave when its course is deflected. Professor Tyndall first drew attention to this interesting fact, proving it by a series of measurements on the curvatures of the Mer-de-Glace between Trélaporte and Montanvert, and arrived at the conclusion that "the line of maximum motion in a glacier is a curve more deeply sinuous than the valley itself, crossing the axis of the valley at each point of contrary flexure." *

The central parts of a glacier being those in most rapid motion, the sides must necessarily be in a state of strain from the constant drag taking place towards the centre. This is the case, and as ice is incapable of stretching, the glacier breaks at right angles to the line of tension. These cracks, gradually opening by the continued pull, form the so-called *marginal crevasses,* indicated by the double border lines in fig. 3. The crevasses must thus point down the valley, at first sight appearing as if the glacier moved more rapidly at its edges than at its centre. It was this anomalous appearance which so greatly puzzled the early observers. Recently, however, it has been shown by a celebrated English geometer,

* Phil. Trans., 1859, p. 268.

Mr. Hopkins, that the lines of greatest tension in a glacier make an angle of 45° with the side of its valley; along these lines (shaded in fig. 3), the ice is most severely strained, and as a necessary consequence its tendency to break is greatest in a direction perpendicular to them.

Fig. 2.



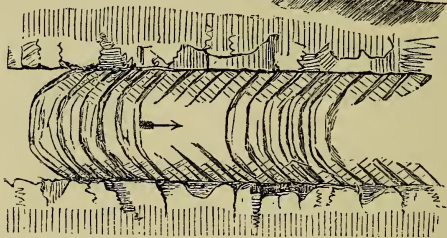


Fig. 3.

In fig. 3, which is a sketch in plan of part of the Lower Grindelwald Glacier, the arrow shows the direction of the motion; the lines on each side, parallel with the barbs of the arrow, indicate the direction of the strain; whilst the blacker lines across the former show the marginal crevasses. In some places in the drawing the crevasses are seen to stretch quite across the figure. This is caused by a sudden change of inclination in the bed of the glacier; the ice, being unable to pass over the bend without rupture, snaps across, and deep *transverse crevasses* are the result. The union of these with the marginal crevasses creates in certain places continuous fissures, which swoop in immense curves across the glacier, the convex side of the curve being always turned upwards. The formation of the transverse crevasses is seen in fig. 2, each portion of which represents in section the parts shown directly beneath in plan. As the leaves of a book open when its back is bent, or as a stick snaps when strained across the knee, so the glacier breaks up into huge wedges of ice when passing over an uneven bed. After a level surface has been attained, the broken masses are forced together by the pressure from behind, they re-unite, and scarcely a trace is left of the gaping chasms above. The marginal crevasses, it must, however, be remembered, still continue to be formed from the onward movement of the glacier. At a favourable point of view there can be seen across the glacier curved streaks of mud, known as *dirt-bands*, faintly shown on the Glacier du Géant in fig. 1. These are supposed to have their origin mainly in the great ice cascades of the Alps; the *débris* of the glacier being washed into the fissures, the subsequent melting of the ice leaves the silt in successive curved stripes. In addition to the marginal and transverse, there are also *longitudinal* crevasses which appear at the terminal portions of some glaciers, and are induced by a resistance in front, causing a lateral movement where the glacier has room to expand.

Such are the main phenomena of glacier motion. The question now arises, *how* can so brittle a solid as ice flow like a river, or bend hither and thither like a stream of molten lava? Looking at this latter comparison, it suggested itself to Principal Forbes that ice was probably not so solid as we had hitherto supposed it; but that its nature might approximate to that of a plastic body like wax or dough; or, indeed, it might be of a viscous character like tar, honey, and Canada balsam. This extremely bold idea gave rise to a certain explanation of glacier motion, known as Forbes's, the plastic, or the viscous theory. According to this theory ice is assumed to be plastic or viscid, and from the possession of this property glaciers move through their channels just as lava moves down a mountain side, and several glacier-streams unite just as several streams of lava would. But imagine a stream of dough flowing down the Alps; it would move without rupture and over a moderate declivity it would fall without breaking. Indeed, one of the distinguishing characteristics of a plastic body is that it can be stretched or drawn out into filaments when under tension. But though the passage of the glacier through narrow gorges shows that ice can yield to pressure, observation has failed to indicate its power of stretching even in the smallest degree; otherwise the crevasses would not be formed. The plastic theory fails, therefore, to account for all the facts.

We are not, however, left to bare speculation for an explanation of the wonderful power of accommodation possessed by ice. One of Mr. Faraday's simple but suggestive experiments put the key of glacier motion into the hands of Professor

Tyndall. At a Friday evening meeting at the Royal Institution, in June, 1850, Mr. Faraday stated that when two fragments of melting ice are placed together, they freeze at their points of contact. This fact, subsequently termed *regelation,* recalled glaciers to Professor Tyndall, and from glacier ice to glacier snow was a rapid transition. If two pieces of ice freeze together, may not innumerable granules of snow freeze into a solid mass? The probable formation of the *névé* and the glacier were thus swiftly suggested. In his own words, Professor Tyndall says :—

Snow was in the yard of the Royal Institution at the time; stuffing a quantity of it into one of the steel moulds which I had previously employed to demonstrate the influence of pressure on magnetic phenomena, I squeezed the snow, and had the pleasure of seeing it turn out from the mould as a cylinder of translucent ice.

A section of the identical mould used in this experiment is given in fig. 4. A B is the solid base of the mould; C D E F a hollow cylinder let into the base; P is the solid plug used to compress the snow. When sufficiently squeezed, the bottom A B is removed, and the cylinder of ice is pushed out by the plug.

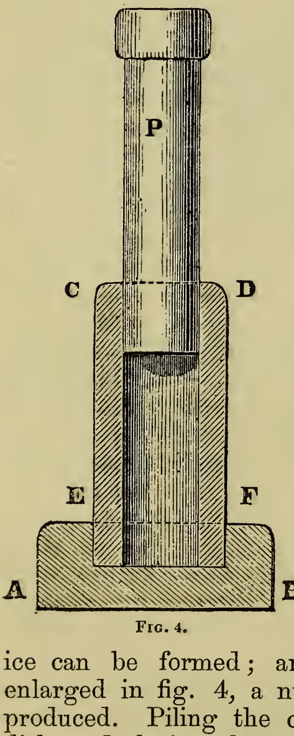


Fig. 4.

But what is true of snow is equally true of fragments of melting ice. These can be moulded into any shape by pressure, just as the snow was moulded. The following beautiful experiment illustrates this fact:—Placing a quantity of broken ice in a boxwood mould (fig. 5), shaped like a cup and ball, and powerfully squeezing the mass, the fragments are crushed; but by this very act are brought into close contact; regelation occurs at innumerable places, and finally on relieving the pressure a perfect cup of clear ice can be turned out of the mould. Filling another mould in the same way, a circular disk of ice can be formed; and by means of the mould, shown enlarged in fig. 4, a number of little ice cylinders can be produced. Piling the cylinders one over the other on the disk, and placing the cup on the top, a claret-glass of transparent ice is obtained (see fig. 7); the parts, shown separately in fig. 6, being rigidly united by regelation. From this novel ice-cup, quite liquid tight, several draughts of cooled wine can

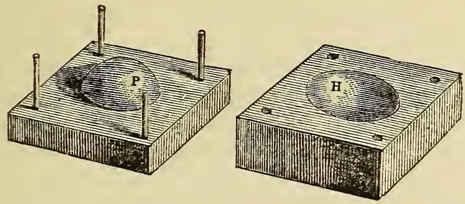


Fig. 5.

easily be taken. By placing the rims of two cups together, a hollow sphere of ice is produced. In the same way Professor Tyndall has recently formed a ring of ice by merely hammering a plug into a suitable mould crammed with broken ice.

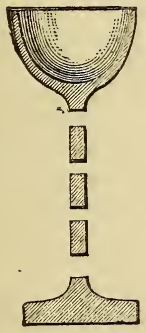


Fig. 6.

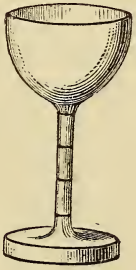


Fig. 7.

The application of the foregoing experiments to glaciers is obvious. Professor De la Rive in his inaugural address, as president for this year of the Swiss Society of Natural Sciences, has aptly done this in the following words:

Such is the discovery of Tyndall, which may well be thus named, particularly in view of its consequences. For all these moulds magnified become the borders of the valley in which a glacier flows. Here the action of the hydraulic press which has served for the experiments of the laboratory is replaced by the weight of the masses of snow and ice collected on the summits, and exerting their pressure on the ice which descends into the valley. Supposing, for example, a graduated series of moulds to exist, each of which differs very little from the one which precedes and from that which follows it, and that a mass of ice could be made to pass through all these moulds in succession, the phenomenon would then become continuous. Instead of rudely breaking, the ice would be compelled to change by insensible degrees from the spherical to the lenticular form. It would thus exhibit a plasticity which might be compared with that of soft wax. But ice is only plastic under *pressure;* it is not plastic under *tension;* and this is the important point which the vague theory of plasticity was unable to explain.

It is then by *fracture and regelation* that glaciers are able to flow, and weld themselves together like streams of lava. But our readers are probably wondering whether other bodies besides ice possess this convenient natural cement. Apparently they do not, for as far as the experiments which Mr. Faraday has made on this point have gone, it seems a special property of ice.* Regelation only takes place when the two surfaces of ice are in a melting condition, but if in this state it invariably occurs. In water as well as in air, fragments of ice will instantly freeze together by the gentlest contact; and even under water as hot as the hand can bear, two pieces of rapidly melting ice may suddenly be frozen into one by merely bringing them together. The cause of the phenomenon of regelation has been the subject of much controversy among scientific men. It would take us too far from our subject to enter into it here, but it may be stated that the original explanation given by its discoverer, whilst being of the highest interest, harmonizes with all the facts. †

Ice is one of those bodies which nature appears to have put together with special care; for, it may be only subjectively, there are some natural objects which after a prolonged examination seem more wonderful than others. Let us look at the substance itself. Here is a block of clear ice, such as any fishmonger can supply. Rows of air-bubbles can be seen running parallel to each other throughout the mass; and in some irregular places there is a fine gauze-like appearance produced by a web of minute bubbles. This is but the poetical way in which ice expresses a split; for this beautiful netting is the result of nothing more than some accidental blow. Cutting a slice from the block *across* the bubbles, let us hold it close to a naked gas-flame (the reason for which will be seen directly), and now let us observe it. The lamp of Aladdin could not have wrought a more wondrous change. The part before clear and unmarked is now studded all over with lustrous stars, whose centre shines like burnished silver. A fairy seems to have breathed upon the ice and caused transparent flowers of exquisite beauty suddenly to blossom in myriads within the ice, and all with a charming regularity of posi-

* Proc. Royal Society, vol. x. p. 440.

† Published as report of lecture by Mr. Faraday, in the *Athenæum*, 1850, p. 640; and "Experimental Researches in Chemistry and Physics," p. 377. See also a paper by Professor Tyndall, in the December number of the *Philosophical Magazine*, for a *resumé* of the discussion.

tion (see Plate IV.).* It is the intangible fairy heat that has worked this spell. The ice was laid down according to the same laws that shape the snow into those beautiful and well-known crystalline forms so often to be seen in snow-storms here and elsewhere. Ice is indeed only an aggregate of crystals similar to those of snow, which lying together in perfect contact, as we have already explained, render each other invisible and the block transparent. When the heat of the gas-flame entered the slab, it set to work to pick the ice to pieces, by giving it, in certain places, a rapid molecular shaking, and the fairy-flowers which appear in the warmed ice are the result of this agitation. On *à priori* grounds, we should therefore infer that the shape of these liquid crystals—for they are merely water—would be the same as the solid crystals which originally built up the ice. This is found to be the case. In order to make the comparison easy, I have shown, side by side, in the upper part of the plate some snow crystals taken from Mr. Glaisher's drawings, and a few of the most characteristic shapes of the "ice-flowers." The two are seen to be identical; each have six rays, and the serrations in both follow the common angle of 60°. Just as the ice freezes, so, under suitable conditions, it liquefies; the ice-flowers, or negative crystals, appearing in the same plane as that in which they were formed. The air-bubbles in ice show this direction. The bubbles collect in widely distant layers, marking the successive stages of freezing; between the layers there is either a clear intervening space or those perpendicular rows of bubbles already noticed. Accordingly the ice freezes parallel with the former, and at right angles with the direction of the latter bubbles. Some of both classes of bubbles are shown in the plate, their position relative to the ice-flowers being thus indicated.

In the plate the artist has striven to show, as faithfully as possible, the result of the internal liquefaction of a block of ice through the agency of heat from a luminous source. For the rays from a fire, the sun, or the electric light, are equally competent to develop the flowers; but they cannot be so well produced by a lamp, when the flame is surrounded by glass chimneys.† Beautiful as the plate appears, it is, however, impossible for the most skilful artist

* It is to Dr. Tyndall we are indebted for this revelation of the structure of ice.

† I have to thank Mr. W. West for the care with which he repeatedly examined blocks of ice whilst making the engraving from the substance itself. In order to give a general idea of the disintegration the artist has combined two or three points of view: this will account for anything appearing like irregularity, where, naturally, all is order and precision.

to represent the loveliness generated in a lump of ice by the mere passage of a sunbeam through its substance. Let the reader test this assertion for himself, and not rest satisfied by looking at the drawing. With a little patience and care nothing can be easier than to reproduce the phenomena. All that is necessary is to procure a block of Wenham Lake ice, saw a slice from it in the direction named, smooth the sides by rubbing on a warm metal plate, hold the slab close to a candle or gas flame, and during its disintegration observe the ice, assisting the eye by a lens,—the formation of the exquisite six-petalled liquid flowers will then be instructively and distinctly seen.

When ice is examined late in the season, a cloudy appearance is seen within it, looking very much as if a kind of angular dust had permeated the block and arranged itself in striæ parallel with the bubbles: this appearance is shown in the lower part of the engraving. The heat of a gas flame expands each of these points into a liquid spot with a crimpled border; in fact, it is an incipient ice-flower, such as is shown among the enlarged drawings in the upper part of the plate. All the flowers begin in this way; as the heat continues their petals get more pronounced, and, becoming serrated, exhibit the successive changes represented by *a b c d* in the upper engraving. Still holding the ice before the flame, fern-like spiculæ will generally be seen shooting downwards, in planes inclined to each other at angles of 60°. The appearance of the ice at this stage is shown in the plate. At first the ice breaks up into a honeycomb structure, the axes of the rude hexagons being perpendicular to the flowers, and their sides composed of water; and finally it is sometimes possible, by a smart tap, to cause the ice to fall to pieces into irregular six-sided prisms.

Thus crystalline and beautiful is the structure of ice. One can never tire of looking at its dissolution, but recurs to it again and again, each time with fresh delight, as some new feature is discovered. Indeed, I know of no source whence keener and purer intellectual joy can be derived, than from a right and intelligent examination of a block of ice. And when we think of whole icebergs and Polar seas, and, to a certain extent, glaciers constructed in this way, it is a contracted mind that is not impelled to inquire whence came this structure, so exquisite and yet so long unrecognized by man. Then, as the gaze passes beyond the ice and beyond the man, it becomes well-nigh impossible to withhold the conviction that both are products of the same infinite skill, —both designed to glorify One who employs His works as witnesses of His existence.

FIG. 2.

FIG. 3.

FIG. 1.

FIG. 5.

FIG. 6.

B FIG. 4. A

Climbing Plants.

ON THE PHENOMENA OF MOTION AND SENSITIVENESS IN CLIMBING PLANTS.

BY THE REV. GEORGE HENSLOW, M.A., F.L.S., &c.

PREVIOUSLY to Mr. Darwin's elaborate investigations on climbing plants, observations had been made by Palm, Mohl, Professor Asa Gray, and others; but in point of variety and novelty many of his researches far surpass those of the latter botanist. A *résumé* of his deeply interesting paper in the *Journal of the Linnean Society,* vol. ix., Nos. 33 and 34, we purpose submitting to the readers of the POPULAR SCIENCE REVIEW.

Mr. Darwin commences by observing that climbing plants may be conveniently divided into four classes; namely, those which twine spirally round a support (spirally twining plants), those which ascend by the movements of the foot-stalks or tips of their leaves (leaf climbers), those which ascend by true tendrils (tendril bearers), and, lastly, those which are furnished with hooks or rootlets (hook and root climbers).

I. *Spirally Twining Plants.*—This is the largest class, and they apparently indicate the simplest or primordial condition. The first example is that of the hop, the movement of which Mr. Darwin thus describes:—

"When the shoot of a hop *(Humulus lupulus)* rises from the ground, the two or three first-formed internodes are straight, and remain stationary; but the next formed, whilst very young, may be seen to bend to one side, and to travel slowly round towards all points of the compass, moving, like the hands of a watch, with the sun. . . . The average rate was 2h. 8m. for each revolution. . . . Each separate internode, as it grows old, ceases to revolve, becoming upright and rigid. . . . Generally, three internodes revolve simultaneously; with all the plants observed, if in full health, two revolved; so that by the time one had ceased that above it was in full action, with a terminal internode first commencing to revolve."

A point connected with this revolving motion, but not the cause of it, is that the axis of each internode becomes twisted as the plant continues to grow and as each internode assumes a rigid form; thus the first internode of the hop became twisted three times round its own axis, while the internode itself gave no less than 37 revolutions before becoming rigid. It is a curious point in connection with this twisting that it is in a direct relation to the inequalities of, or freedom from the support; for stems do not become twisted if allowed to climb small glass rods, but only rough sticks or when hanging freely in the air. "The most probable view," Mr. Darwin says, "is that the stem twists itself to gain rigidity (on the same principle that a much twisted rope is stiffer than a slackly twisted one), so as to be enabled either to pass over inequalities in its spiral ascent, or to carry its own weight when allowed to revolve freely."

He offers the following in explanation:—"that the lower parts of the terminal internodes very gradually and successively lose their power of movement, whilst the portions just above move onwards, and in their turn become motionless, and this ends in forming an irregular spire."

The following is our author's explanation of the purport of this motion:—

> "The purpose of this spontaneous revolving motion, or, more strictly speaking, of the continuous bending movement successively to all points of the compass, is obviously in part to favour the shoot finding a support; . . . but when this is gained, the motion at the point of contact is arrested; while the free part projecting above continues to revolve, and by the very motion cannot fail to twine itself round the support."

Mr. Darwin gives an interesting series of tables showing the direction and rate of motion of several twining plants selected from all parts of the vegetable kingdom, proving that every kind behaves in a nearly uniform manner. We purpose giving some of the more important conclusions deduced.

Of thirty-nine plants, twenty-five revolved in a course opposed to, and twelve with, the sun; two revolved both with and against the sun. No instance is at present known of two species of the same genus twining in opposite directions. The average rate at which the first circle of revolution is described is about 6h. 10m., computed from thirty-five different plants; the longest period being 26h. 15m., viz., of a young shoot of *Lapagerea rosea* (*Philesiaceæ*); while the most rapid was that of *Scyphanthus elegans* (*Loasaceæ*), viz. 1h. 17m. The average rate of twining plants is 5h. 45m. for five revolutions. It must be borne in mind that young shoots commence slowly, and do not arrive at the maximum time of rotation until they have accomplished several circles or ellipses as the case may be.

Light has a remarkable power in hastening the revolutions. Thus :—

Ipomœa jucunda performed its first circle in 5h. 30m.; the semicircle *from* light in 4h. 30m., and *to* light in 1h. 30m.; the difference being 3h. 30m. It must be observed, however, that the rate of revolution in all plants was nearly uniform during night as well as day; hence Mr. Darwin infers the action of the light to be confined to retarding one semicircle and accelerating the other, so that the whole rate is not greatly modified.

Heat likewise affects the rapidity of revolution, by increasing it; thus, *e. g.*, of *Loasa aurantiaca*, one plant which moved against the sun, completed its first circle in 2h. 37 m. (June 30). Another, which followed the sun, completed its circle in 1h. 51m. (July 11), and its 4th circle in 1h. 48m., that being a very hot day; whereas its 5th circle, on the cool morning of July 12th, was finished in 2h. 35m.

Mr. Darwin describes a peculiar instance of a natural reversal of movement in *Hibbertia dentata*. He found that, although its long flexible shoots were evidently well fitted for twining, yet they would make a whole, or half, or quarter circle in one direction, and then in the opposite one. He could not at first discover for what purpose was this adaptation, until after offering the plant various arrangements of sticks and twigs, &c., he surrounded it with several thin upright sticks; and "now the *Hibbertia* had got what it liked, for it twined up the parallel sticks, sometimes winding round one and sometimes round several. . . . Though the revolving movement was sometimes in one direction and sometimes in another, the twining was invariably from left to right. . . . It would appear that this *Hibbertia* is adapted to ascend by twining, and to ramble laterally over the thick Australian scrub."

Mr. Darwin concludes the first part with recording several miscellaneous and curious cases. For example, he observes that "the main stem of *Tamus Elephantipes* does not twine: only the branches." In a species of *Asparagus*, the leading shoot, and not the branches, twine. *Combretum argenteum* produces two kinds of shoots, several of the first formed showed no tendency to climb until "one appeared from the lower part of one of its main branches, five or six feet in length, differing greatly in appearance from its leaves being little developed. It revolved vigorously, and twined." Lastly, a still more remarkable instance occurs in *Ipomœa argyrœoides*, which, in S. Africa, almost always grows erect and compact, from twelve to eighteen inches; whereas seedlings raised at Dublin twined up sticks eight feet high! "These facts," says Mr. Darwin, "are highly remarkable, for there can hardly be a doubt that in the dryer provinces of S. Africa these plants must have propagated themselves for thousands of generations in an erect condition; and yet during this whole period they have retained the innate power of spontaneously revolving and twining, whenever their shoots elongated under proper conditions of life."

II. *Leaf Climbers.*—Mr. Darwin commences his 2nd class by remarking "that it has long been observed that several plants climb by the aid of their leaves, either by the petiole or by the produced midrib." He observed nine different genera; and of two, *Clematis* and *Tropæolum*, eight species of each in order to discover what amount of difference there might be within the same genus; and this, it appears, is considerable.

Clematis glandulosa. The thin upper internodes revolved, against the sun, at an average rate of 3h. 48m. The leading shoot twined round a stick placed near it, first in one direction, then ascending straight, and that portion becoming rigid, twined in an opposite course. This peculiarity was common with other species of this genus. No use is made of the leaves while twining up a vertical stick: "nevertheless if the footstalk of a young leaf be rubbed with a thin twig a few times on any side, it will in the course of a few hours bend to that side; afterwards, however, straightening itself. When first developed, the petioles are upturned, parallel to the stem; they then slowly bend downwards, remaining for a short time at right angles to the stem, and then become so much arched downwards that the blade of the leaf points to the ground with its tip curled inwards, so that the whole petiole and leaf together form a hook. The young leaves are thus enabled to catch twigs when brought into contact with them by the revolving movement of the internodes. The petioles which have clasped any object soon become much thickened and strengthened (as may be seen by reference to Pl. V., fig. 1). If they come into contact with no object, they retain their downward position for some time, and then bending upwards re-assume their original position, which is retained ever afterwards."

Space will not allow us to mention particulars of other species of clematis, to show what amount of variability obtains in this genus; but we introduce a figure of a young leaf of *Clematis viticella* (Pl. V., fig. 2), to compare with that of *C. glandulosa.* In this species, the whole petiole, which with the sub-petioles is sensitive, acts as a hook, being rectangularly bent at the extremity. We may remark that there is a gradation of sensitiveness in the petioles of species of this genus. In *C. montana* it is confined to the main petiole, while in

C. viticella it has spread through the petioles of the several leaflets.

We will conclude our account of leaf-climbers with a short notice of *Solanum jasminoides* (Pl. V., figs. 3 and 4). Some members of the genus *Solanum* are twiners; but this is a true leaf-climber. A long shoot made four revolutions, against the sun, very regularly at an average rate of 3h. 26m. In no other leaf-climber was a leaf grown to its full size capable of clasping a stick, though it took several weeks to do it.

"When a petiole of a half-grown leaf has clasped a support, in three or four days it increases in thickness, and after several weeks becomes hard and rigid. On comparing a thin, transverse slice of this petiole with one from the older leaf beneath, which had not clasped anything, its diameter was found to be doubled, and its structure greatly changed. The sections in fig. 4 will illustrate this peculiarity. In that of the petiole in its ordinary state (A) we see a semilunar band of cellular tissue, slightly different from that outside it, and including three closely approximate groups of dark vessels. Near the upper surface of the petiole, beneath two ridges, there are two other small circular groups of vessels. In the section of the petiole (B), which had during several weeks clasped a stick, the two upper ridges have become much less prominent, and the two groups of woody vessels beneath them much increased in diameter. The semilunar band is converted into a complete ring of very hard, white, woody tissue, with lines radiating from the centre. The three groups of vessels, which, though closely approximate, were before distinct, are now completely blended together. The upper part of the new ring of woody vessels formed by the prolongation of the horns of the original semilunar band is thinner than the lower part, and is slightly different in appearance, from being less compact. The clasped petiole had actually become thicker than the stem close beneath; and this was chiefly due to the greater thickness of the ring of wood, which presented, both in transverse and longitudinal sections, a closely similar structure in the petiole and axis."

We must now pass on to—

III. *Tendril Bearers.*—True tendrils are formed by the modification of leaves with their petioles, of flower-peduncles, and perhaps also of branches and stipules.

Of *Bignonia*, nine species, taken at hazard, and observed by Mr. Darwin, afforded connecting links between twiners, leaf-climbers, tendril-bearers, and root-climbers. *B. unguis.*—Young shoots of this species revolve, climbing sometimes in different directions. It is a leaf-climber, though possessing tendrils. Each leaf consists of a petiole bearing a pair of leaflets and terminating in a tendril, a little larger than that represented in Pl. V., fig. 5, and resembling a bird's foot and leg with the hind toe cut off. The toes terminate in sharp and hard claws. The main petiole and tendril are alone sensitive, the sub-petioles of the leaflets being inert; hence, when a shoot grows through branching twigs, its revolving movement soon brings the tendril into contact with some twig, and then all three toes bend, and after several hours seize fast hold of a twig, exactly like a bird when perched.

Of all the species of *Bignonia* examined by Mr. Darwin, *B. Capreolata* seems to offer the most curious points for observation.

The tendril consists of five branches, apparently representing two pairs of leaflets and a terminal one. Each branch is bifid or trifid, the points being blunt, but hooked. The tendrils revolve in an apparently capricious manner, sometimes not at all, or very slightly, but at other times they describe large regular ellipses. A remarkable fact about them is, that although they bent round sticks, the tendrils again loosed it, sometimes repeating the operation three or four times, recoiling from it "in disgust," and then straightening themselves. The tendrils, moreover, avoid the light, and when a rough post with crevices is given to them, the claws of the tendrils crawl into them. But the substance best adapted to the plant is evidently of a fibrous nature, for when—

"Cotton wool or flax was placed in the proximity of the tendrils, the hooked points caught the fibres; which, from the excitement they produced, caused the hooks to penetrate and curl inwards, so that they securely grasped one or two or a small bundle of them. The tips and inner surfaces of the hooks now begin to swell, so that, after a few days, they are converted into whitish irregular balls, rather above the 1-20th of an inch in diameter, and formed of coarse cellular tissue, which sometimes wholly enveloped and concealed the hooks themselves. The surfaces of these balls secrete some viscid resinous matter, to which the fibres of the wool, &c., adhere . . . . As the whole surface of the ball continues to grow, fresh fibres adhere and are enveloped;"

So that a ball with between fifty and sixty fibres of flax, crossing at various angles, all imbedded more or less deeply, were seen by Mr. Darwin. From these curious discoveries, it is deduced that although this *Bignonia* can occasionally adhere to smooth cylindrical sticks, and often to rugged bark, yet its tendrils are specially adapted to climb trees clothed with lichens, mosses, or with *Polypodium incanum;* which Prof. Asa Gray says is the case with the forest-trees where this *Bignonia* grows.

"Finally, it is a highly remarkable fact that a leaf should become metamorphosed into a branched organ which turns *from* the light, and which can by its extremities either crawl like roots into crevices, or seize hold of minute projecting points; these extremities subsequently forming cellular masses which envelop by their growth the finest fibres, and secrete an adhesive cement."

Cobœa scandens furnishes many points for observation worthy of note. We can only give one. The tendril being vertical, sweeps a circle right over the axis of the stem which is turned to one side. As soon as the tendril comes in contact with a stick, the branches commence lifting themselves up and down, and arrange themselves in conformity with every irregularity of the surface, and so bring the hooks with which the extremities of the tendrils are furnished, originally facing in various directions, into contact with the wood. Mr. Darwin thus describes the beautiful adaptation of this plant :—

"A tendril caught a thin stick by the hooks of one of its two extreme branches ; though thus held by the tip, it continued to try and revolve, bowing itself out to all sides, and thus moving its branches ; the other extreme branch soon caught the stick; the first branch immediately loosed itself, and then, arranging itself afresh, again caught hold. After a time, from the continued movement of the tendril, a third branch became caught by a single extreme hook . . . . the main stem now began to contract into an open spire, and thus to shorten itself ; and so, as it continued to try to revolve, a fourth branch was brought into contact. As the spiral contraction travelled down the main stem and down the branches of the tendril, all the lower branches, one after another, were brought into contact with the stick, and were wound round it and round their own branches, until the whole was tied into an inextricable knot round the stick. The branches of the tendril now became rigid, and even stronger than they were at first. This plant is secured to its support in a perfect manner."

Corydalis claviculata.—Of this plant we have introduced a figure (Pl. V., fig. 6), because it affords an instance of an actual state of transition from a leaf-climber to a tendril bearer. In a full-grown plant *all* the leaves have their extremities more or less converted into tendrils. All the reduced leaflets have branching nerves, and terminate in little spines like the fully developed leaflets. Every gradation can be traced until we come to branchlets *a*, and *d*, which show no vestige of a lamina. The terminal branches are highly sensitive, the sensibility of the petiole gradually diminishing from the tendril-like extremities to the base. The internodes are not at all sensitive.

We must now pass on to the order

Vitaceœ.—In this, in *Sapindaceœ,* and in *Passifloraceœ,* the tendrils are modified flower peduncles. *Vitis vinifera,* common vine. The tendril is of great size and thickness, sometimes sixteen inches in length. It consists of a peduncle, bearing two branches, which diverge equally from it like the letter Y (Pl. VI., fig. 7). One branch (B) has a scale at the base, and is the longer, and often bifurcated. After a tendril has clasped any object, it contracts spirally. The revolving movement of the internodes is extremely slight.

The diagram of the flowers of the vine (Pl. VI., fig. 8) will show that the tendril here described is a modified flower peduncle.

The two branches above mentioned correspond to B and C (as lettered in the figures), only here the longer (with the bract) bends downwards, evidently to give extra support to the bunch of grapes, which is formed upon what is homologically the other branch of the tendril.

The peduncle, C, increases in length, and loses its sensitiveness in an inverse degree to the number of flower-buds. Thus, the fewer there are, the greater the length of the peduncle, and the more nearly does it assume the character of a tendril.

Similarly, the "flower-tendril," B, occasionally bears flowers, and then "in this state they retain their characteristic qualities of sensitiveness and spontaneous movement, but in a somewhat lessened degree." In fact, a perfect gradation may be seen from the ordinary state of a "flower-peduncle" to that of a true tendril. Mr. Darwin remarks that this affords a good instance of the law of compensation.

Ampelopsis hederacea, or *Virginian Creeper.*—Pl. VI., fig. 9, will illustrate the appearance of the tendril. There is but feeble sensitiveness in the branches, which turn from the light, as their purpose is not to climb by twining round objects, but by means of discs on flat surfaces, as follows:—When they meet a wall they all turn their branches towards it and bring the hooked tips laterally in contact with it. After arranging the branches satisfactorily, the curved tips swell, become bright red, and form on their under side little disks or cushions which apparently secrete some resinous fluid, and so assist in adhering the tendril firmly to the surface, for "the cellular outgrowth of the disk completely envelops every minute and irregular projection, and insinuates itself into every crevice." An attached tendril increases in size, contracts spirally, and becomes highly elastic; and even when subsequently dead, retains its strength and elasticity.

Mr. Darwin mentions one branchlet which had been attached for ten years, yet supported a weight of two pounds. If any entire tendril, or branch of a tendril, do not attach itself, it shrivels up, and very soon drops off (see Pl. VI., fig. 10).

Our author concludes Part III., on Tendril-bearers, by several interesting remarks upon the *Spiral contraction of Tendrils.* This movement begins in half-a-day or a day or two after the extremities have caught some object. It occurs in all tendrils after seizure, with the principal exception of *Corydalis* *claviculata;* the branchlets of which become deeply sinuous or zigzag, which may be the first indication of the spiral contraction which takes place on the lower surface, as indicated by the abruptly bending of the petiole, when it has not seized an object. This "indication" would seem to corroborate the statement already made, that this plant is an example of a state of transition between a leaf-climber and a tendril-bearer. Tendrils of many plants, if they catch nothing, contract after several days or weeks into a close spire; whereas when caught, they contract immediately, and in other instances (as *Virginian Creeper*) wither and drop off without contracting spirally; thereby showing the intimate connection between the spiral contraction of a tendril and the previous act of clasping a support.

The use of the spiral contraction is varied. If it has caught a twig higher than the shoot which is inclined, it drags it up. Again, when it has once secured a hold, and the internodes of the shoot continue to lengthen, were it not for this contraction, the shoot would be slackened. Another most important service is that the tendrils are thus made more highly elastic. The strain (as in *Virginian Creeper*) is equally distributed to the several attached branches of the tendril, thereby vastly strengthening it. Little can be said upon the exciting cause of the spiral contraction. At present, therefore, it must be called a vital action without any further explanation being attempted.

IV. *Hook Climbers and Root Climbers.*—In this group there is no spontaneous revolving movement; the former of these, as *Galium Aparine, Rubus Australis,* and climbing roses, apparently depend solely upon the mechanical support gained by their hooks, as is the case with certain palms in the New and Old Worlds. In the latter group are a good many plants which are excellent climbers.

"One of the most remarkable is the *Marcgravia umbellata*, which in the tropical forests of South America, as I hear from Mr. Spruce, grows in a curiously flattened manner against the trunks of trees, here and there putting forth claspers (roots), which adhere to the trunk, and, if the latter be slender, completely embrace it. When this plant has climbed to the light, it sends out free and rounded branches, clad with sharp-pointed leaves, wonderfully different in appearance from those borne by the stem as long as it is adherent . . . ."

The following are Mr. Darwin's concluding remarks :—

"Plants become climbers, it may be presumed, to reach the light, and to expose a large surface of leaves to its action and to that of the free air. This is effected by climbers with wonderfully little expenditure of organized matter, in comparison with trees, which have to support a load of heavy branches by a massive trunk. . . . . . I have ranked twiners—leaf and tendril climbers—as subdivisions of one class, because they graduate into each other, and because nearly all have the same remarkable power of spontaneously revolving. Does this gradation indicate that plants belonging to one subdivision have passed, during the lapse of ages, or can pass from one state to another?"

Mr. Darwin believes that they can and have done so. He believes this to be true from the fact that the internodes of leaf-climbers revolve, and that many are capable of spirally twining round supports. Moreover, "several leaf-climbing genera are closely allied to other genera which are simple twiners." Similarly he believes tendril-bearers to have been primordially climbers. "For the internodes of the majority revolve, and in a very few the flexible stem still retains the capacity of spirally twining round an upright stick." He proceeds to give the advantages a spirally-twining plant gains by becoming a tendril-bearer. Thus:—

"It might be an advantage to a plant to acquire a thicker stem, with short internodes bearing many or large leaves; and such stems are ill fitted for twining. Moreover, it is easy to see how incomparably more securely they grasp an upright stick than do simple twiners. From possessing the power of movement on contact, tendrils can be made very long and thin, so that little organic matter is expended in their development, and yet a wide circle is swept. Tendril-bearers can from their first growth ascend along the outer branches of any neighbouring bush, and thus always keep in the full light."

He then enumerates several of the diverse powers of movement possessed by climbing plants, as follows:—

"In the first place, the tendrils place themselves in the proper position for action.

2nd. If the young shoot of a twining plant, or if a tendril, be placed in an inclined position, it soon bends upwards, though completely excluded from the light.

3rd. Climbing plants bend towards the light; except in a few instances when they bend in a conspicuous manner towards the dark.

4th. Stems, petioles, flower-peduncles, and tendrils spontaneously revolve, the motion being contingent on the youth and vigorous health of the plant.

5th. There exist in tendrils movements, often rapid, from contact with any body.

6th. After clasping, tendrils generally contract spirally."

Finally, Mr. Darwin concludes his long and deeply interesting paper by the following excellent words:—

"We see how high in the scale of organization a plant may rise, when we look at one of the more perfect tendril-bearers. It first places its tendrils

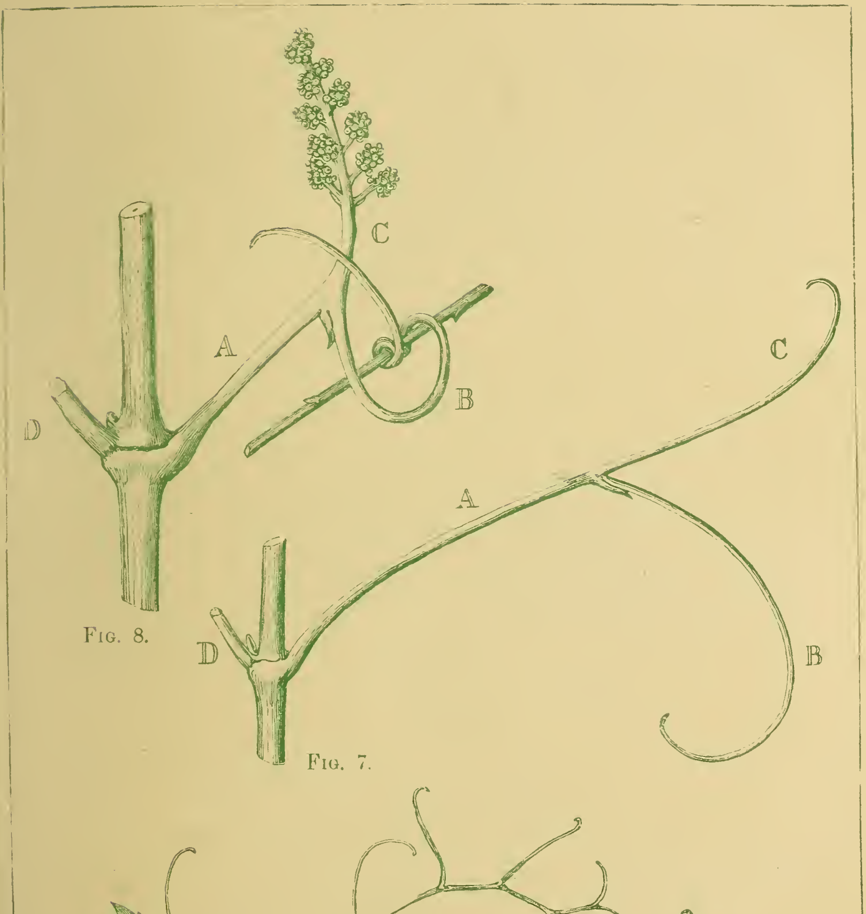


Fig. 8.

Fig. 7.

Fig. 9.

Fig. 10.

Climbing Plants.

ready for action, as a polypus places its tentacula. If the tendril be displaced, it is acted on by the force of gravity, and rights itself. It is acted on by the light, and bends towards or from it, or disregards it, whichever may be most advantageous. During several days the tendril or internodes, or both, spontaneously revolve with a steady motion. The tendril strikes some object, and quickly curls round and firmly grasps it. In the course of some hours it contracts into a spire, dragging up the stem, and forming an excellent spring. All movements now cease. By growth the tissues soon become wonderfully strong and durable. The tendril has done its work, and done it in an admirable manner."

EXPLANATION OF PLATES.

Plate V.

Fig. 1. *Clematis glandulosa*, with two young leaves clasping twigs, with the clasping portions thickened.

„ 2. A young leaf of *Clematis viticella*.

„ 3. *Solanum jasminoides*, with one of its leaves clasping a stick.

„ 4. *Solanum jasminoides*. A. Section of petiole; B. Section of a petiole some weeks after it has clasped a stick, as shown in fig. 3.

„ 5. *Bignonia*, unnamed species from Kew.

„ 6. *Corydalis claviculata*. Leaf-tendril, of natural size.

Plate VI.

„ 7. Tendril of the Vine.
A. Peduncle of tendril.
B. Longer branch, with a scale at its base.
C. Shorter branch. D. Petiole of opposite leaf.

„ 8. Flower of the Vine. A. Common Peduncle ; B. Flower-tendril, with a scale at its base ; C. Sub-peduncle ; D. Petiole of opposite leaf.

„ 9. *Ampelopsis hederacea*. Tendril, with the young leaf.

„ 10. *Ampelopsis hederacea*. Tendril, several weeks after its attachment to a wall, with the branches thickened and spirally contracted, and with the extremities developed into disks. The unattached branches have withered and dropped off.

ON THE CONSTRUCTION AND USE OF THE SPECTRUM-MICROSCOPE.

BY H. C. SORBY, F.R.S.

EVERY one is in the constant habit of distinguishing different objects by their colour. In many cases this is sufficient to characterize various small bodies seen with the microscope. Now, strictly speaking, spectrum analysis is nothing more than a refined and scientific method of applying the same principle, and the spectrum microscope is simply an instrument which enables us to employ it in the case of very small objects. It is a more refined method, because we may have a number of different substances so nearly of the same colour, that it would not enable us to tell one from another; and yet, when examined with a spectroscope, their spectra might be entirely different and quite characteristic. On the contrary, we may have cases where the presence of foreign colouring matter so entirely disguises the natural colour of a substance, that its presence would scarcely be expected; and yet, when examined with a spectroscope, the spectrum may be so characteristic, that its presence is perfectly well established. In these remarks I refer to coloured solids or liquids. The spectroscope has been so commonly restricted to the examination of coloured flames—*i.e.*, to the study of the light given off from incandescent vapours—that I have found many persons who believed that in order to obtain the spectrum of such substances as blood, it is requisite to burn it. There can be no doubt whatever that, on the whole, the facts to be learned from the study of mineral matter in the state of incandescent vapour are far more important and decided, because the spectra are far more characteristic; but still we may learn a number of valuable facts in studying the light transmitted or reflected from solid or liquid coloured substances.

In this communication I purpose first to describe what I consider to be the best form of instrument; and then, after some general remarks, to give a few hints on the preparation of objects for examination; and conclude with the description of some characteristic examples.

Fig. 1.

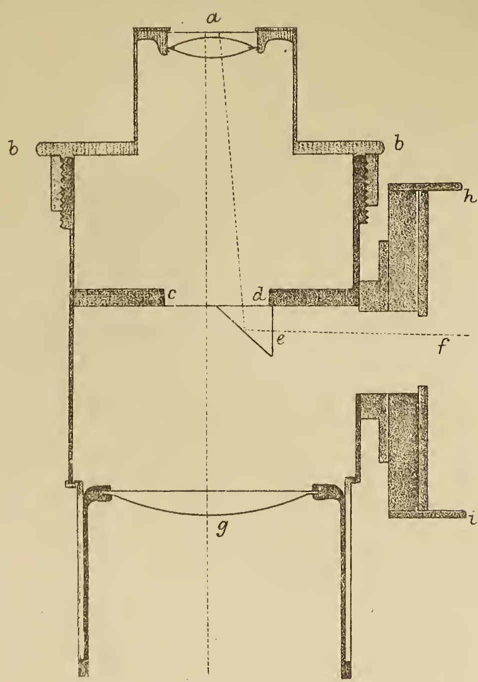


Fig. 2.

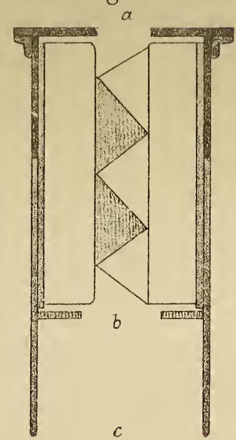


Fig. 3.

Fig. 4.

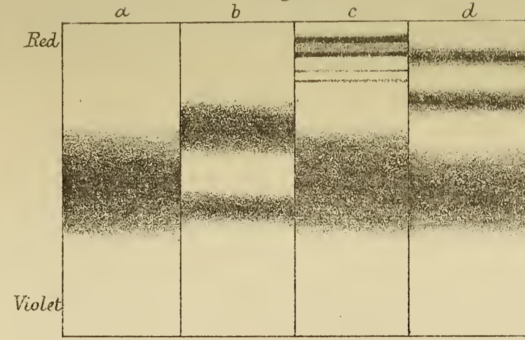
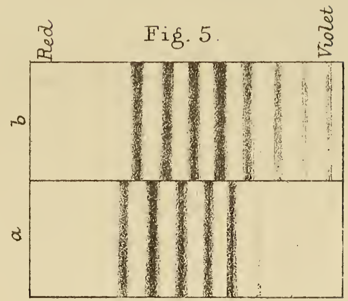


Fig. 5.



H. C. Sorby. del.

W. West, lith.

The Spectrum Microscope.

When I first commenced this subject, I confined myself to such a form of apparatus as could be easily constructed with an ordinary simple triangular prism, which was placed below the achromatic condenser. I described the details of the arrangements, and a number of facts which could be learned by means of the instrument, in a paper in the *Quarterly Journal of Science*, April 1865, vol. ii., 198. However, I afterwards perceived that if a suitable direct-vision prism could be contrived, to use over the upper lens of the eye-piece, it would present many great advantages. Mr. Browning lent me a number of different prisms, made others at my suggestion, and has carried out my views with such zeal, that we have at length succeeded in obtaining what appears to me a perfectly satisfactory form of instrument. I shall not attempt to describe all the minute points in its construction, since that is a question which more concerns an instrument-maker than a general reader or experimenter, but will give such a general description as may serve to explain its capabilities.

The prisms employed to obtain the spectrum are composed of two rectangular prisms of flint glass, between which is a rectangular prism of crown glass, and at each end another prism of crown with an angle of about 75°, as shown in section by fig. 2. These are all cemented together with Canada balsam; and since we get the sum of the dispersive action of the two flint prisms corrected for refraction by the three of crown glass, we obtain a very satisfactory spectrum with perfectly direct vision. In some cases a less dispersion is desirable, and I therefore have another compound prism composed of one rectangular flint and two crown glass prisms of about 60°; and in a few cases, when a wider dispersion is required, I combine the two series. On the whole, however, the compound prism shown in the fig. is just of that medium power which is required in by far the larger number of cases. These analyzing prisms are mounted in a tube having a cap with an elongated opening at *a*, a circular stop at *b*, and a free part of tube *b c*, which fits over the upper lens of the eye-piece like an ordinary cap.

Since some persons who have not paid attention to the ordinary kind of spectroscope, may be induced to take an interest in its application to the microscope, it may, perhaps, be well to say a word or two with reference too the use and need of a slit. Without it, on placing the prism over the eye-piece, all the objects in the field would appear fringed with the prismatic colours, without anything definite being seen. What is wanted is a narrow beam of light, which, on passing through the prism, is spread out in such a manner, that, if any particular rays are deficient in the light, the fact may be made apparent by there being no light in that particular part of the spectrum. If the beam be broad, the deficient part is spread over too wide a space, overlapping and being overlapped by the contiguous rays; but if the beam be narrow, the deficient part is restricted to its true dimensions. Hence the necessity of a narrow beam passing between two straight edges. However, since, on reducing the width, the amount of light is reduced, there is in all cases a particular width which gives the best general result; and therefore it is always desirable to have the means of varying the width of this narrow opening or slit by a screw movement. Now, with such a compound prism mounted in a tube as I have described, all that is absolutely requisite, to obtain a good spectrum, is to have such a slit which can be inserted into an ordinary eye-piece like a micrometer, so that it may be in the exact focus. Then, on placing the cap holding the prisms over the upper lens, a very good spectrum is seen. There is, however, this disadvantage in what would otherwise be a very simple arrangement—that the upper lens is not achromatic, and therefore the whole spectrum is not in focus at the same time; and moreover, since it is often most useful to be able to compare two spectra side by side, I consider that it is well worth while to have a special eye-piece, as shown in fig. 1, which can be adapted to any microscope, and comprises, with the prism, all that is requisite for the majority of objects. The upper lens (*a*) is compound and achromatic, and is mounted so that the focus may be adjusted by turning round the milled head *b b*. The slit is supposed to be represented by the opening *c d*, and a small right-angled prism (*e*) is fixed half over it, so that light passing through an opening at *f* is reflected through the half of the slit, on the side *d;* whilst light coming up the body of the microscope through the field-glass *g*, passes through the other half on the side *c*. Therefore, when the analyzing prism is placed over the eye-piece, we see side by side the spectrum of the light passing from *f*, and that passing from *g*; and if the reflecting prism is properly adjusted, the two spectra are quite continuous. In order to hold objects in front of the opening at *f*, a stage is attached as shown at *h i*, with appropriate springs to hold flat pieces of glass, or test tubes, which fit into V-shaped notches at *h* and *i*, and lie flat on the surface of the stage. Since the amount of light passing up the body of the microscope is much less than that passing through *f*, on account of being spread over a larger surface by the magnifying power of the object glass, it is requisite to have a second vertical slit at *f*, which can be made wider or narrower till the two spectra are of equal brilliancy.

In using this eye-piece with a simple microscope, the object on the stage may be first examined by means of an ordinary eye-piece, and placed in the centre of the field, and then this eye-piece substituted and the spectrum examined and compared with the natural spectrum due to the light passing through the opening at *f*, or with that of any coloured substance placed in front of that opening on the stage *h i*. It is, however, far better to use a binocular microscope, since then one tube can be used to examine the object, and place it in the centre of the field, and the eye-piece and prisms I have described can be kept permanently in the other tube to study its spectrum. By pulling out the other eye-piece, the focal length of both can easily be made the same. Of course, a high power could be used, but it is better to use as low as convenient, in order to obtain more light. If the object be too small to cover the whole length of the slit, I have a small slide worked with a screw to reduce its length to the size of the object.

I always feel that the detailed description of apparatus is tedious and unsatisfactory. More could be learned in a few minutes' inspection than by reading pages of description, which often make what is very simple appear very complicated. Still, some description of the apparatus was essential, and I trust what I have said may suffice to explain its general construction, without trenching on space that should be devoted to an account of the objects to which it may be applied.

Summing up, then, the advantages of this form of apparatus, I may say that it enables us to examine the object itself, and its spectrum, without any changes of focus or position. By simply removing the prisms, we can easily see whether any very minute object is in front of the slit, and, if need be, open the slit wider so as to be sure that it is in the best position; and we can compare its spectrum,—and the whole of the rest of the field of view is quite dark,—side by side with that of white light, or of any other larger object placed on the stage at the side of the eye-piece; and all the spectrum is in focus at the same time.

In studying the spectra of coloured solids or liquids, it is very essential to distinguish between what may be called characteristic and uncharacteristic spectra. Unfortunately, very many substances belong to the latter class, and it is this, more than anything, which limits the application of this method of research. In the case of these uncharacteristic spectra, when the object is only slightly coloured on account of being very thin, or a very dilute solution, it begins to absorb either the red or the blue end of the spectrum; and on increasing the thickness or the strength of the solution, more and more of the spectrum is obscured, until we may have a spectrum consisting merely of blue, shading off into obscure green, or of red shading off into obscure orange. Such spectra afford little positive evidence of what the object may be, since a great variety of simple or mixed substances might give just the same results. On the contrary, some objects, even when the colour is very faint, almost totally cut off the light in well-defined bands, of which the general character and position may be so characteristic that there is little fear of confounding the substance with any other, even if its ordinary colour be disguised by coloured impurities. Sometimes these so-called absorption bands are broad and indistinct, but in other cases remarkably narrow and well defined, and are then so much the more characteristic. Sometimes only one exists, but in other cases they are numerous, and they appear to me to be of special interest, as showing some intimate relation between the molecules of the body and vibrations of light of particular velocities—the molecules, perhaps, having a natural tendency to vibrate in unison with particular waves of light, and to convert them into heat. If this view be correct, we might expect that they would furnish us with a test for otherwise very inappreciable molecular changes, and such appears to me to be the fact. It is, indeed, somewhat analogous to what would occur if the vibration of the air corresponding, for example, to the notes A, B, C, D, were to pass through a number of strings all tuned to B. They would be set in motion by the vibrations corresponding to B, and the intensity of that note would be diminished by the force required to move the strings; whereas A, C, D, would not be affected in that manner, and we should have, as it were, an absorption band at B. If then we found that the absorption band was at C, we should know that some change had occurred to alter the pitch of the strings from B to C. Excellent examples of similar changes are met with in coloured spectra.

The objects most easily obtained, and which furnish us with the greatest variety of spectra, are coloured crystals, coloured solutions, and coloured glasses. The spectrum-microscope enables us to examine the spectra of very minute crystals, of very small quantities of material in solution, and of small blowpipe beads. As previously named, the thickness of the object makes a very great difference in the spectrum. For example, an extremely thin crystal of ferridcyanide of potassium cuts off all the blue rays, and leaves merely red, orange, yellow, and more or less green; but on increasing the thickness the green and yellow disappear, and when very much thicker little else but bright red light is transmitted. In all such cases, the apparent magnitude of the effect of an increase in thickness is far greater when the object is thin than when thick, and past a certain thickness the change is comparatively very slight. If only small crystals can be obtained, it is well to mount a number of different thickness; but when it is possible to obtain crystals of sufficient size, it is far better to make them into wedge-shaped objects, since then the effect of gradual change in thickness can easily be observed. Different kinds of crystals require different treatment, but as a general rule I find that it is best to grind them on moderately soft Water-of-Ayr stone with a small quantity of water, which soon becomes a saturated solution, and then to polish them with a little rouge spread on paper laid over a flat surface, or else in some cases to dissolve off a thin layer by carefully rubbing the crystal on moist blotting-paper until the scratches are removed. Then, whenever it is admissible, I mount the crystal on a glass, and also cover it with a piece of thin glass with Canada balsam. Strongly coloured solutions may be examined in test tubes, or may be kept sealed up in small bottles made out of glass tubes, the light then examined being that which passes through the centre of the tube from side to side. Such tubes may be laid on the ordinary stage, or held on the stage attached to the eye-piece. Smaller quantities may be examined in cells cut out of thick glass tubes, one side being fixed to the ordinary glass with Canada balsam, like a microscopic object, and the other covered with thin glass, which readily holds on by capillary attraction, or may be cemented fast with gold size or Canada balsam, if it be desirable to keep it as a permanent object. Such tubes may be made of any length that may be required for very slightly-coloured solutions. Cells made out of spirit thermometer tubes, so as to be about one-tenth of an inch in diameter, and half an inch long, are very suitable for the examination of very small quantities; but where plenty of material can be obtained, it is far better to use cells cut out of strong tube, having an interior diameter of about three-fourths of an inch, cut wedge-shape, so that the thickness of the solution may be one-fourth of an inch, or more, on one side, and not above one-fortieth on the other; and then the effect of different thicknesses can easily be ascertained. The accompanying figure will better explain my meaning (see fig. 3). If we place a small object on the stage of the microscope, and then one of these oblique cells on the stage attached to the eye-piece, we can easily move it in front of the opening *f* (fig. 1), until the two spectra are exactly the same, or until we can see that they are in no case identical.

For the same reason, it is very desirable to have pieces of coloured pot-metal glass cut wedge-shape, so as to be able to compare the spectrum of different thicknesses of a known material, with that of blow-pipe beads coloured with some unknown substance.

Though perhaps not in all cases, yet very often, a reduction in the amount of light transmitted through the slit is equivalent to an increase in the thickness of the object. Therefore, by varying the width of the opening in the stage attached to the eye-piece, we modify the spectrum much as if we altered the thickness of the object. To some extent, the same effect is produced by altering the width of the slit inside the eye-piece, but then the spectrum is also modified in other respects, and well-defined absorption bands are made less so if the slit be too wide. At the same time, some wide and obscure bands are far more distinct when the slit is wide; a wider slit and greater dispersion being in some degree equivalent to a narrower slit and less dispersion.

Having now, I trust, given a sufficient general account of the preparation of objects, I will proceed to describe a few particular applications of the instrument; and since I have just referred to blow-pipe beads,—and that is a new branch of the subject,—it will perhaps be well to say a few words on it now. I shall only give a few illustrations, because I have, so far, done little more than convince myself that in some cases the instrument may be very advantageously employed. The blue modifications of salts of cobalt present us with very characteristic spectra. The pink hydrated crystals of the chloride give two well-marked absorption bands, one in the light part, the green, and the other in the blue green, as shown in fig. 4, *b*; but when dissolved in water there is only one broad absorption band in the centre of the green, as shown in *a*, which cannot be looked upon as characteristic. If dissolved in a concentrated solution of chloride of sodium, the position of this absorption band is not materially changed, though the general colour is more red; but if dissolved in a concentrated solution of chloride of calcium, there is a complete change. We obtain a blue solution, which gives a most characteristic spectrum when there is only sufficient cobalt present to give a very pale blue tint. To see it to advantage, lamp-light should be used. We then get a spectrum somewhat as shown in fig. 4, *c*, which is, however, not exactly like what is seen with any one case, but shows the characteristic peculiarities of different intensities of colour. There is an absorption band in the red which may be separated into two; another in the lower part of the red, and another more faint in the orange. These two bands are so very sharp and narrow, that they look almost like the so-called Fraunhofer's lines seen in the spectrum of day-light. To see both distinctly is the most refined test I have yet found for a spectrum-microscope. Then there is another much broader absorption band in the green, which is not well seen until the thickness or strength of the solution is such, that the bands in the red and orange have so far coalesced, that the spectrum consists of a well-defined bright greenish-yellow band at one end, and a broad blue at the other. Now, the relation between this spectrum and that of blue cobalt glass, fig. 4 *d*, is very curious and instructive. Instead of having, as it were, two double absorption bands, there are two single. The rest of the spectrum is similar, but is as it were dislocated, or, to use a geological expression, faulted and thrown down, as will be seen on comparing it with *c*. The result is, that in the case of the glass there is a far broader band of red, which is visible when the thickness of the object is sufficient to cause the two absorption bands to coalesce; and then, besides the broad blue, there is a bright band in the green; whereas, in the deep blue solution, it is in the yellow, and there is no extreme red band. Day-light is too poor in extreme red rays to show these facts to advantage, and they are also obscured by the black Fraunhofer lines. These different spectra, obtained with various modifications of cobalt, serve very well to explain what I mean when I speak of characteristic and uncharacteristic spectra. Not, indeed, that we can draw a definite line between them—it is more a question of degree—but we may say that *c* is so remarkably characteristic that one cannot expect that any other substance would give the same result, whilst *a* is so little characteristic that the colouring matter of various red fruits shows precisely the same spectrum. As the spectrum of a glass, *d* is also sufficiently characteristic; and as that of a crystal, *b* is so much so that it would probably be very difficult to find any other that would give a similar result. These four spectra will also serve to illustrate the effect produced by different molecular states of the same substance. The change from *b* to *a* may probably indicate that the hydrated crystallized chloride of cobalt *combines* with additional water when it dissolves in water; whilst, when dissolved in a concentrated solution of a salt like chloride of calcium, it loses its former water of crystallization. On the contrary, when the anhydrous oxide is dissolved in glass, the spectrum is still further modified.

After this description of the spectrum of glass coloured with oxide of cobalt, the application of the spectrum-microscope to the examination of blow-pipe beads suspected to contain cobalt will be readily understood. Supposing we have got a borax bead coloured more or less blue, we may place it on the stage of the microscope and compare its spectrum with that of a wedge-shaped piece of glass, known to be coloured with oxide of cobalt. If the bead be coloured with oxide of cobalt, it is easy to so adjust the wedge-shaped glass that the two spectra are precisely the same. But since the characteristic light and dark bands are in the green, yellow, and orange part of the spectrum, it is quite clear that any other substance which did not absorb those rays might be present in such quantity as to entirely alter the colour of the bead, and yet the bands characteristic of the cobalt might be so well seen as to leave no kind of doubt of its presence. Oxide of iron and oxide of manganese, which more than any other substances are likely to interfere with the ordinary method which relies on colour without spectrum analysis, are of this character. The bead may be so far coloured green or pink that the blue colour of the cobalt is quite disguised, and yet the dark and light bands characteristic of cobalt may be easily seen.

Few substances give a more striking spectrum than permanganate of potash. A solution so dilute as to be a pale pink gives five well-marked absorption bands, at about equal intervals, in the green, and one or more very obscure in the blues. Since this solution is decomposed by organic matter, and even by long contact with flint glass, it should be sealed up in tubes of glass free from oxide of lead. The crystals are too highly coloured to show these bands, but if pressed with an agate pestle on glass, so as to be very thin, the spectrum of the crystalline salt may be seen to be exactly the same as that of the solution. I know no better example of the value of being able to compare two spectra together, side by side, than that furnished by crystals of perchlorate of potash coloured with permanganate, as compared with their solution in water. These two salts are isomorphous, and readily crystallize together; but some care is required to obtain the crystals moderately free from fluid-cavities, which render them opaque, and to arrange the relative amount of the two substances, so that they may be dark enough to show the absorption bands distinctly, and not so dark as to cause them to be united into one broad band. Sometimes on cooling from a hot solution, small thin crystals are formed, which are admirably suited for examination; and by slow spontaneous evaporation in a vessel covered up, so as to prevent the access of particles of dust, larger and sufficiently transparent crystals can be obtained. They should be of a clear pink colour. Now, though the two salts are isomorphous, and though the permanganate, in a crystalline condition, or dissolved alone or along with the perchlorate, when thin enough or dilute enough to transmit a bright pink light, gives a spectrum like fig. 5 *a*, with five well-marked absorption bands in the green; yet when crystallized along with the perchlorate, the spectrum differs in a very interesting manner, and is as fig. 5 *b*. There are four well-marked bands in the green, one moderately distinct in the blue, and two or three very faint bands in the violet. In the spectrum of the solution these latter are so obscure, that I hesitate to decide whether they exist or are absent. At all events, all the bands are better defined and far more distinct in the spectrum of the compound crystals, and yet in other respects there is a remarkable similarity. It is, however, very curious to see how the dark bands in one always occur where the bright bands exist in the other; and we have here, as in the case of the cobalt solution and cobalt glass, an instance of a molecular change, which, besides producing slight variations in the general spectrum, displaces the absorption bands, as if, so to speak, the pitch of the natural vibrations of the permanganate were raised by being crystallized along with the perchlorate of potash. We may also conclude from the spectrum that these compound crystals are decomposed when dissolved in water—the two salts do not dissolve in combination—and this agrees very well with the fact of their containing far less permanganate when re-crystallized.

The spectra of some natural minerals are very interesting; and some which contain both protoxide and peroxide of iron give the spectrum of the protoxide in one direction and of the peroxide in another, as if the planes in which the two oxides vibrate with greatest facility were perpendicular to one another.

Fortunately, the various modifications of the colouring matter of blood yield such well-marked and characteristic spectra, that there are few subjects to which the spectrum-microscope can be applied with greater advantage than the detection of blood-stains. I have already, in my paper in the *Quarterly Journal of Science* (April, 1865, II., 205), entered at so great length into this question, that I need not say much about it on the present occasion. The form of apparatus I have described enables us, however, to examine the objects in a different manner: surface illumination may be used, provided a sufficiently bright light be thrown on the object by means of a parabolic reflector or bull's-eye condenser. A speck of blood on white paper shows the spectrum very well, provided it be fresh, and the colour be neither too dark nor too light, and the thickness of the colouring matter neither too great nor too little. A mere atom, invisible to the naked eye, which would not weigh above the millionth of a grain, is then sufficient to show the characteristic absorption bands. They are, however, far better seen in a solution. About $\frac{1}{100}$ of a grain of liquid blood, in a cell of $\frac{1}{10}$ of an inch in diameter and $\frac{1}{2}$ inch long, gives a spectrum as well marked as could be desired. In exhibiting the instrument to a number of persons at a meeting I have found that no object is more convenient, or excites more attention, than one in which a number of cells are fixed in a line, side by side, containing a solution of various red colouring matters. In one I mount blood, which gives two well-marked absorption bands in the green; in another magenta, which gives only one distinct band in the green; and in another I place the juice of some red-coloured fruit, which shows no well-defined absorption band. Keeping a larger cell containing blood on the stage attached to the eye-piece, these three objects can be passed one after another in front of the object glass, and the total difference between the spectrum of blood and that of either fruit-juice or magenta, and the perfect identity of the spectra when both are blood, can be seen at a glance. By holding coloured glasses, which cut off the red, but allow the green rays to pass, we can readily show how the presence of any foreign colouring matter, which entirely alters the general colour, might not in any degree disguise the characteristic part of the spectrum; and by changing the cell held on the eye-piece for a tube containing an ammoniacal solution of cochineal, it is easy to show that though it yields a spectrum with two absorption bands, more like those due to blood than I have seen in any other substance, they differ so much in relation, size, and position, that there is no chance of their being confounded, when compared together side by side.

It would be easy to extend this essay to a most unreasonable length by describing the spectra of various other objects. So far, too little is known to enable us to form any decided opinion with regard to the comparative spectra of the same substance in different conditions. Sometimes the spectra of the solid material, and of its solution, are quite identical; sometimes the solution shows distinct absorption bands when the solid material shows none at all; and sometimes it is the reverse. The presence of different foreign substances may also modify the results in a surprising manner, and the only general conclusion I can form is, that by comparing the spectra of the same material in different conditions, we may detect molecular changes which otherwise could not be recognised.

I probably could not better conclude this communication than by saying a few words about what I look upon as the best test objects for a spectrum-microscope. For fine definition, I know none equal to the pale blue solution of chloride of cobalt in a concentrated solution of chloride of calcium. If we can see the two lines in the orange, the definition must be very satisfactory, and the dispersion as great or greater than usually required, and to see them well the two analyzing prisms should be combined. A very weak solution of blood is a good moderate test, and requires the medium amount of dispersion which is obtained by the analyzer containing two rectangular flint-glass prisms. As a good test for what cannot be well seen except with a small dispersion, I may mention the double oxalate of chromium and soda, which is also a very interesting object in other respects. The best way to prepare it is to place a few drops of a strong hot solution on glass, so that a number of minute crystals may be deposited on cooling, and then to leave the rest to deposit by spontaneous evaporation. Very well formed microscopic crystals are then obtained, which, according to the position in which they lie, or their thickness, are a beautiful blue or purple, or various shades of green and red. I know no object which shows in a more striking manner the effects of dichroism in both senses of the term. It is, indeed, polychroic, and is an excellent object to exhibit with an arrangement I am now carrying out, so as to be able to make use of the microscope as a dichroiscope.

When the crystals are moderately thin, they show a broad absorption band in the yellow and yellowish-green, and transmit the dark green, with a variable amount of red and blue, according to the position of the crystal; but when thicker, the absorption band becomes darker at each end, so that we appear to have two absorption bands, one in the red and another in the dark green, separated by an obscure division not well seen except the dispersion be small.

It must not be thought that the subjects I have chosen for illustration by any means exhaust those to which the instrument may be applied. Whenever colour is a character of any importance, then to a still greater degree is its more accurate study by means of the prism likely to yield valuable facts.

REVIEWS.

THE PROGRESS OF ZOOLOGY.*

NONE but the working naturalist can estimate the value of a well-arranged treatise devoted to zoological bibliography. To the amateur such a volume as that which lies before us is but an enormous accumulation of dry names, which certainly gives a clue to the advance of a particular branch of science, but has little practical use. Yet is Dr. Günther's work one which will be highly prized, both in this country and abroad, by all engaged in original research. To the professional zoologist it will supply information which, without it, he would require months of laborious study to obtain ; and for him it is especially intended. Those who are conversant with even the periodical literature of zoology know how difficult, if not impossible, it is to keep *au courant* with what is being done every year in the wide field of Natural History. Zoological literature increases day by day in extent and importance ; and were not some machinery devised to effect an easy mode of reference to the progress of our knowledge in each separate department, original inquiries could not be made without a fearful expenditure of time ; and we should often find that three or four zoologists had really worked out, in successive periods, precisely the same subject. These obstacles were thought of, and attempted to be met, long ago. Many years since Agassiz published his celebrated "Bibliographia Zoologiæ," and, as it were, laid the foundation-stone of the building which Dr. Günther and his *collaborateurs* have now completed. His treatise, which was published by the Ray Society, contains reference to all the memoirs on special and general Natural History which had appeared up to the date of its publication. It had, however, one serious defect—such a defect, in fact, as the catalogue of the British Museum has—the works were arranged in relation to the authors' names, and these latter were alone grouped in alphabetical order. Hence Agassiz's compilation, though of exceeding interest, in so far as it recorded the labours of distinguished *savants*, was utterly valueless to the working naturalist. If one who was engaged in some special investigation required to know what had been achieved in that particular branch, he found the "Bibliographia Zoologiæ" of no use to him whatever. For, in order to find out what had been written, he should know the writers' names—a knowledge, it will

* "The Record of Zoological Literature," 1864. Vol. I. Edited by Albert C. L. G. Gunther, M.A., Ph.D., &c. London : Van Voorst. 1865.

be conceded, that very few, if any, possess. Thus it happened that Agassiz's treatise did not supply what was required. The gap, however, was filled, we think about six years ago, by the publication of a most valuable German treatise by Professor Carus. This work was arranged upon a scheme the opposite to that of Agassiz's ; the essays and memoirs were arranged alphabetically and according to their proper groups, so that reference to "work done" became no longer a difficulty. But each year brought its own quota of grain to the garner of scientific knowledge, and it was found necessary to make some provision for its reception. This labour, therefore, was taken in hand by the conductors of the "Natural History Review," when that periodical passed from its former Irish to its present English managers. Each quarter this journal supplied classified lists of the memoirs previously printed, and in this way it formed an excellent supplement to Carus's "Bibliotheca." For this particular feature, the "Natural History Review" was highly esteemed, and we believe we are correct in saying that these bibliographical records obtained for it many subscribers who were not attracted by its Darwinian principles. Now, good and useful persons are often, if not always, exceedingly dull companions ; and we believe that to the great mass of our scientific readers, there is an analogy between people and literature. Useful reading is seldom light and entertaining. At least so it appears to have been in the case of the readers of the "Natural History Review," who seem to have had a species of mental dyspepsia, which forbade their partaking of any but the very lightest scientific literature. The publishers (publishers in matters of this kind are invariably the most considerate of mortals) soon diagnosed the condition we have referred to, and so the *pièce de résistance* was removed, and the "Natural History Review" ceased to provide for the bibliographical wants of zoologists. In this state the matter was left for a couple of years, until Dr. Günther, with an energy and enthusiasm which do him infinite credit, conceived the plan of publishing a yearly volume, which would bring the record of zoological progress up to within twelve months of the period of its issue. He planned and he has executed, and in the large handsome closely-printed book upon our table, we have, in all that relates to the progress of zoology, a nearly complete, and a most valuable volume. If we say nearly complete, it is not in deprecation we employ the term ; it is simply from the circumstance that the record of memoirs upon the Protozoa and Cœlenterata did not reach the editor in time for publication in the present volume.

The "Zoological Record," though constructed somewhat upon the plan of Carus's work, and being more easy of reference, is fuller in its details. It embraces not only the titles, dates, and places of publication of the several zoological essays issued during the year 1864, but in most instances it supplies short and pithy abstracts of them. In employing it, the naturalist not only discovers at a glance what papers have been written upon the subject he is pursuing, but he is enabled to perceive the mode of treatment adopted in each, and in this way has his journey immensely shortened and facilitated. Throughout the entire volume unity of plan has been aimed at, and although here and there we find the caprices of individual writers displaying themselves in deviations from the editor's scheme, still, on the whole, there is an excellent symmetry of execution. The letter-press extends over more than 600 pages, and is divided into sections corresponding to the animal classes, commencing with Mammalia and ending with Echinodermata. Each record begins with a list of the various publications arranged chronologically, systematically, or alphabetically, with such remarks as must be of a general character. In the second part, the titles of these publications are arranged in systematic order, and short abstracts are given ; papers less accessible to the generality of zoologists being given at greater length. Of new genera, short diagnoses are supplied, whilst the names only of sub-genera divisions are mentioned. The titles of anatomical papers are given, but only those which have a direct bearing upon special zoology are more fully treated. Finally, mention is made of all those popular scientific publications which, by their tendency to promote scientific knowledge, merit attention.

In the selection of "reporters" for the several departments of zoology embraced in the volume, Dr. Günther has been, in all but one instance, most fortunate ; and this, to those who can appreciate the matter, is saying a good deal. The Mammalia, Reptiles, and Fishes have had ample justice done to them by the editor ; the Birds were committed to the charge of Mr. Alfred Newton ; Mr. W. S. Dallas took in hand the Insects, Myriapods, and Arachnida ; whilst Dr. E. Von Martens had charge of the Mollusca ; the Helminthes were left to Dr. Spencer Cobbold, and the Molluscoida, Rotifera, Annelida, and Echinodermata to Mr. J. R. Greene. In all respects, the "Zoological Record" is an excellent volume, easy of reference as regards its arrangement, fully comprehensive as a register, and minutely accurate in its condensation of the publications it records. When we remember that the literature to which it forms a guide extends over more than 15,000 pages, we cannot but regard Dr. Günther's work as, *par excellence*, *the* zoological treatise of the year.

POPULAR PHYSICS.*

IF we were asked what subject is best calculated to awaken at the same time the reasoning and perceptive faculties of the mind, we should reply, Experimental Physics. The science of natural physical phenomena is one which every moment of our lives thrusts itself beneath our notice, and yet it is one of which most of us are exceedingly ignorant. Our steam-engines, telegraphs, barometers, and telescopes, are suggestive enough of the laws of natural philosophy, yet how few of us understand their principles. We apprehend that our ignorance proceeds less from indifference than from the absence of treatises which can be read by those unfamiliar with the higher mathematics. It is true enough that works have been published in which the phenomena known as physical are described, without reference to mathematical complications, but we regret to think that in most of them there is either no allusion to first principles, or there is that jargon of the popular

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* "Elements of Physics ; or, Natural Philosophy. Written for General Use in Non-technical Language." By NEILL ARNOTT, M.D., F.R.S. Sixth and Completed Edition, Part II. London : Longman & Co. 1865.

savant which is nothing better than a tricky cloak for ignorance. We were glad, therefore, in a former number, to perceive a new edition of Dr. Arnott's well-written treatise ; and to the first part, which then came under our notice, we awarded such praise as we believed the book to deserve. Part II. has now appeared, but we must candidly confess it has not fulfilled our anticipations. It is "behind the time," contains no account of the progress of physics during the last few years, and is in some cases remarkably inaccurate. What shall we say, for example, of a treatise, in which the splendid results of Tyndall's researches are left unnoticed, and in which the principles and discovery of the spectroscope—the most wonderful scientific instrument of the present century—remain unexplained ? Dr. Arnott's descriptions are clearly written, and in most cases are sound ; but he has not done justice to many of the departments of science upon which he has written ; he has attempted too much and effected too little. Had he left out much that he has said about the knowledge of the ancients, had he tried to be less classically erudite and more strictly scientific, he would not have damaged his early reputation, and would have materially benefited the amateur student. Why does he dismiss the principles of the compound microscope in a few paragraphs ? Why is there no mention of the ophthalmoscope and laryngoscope ? Why are all the physical wonders of photography disposed of by saying that "This new art is called photography" ? Why do we not find a syllable about the Casselli or Morse's telegraph ? These are all questions which the public has a right to ask of the author.

The chapters upon optics are by far the best in the volume, and in dealing with some of the complex questions of this branch of natural philosophy, Dr. Arnott has shown his clear, terse method of explaining difficult problems. A subject which more than any other has puzzled physiologists is the fact that we perceive objects in their true position, although on the retina of the eye they are depicted inverted, as they are in a camera obscura. This fact leads our author to the following remarks :—

"The explanation is simple. It is known that a man in bed, with his cheek on the pillow, judges as correctly of the position of the objects around him as any other person, never deeming them to be inclined or crooked because their images on his retina are inclined, in relation to the natural perpendicular when the head is erect. And boys who at play bend themselves downwards, to look backwards from between their knees, although a little puzzled at first because the usual position of the objects on the retina are reversed, soon see as correctly in that way as in any other. It appears, therefore, that while the mind studies the form, colour, etc., of external objects in their images as depicted on the retina, it judges of their position, not by the accidental position of the images on the retina, but by the direction, as ascertained by the touch and experience, in which the light comes from the object and its parts towards the eye—no more deeming an object to be placed low because its image is low in the eye, than a man in a room into which a sunbeam enters by a hole in the window-shutter deems the sun low because its image is on the floor."

THE BRITISH HEMIPTERA. *

THE study of British bugs can hardly be termed a very fascinating pursuit. Although the insect which takes up its abode in localities unknown for their relation to godliness, is not an Anglo-Saxon, still its English relatives have many of its obnoxious qualities, and among others that of emitting when touched an extremely unpleasant odour. Still the enthusiasm of naturalists—and to what limits does not that enthusiasm extend?—has prevented our native hemiptera from completely wasting "their sweetness" upon the pages of mere periodicals. Messrs. Douglas and Scott have in the volume published by the Ray Society given us a minute zoological history of the Hemiptera-Heteroptera of these countries. The name Hemiptera is given to an order of insects whose members are known by the presence of a proboscis instead of the ordinary chewing apparatus, and of imperfectly formed wings. Now this order is divided into two sections : in the one both sets of wings are of the same material and this is called Hemiptera-*Hom*optera ; in the other the anterior pair of wings is composed of a material different from that of the posterior one, and it is styled Hemiptera-*Heter*optera. It is with these latter that the work before us has to do. Although we cannot congratulate the authors upon their selection of a subject for investigation, still for this very reason we are bound to give them the highest praise for their exertions in adding to our knowledge of our insect fauna. Lepidoptera and Coleoptera have been carefully studied by several entomologists, but the Hemiptera remained undescribed by Englishmen. This was the less creditable to our insect-hunters, from the circumstance that upon the Continent the order has been carefully worked out by Fieber and Flor. Fieber's "Europaischen Hemiptera," published in 1861, is a masterpiece of natural history literature, containing as it does descriptions of all the European species, and being the result of the observations of a lifetime. The "Rynchoten Livlands" of Flor is also a most valuable treatise, worked out in a philosophic manner, but differing materially from Fieber's monograph. Fieber's analytic method presents some objectionable features, and Flor's numerous sub-genera are cumbrous and confusing ; but while the former is of great value from its comprehensiveness, the latter is equally worthy through the mode of classification it adopts. The plan of the Ray Society's volume is somewhat different from that of either of the foregoing. First, we have a separation of the group into divisons and sub-divisons ; these in their turn are split into sections, and then again into families ; then follow the genera and species. All the descriptions have been made from actual specimens, and the synonomy and localities are, so far as we can perceive, accurate. The descriptions are, of course, entirely technical, and hence the book is one which can only be employed for reference ; but for this purpose it must prove the

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* "The British Hemiptera. Vol. I. Hemiptera-Heteroptera." By John W. Douglas and John Scott. London : Published for the Ray Society by Robert Hardwicke. 1865.

only work, and from what we have seen of the diagnostic characters and the plates, we regard it as a treatise which no entomologist's library should be without. It may be useful to our readers to know how the authors preserve their specimens. The best method, they say, "is to fix them on stout card by means of gum tragacanth reduced to the consistence of paste by means either of dilute acetic acid, or of water in which a little oxalic acid or corrosive sublimate has been dissolved. Turn the insects on to a piece of white blotting-paper, sort them into species, cut the card into strips wider than the length of the insects, pin one strip to a piece of thin cork, and cover rather thickly with the gum as much space as will suffice for one insect, lift the specimen by means of a wetted brush on to the gummed card, and place its legs and antennæ quickly into their natural position, taking care not to force them and to lift the antennæ from the base." Messrs. Douglas and Scott promise to complete their history of Hemiptera by publishing a treatise on the Homopterous species.

THE PLANET SATURN.*

IT might be thought that a chapter in any astronomical treatise would be sufficient space to devote to the consideration of a single planet. Mr. Proctor, however, evidently does not think so, and has given us a beautiful monograph upon the ringed planet, well written, full of erudition, and containing some new and original views. A mere glance at his work is sufficient to show what attention the author has given to the subject; and although we think he now and then commits himself to opinions which he has not elaborated, we must confess that on those points which he wishes to prove he has brought an overwhelming mass of evidence to bear. His book is divided into two parts: 1st, that treating of the planet; and 2nd, a sort of appendix, in which we are treated to an account of the astronomy of the ancients, and to a description of some very recent astronomical phenomena. The author leaves the history of the discovery of Saturn pretty nearly as he found it, so that the date cannot be stated. The most interesting part of his book is that upon the constitution of Saturn's rings. These bodies he does not consider to be solid masses, but concludes, from a number of arguments we cannot here introduce, that they are composed of flights of disconnected satellites, so small and so closely packed, that, at the immense distance to which Saturn is removed, they appear to form a continuous mass. Mr. Proctor considers that this theory is further borne out by the existence of what is recognized as the "zone of meteorites," and by what is known as the zodiacal light, which theory supposes to be produced by a ring of minute cosmical bodies surrounding the sun. "The Planet Saturn" is well worth reading.

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* "Saturn and its System." By RICHARD A. PROCTOR, B.A. London: Longmans & Co. 1865.

THE WORLD BEFORE THE DELUGE.*

FANCY a handsome volume, full of beautifully-executed ideal illustrations, and no less fertile in errors of science, containing much useful instruction, conveying many absurdly-erroneous doctrines, and harmonizing Scriptural and scientific evidence, and you may see M. Figuier's book. It is likely to have a success, nevertheless, for its English version is clearly translated, and it is profuse in sensation pictures. So that a book is readable, is printed in agreeable type, and is studded with handsome plates on tinted paper, it matters very little now-a-days whether the views it puts forth be sound or not. Such at least is the only explanation we can offer of the fact —for fact it is—that bad books in good covers sell, and good books in bad ones very often do not. We cannot say that we are desirous of seeing works like those of which M. Figuier's is the type circulate very freely in this country. Our popular science has of late years attained to a very bad odour, and we believe it is entirely because of the publication of books which are said to be popular, but which are nothing but blundering expositions of true science. Scientific teaching should have two objects: the cultivation of the memory and observing faculties, and the development of a love of the beautiful in nature. Books like M. Figuier's cannot effect this entirely; teaching a mind to reason falsely is more injurious than not teaching it at all, and an inaccurate scientific work must either simply record facts or warp the reader's mind by leading him to false conclusions. Of the subject matter of the treatise before us we may say that it traces the world, from its first commencement as a nebulous mass, to its condition at the present day. The writer supports Laplace's doctrines, the incandescence theory, and the modified Biblical record of the deluge. There is too much space given to abstract considerations, and Cuvier's discoveries are dwelt upon so frequently that there is no room, apparently, for the mention of equally worthy observers. Not the least valuable of the author's speculations are those upon the future state of man. He considers that man will be succeeded by a "being yet more perfect. This new being religion and modern poesy would present in the ethereal and radiant type of the Christian angel, with moral qualities whose nature and essence would escape our perceptions—of which we could no more form a notion than a man born blind could conceive of colours, or the deaf and dumb of sound." We do not approve of M. Figuier's volume, and we should like to know why the translator's name is omitted from the title-page. Are we to attribute the introduction of the book to the enterprise of the firm which publishes it, or to the praiseworthy discriminating powers of the person who has given it an English garb?

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* "The World before the Deluge." By LOUIS FIGUIER. Translated from the Fourth French Edition. London: Chapman & Hall, 1865.

HOMES WITHOUT HANDS,*

THE earlier numbers of this the best work which Mr. Wood has yet written, received a favourable notice at our hands. The volume is now published in its complete form, and it is only just to say that it is one of the most interesting treatises on natural history which our language possesses. The author has conceived the happy plan of treating of animals according to the mode of construction shown in their habitations. We know of no previous work in which this scheme has been adopted, and hence we think that "Homes without Hands" is likely to become the book of reference upon the subject of the dwellings of animals. Of course, the great bulk of Mr. Wood's labours was that of the compiler, and therefore there is not much originality to be sought for or expected; but so far as the compilation is concerned, we think the writer has conscientiously discharged his duty to the public. We notice a few errors, but after all they are trifling ones when the whole merit of the work is taken into consideration. Mr. Wood has divided his subject into seven distinct parts. He begins with the simplest and most natural form of habitation, namely, a burrow in the ground. Then follows an account of those creatures that suspend their homes in the air. Next in order come the animals that are real builders, forming their domiciles of mud, stones, sticks, and similar materials. The fifth section includes those creatures which live mainly in communities; the sixth, those which are parasitic on animals or plants; and the seventh, those which build on branches. Under each of these divisions the animals are arranged in their proper zoological order, commencing with mammalia. Let us select examples from some of these groups. Until Dr. Bennet published his observations, we knew very little of the habits of the Ornithorynchus. Now, however, this creature's natural history is fully made out, and the following is Mr. Wood's account of its burrow:—"The duck-bill always makes its home in the bank of some stream. There are always two entrances to the burrow, one below the surface of the water and the other above. This latter entrance is always hidden most carefully under overshadowing leaves and drooping plants. When the grasses are put aside, there is seen a hole of moderate size, on the sides of which are imprinted the footmarks of the animal. From this the burrow passes upwards, winding a sinuous course, and often running to a considerable length. From twenty to thirty feet is the usual average, but burrows have been found where the length was full fifty feet, and where the course was most amazingly variable, bending and twisting about so as to tire the excavators." In this manner does Mr. Wood proceed to describe all the burrowing animals. Not confining himself either to the description of the habitations, he comments upon the habits and characters of the animal, so that his work is a vast comprehensive store of natural history knowledge. Here is an account of a spider

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* "Homes without Hands." By the Rev. J. G. Wood, M.A. London: Longmans & Co. 1865.

which lives in a sort of suspension home :—" A peculiarly beautiful pensile cocoon is constructed by a common British spider, scientifically termed *Agelena brunnea.* The cocoon is shaped rather like a wine-glass, and is always hung with the mouth downwards, being fastened by the stalk to a leaf or twig of gorse. It is very small, only measuring a quarter-of-an-inch in diameter, and when it is first made is of the purest white." We wish we had space to follow the writer in his descriptions of the nest-building habits of the sticklebacks, and of the homes of the beaver, the dormouse, and the bee. Pressure on our pages forbids our doing more than commending the volume to the attention of our readers, and assuring them that it will repay a careful perusal.

IRON SHIP-BUILDING.*

IN this book the author enters upon all the technical bearings of his subject, and yet has not surrounded his remarks by difficulties which cannot be overcome by any ordinarily intelligent reader. The portion of the book most interesting to the general public is that concerning the relative values of iron and wood in the construction of vessels of war. Mr. Fairbairn, though a well-known and enthusiastic advocate of the use of iron, in all forms of architecture, does not approve of vessels of such construction as the *Warrior.* He shows in the clearest manner that if we would build vessels capable of resisting our present ordnance, we should make them of such a thickness and bulk that they could not be managed in any but the calmest waters. He proposes not to dispense entirely with the armour-plates, but to apply them with careful attention to the more vulnerable parts of the ship, so as not to injure her sailing powers and other conditions necessary to the attainment of speed. This he thinks can be effected by a simple belt of plating, eight feet deep, that is four feet above and four below the line of floatation. We believe Mr. Fairbairn's suggestion is being carried out by the Admiralty, who are building, or intend to build four vessels plated upon the above plan ; or, as Lord Clarence Paget calls them, " an improved class of *Alabamas.*"

MODERN CHEMISTRY.†

DURING the last thirty years the science of Chemistry has been undergoing serious transformations. It has thrown off the shackles of hypothetical doctrines, and has burst the prison-walls of vague speculation. To-day it is no longer a collection of dry facts and ill-supported explanations, but is qualified to range amongst the exact sciences. Chemists of the present

* " Treatise on Iron Ship-building : its History and Progress." By W. FAIRBAIRN, C.E., F.R.S. Longmans & Co. 1865.

† " Introduction to Modern Chemistry, Experimental and Theoretic." By A. W. HOFMANN, LL.D., F.R.S. London : Walton & Maberly. 1865.

day no longer satisfy their minds with the theories of imaginative dreamers; but they search for facts, and prefer ignorance to questionable truth. A spirit of positivism has crept in among our philosophers of the laboratory, and the laws of their science are now only framed in accordance with demonstrated truths. In the little volume before us, which is a reprint of lectures delivered in the Royal College of Chemistry, the author—one of the leading members of the "new school"—advocates the unitary system of notation. The arguments for this are forcibly put forward by Dr. Hofmann, but are of much too lengthy and complex a character to be noticed here. Of the style of Dr.Hoffmann's composition we cannot speak very highly. The English is grammatical, but the sentences are constructed upon the German plan, and are very tedious reading. Such terms too as "crith," "chemism," "ponderal," "molar," "quantiquivalential," the fruit of the writer's inventive powers, might with advantage have been omitted. The author expresses his obligation to Mr. F. O. Ward for his assistance in preparing the volume, and alludes, in passing, to that gentleman's "known powers of lucid composition." If Mr. Ward is any way responsible for the elongated sentences and general character of sesquipedalianism which the book exhibits, we think Dr. Hofmann's comment more flattering than just. The book is an excellent one, but it requires simplification.

GEOLOGICAL TERMS.*

STUDENTS of geology are already much indebted to Mr. Page for his many useful treatises upon the science of the rocks. They have been helped over many a difficulty by his clear method of instruction and accurate statement of geological phenomena, and they will therefore hail with satisfaction the appearance of a new edition of his handbook of geologic terms. Although Mr. Page's book is essentially of the dictionary stamp, it is one which may be taken up at any time to refresh the memory upon the questions it treats of, and as the explanations of the technicalities of the science are written in a pleasing style, the subject is divested of much of the dryness which is characteristic of many books of reference. The work is divided into three portions : an opening series of tables, showing the present arrangement of existing and fossil species, the synonymy—English and foreign—of the several rock systems, and the relation of the various minerals ; a comprehensive dictionary of the terms used by geologists ; and a list of specific appellations in which the terminations indicative of gender are given. Of these three divisions, the first and last may be simply regarded as accessory, the volume deriving its entire character from the second. This latter, we consider has been well arranged ; the definitions are lucid and accurate, and the list includes even such recent words as *Eozoon*, etc. The specific appellations are a useful addition, and will save many an unclassical geologist from falling

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* "Handbook of Geological Terms, Geology, and Physical Geography." By DAVID PAGE, F.R.S.E. Second edition. Edinburgh : Blackwood & Sons. 1865.

into error. The only portion of the work which deserves censure is that in which the classification of the animal kingdom is given. This is a most heterogeneous conglomeration of what may be styled geologically "fossil" and "recent" views. We find the Echinoderms under both Radiata and Articulata. Volvox is called an animal; Anthozoa is made the equivalent of Cœlenterata; Cirrhopoda is separated from Crustacea; and the Hydra is put along with the sea-anemones. All these are glaring errors, which might easily have been avoided had the author submitted his proof-sheets to any one conversant with modern zoology.

CONTRIBUTIONS TO NATURAL HISTORY.*

A RURAL D.D. has in this volume put together a number of reviews written chiefly for the *Quarterly Journal of Agriculture.* He recommends us to look for new sources of food in fish and fungi, and is here and there facetious at the expense of men whom, in the absence of the author's name, we must consider his superiors. The several chapters of which the book is composed are written in that harem-scarem, funny style which *savants* of a certain class are wont to adopt when preparing literary side-dishes for the journalistic table. The book defies analysis, for it merely contains the matter of other treatises upholstered with the current small-wit and reflection of "periodical" critics. A little really nutritious matter drowned in *sauce-piquante* may be palatable enough to some, but we are more fatidious, and must confess that a Rural D.D.'s "Contributions to Natural History," as he modestly styles them, have afforded us neither pleasure nor profit. The chapter on the herring is the only one worthy of notice which the book contains. In it we find Mr. Mitchell's work reviewed, and its author as well abused as possible. A D.D. does not consider Mr. Mitchell to be an original observer, but regards him as a compiler. An opinion of this kind coming from an anonymous writer has its own insignificance but to those who are aware how valuable are Mr. Mitchell's numerous researches, it seems simply absurd. However, let the author of one of the finest zoological monographs which has yet been written take consolation; he travels in the same boat with Professor Huxley, who, in common with the other deep-sea fishery commissioners, is charged with "sanctioning a loose morality and reckless disregard for the future by no means to be encouraged." The following passage is the best example we can offer of the rational character of a D.D.'s argument:—"Having heard Professor Huxley arguing that the archetype of the human frame is that of the monkey, we presume that he at least will not be astonished if it be shown that the herring is merely a developed garvie." The volume has neither literary nor scientific merit, and save as a source of gratification to the author, we are at a loss to imagine why it was published.

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* "Contributions to Natural History, chiefly in Relation to the Food of the People." By a Rural D.D. Edinburgh: Blackwood & Sons. 1865.

SCIENCE-GOSSIP.*

JUST twelve months ago, a little, unpretending monthly journal stole quietly out from the printing-press. It bore no editorial name, did not thrust itself boldly before the public, and addressed itself simply to those amateur lovers of Nature's works who did not deem themselves worthy to be ranked among the *savants.* It was well conducted, abundantly illustrated, and full of accurate and interesting information, and need not have been bashful in asserting its worth. However, its modesty has been well rewarded; it has been favourably regarded by the working naturalists, and has become the recognised organ of the amateurs. The volume for the year is now completed, and bears upon its title-page the name of the man to whom it owes its development. Mr. Cooke has discharged his duties ably and discriminately; himself a professional botanist of great repute, he has not crushed his periodical by obtruding his own subject of pursuit, but has carefully studied the requirements of his readers, and has produced—and we say it conscientiously—the best popular natural history journal which has yet been published. The volume before us is a veritable storehouse of the records of natural phenomena. To give an account of its contents would be absolutely impossible in the space at our disposal, but we may safely aver, that it contains over a thousand articles, notes, and memoranda, relating to birds, mammals, fishes, reptiles, mollusks, insects, etc. Ample information will also be found in it upon the subjects of aquaria, herbaria, microscopes, and all the various apparatus with which the naturalist, properly so called, should be familiar. Each number of *Science-Gossip* consists of short articles, and notes and queries, and it thus fully carries out its promise of being a "medium of interchange of opinions for students and lovers of nature." We recognise in this new journal a worthy contemporary, and we wish it all the success it so eminently deserves.

Australia for the Consumptive Invalid. By I. BAKER BROWN, Jun. (London: Hardwicke, 1865). This is a cleverly-written little volume from the pen of one who speaks from practical experience of the country whose climate he treats of. It contains some very important hints in relation to the voyage out to, and life in, Australia. The various types of phthisis are considered in relation to the alteration of their symptoms by change of air. We do not agree with the author in thinking that no treatise setting forth impartially the advantages of the Australian climate has been published, but as his book is especially addressed to the general public, it holds a place in

* "Hardwicke's Science-Gossip for 1865." Edited by M. C. COOKE. London: Hardwicke. 1866.

its own branch of literature, and we have much pleasure in commending it to the careful perusal of our readers.

Philocalia. By WM. PURTON, M.A. (London : Whittaker, 1865). Mr. Purton strives to explain what poetry and art are. He adopts Aristotle's views, and supports them with much force. To us he seems to be correct in believing that both poetry and art are eminently imitative, and we confess that the following definition, which Mr. Dallas has given, appears very like well-expressed nonsense : Poetry is "*the imaginative, harmonious, and unconscious activity of the soul.*"

The Food, Use, and Beauty of British Birds. By C. O. G. NAPIER, F.G.S. (London : Groombridge, 1865), is a little volume with bad print, worse paper, and a very obscure photograph, illustrative of nothing in particular. The writer clearly estimates himself at no small mark. The matter of the book is sound, and embraces a variety of information relating to the food of British birds, which can hardly be found elsewhere. It is worth reading.

A Treatise on Solar Action. By THOMAS AYERS (Yarmouth : Nall, 1865). This is a curious little *brochure* embodying some of the more recent discoveries, and displaying a good deal of original thought and a few errors.

British Association Reports (Hardwicke, 1865). The Proceedings of the Birmingham meeting are here reported, and form a convenient volume for reference. This Report has the advantage of being published earlier than the official one, and of containing a much fuller report of the papers read.

The Magic Lantern. By A MERE PHANTOM (Houlston & Wright), will be found a most useful companion by those who employ the instrument either for amusement or instruction.

The Atlantic Telegraph (Day & Son, 1865). This beautiful volume shall be noticed in our next number.

Cholera Prospects, by TILBURY FOX, M.D. (Hardwicke, 1865). Dr. Fox was in Egypt during the epidemic of cholera which broke out in the spring of last year. He gives a most graphic account of the sanitary condition of the notorious cholera-haunts of Africa and Asia, and shows that the pilgrims to Mecca are the medium through which the disease is propagated. These worshippers of Mahomet he styles cholera-conductors. His pamphlet deserves to be read, and is indicative of the high claims which the author possesses to be ranked among our cholera investigators.

SCIENTIFIC SUMMARY.

ASTRONOMY.

The Sun's Photosphere.—The kind of solar observation set on foot by Schwabe and Carrington is now being employed in the most satisfactory manner by De La Rue, Stewart, and Lœwig, and the first series—"On the Nature of Sun-spots"—of their "Researches on Solar Physics," published early in December—and, let us add, printed at the expense of Mr. De La Rue —is a most important contribution to an important subject.

The authors have endeavoured to answer the following questions :—I. Is the umbra of a spot nearer the centre than its penumbra ? or, in other words, is it at a lower level ? II. Is the atmosphere of our luminary to be viewed as composed of heavy solid or heavy liquid matter, or is it rather of the nature of a cloud ? III. Is a spot, including both umbra and penumbra, a phenomenon which takes place beneath the level of the sun's photosphere or above it ?

Now with regard to I., we know that the sun has an atmosphere, and the effect of the refraction due to this atmosphere will be to lessen the apparent encroachment of the umbra upon that side of the penumbra lying nearest the centre of the disc, *if we suppose the umbra to be the lowest.* Still the encroachment will not be obliterated. 530 spots have been carefully examined from this point of view, and 456, or 86 per cent., are in favour of the assumption that the umbra is the lower stratum. With regard to II., it is held that faculæ—and probably the whole photosphere—consist of solid or liquid bodies of a greater or less magnitude, either slowly sinking or suspended in equilibrio in a gaseous medium. A table is given, which indicates that an obvious explanation of a large per-centage of faculæ being to to the left of the spots, is that they have been uplifted from the area occupied by the spot, and have fallen to the left from being thrown into a region of greater velocity of rotation. It is difficult in the present state of our knowledge, to grapple very successfully with III. ; but our authors are inclined to answer it in the affirmative. The concluding remarks of this memoir are of the utmost importance :—

"It would thus appear that the central part of a spot is nearer the sun's centre than the penumbra, and that both the umbra and the penumbra are probably beneath the general level of the surrounding photosphere. Now the umbra or lowest part of a spot is much less luminous than the general photosphere. But what does this probably imply, according to the laws with which we are acquainted ? It implies that in a spot there is probably some matter of a lower temperature than the photosphere. For is it not now recognized as a law, that if a substance, or combination of substances, of indefinite thickness and surface of small reflecting power have all its particles at a certain fixed temperature, this substance will give out nearly all the rays of heat belonging to that temperature? Now the sun, even when we look into a spot, is certainly a substance of indefinite thickness; and since a spot appears much less luminous than the ordinary surface, ought we not to conclude either that we there view matter of a lower temperature than the ordinary surface, or that the matter which appears within a spot has a very high reflecting power compared to the ordinary matter of the photosphere? This last supposition is an unlikely one, and the probability is that in a spot we view matter of a lower temperature than the photosphere. Presuming this to be the case, it appears to imply one of three things. (1.) Either the general body of the sun at the level of the bottom of a spot is of a lower temperature than the photosphere; (2) or the lower temperature is produced by some chemical or molecular process which takes place when a spot is formed; (3) or it is produced by matter coming from a colder region.

"The first of these suppositions will not be generally received, unless we are fairly driven to accept it.

"The second hypothesis has already been started to account for the lower temperature of a spot; but we think that, according to the laws by which we should be guided in receiving or rejecting an explanation in a case of this nature, this idea ought to be rejected.

"No doubt, if we knew of a case of the production of low temperature, and had at the same time an independent proof of some chemical or molecular process, such as evaporation, it would be quite allowable for us to associate the chemical or molecular process with the production of cold, as at any rate the most likely hypothesis; but we do not advance in our explanation of the low temperature by attributing it to an imaginary process, of the existence of which we have no proof, and which is equally mysterious with the phenomenon for which it is supposed to account. Rather let us see if this reduction of temperature can be explained by any other phenomenon of the existence of which we have independent evidence. This leads us to consider the third hypothesis, which supposes that the reduction is produced by matter coming from a colder region. Now, in the first place, we have such a region in the atmosphere above the photosphere, which we have shown to be of a lower temperature than the photosphere itself. Again, the observations of Chacornac and Lockyer on the behaviour of the matter surrounding a spot appear to suggest the existence of a downward current, which is therefore a current from the colder regions above. On the other hand, the proper motion of spots observed by Carrington is in favour of this hypothesis, since a current coming from a region of greater to a region of less absolute velocity of rotation would be carried on forward, and most so nearest the equator; and this is precisely the motion of spots observed by Carrington. Again, we have seen that the faculæ fall behind; so that we may imagine two currents to be engaged in the formation of a spot—the one an ascending current carrying the hot matter behind, the other a descending current carrying the cold matter forward. One advantage of this explanation is *that all the gradations of darkness, from the faculæ to the central umbra, are thus supposed to be due to the same cause*—namely, the presence, to a greater or less extent, of a comparatively cold absorbing atmosphere . . . . . .

"In conclusion, we would venture to suggest that if the photosphere of the sun be the plane of condensation of gaseous matter, this plane may be found to be subject to periodical elevations and depressions in the solar atmosphere. It may be that at the epoch of minimum spot-frequency this plane is uplifted very high in the solar atmosphere, so that there is comparatively little cold absorbing atmosphere above it, and therefore great difficulty in forming a spot. If this were the case, we might expect a *less* atmospheric effect or gradation of luminosity from the centre to the circumference at the epoch of minimum than at that of maximum spot-frequency."

The important observation made by Lockyer, above referred to, has been confirmed by Secchi and Brodie, whose paper, printed in the last number of the "Monthly Notices," describes an almost identical phenomenon. We think, therefore, that it is not premature to look upon the down-rush and consequent melting of masses of photospheric matter into a spot as established; with this a most important point is gained. Here we have a field of observation opened out to those who have large telescopes surpassing immeasurably in interest anything belonging to the willow-leaf controversy.

We must now refer to other solar observations made in the southern hemisphere.

The *Bulletin International* for Dec. 12 and 13 contains a communication from Father Secchi, detailing the observations made by Father Cappelletti at La Conception, on the total eclipse of April 15 of the present year. Following the example set by Mr. De La Rue in the famous Spanish eclipse, Father Cappelletti set himself the task of photographing the red protuberances. Unfortunately, however, a mist rendered these attempts unsuccessful; but the eye observations were of the greatest interest. The first appearance observed after the commencement of the totality was that of an immense fiery mountain, of a rose colour, in shape like a horn. This prominence was observable for 2 min. 22 sec. Almost diametrically opposite to this there was a smaller one, similar in form, but clearer in colour. The former was estimated at 2 min. 40 sec. and the latter 2 min. in height. After 38 seconds there appeared a series of rose-coloured flames, as if the sun were on fire, and which fired in succession like a train of powder. The light of these was very vivid.

A rainbow in form of a crescent, some 30 deg. from the sun, its extremities resting on a tangent to the lower limb of the sun, was also observed.

When the sun was obscured, three faculæ of light were observed in a direction normal to the edge of the moon. One of them was so bright, that the eye could scarcely bear to look upon it in the telescope.

We now know, thanks to Mr. De La Rue's photographs, and the investigations of the Astronomer Royal, that the words "apparent diameter of the moon" mean very much more than is ordinarily assigned to them. Time out of mind, the "new moon," which carries the "old moon" in its arms, has been looked upon as a larger fellow, but it did not strike us that this effect of irradiation would be perpetuated in our telescopes. This, however, is the case, as has been recently proved by measuring the *dark moon*—a feat of observation rendered possible, we may remind the reader, in solar eclipses and occultations of stars at the dark limb.

The Astronomer Royal's result is, that the moon's angular diameter hitherto received is too large by 2″; Mr. De la Rue's that it is too large by 2·15″. This quantity must be looked upon in its entirety as a telescope fault, or we must attribute part of it to the effect of the lunar atmosphere. The Astronomer Royal remarks that if the whole be attributed to such a cause, it would imply a horizontal refraction of 1″, or about $\frac{1}{2000}$ of the earth's. This would indicate an atmosphere discoverable in no other way. But Luna may console herself; she is to have a beautiful map. At the last meeting of the Lunar Committee of the British Association, it was decreed to prepare at once a skeleton map 100 inches in diameter, from Mr. De la Rue's photographs, reduced to a state of mean vibration; and this map is to be served out in zones of 1° wide to all who will promise to help forward the complete work.

The mention of Mr. De la Rue's photographs reminds us that Mr. De la Rue now generously confesses himself beaten by Mr. Rutherford in the matter of lunar photography, a night of surpassing definition having enabled the American physicist to secure a faultless negative.

Mr. Dane's admirable drawings of Mars are to appear in the Monthly Notices for January.

The small planets now number 85, the discovery of one of 9½ mag. having been made by Mr. James Watson, of the Ann Arbor observatory, on the 9th October.

To come to Comets, those of Biela continue to elude too many of our observers, in spite of Mr. Bishop's widely-circulated ephemerides. It appears probable that the lines of perihelion passage of the two Biela comets in 1866 will fall on January 27 and January 29, or nearly so, G. M. T. It would seem that they have considerably changed in brightness.

In the *Comptes Rendus* for 27th November, M. Liais returns to the question of the earth's passage through the tail of the comet of 1861. His examination of the problem is conducted very carefully, and his results are as follows:—

"The breadth of the comet's tail, judging from the angle of 3° 30′, which it subtended on June 19, was equal to the fraction 0·02334252 of the earth's orbit, or 878,000 French leagues (of 4 kilometres). The distance of the earth from the point of contact between its orbit and the axis of the tail at my station, Rio Janeiro, at 6h. 12m. 10s., on June 30, in the morning, was equal to 0·0087598 of the same radius. As the angle between the paths of the earth and comet was almost a right angle, 91° 2′ 54″, the distance of the earth from the axis was therefore 329,000 French leagues. Thus, at this moment the tail inclosed the earth, which was plunged into it to the depth of 110,000 leagues."

We learn from the Anniversary Address delivered by the President of the Royal Society, that the good people of Melbourne, although they have rejected Mr. Lassell's 4-feet speculum reflector, are still to have a reflector by Grubb, of Dublin. We venture to think that this decision will yet be regretted. The reflector is, we believe, to cost £5,000. Mr. Lassell's, although, *teste* Struve, is no better than the Poulhower 16-inch refractor, is doubtless as good as, in the nature of things, Mr. Grubb's will be. Now a speculum has two unfortunate habits; it has a tendency to bunch stars into "cocked hats," as was said of one of Herschel's best mirrors, and it lines on polishing. Now we know of no De la Rue, or Lord Rosse, or Lassell, or Grubb, in Australia, to supply the necessary pabulum ; and as to the expense, we believe that the 25-inch refractor, now nearly completed by Messrs. Cooke and Sons, will cost less money.

And now one word about small telescopes. We think it our duty to enter our protest against much that has lately been written on the subject of Steinheil's new telescopes constructed on the Gaussian system, which has recently formed the subject of an interesting address to the Astronomical Society, by Mr. Pritchard.

It may be that the new form of telescope does nearly as much as the English one does ; but that it does so much as the English form in the hands of such artists as Cooke and Dallmeyer, in the absence of evidence, we do not believe. Besides, the new form bristles with adjustments, and all tried observers with alarm look upon its much-belauded short focal length as a positive bane. There is no power so genuine as that which results from focal length, and simply because the defects of the image are reduced to a minimum. When Dr. Steinheil produces a $3\frac{3}{4}$ which shows the sixth star on the trapezium, as one of that size by Cooke has done, and a $4\frac{1}{3}$ which will elongate as one of that size by Dallmeyer has done, and when, moreover, his object-glasses require as little adjustment, then we will acknowledge that the Gaussian form is as good as the English one—but not till then.

Geodesy is really making important strides and attracting marked attention on the Continent. At the fourth meeting of the Swiss Geodesical Commission recently held at the observatory of Neufchatel, under the presidency of General Dufour, much good work was reported. The first meeting of the Italian Commission was held at Turin in June, General Ricci occupying the chair.

It is intended to measure chains of triangles along three meridians and three parallels ; the former being on the prolongation of those chosen by the conference of Berlin. It will also be attempted to connect Sicily trigonometrically with Africa. The local disturbing causes in Italy, due to volcanoes, &c., will necessitate a large number of astronomical determinations.

The President of the Royal Astronomical Society will hold a soirée at Willis's Rooms, on January 17, at 9 p.m.

BOTANY.

The Rat-tail Radish.—At the meeting of the Edinburgh Botanical Society, held on the 9th of November, Mr. McNab presented specimens of this plant (*Raphanus caudatus*) grown in the open air. The seeds were received from Mr. William Bell, superintendent of the Botanic Gardens, Saharunpore, in April, 1865, under the vague name of "Radish three feet long." These were dibbled into a piece of ground, and covered with a two-light frame. They very soon commenced to grow, so that the glazed frame had to be removed. Seven weeks after being sown, they flowered profusely, and numerous seed-vessels of a purplish-green colour were produced. These went on elongating till many of them had reached the length of 2 feet 9 inches, each plant bearing from 18 to 20 long tapering snake-shaped seed-vessels. In the young state the seed-pods may be used like the ordinary cultivated ground radish, as they possess a peculiar pungent taste. They will also be found useful for making up mixed pickles, &c. About eight years ago seeds were received from Madras under the name of "Rat-tail radish, *Raphanus caudatus*," with seed-pods 8 inches long. This variety produces seeds freely, and is annually grown in the garden ; it possesses the same pungent taste as the long-fruited plant. The large radish is very hardy, as both flowers and fruit were found on it in the open air as late as 9th November, 1865. Independent of the various culinary purposes to which this radish may be turned, it is of itself a great vegetable curiosity. If the seed is sown singly, and each plant is tied upright, the fruit will, when matured, be found hanging all round—sometimes perfectly straight, at other times assuming contorted forms. This contortion is most perceptible at the period when the seeds are swelling. At no state of their growth does either of the varieties show the slightest tendency to produce the radish underground.

Plants within Plants.—In one of the recent numbers of the *Comptes Rendus*, M. Trécul gives an account of some curious observations, showing that plants sometimes are formed within the cells of existing ones. He considers that the organic matter of certain vegetable cells can, when undergoing putrefaction, transform itself into new species, which differ entirely from the species in which they are produced. In the bark of the Elder, and in plants of the potato and stone-crop order, he found vesicles full of small tetrahedral bodies containing starchy matter, and he has seen them gradually transformed into minute plants by the elongation of one *of their* angles.

De Candolle's Prize.—The Physical and Natural History Society of Geneva will next year award De Candolle's botanical prize of four hundred francs for the best essay upon a genus or family of plants. Memoirs must be sent in not later than the 1st of July, 1866. The ordinary members of the Society will not be allowed to compete. The Society reserves to itself the right of printing in its memoirs the successful essay.—Vide *The Reader*, Dec.

The Vitality of Yeast.—On this subject a very important paper has been read before the French Academy by M. Trécul. The author differs from most physiologists in supposing that the phenomena of fermentation are not due simply to a sort of catalytic action of the yeast, but depend simply upon the nutritive processses of this vegetable. He washed and washed globules of yeast until they appeared to be mere envelopes of cellules, and found that they still retained the power of changing cane-sugar into glucose, and setting up the alcoholic fermentation, which proves, he considers, that the property of setting up fermentation resides in the living cellule, and is a consequence of the act of nutrition of this cellule.

Vegetable Parasites.—In a paper reead before the Microscopical Society (November 8th), Mr. Jabez Hogg showed that these vegetable growths do not produce disease, but are developed because the diseased part supplies the conditions requisite for their growth. He believes that the diseases in which the vegetable parasites appear are always associated with neglect of person, dirt, bad air, want of light, and deficient nourishment; that the spores of fungi are always floating about in the atmosphere, and are thus ever ready to be deposited and take root in a favourable soil; of this Mr. Hogg gave many illustrations, and showed that although yeast, *penicillium*, *aspergillus*, and some other well-known fungi, had been separately classed, that nevertheless they could be made to pass through the same changes, and produce ferments that could not be recognized one from the other; and, therefore, difference of form he believed to be entirely due to the soil or nourishment supplied, and dependent on such circumstances as whether the growth of the fungi takes place in a sickly plant, a saccharine solution, or an animal tissue.

The Function of Leaves.—M. Boussingault has contributed some very valuable essays upon the physiological office of the leaves of plants. His first series of experiments enabled him to conclude that vegetable essential oils exert no deleterious influence on leaves, except oil of turpentine, which diminishes the carbonic acid decomposing power of oleander leaves. His second series of observations shows us the action of mercurial vapour. When leaves are placed under a glass bell with their peduncles immersed in mercury, it would appear that they are completely deprived of their power of decomposing carbonic acid; but when the leaves are not directly in contact with mercury, but still exposed to the metallic vapour, the decomposing power is lessened, but not completely destroyed. The foregoing experiments were conducted in the light; but the author has proved that leaves kept in the dark in contact with mercury transform quite as much oxygen into carbonic acid as a leaf similarly placed in confined air will when not in contact with mercury. M. Boussingault next describes how he collected the gases evolved from the branch of an oleander still attached to the plant. The gas escaped from the branch at the rate of 3·3 c.c. per hour, and in twenty-three hours there were collected 76·93 c.c. of a mixture having the following percentage composition:—Nitrogen, 88·01; oxygen, 6·64; carbonic acid, 5·35. This gas, the author says, is similar in composition to that confined in strongly manured soil. On reaching the leaves with the sap, it only brings carbon to the vegetable organism, or, as the author said at the commencement of his memoir, carbonic oxide, hydrogen resulting from the simultaneous decomposition of carbonic acid and water.—Vide *Comptes Rendus*, Oct. 23rd.

Spiral Vessels.—According to the inquiries of M. Lestiboudois, air, or even fluids capable of solidification may be present in the tracheal tubes: in one instance he found one of the vessels in the centre of the fibres of *Calamus Rotang* filled with a peculiar white substance, arranged in a cylindrical manner, and which, when placed in water, became converted into granules, which exhibited rapid movement.

An International Botanical Congress will be held in London next May, under the presidency of M. de Candolle. Papers intended to be read should be sent in before March next to Dr. Seemann, 57, Windsor Road, N., who is the Honorary Secretary. The congress will be restricted to two morning meetings, and the papers will be accompanied by translations.

An Australian Poison Plant.—In one of the numbers of the "Proceedings of the Royal Society of Victoria," Mr. F. Müller gives an account of this plant, the *Gastrolobium grandiflorum*. This plant, which has proved so detrimental to herds and flocks, is a bush several feet high, bearing orange-coloured flowers. Mr. Müller gives the following account of it:—J. Macdouall Stuart, the famous explorer, brought the first specimens from Attack Creek, south of Arnhem's Land. It is to be feared that the plant has a wide range in tropical Australia (though it was not met with on the route of the expedition to which I was attached). To some extent the occupants of territory in which it occurs may, however, guard against this bane, since the plant has become widely known; nor is it unlikely that it may be extirpated by setting fire repeatedly to the scrubby ridges on which it grows. *G. grandiflorum* is the only species of the genus as yet found beyond South-West Australia, where several congeners (*G. bilobum*, *G. calycinum*, *G. callistachys*, *G. oxylobioides*), on account of their poisonous properties, render extensive tracts unoccupiable. On a future occasion I shall have to enter on detailed statements of the effects of the *Gastrolobia* on the animal frame, give the results of their chemical analysis, and refer to the highly deleterious effect of the *Swainsonia Greyana* (which, as a pasture herb on the Darling flats, frequently causes the death of horses during dry seasons, when other herbage fails), as well as to the deadly effect of the *Lotus australis* on sheep.

The Pollen Grains of Ranunculus.—Professor Gulliver gives the following as the results of his measurements and observations of the pollen grains of Ranunculus:—*R. auricomus*, pollen grains round and smooth, and $\frac{1}{800}$ of an inch in diameter; *R. acris*, pollen grains round and smooth, and $\frac{1}{840}$ of an inch in diameter; *R. repens*, round and smooth, and $\frac{1}{866}$ of an inch in diameter; *R. bulbosus*, round and smooth, and $\frac{1}{727}$ of an inch in diameter; *R. hirsutus*, pollen grains smoothish, with three depressed scars, and $\frac{1}{888}$ of an inch in diameter; *R. arvensis*, pollen grains round, rough, and so much larger than those of the other species as to measure $\frac{1}{470}$ of an inch in diameter. The roughness remains when the pollen grains are heated either with dilute acids or water.—Vide *Microscopical Journal*, No. XX.

The Process of Fructification in the Sphæriæ.—Herr Sollman thus describes one of the processes of fructification in this low order of plants:—Eight membraneless bodies (cytoblasts) are developed in the ascus, either by free cell formation, or by division, but probably by the former. These bodies have a smooth surface, and become elongated in the direction of the longitudinal axis of the ascus. Thus they become first roundly elliptical, and at last elongate-elliptical. Up to this time they have no spiral membrane. At this stage the spermatia attach themselves by one end firmly to the surface of the cytoblasts. At the point where the spermatium attaches itself, the surface of the young spore gradually disappears, and the pole of the spermatium thus at last comes into contact with the contents of the spore. The spermatia come from all directions, and attach themselves firmly all over the surface of the young spore. The portion of the spermatium which penetrates the spore remains visible within it for a considerable time. Ultimately, the spermatia make their way *into* the spore, and the edges of the openings through which they have entered unite, leaving the surface of the spore with slight elevations at the points of entry. As the spermatia get deeper into the spore, these elevations disappear, and the surface becomes even. The spore is now for the first time surrounded by a double-outlined membrane. By degrees the spermatia become disintegrated, and are no longer visible in the contents of the spore.

CHEMISTRY.

Does Ozone exist in the Atmosphere?—Admiral Berigny put this question seriously to the Academy of Sciences at its meeting on Nov. 27th. This gentleman has been led, after ten years of ozonometric observations, to doubt the existence of ozone properly so called in our atmosphere. He therefore asks the Academy to appoint a commission in order to decide definitively, (1) whether ozone exists in the atmosphere; (2) whether Schönbein's or anybody else's papers prove the presence of electrized oxygen; and, lastly, whether an easy and reliable method of detecting it could not be devised. The Academy appointed a commission, composed of Chevreuil, Dumas, Pelouze, Pouillet, Boussingault, Le Verrier, Valliant, Frémy, and E. Becquerel, whose report will, no doubt, scatter popular notions on atmospheric ozone to the winds. To say the truth, the evidence in favour of the presence of ozone in the atmosphere is, as M. Frémy showed to the Academy, of the most doubtful character. M. Frémy said that he knew of only one certain test for ozone in the air, and that was the oxidation of silver, by passing a current of moist air over the metal; and this test he had applied many times without obtaining any indication of ozone. We are very far from being acquainted, he said, with all the bodies held in suspension in the air, and, consequently, ignorant of the action they may exert on iodide of potassium. May not, he asked, this salt become alkaline, or set free iodine under other influences besides that of ozone? He did not deny the fact of its presence, but he asked a positive proof of it. Such a proof is required; for seeing that ozone is instantly destroyed by organic matters, and absorbed by nitrogen, it is difficult to understand how such a body can continue to exist in the air, which contains precisely the elements which would at once change the ozone. As regarded the test-papers, he asked, what use there could be in a re-agent which was affected not only by ozone, but by the oxygen compounds of nitrogen, by oxygenated water, by ammonia, by formic acid, by essential oils, by the acid products of combustion, by dusts—in a word, by all sorts of things which are held in suspension in the air.—Vide *Chemical News*, December.

Formation of Nitrous Acid from Ammonia.—It is well known that ammonia is decomposed by permanganate of potash, and nitrogen evolved. It does not, however, appear to have been hitherto observed that a good deal of nitrous acid is formed at the same time. If the decolourized solution is filtered from the precipitated hydrated peroxide of manganese, and slowly evaporated to dryness, a mixture of carbonate and nitrite of potash is obtained. Abundant red fumes of nitrous acid will be evolved from the residue on the addition of an acid. W.—*Annal. der Chem. und Pharm.*, November, p. 256.

Detection of Antimony in Tube Sublimates.—A method for the detection of antimony under the above conditions, when the operator has only access to a portable blowpipe, is given by Professor Chapman, of Toronto. It is as follows:—The portion of the tube to which the chief part of the sublimate is attached is to be cut off by a triangular file, and dropped into a test-tube containing some tartaric acid dissolved in water. This being warmed or gently boiled, a part at least of the sublimate will be dissolved. Some bisulphate of potash—either alone or mixed with some carbonate of soda and a little borax, the latter to prevent absorption—is then to be fused on charcoal in a reducing flame; and the alkaline sulphide thus produced is to be removed by the point of the knife-blade, and placed in a small porcelain capsule. The hepatic mass is most easily separated from the charcoal by removing it before it has had time to solidify. Some of the tartaric acid solution is then to be dropped upon it, when the well-known orange-coloured precipitate of SbS_3 will at once result.

The Volatile Hydro-carbons.—In a very important essay published in the Memoirs of the American Academy, Mr. C. M. Warren has endeavoured to prove the following serious statement:—

1. That coal-tar naphtha contains only four hydro-carbons within the range of 80° to 170°, as taught by Mansfield and confirmed by Ritthausen.

2. That the benzole series within that range of temperature is limited to four members, and, therefore, does not contain five, as generally supposed.

3. That these four members have the boiling-points 80°, 110°, 140°, and 170° respectively; and, consequently, that the boiling-point difference in this series for an elementary difference of C_2H_2 is 30° instead of 22° and a fraction.

4. That the body obtained from coal-tar naphtha is not identical with cumole from cuminic acid, as assumed by Mansfield, nor even isomeric with it; but that it has the formula which has been assigned to xylole, containing C_2H_2 less than that of cumole.

5. That the body obtained from coal-tar naphtha boiling at 170° is quite a different body from cymole from oil of cumin, these bodies differing from each other by C_2H_2.

6. That cumole from cuminic acid, and cymole from oil of cumin, do not even belong to the benzole series.

7. That the parabenzole of Church was in all probability only a mixture of benzole and toluole.

The Preparation of Lime for Organic Analysis.—A useful method has been described by M. Fausto Sestini, who impregnates the purest statuary marble with a thick syrup and then burns it. When the lime is causticised, he makes thin milk of lime in which any carbonaceous matter deposits. He then collects the lime on a filter, and washes well to remove any sulphide of calcium which may have been formed from sulphate in the marble. He then dissolves the lime in nitric acid, precipitates with carbonate of ammonia, and again burns the carbonate into quick lime. He thus obtains lime quite free from chlorine and sulphuric acid, and so adapted for use in the analysis of organic bodies containing chlorine.—Vide *Zeitschrift für Anal. Chemie*, part I. vol. IV.

Manufacture of Arsenic Acid.—M. Gerardin's method consists in suspending powdered arsenious acid in water, and passing chlorine into the mixture, by which means he obtains a clear solution of arsenic acid in solution in hydrochloric acid. By evaporating this solution, a mass of arsenic acid containing no trace of arsenious is procured. As it is difficult to keep any considerable amount of arsenious acid in suspension in water, the author finds it better to make a saturated solution of that acid in hydrochloric, and pass the chlorine into such solution while hot. The stream of chlorine is stopped when a little of the fluid neutralized with potash no longer gives a green precipitate with bichromate of potash; thus showing that all the arsenious acid has been converted. The hydrochloric acid may then be recovered by distillation, and the syrupy solution of arsenic acid left in the retort evaporated.—Vide *Chemical News.*

The Nature of White Phosphorus.—The researches of M. Baudrimont tend to prove that white phosphorus is neither a hydrate nor an allotropic condition of the ordinary element; that it does not result from a devitrification of transparent phosphorus, but that it is simply ordinary phosphorus corroded on the surface by the action of air dissolved in water,—a slow combustion, which is accelerated by the action of light, and ceases when all the oxygen is removed. M. Baudrimont has found that phosphorus covered with a white crust lost very little in drying, while a stick of transparent phosphorus exposed in distilled water lost weight as it became covered with the crust. If the crust had been a hydrate, an increase of weight would have been observed. On becoming covered with the crust, phosphorus loses none of its properties; its solubility and fusion-point remain exactly the same, and it is as readily transformed into red phosphorus. Hence it would appear that nothing like an allotropic difference is observable. Lastly, it is shown that water deprived of air and oxygen has no effect on semi-transparent phosphorus, while other specimens kept in water containing air, and often renewed, become covered with the white crust, the water becoming acid from the formation of phosphorous acid.—Vide *Comptes Rendus*, Nov. 13.

Cheap Mode of Producing Oxyyen.—The ordinary methods of obtaining oxygen are attended with so much expense that chemists will gladly learn that a new method for the production of this gas upon a large scale has been spoken of. Indeed a company has been started in Paris for the purpose of supplying oxygen at the rate of about threepence per cubic foot, which is hardly a fiftieth of the present cost. The oxygen is obtained by acting on sulphate of lime with silex in a furnace of peculiar construction, the results being silicate of lime, sulphurous acid, and oxygen—

$$Si_2O_3 + CaO,SO^3 = CaO,SiO_3 + SO_2 + O$$

The gaseous mixture is conducted into a chamber, where it is exposed to a pressure of three atmospheres, which liquefies the sulphurous acid; the oxygen is purified by transmission through lime-water, and then compressed.

How to test Otto of Roses.—A method is suggested by Hagar, which consists in mixing five drops of the suspected oil with twehty drops of concentrated sulphuric acid. Whether the oil be adulterated or not, a thick yellowish-brown or reddish-brown mixture results. When this mixture is cold, it is shaken up with three drachms of absolute alcohol. If now the otto is pure, a tolerably clear yellowish-brown solution results, which, after heating to boiling, remains clear; but if the otto is adulterated with geranium, palm-rose, or pelargonium oil, the solution remains very cloudy, and in some cases a darker fluid separates, in which a deposit forms. On heating this solution, the sediment melts together, and from the size of the mass the author infers the degree of adulteration. If, for example, the mass has one-fourth the volume of a drop, he concludes that the otto was mixed with at least one-third of foreign oil. If the otto is adulterated with spermaceti, this substance separates and floats on the surface of the solution, or remains suspended in the liquid as a scaly crystalline mass. The above test is founded on the circumstance that pure otto of roses forms, with strong sulphuric acid, a resinous substance, which is completely soluble in absolute alcohol; while the substance formed with other oils is only partially soluble. Guibourt has observed that the odour of pure otto is not affected by mixture with strong sulphuric acid, but if other oils are present a disagreeable odour is developed—*Zeitscht. für Analyt. Chem.*, No. 4, p. 479.

The Chemistry of the Development of Silkworms.—An interesting note on this subject has been presented to the French Academy by Pelouze. His experiments related chiefly to respiration, and have enabled him to draw the following conclusions:—1. The development of the larvæ is accomplished by the transport and assimilation of part of the nitrogenized matter of the mulberry leaves. As the chemical composition and anatomical structure are probably the same throughout this stage of the rearing, in the worm just born and in the worm arrived at maturity, the phenomena of nutrition are equally the same during the various phases of the growth of the larvæ. 2. The results of the analyses prove a considerable loss of carbon, which is found as carbonic acid in the air expired by the insect. The amount of carbonic acid shows that in order to fix 100 parts of carbon from the leaves the worm consumes from 40 to 50 other parts, which are transformed by respiration into carbonic acid. Regnault and Reiset have already remarked that the respiration of the silkworm is more active than that of most of the animals upon which they experimented. 3. There does not appear to be any exhalation or fixation of nitrogen during the development of the silkworm. 4. The analyses prove a loss of hydrogen that seems to correspond to a loss of oxygen, which points to the conclusion that some of the alimentary substance disappears in the form of water.—Vide *Comptes Rendus*, Nov. 20.

A new body intermediate between Nitric Acid and Ammonia.—In the course of a discussion on a paper read at the Birmingham meeting of the British Association, Section B, by Dr. Calvert, "On the Action of Acids on some Metals and Alloys," Dr. Hofmann asked Professor Calvert whether, in his experiments on the action of acids, and more especially of nitric acid, upon the metals, he had met with some of the extraordinary bodies lately observed by Dr. Lossen. This young chemist, at one of the late meetings of the Berlin Academy, had laid before that body an account of several substances which had attracted general attention. It was well known that among the products of the action of nitric acid upon certain metals ammonia invariably occurred. But it appeared that ammonia was only the last product of the reaction, and that a whole series of intermediate compounds existed. One of these bodies Dr. Lossen had succeeded in isolating. It was a compound which, from its composition, might be termed protoxide of ammonia, having, in fact, the formula H_3NO. This substance, like ammonia, combined with acids, producing a series of magnificent salts, remarkable for the facility with which they crystallize. The simplest method of producing this interesting compound, consisted in submitting nitrate of ethyl to the action of metallic zinc in the presence of an acid. It would be observed that the derivation of the new body from nitric acid was perfectly analogous to that of aniline from nitrobenzol.

Nitrobenzol.	Aniline.
$C_6H_5NO_2$	$C_6H_5NH_2$
Nitric acid.	Hydorylamine.
HO,NO_2	HO,NH_2

The new body might be looked upon as ammonia, in which one atom of hydrogen is displaced by what might be called the residue of water, the atomic group HO, which by some had been called hydroxyl, by others hydoryl.

Ammonia.	Hydorylamine.
$\left.\begin{matrix} H \\ H \\ H \end{matrix}\right\} N$	$\left.\begin{matrix} HO \\ H \\ H \end{matrix}\right\} N$

It was certainly interesting to see the simplest of reactions, familiar to every chemist, still yielding a harvest of such splendid results.

Action of Potassium on Gun-cotton.—Some curious facts relating to the action of the alkaline metals on gun-cotton have been pointed out by Mr. W. S. Scott. In some of his recent experiments he accidentally dropped a piece of potassium upon some gun-cotton lying upon his laboratory table, and was surprised to see that the gun-cotton immediately exploded. He then instituted a series of researches to determine what conditions were necessary for the explosion to take place—whether the phenomenon was the result of moisture; whether other metals would act similarly; &c. He found that, notwithstanding all his precautions to prevent friction, the gun-cotton still exploded. When sodium was employed, a like result followed, though the gun-cotton had been rendered perfectly anhydrous. When an amalgam of sodium and potassium was used, no apparent result was produced. Various other metals were experimented with, but decided effects were obtained only with the metals of the alkalies. One of Mr. Scott's discoveries is the fact that when metallic arsenic is mixed with gun-cotton, a blow of the hammer is sufficient to ignite it.

GEOLOGY AND PALÆONOTLOGY.

The Fossils of the Hoyle's Mouth Cavern.—In a letter to the *Geological Magazine*, Mr. H. H. Winwood describes his explorations of the "Hoyle's Mouth Cave," near Tenby. In one of the furthest chambers from the entrance, he found, beneath a mass of undisturbed breccia, the right and left thigh-bones, the hip-bone, some vertebræ, and other relics of the great cave-bear: these were extracted in a very perfect state. Near them were the radius of *Hyæna spelæa*, and several loose bones and teeth of the fox, deer, and ox. In one of the passages leading from this chamber he discovered fragments of bones and an incisor of the hyæna; also, in the breccia the bones of some large bird, and what is of special interest, a worked flint, apparently of the barbed type. All these remains were below the level of the old stalagmitic floor.—Vide *Geological Magazine*, October.

The Royal Society's gold medal was awarded at the anniversary meeting, to Joseph Prestwich, Esq., F.R.S., for his valuable researches in the Quaternary deposits of France and England, the results of which have already appeared in the *Philosophical Transanctions.* The Quaternary deposits are those in which the remains of pre-historic man have been so abundantly found, and Mr. Prestwich's inquiries have done much to show their relation to the question of man's antiquity.

The Maltese Bone Caves.—At the Birmingham meeting of the British Association, Dr. A. L. Adams and Mr. Busk presented a paper on this subject. There are two caverns in the island of Malta, one in the south-east, and the other in the centre of the island, in which remains had been found ; in the latter the remains being those of the elephant, and in the former chiefly of the hippopotamus. Recently another cave on the south coast, and not 100 yards from the Phœnician ruins in that part of the island, had been discovered, and Capt. Spratt had found in it some remains, after which Dr. Adams proceeded with the further exploration of the cavern, resulting in the discovery of relics which proved that that part of the surface of the earth which now constituted the island of Malta was once the home of two species of pigmy elephant and one species of elephant of the size now existing. The island would not now yield a month's food to many individuals of even one speeies of elephant ; therefore it must at one time have joined to the opposite coast of Africa ; and in this opinion the authors of the paper were supported by other considerations.—Vide *Hardwicke's Report of the Proceedings of the British Association*, 1865.

A fossil spider, which was found in a piece of shale from the "coal measures" of Upper Silesia, has been described by Professor F. Römer. The specimen is beautifully preserved, and shows not only the four pairs of feet, with all their segments and the two palpi, but even the coriaceous integument of the body, and the hairs attached to the feet The interest in the discovery of this fossil lies in the fact that hitherto spiders have not been known from any rocks older than the Jurassic, and that now their existence in the Palæozoic rocks is satisfactorily proved. From the resemblance to the recent genus *Lycosa*, and its occurrence in the coal measures, the new species has received the name of *Protolycosa anthracophila.*

A cetacean vertebra which had been discovered in the valley of the Don, in Yorkshire, was exhibited by Mr. Hardy, at the meeting of the Manchester Philosophical Society, held on the 28th of November. The bone was met with in excavating, at a depth of 14 feet below the surface of the ground, in a bed of gravel overlaid by the alluvium of the valley. In answer to questions put by Messrs. Binney and Hull, Mr. Hardy described the bone as one of the lumbar vertebræ of a species of whale, probably identical in genus with the Balæna of the present seas. The bone measured on its largest diameter a little over ten inches, in thickness seven inches, and in circumference about three feet. It presented every appearance of having lain in the earth for a very considerable length of time ; but as it only reached Manchester on the day previous, the geological character of the gravel in which it was found had not been ascertained.

Action of Ice in forming Lake-basins.—On this interesting subject we have received an important reprinted essay, by Mr. Thomas Belt. The author believes firmly in the action of glaciers in forming lake-basins. Supposing, he says, the existence of a depression in the pathway of a glacier which has reached such a depth that the ice simply fills it, what would happen? At the bottom and sides of the hollow, the ice would be slowly melted by the earth's heat, increasing with the depth of the basin. As the ice at the lower end of the basin melted, the whole mass would be pushed along by the thrust of the moving glacier above it. Into the crevice at the upper end would pour the water coming down the bottom of the glacier from above the basin, which would pass underneath and be forced out at the lower end, carrying with it the mud produced by the crushing down of the ice as it melted at the bottom, and by the grinding along its floor as it melted at the lower end of the basin. The water coming from above would assist in melting the ice, especially in summer; but its most important effect would be the scouring out of the bottom of the basin, so that an ever clean face of rock would be presented to the huge natural tool operating upon it. Such an action would, in some measure, resemble that of a hollow drill which has been prepared for boring holes in rock through which a current of water is forced to carry off the ground stone. Mr. Belt accounts for the difference in depth of the lake-basins of Switzerland and Nova Scotia by stating that in one case the ice-chisel operated on hard granites and in the other on soft, easily-worn materials.—Vide *Transactions of the Nova Scotia Institute of Natural Science*, vol. II., No. 3.

New Relation of the Calcaire Grossier.—MM. Briart and Cornet have discovered that this deposit is to be found at Mons, below the "Lower Landenian," which is the lowest of the Belgian tertiaries and the one immediately overlying the chalk. It is equivalent, according to Mr. Prestwich, to the Thanet sands of the London basin. The characters of this new bed are very similar to those of the Calcaire Grossier proper of the Oise, and to its Belgian equivalent, the "Système Bruxellien" of Dumont. The fossils which it contains are those of the Calcaire Grossier, which, moreover, do not occur in the intervening Landenian series or in their French representatives. It would appear then, that a fauna had existed for a time, disappeared in the intermediate beds, and then reappeared. A similar occurrence has been pointed out by M. Barrande in Bohemia. His observations go to prove that there were during the Silurian epoch different contemporaneous faunas, and that one of these obtained a temporary existence in a locality where the ancient fauna afterwards prevailed. This is what M. Barrande calls a colony.—Vide *Bull. de l'Acad. Royale de Belgique*, Nov. 4.

Fossil Forest in Arran.—Mr. E. A. Wünsch has recorded a very curious discovery made by him while studying the carboniferous strata of North-eastern Arran. The beds of coal close to the coast are interstratified with layers of volcanic ash, and passing up through both may be seen the trunks of trees:—"Trunks of trees 18 to 24 inches in diameter and 2 to 3 feet in height, standing erect upon the thin seams of shale and coal on which they grew, and covered by layers of ash two or three feet in thickness, are found regularly dispersed over the area." The ash overlying them, in which they are embedded, contains numerous branches from 4 inches in diameter down to the minutest dimensions, some of the impressions displaying an almost feathery foliage, as though suddenly covered up before the foliage had time to decay or become water-worn. The larger branches remain perfectly round, and show the pith in an admirable state of preservation; and the cellular tissue, filled up with mineral matter, is plainly visible to the naked eye.—Vide *Geological Magazine*, October.

The Fossil Plants of Hungary.—Professor Unger has presented to the Academy of Sciences of Vienna a Memoir on the Fossil Plants of Hungary and Transylvania, in which he treats specially of those found by M. Stur in the Upper Cretaceous Deposits of Déva, Transylvania. All the specimens are well preserved, so that they can be recognized with certainty as belonging to genera allied to those of the present day; a fact of much importance in the determination of the Dicotyledonous plants of the Cretaceous period.

The "Parallel Roads" of Glenroy.—The Rev. R. Boog Watson read a paper before the Geological Society (Nov. 8th), in which, after a brief description of these peculiar "Roads," he gave an analysis of the two principal theories that have been started to account for their formation; namely, the ice-dam theory and the marine theory. With regard to the first theory, Mr. Boog Watson stated his opinion that although it has some strong points, especially in respect of the coincidence between the levels of the "Cols," at the glen-heads, and those of the "Roads," yet, on the other hand, it is weak, inasmuch as the cause assigned is extremely local in its action, while the phenomena to be explained are very general and have a wide range,—terraces similar to those of Glenroy occurring in Scandinavia and elsewhere. In the author's opinion, also, the ice-dam is impossible, and would be inefficient if possible; it would not be water-tight, and there is no place for it in the history of the Post-pliocene changes in Scotland. But he remarked that objections like these cannot be urged against the marine theory, as the sea has been on the spot, and is able to perform the work required of it. At the same time the author admitted that the marine theory is not free from difficulties, the chief being the perfection and horizontality of the "Roads," and their barrenness in marine organisms; and he concluded by suggesting some explanations of these apparent anomalies.

A combustible mud has been described to the Asiatic Society of Bengal, by Major Risely. It exists in large tracts, especially in the Pertabghur district in Oudh, where there is a swamp of it, which has the appearance of ashes, but the material of which smoulders like wood. When dried, the mud blazes freely. It has been tried by a locomotive fireman, and found to produce very nearly as much steam as wood does. The Calcutta chemists call it an impure peat, resulting from the continual deposition of vegetable matter at the bottom of a marsh. It seems remarkable that the natives, though well aware of its properties, make no use of it; their reason being that it owes its origin to "enormous sacrifices of ghee and grain" which former races burnt upon the spot where the marsh now stands.

Origin of the Salts which compose the Earth.—Dr. Sterry Hunt has been contributing to the American journals a series of papers on the constitution of natural waters, in one of which he gives the following theory in explanation of the origin of salts, metallic veins, and other deposits. Starting with the idea that at the commencement of the earth's history, the various substances in ignition reacted on each other, he observes: "The quartz, which is present in such a great proportion in many rocks, would decompose the carbonates and sulphates, and, aided by the presence of water, the chlorids both of the rocky strata and of the sea ; while the organic matters and the fossil carbon would be burned by the atmospheric oxygen. From these re-actions would result a fused mass of silicates of alumina, alkalies, lime, magnesia, iron-oxyd, &c. ; while all the carbon, sulphur, and chlorine, in the form of acid gases, mixed with watery vapour, nitrogen, and a probable excess of oxygen, would form an exceedingly dense atmosphere. When the cooling permitted condensation, an acid rain would fall upon the heated surface of the earth, decomposing the silicates, and giving rise to chlorids and sulphates of the various bases, while the separated silica might take the form of crystalline quartz. In the next stage of the process, the portions of the primitive crust not covered by the ocean would undergo a decomposition under the influence of hot moist atmosphere charged with carbonic acid, and the felspathic silicates become converted into clay, with separation of the alkali. This, absorbing carbonic acid from the atmosphere, would find its way to the sea, where, having first precipitated from its highly-heated waters various metallic bases then held in solution, it would decompose the chlorid of calcium, giving rise to chlorid of sodium on the one hand, and to carbonate of lime on the other. In this way we obtain a notion of the processes by which from a primitive fused mass may be generated the siliceous, calcareous, and argillaceous rocks which make up the greater part of the earth's crust ; and we also understand the source of the salts of the ocean.—Vide *Canadian Naturalist*, vol. II. note 4.

The Green Marble of Connemara.—Professor Harkness, of Queen's College, Cork, communicated his observations on these rocks to the British Association, at its last meeting. A series of sections and maps, which he displayed, proved that the green marbles of Connemara are a local and peculiar development of light-grey subcrystalline limestone, which lies on the north side of the gneiss rocks of the south of the Bens of Connemara. This limestone dips conformably under these gneissic rocks. It is superposed conformably on quartz rocks, and these quartz rocks, with their superposed deposits, are thrown into numerous contortions in the Connemara country. Where they are most curtailed, the limestones have opened out in their lines of lamination, and into these openings the serpentinous matter, to which the green marble owes its colour, has been introduced. The metamorphic strata in the Connemara country appertain to the Lower Silurians. They are the equivalents of the Quartz rocks, Upper Limestone, and Upper Gneiss of the Highlands of Scotland, described by Sir R. I. Murchison. It has been stated that *Eozoön Canadense* occurs among the green marbles of Connemara. The structure which has given rise to this opinion is purely mineral, and has resulted from the deposition of Serpentine upon Tremolite and asbestiform minerals.

The Lower Lias of Somerset.—In a paper read before the Geological Society (Dec. 6th), the Rev. P. B. Brodie described a section recently exposed at Milton Lane, one mile and a half north of Wells, which exhibited the Lima-beds passing into and overlying the White Lias and *Avicula-contorta* zone. The author described the section (which was constructed by Mr. J. Parker and himself) in detail, and showed that the Lima series attained here a thickness of 10 feet 4 inches, and the Rhætic bads, including the grey marls, of 18 feet 6 inches; he was not able to discover any trace of *Ammonites planorbis*, nor of any of the peculiar limestones indicating the "Insect" and "Saurian" zones. He found one fragment of bone-bed lying loose at the end of the Lane, and containing characteristic fish-remains; but though he searched carefully, he could not find *in situ* the bed from which it had been detached.—Vide *The Reader*, December.

MEDICAL SCIENCE.

The Congelationof Animals.—It is generally supposed that certain animals cannot be frozen without the production of fatal results, and that others can tolerate any degree of congelation. Both these views have been shown to be incorrect in a paper read before the French Academy, by M. Pouchet. The writer arrives at the following conclusions:—(1.) The first effect produced by the application of cold is contraction of the capillary blood-vessels. This may be observed with the microscope. The vessels become so reduced in calibre that the blood-globules are unable to enter them. (2.) The second effect is the alteration in form and structure of the blood-globules themselves. These alterations are of three kinds; (*a*) the nucleus bursts from the surrounding envelope; (*b*) the nucleus undergoes alteration of form; (*c*) the borders of the globule become crenated, and assume a deeper colour than usual. (3.) When an animal is completely frozen, and when, consequently, its blood-globules have become disorganized, it is dead—nothing can then reanimate it. (4.) When the congelation is partial, those organs which have been completely frozen become gangrenous and are destroyed. (5.) If the partial congelation takes place to a very slight extent, there are not many altered globules sent into the general circulation; and hence life is not compromised. (6.) If, on the contrary, it is extensive, the quantity of altered globules is so great, that the animal perishes. (7.) On this account an animal which is partially frozen may live a long time if the congelation is maintained, the altered globules not entering into the general circulation; but, on the contrary, it dies if heat be suddenly applied, owing to the blood becoming charged with altered globules. (8.) In all cases of fatal congelation the animal dies from decomposition or alteration of the blood-globules, and not from stupefaction of the nervous system.

The Development of Muscular Fibre.—In the Proceedings of the Royal Society, a paper appears containing some new views. It is written by Dr. Wilson Fox, of University College, and is intended less or more as an argument in favour of the cell theory; but it will be seen by those who understand the views of Huxley and modern writers, that it is really an advocacy of the *periplast* view. According to Dr. Fox's observations, the earliest form in which muscular tissue appears in the tadpole, is an oval body coontaining a few nuclei, and packed closely with pigmentary granules. From the well-defined outline of this body the writer is disposed to regard it as a cell though he has not been enabled to isolate any limiting membrane or cell-wall. These bodies increase in length with or without multiplication of their nuclei, and, after a short period, a portion of their structure loses, in great part, its pigment, and exhibits a striation which is sometimes transverse, sometimes longitudinal, and occasionally both; but at this period there is no distinct line of demarcation between the striated and non-striated portion of the cell-contents, showing that the change takes place within the contents of the cell.

The Extract of Meat.—Baron Liebig, who has favoured us with some admirable samples of this excellent preparation, has also forwarded to us a letter in which he very clearly explains what is the exact nutritive value of the *extractum carnis*:—"The meat," says the Baron, "as it comes from the butcher, contains two different series of compounds. The first consists of the so-called albuminous principles (albumen, fibrin), and of glue-forming membrane. Of these, fibrin and albumen have a high nutritive power, although not if taken by themselves. The second series consists of crystallizable substances, viz., creatin, creatinin, sarcin, which are exclusively to be found in meat; further, of non-crystallizable organic principles and salts (phosphate and chloride of potassium), which are not to be found elsewhere. All of these together are called the extractives of meat. To the second series of substances beef-tea owes its flavour and efficacy, the same being the case with the *extractum carnis*, which is, in fact, nothing but solid beef-tea—that is, beef-tea from which the water has been evaporated. Besides the substances already mentioned, meat contains, as a non-essential constituent, a varying amount of fat. Now neither fibrin nor albumen is to be found in the *extractum carnis* which bears my name, and gelatine (glue) and fat are purposely excluded from it. In the preparation of the extract the albuminous principles are left in the residue. This residue, by the separation of all soluble principles, which are taken up in the extract, loses its nutritive power, and cannot be made *an article of trade* in any palatable form. Were it possible to furnsh the market at a reasonable price with a preparation of meat containing both the albuminous and extractive principles, such a preparation would have to be preferred to the *extractum carnis*, for it would contain all the nutritive constituents of the meat. But there is, I think, no prospect of this being realized." These remarks show very clearly the actual value of the extract. It is, in fact, concentrated beef-tea; but it is neither the equivalent of flesh on the one hand, nor an imperfectly nutritive substance on the other. It is never theless amost valuable preparation, and now commands an extensive sale in these countries and abroad; and it is, furthermore, the only valuable form in which the carcasses of South American cattle (heretofore thrown away as valueless) can be utilized.

Engrafting Animal Tis sues.—In one of our numbers we recorded some of M. Bert's experiments in this direction; but one which he has recently reported is of still greater interest than any he has yet made known. It is briefly as follows:—The tail of a full-grown rat was separated from the body, and having been placed in a glass tube, was maintained at a temperature of from 7° to 8° Centigrade for a period of seventy-two hours. It was then stripped of the membrane covering its base, and was inserted beneath the skin of another full-grown rat. Strange to say, it took root, and grew as perfectly from the back of the second rat as if it had been connected with its true proprietor. To prove that it was nourished in the proper manner, M. Bert killed the second rat three months after the operation, and injected coloured fluid into its aorta. Upon then examining the engrafted tail, he found that the coloured matter had penetrated into the marrow of the vertebral bones, thus showing that a connection had taken place between the unwilling host and the tissues of his strange guest.

Death of Herr Remak.—We regret to announce the death of Remak, of Berlin, so famous for his researches in the histology of nerve-tissues. He was one of the greatest anatomists in Europe, and previous to his death had given much attention to the curative powers of electricity. He died at Kissingen, of carbuncle.

Extract of Cod-liver Oil.—In a paper in the *Pharmaceutical Journal* for December, Dr. Attfield remarks the fact that some of the preparations sold in this country are the grossest impostures. In this article the writer details the results of his analysis of a production sold as "saccharide of cod-liver oil," and makes some startling announcements. He has found that this preparation contains not the faintest trace of the elements of cod-liver oil. This is what Dr. Attfield writes of it:—"It is nothing but powdered milk-sugar. A considerable quantity of this sugar is now extracted from milk, chiefly for use in the manufacture of homœopathic globules and certain varieties of infants' food. It can therefore be had readily and cheaply. A quantity costing a few pence is placed in a box labelled, so as to induce the public to believe that it is cod-liver oil in a concentrated, convenient, and palatable form, and forthwith sold for five shillings." It is only fair to add that the *dragées* of Messrs. Barr & Co. are genuine preparations, in which the true watery extract of the cod's liver is presented in the form of a sugar-coated pill.

The Anatomy of the Eye.—M. Dousmain differs as to the results of his observations from most anatomists. He considers that the capsule of the crystalline lens presents the same thickness throughout. The suspensory ligament of the len has, saccording to him, no existence, that which has been mistaken for a ligament being simply the union of the common envelope with the sac of the hyaloid membrane. The zonule of Zinn he describes as being composed of four distinct layers, and he denies the existence of the posterior chamber, and the canal of Petit.

Perchloride of Iron a Specific for Cancer.—M. Bitot recommends the perchloride as a sovereign remedy for cancerous growths, and he compares its action to that of iodine in scrofula.

How to detect the Adulteration of Essential Oils.—Mr. Sugden Evans describes a most ingenious method for effecting this purpose. It is simply an application of the polariscope, and depends upon the fact that, in examining an essential oil, the "analyser" of the polariscope must be turned round in order to procure the brightest play of colours. This instrument is simply a modified polariscope, the eye-piece of which is set in a circular disc of brass, whose circumference is divided into 360 degrees. The prisms are so arranged that an index-needle in the eyepiece points to zero when a ray of light transmitted through the apparatus, is at its maximum intensity. When the light is sent through a pure oil, the ray of greatest intensity is indicated by the number to which the needle points. When it passes through an impure specimen, the production of the brightest ray will be effected by turning the index to a different number, and thus the impurity, and possibly its degree, may be estimated.—Vide *Pharmaceutical Journal*, October.

Does Iodine remain Unaltered in the System ?—Signor Bellini replies to this question in the negative, and his numerous experiments appear to bear out his conclusions, which he thus summarizes:—1. When iodine is introduced in a poisonous dose into the stomach of an animal, it is neither decomposed nor absorbed entirely in the digestive canal. 2. Iodine is in part absorbed as a simple body; either dissolved or reduced to vapour by the animal heat. It thus passes into the circulation. 3. Before it has travelled through the walls of the capillaries, it is decomposed by some materials of the blood, which, by reason of the rapidity of the circulation, are renewed incessantly. 4. From this decomposition there result the iodic and hydriodic acids, and the alkaline iodates and iodurets, which, in proportion as they are formed, are drawn away by the circulating current, and distributed over the body. 5. The iodic acid combining with the free alkaline bases, or with the carbonates, prevents the presence of free iodine. 6. The hydriodic acid, in the presence of alkaline bases, appears to be converted quickly into an alkaline ioduret. 7. In these several reactions, the blood, lymph, tissues, organs, and secretions lose less or more their alkalinity, although the acid ones lose their acidity.—Vide *Lancet Record of the Progress of Medical Science,* December.

The Sphygmograph in Comparative Physiology.—The sphygmograph, an instrument for recording graphically the several movements of the heart and their relation to each other, has been employed in a new field by M. Marey. The French *savant*, in a memoir quite recently published, describes the results of his application of the sphygmograph to the hearts of dogs, cats, tortoises, frogs, birds, fish, &c. M. Marey's essay is illustrated by a number of charts —fac-similes of those drawn by the instrument,—which show what a close relationship there is between the movements of diastole and systole of all animals.—Vide *ibid.*

Presence of Copper in Animal Bodies.—Dr. Ulex, who has been analyzing the bodies of several animals, has published some curious statements upon the above subject. Several of the carnivora in the Hamburg Zoological Gardens having died after feeding upon the same horse, they were supposed to have been poisoned by its flesh. Strychnine, phosphorus, and arsenic were searched for in vain; but in all the animals small quantities of copper were found. This was the case also with the horse which had furnished them with food, and it was concluded that this metal had induced the poisoning. Upon examining the flesh of another freshly-slaughtered and healthy horse, however, copper was also found in it; and a chemical investigation was forthwith set on foot, and this metal was found in the mammalia from man downwards, birds, amphibia, crustacea, insects, &c., to the lowest members of the animal kingdom—in fact, wherever it was sought for, in the most different animals, coming from the most different countries. The wide-spread existence of this copper in the vegetable kingdom, as well as in sea-water, has been demonstrated by various chemists. It may be even detected in minute quantities in an article usually regarded as of great chemical purity—the Swedish filtering-paper, and in wood charcoal. Both these substances were employed in the above-mentioned researches, but in too small quantities to furnish any of the copper discovered. The fact of the remarkable diffusion of copper throughout the three kingdoms of nature is at all events well deserving greater attention on the part of the physiologist and medical jurist.—*Allge. Wien. Zeit.*, 34.

The Accommodative Power of Eye.—As recent continental inquiries have shown how utterly impossible it is for the ciliary muscle or processes to have any action on the crystalline lens, the following interesting case shows how much the phenomena of accommodation may depend upon the cornea or iris, or both. The case is given in a paper by Dr. Mackenzie, and is as follows :—" As illustrating the power of distinct vision, sometimes possessed by those who have lost the crystalline, I may notice the instance of a gentleman, mentioned to me by Professor Allen Thomson. This gentleman had cataract in both eyes at rather an early period of life. He regained the use of one of them some twenty or twenty-five years ago, by extraction, under the care of the late Mr. Alexander. Employing a convex lens of about four inches focal length, he possesses an acuteness of vision wonderful, not merely for a person in his circumstances, but for any one. Always employing (as far as Professor Thomson recollects) the same lens, he enjoys as complete a power as most persons of seeing with clearness and precision near or distant objects. To show how minute his vision was, he wrote a long passage of a letter in so small a character that Professor T. found it necessary to use a strong magnifier to enable him to read what had been written. Professor T. had frequently seen this gentleman read alternately the smallest type of a printed book at a near distance, and the larger type of the title-page across a room, as well as the words of a sign-board or the names over shops, across a wide street. He could have no doubt whatever that *his vision at these various distances was just as well defined and precise as that of persons possessing the ordinary powers of accommodation.*"—Vide *Ophthalmic Review*, No. VII., p. 227.

MECHANICAL SCIENCE.

Armour-plated Vessels.—The *Minotaur* has now been added to our iron-clad navy, having been launched at the end of last year, and tested during September of the present year. This frigate differs from the *Warrior*—1st, in carrying the armour-plates round the bows and stern, as well as on the broadside ; 2nd, in having the armour-plating on the broadside 5½ inches thick on 9 inches of teak backing, instead of 4½ inches thick on 18 inches of backing. With full boiler power her mean speed was 14·778 knots, with 57½ revolutions of the engines, the boilers working at 25½ lbs. pressure. With half-boiler power her mean speed was 12·406 knots ; revolutions of engines, 48 ; and pressure of steam, 20 lbs. These trials were at the light draught of water, 23 feet forward and 24 feet aft. Compared with the *Warrior's* speed at deep draught of 14·356 knots, the speed of the *Minotaur* is so little in excess that she will probably prove the slower frigate of the two. The *Bellerophon* on her trial trip has fallen further short of the *Warrior* standard, making only 13⅘ knots, instead of the 15 knots expected, the engines developing only 5,000 h. p. indicated, instead of 6,000 estimated by the makers of her machinery. In these trials there was found to exist a very remarkable amount of negative slip of the screw, the velocity due to the pitch of the screw being only 12 knots. The screw propeller used in these trials was a novel modification of the Mangin screw, having no less than eight blades, in four pairs. It is probable that when this propeller is replaced by one more in accordance with ordinary practice, the discrepancies between the estimated and actual speed will partly disappear, and the performance of the vessel will correspondingly improve.

British Association for the Advancement of Science.—Amongst the more interesting papers read before the mechanical section of the Association at Birmingham, we may refer to the history of the development of the Bessemer process, by Mr. Henry Bessemer ; a paper on chain-cable-testing machinery, by Sir William Armstrong ; Mr. Levick's paper on coal-cutting machinery ; Mr. Cowper's description of the lock-saw-gin for cleaning cotton ; and Mr. Robinson's account of the Giffard injector. In reference to this last, the most novel facts were, that the steam-jet pump had been applied in combination with the injector in cases where the level of the supply-water was much below that of the injector itself, the water having been raised by suction, in some cases to a height of 16 feet by this means ; and that a simple form of the injector had been applied to raising water in mines. In one remarkable case, with steam pressure of 45 lbs. per square inch, corresponding to a column of water of only 104 feet, the water was actually raised to a height of 261 feet vertical.

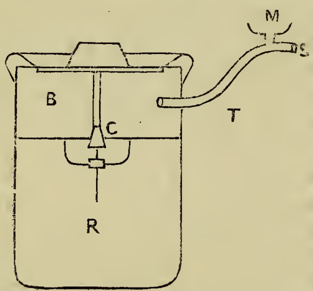
Machinery for Puddling Iron.—The increasing difficulties caused by the disputes between masters and men in Staffordshire are causing attention to be redirected to the possibility of puddling iron by machinery, and more than one system of machine puddling is undergoing thorough trial and investigation. At the Dowlais works, Mr. Walker's plans are being tried with encouraging results, the molten metal being brought into contact with the flame by the rotation and oscillation of the vessel containing it, the process being completed by the ordinary hand labour. Mr. Bennett, of the Wombridge Works, Salop, has introduced another system, in which the ordinary rabble, or rake, is worked at the rate of 50 strokes per minute, mechanism outside the furnace. With single furnaces and charges of 5 cwt., the consumption of coal is 28 cwt. per ton of puddle bar made. With double furnaces and 10 cwt. charges, the consumption of coal is only 17 cwt., being a reduction of 39 per cent. M. Gaudray has described to the Institute of Civil Engineers of France, a similar system in use at St. Dizier. The rabble receives from machinery attached to the brickwork of the furnace a rectilinear motion transverse to the furnace, and at the same time a slower travelling motion lengthways of the furnace, by which it is brought successively over every part of the furnace floor. The saving in fuel is shown by the following figures :—

Before the machine was applied ...	15·21	cwt. coal	per ton	pig iron.
With the machine	11·79	"	"	"
Machine thrown out of action ...	13·43	"	"	"

The balling up of the iron is effected by hand labour in the ordinary way.

Rotatory Engine. — An extremely interesting and ingenious form of rotary steam engine was exhibited by Mr. R. W. Thomson, C.E., at the meeting of the British Association at Birmingham. According to Mr. Thomson's statement, in all previous rotary engines a steam stop or abutment is necessary, and in this lies the fatal objection to their employment. The steam stop must get out of the way of the revolving piston at each rotation, and from its necessarily rapid motion, imposes mechanical difficulties of the most insuperable character. In Mr. Thomson's engine these are avoided, by dispensing with the abutment altogether : two pistons are used, which have an alternately accelerated and retarded motion, concentrically with the cylinder, and the retarded piston acts, for the time being, as the abutment to the accelerated piston. The engine has no valves, nor eccentric gear of any kind ; it possesses peculiar facilities for reversing, and it may be worked at a fixed rate of expansion as easily as with full steam. Its cost will not exceed half that of an ordinary engine. Gas exhausters, on the same principle, have been contructed and used with success.

The Rouquarol Self-regulating Diving Apparatus.—A description has appeared in the *Engineer* of October 27, of the extremely ingenious diving apparatus of M. Rouquarol, which has been adopted in the French navy, and was exhibited to members of the English Admiralty during the international courtesies at Cherbourg. This apparatus renders the quantity and pressure of the air supplied to the diver quite independent of the pressure and quantity supplied by the pumps, being, in fact, regulated by the lungs of the diver himself ; and in one form of the apparatus he is independent of the pumps altogether, carrying a reservoir of air on his back, with a supply sufficient for half an hour's work under water. The ordinary cumbrous helmet and air-tight dress is entirely dispensed with.



Skeleton Diagram of the Regulator.

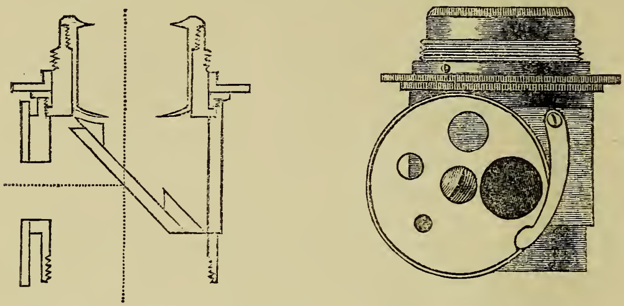
Fig. 1. shows the regulator of the air in section. R is a reservoir of compressed air. Above this reservoir is the equilibrium or air-case, B. This case is closed at its upper part by means of a metallic or wooden plate of a lesser diameter than the casing, and connected to it by a sheet of india rubber or other flexible material. It is obvious, therefore, that the air in the chamber B must always be of the same pressure as the environment of the diver, adjusting itself to that pressure by the rising or falling of the metallic plate on its flexible hinge. The reservoir R and the air-chamber B communicate by a small hole closed by a conical valve, C, opening downwards. This conical valve is connected to the metallic cover of the equilibrium chamber, so that as that cover descends it opens the conical valve and admits the compressed air from the reservoir R, which, in turn, raises the cover and closes the valve. T is the inhaling-tube; M, the mouth-piece; and S, a valve, through which the exhaled air is expelled. The mouth-piece is placed between the teeth of the diver, his nose being closed by spring nippers. The reservoir, in communication or not with the pumps, is placed on his back, and loaded weights on his feet ; and, thus prepared, he is enabled to dive to any depth, breathing the air as securely as above the surface of the water. At each inspiration, the cover of the air-chamber falls, and opens for an instant the

valve of the reservoir, admitting a supply of air equivalent to that respired by the diver. And so, also, in passing from a less to a greater depth, the valve will be opened till the pressure of the air in the chamber is in equilibrium with the pressure of the water by which the diver is surrounded. The valve of the reservoir R is a conical metallic spindle valve; that at S, for permitting the passage of the respired air, is a simple aperture covered with india-rubber, in the same manner as an air-pump valve.

Resistance to Rupture of Hydrostatic Cylinders.—Hitherto it has been assumed that the cause of rupture of cast-iron cylinders to internal bursting pressure resulted simply from pressure on their interior walls; but Mr. St. John V. Day, C.E., has called attention to some observations made by Messrs. Weems, which seem to show that in press cylinders the water obtains entrance into the intermolecular spaces of the cast iron, in effect slicing off a ring of the metal, and proportionately reducing its resistance to internal fluid pressure. It is a known fact, that under comparatively moderate pressures water finds its way completely through cast iron, diffusing itself over the external surface as a fine dew. Taking it for granted, then, that this interstitial permeation of the fluid diminishes the tenacity of the material, Messrs. Weems have sought to prevent its entrance by lining the cylinders with a material of great density and high impermeability. Hitherto, a press cylinder, not strengthened externally, having a ram of 24 inches diameter, could not be relied on at a pressure above $2\frac{1}{2}$ tons per square inch. A cylinder of this diameter bored out and lined with copper by Messrs. Weems, is now working at a constant stress of 3·5 tons per square inch.—*Artizan*, Nov. 1865.

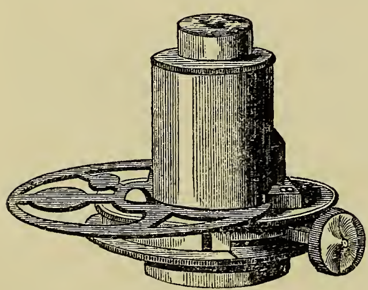
MICROSCOPY.

Illuminator for Opaque Objects under High Powers.—An ingenious instrument for effecting this purpose was described by Mr. Smith, of Kenyon College, U.S., in the September number of *Silliman's American Journal* This, with a very slight but advantageous modification, has now been manufactured and patented by Messrs. Powell & Lealand. In it the object-glass is made its own illuminator. The woodcut beneath will explain how this is achieved. A short brass tube screws on to the end of the body of the microscope, and carries the objective at its other extremity. It is perforated by a small aperture, and has within it, and opposite to this aperture, a plate of clear glass, inclined at such an angle, that light entering the aperture, and falling upon the plate, is thrown down through the object-glass, and upon the object. The light is derived from a lamp placed near the aperture, and having its rays of light collected by a bull's-eye condenser. In Mr. Smith's arrangement, a silver mirror was employed; but as this cut off half the pencil of rays proceeding from the object, Messrs. Powell & Lealand conceived the substitution of a plate of clear glass. This instrument is certainly the most perfect contrivance imaginable. It can be used with power as high as the $\frac{1}{50}$th inch, and from what we have seen of its work with a $\frac{1}{12}$ inch, we can speak of it in the highest terms of commendation. The wheel of diaphragm at the side has an obvious use—to regulate the supply of light.

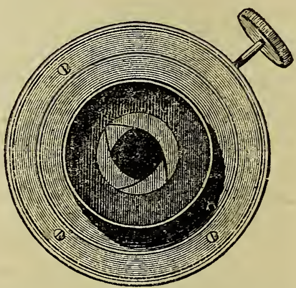


Powell and Lealand's Patent Illuminator for Minute Opaque Objects.

Collins' Webster's Condenser.—Some time back we called attention to this excellent instrument, which, however, was then in an embryonic condition. It has since become developed under the hands of the inventor and manufacturer, and is now, all things considered, the best, cheapest, and most useful piece of accessory apparatus connected with the microscope. It consists simply "of a double concave lens, cemented to a very deep crossed lens," fixed in a suitable body, and capable of being fitted beneath the stage of any ordinary microscope. Below it is provided with a wheel of diaphragms, so formed that oblique light may be obtained, or direct light, or by a stop the effects of dark ground illumination may be produced. In addition, it has one of Mr. Collins' new graduating diaphragms. For all the powers from the inch to the $\frac{1}{12}$th inch this instrument supplies all that the microscopist requires; and it has the advantage of not requiring to be changed. In its present form it is achromatic, and is manufactured by Mr. Collins, of Great Titchfield-street, Oxford-street.



Collins' Webster's Condenser.



Graduating Diaphraghm of Condenser.

A New Growing Slide.—The examination of living objects under the microscope is a subject of great interest, though attended with considerable difficulty. It is by no means easy to prepare without injury a specimen of a growing plant for microscopical investigation. A new "growing slide," as it is termed, therefore promises to be of much service. This contrivance is the invention of Mr. H. L. Smith, an American naturalist, and presents the following features. It is composed of two glass plates 3 × 2 inches, and about the $\frac{1}{25}$th of an inch thick, separated by strips of the same thickness, and cemented with marine glue. One corner of the upper plate is removed, and a very small hole is drilled through the plate at the corner of the space, to be covered by a piece of thin glass placed over the object, whose growth is to be watched. The slide is filled with water by means of a pipette applied to the open corner, and when the covering glass is placed over the little hole, water slowly oozes through by capillary attraction. By this means an object may be kept moist for a period of three days.—Vide *Silliman's American Journal*, September.

Photomicrographs taken with a Common Landscape Camera.—Mr. John Bockett, in a letter to the *British Journal of Photography*, describes how, with the above apparatus, he has taken photographs of the exuvia of the spider, skin of the caterpillar, leg of the beetle, &c. The following is Mr. Bockett's description :—"In the first place, we have the lens, which is mounted on a piece of brass tubing about three inches long, having a fine screw thread, say for two inches, cut thereon. This screw acts as a fine movement, and should be made to work in the flange smoothly and evenly. Our next step is the camera, which is constructed to receive the focussing screen, and back of an old quarter plate walnut-wood one, already used as a general hack. This was made in two parts—1st, a box 10 inches long, which was cut in two, the front portion taking the lens, and the back the focussing-glass and dark slide ; and fitted into their two portions is a smaller box—say $16\frac{1}{2}$ inches long—the whole being knocked up out of three-eighths deal. Of course the whole of the interior is blackened with lamp-black and shellac, mixed and dissolved in methylated spirit. Having fitted our lens to the camera to keep all square, a wooden way is constructed, along which it is possible to glide the camera, acting thus as a rough adjustment. In this way, which is thirty-six inches long, at about four inches from the end, is what I call the adjustable object-holder, made as follows :—A piece of brass is turned so as to have a flange and a screw to fasten it to the tray ; a hole is bored through it, in which is soldered a stout piece of brass tube, having a hole, with a screw, tapped in its side. In this is fitted a binding-screw, so as to grip the object-holder now about to be described. This consists of a piece of very thick brass wire, having a screw cut on it at one end, on which is fitted a brass cup filled with compressed cork : several of different sizes, from a quarter to two inches, should be in stock. In addition to this, if it be intended to photograph microscopical slides, I made an object-holder, consisting of a piece of tin cut of this shape ; at the point a small piece of brass wire is soldered, and the tin bent upon itself. This must be dead-blacked. In the middle of this is then soldered a small pin, whereby the holder is thrust into the cork of the ordinary brass cup before alluded to. It will thus be seen that the object can be raised or depressed at will, and by drawing lines upon the ground glass of the screen, perfect parallelism can be obtained. Behind, or rather, I should say, in front, of this stem and holder is fitted a piece of board working on two hinges sixteen inches long by six wide, having a clamping screw and brass guide, so as to regulate the reflection of light, and also act as a background to the object. This is covered with white cardboard retained *in situ* by means of drawing-pins. For focussing, two Ramsden eye-pieces should be used, one about double the power of the other. By taking this extra trouble the operator will be sure of sharper results. For opaque objects I make use of an ordinary magic lantern reflector, to the back of which I have soldered a piece of brass tube, whioh glides upon another tube let into a turned wooden font. By receiving the rays from off the white cardboard, the object inclosed in the cell or otherwise can be equably illuminated, and, as the whole is all connected together, any vibration is communicated throughout the whole arrangement. With regard to the exposure requisite, the exuvia of spider, skin of caterpillar, leg of beetle, and the star-fish, were all done in open daylight, through an eighth-of-an-inch stop, in one minute and a quarter."

A simple form of finder is now sold by Messrs. Baker, of Holborn, and from its ingenuity and comparative accuracy, is worthy of notice. It consists of a curved bar attached to the stand of the microscope, and moving on a horizontal axis. It is so contrived that when the surfaces of the stage (mechanical stage) are brought into their rectangular positions, and an object is *in situ*, it can be pushed down upon the slide. If the latter be covered with paper, the point of the bar leaves a slight puncture. All that is necessary, when it is required to examine the object in future, is to move the stage till the puncture on the slide comes under the point of the bar or finder. The object will then be in the centre of the field.

A New Method of Illumination.—Count Francesco Castracane suggests a new method of examining microscopic objects, which may possibly be found useful by those engaged in the investigation of the lower plants and animals. The great difficulty which our microscope manufacturers have had to overcome is that of the correction of lenses for chromatic aberration. The ordinary continental objectives are rarely perfectly achromatic, and this is, of course, a great objection to their employment in cases where precision is required. Count Castracane proposes to neutralize this quality of inferior object-glasses by using light of one colour, which cannot be decomposed. His plan consists essentially in the employment of one of the component pencils of the solar spectrum made to fall upon the mirror of the microscope, and be thus reflected to the object. In his researches he employed one of Dubosc's heliostats, by which means he obtained a field wholly illuminated by coloured homogeneous light.—Vide *The Lancet, Record of the Progress of Medical Science*, October.

Abstracts of papers relating to Histology will be found under the following heads :—

Botany.—The Pollen Grains of Ranunculus.
The Process of Fructification in Sphæriæ.
Spiral Vessels.
Plants within Plants.
The Vitality of Yeast.
Medicine.—The Development of Muscular Fibre.
Zoology.—The Development of the Axolotl.
The Ooze from the Atlantic Cable.
The Microscopic Anatomy of Hydrozoa.
The Transformations of *Chloëon dimidiatum*.

METEOROLOGY.

Mr. Glaisher's Observations.—On Saturday evening, December 9th, Mr. Glaisher made his second balloon ascent *by night* from Greenwich, and came down in Bedfordshire. The results were very different from those of the preceding night ascent, but the conditions were quite different. In the first case the sky was cloudless ; in the latter it was covered with cloud. Some of the clouds were within 1,000 feet of the earth ; one such cloud was over London ; so that, although passing north of London near to it, and not in cloud themselves, the aërial voyagers did not see a single light or any effects of London lights. This cloud did not extend to Greenwich, for the lights at Woolwich and Greenwich were very brilliant. The contrast in this respect between the two ascents was very great ; while passing over the country in the first ascent, the reflection of the moonbeams, lighting up the river and many other solitary sheets of water over the country, was seen, suddenly bright, and as suddenly leaving them in darkness, and brightening up others. These successive illuminations were quite wanting on the second ascent ; the moon herself was invisible, the earth was covered in many places with detached clouds far below, some of large extent, covering many miles of country, and others of small extent ; while above, the sky was uniformly black, and kept this appearance throughout, even when they were one mile high. The upper clouds, Mr. Glaisher thinks, must have been very high. Although, however, the moon and its effects were wanting, there were many highly interesting views of the distribution of cloud and of the different effects of the diffused light on woods and fields, which prevail over the earth. Mr. Glaisher says boundaries of fields could be seen even at the greatest elevation, and enabled him satisfactorily to determine his path by noting the angle at which the balloon crossed fields in comparison with the position of the magnet-needle.

The British Rainfall.—We have received the subjoined communication from Mr. G. J. Symons relative to this matter. In speaking of the importance of statistics, he observes :—" It is now some years since I began collecting returns of the fall of rain—with what success I will mention presently, but my main difficulty has been to find out the persons who keep such records, and one of the most obvious sources of assistance is the public press ; I now, therefore, ask from each and every journal in the British isles their all-powerful aid. When the collection was first organized in 1860, scarcely 200 persons were known to observe and record the rainfall ; by steady perseverance, and the aid of a portion of the press, the number has been raised until there are now more than 1,200 places whence returns are regularly received. Still I know there are many more, probably hundreds, who have either never heard of the establishment of a central depôt to which copies of all rain records should be sent, or they have been too diffident to send them. It is of paramount importance to gather these, and make the tables yet more complete. I therefore beg leave through your columns to ask every reader to think for a moment if he or she knows of any one who keeps or has kept a rain-gauge ; or who has any tables of rainfall (or old weather journals) in their possession. And if they do know of such persons, I ask them on behalf of science, of my fellow-observers, and on my own behalf, to use every effort to secure their assistance, and to favour me with their names and addresses. We want old records, we want records for the present year, and from many parts of the country we want returns for the future, if a few persons will notify to me their willingness to assist, and to pay 10s. 6d. for the very cheap and simple gauge now supplied. To prevent needless correspondence, I annex a list of the places in Middlesex whence returns have been already collected for the years mentioned in the last column, and shall be very glad of any additions or corrections. Other counties, or the complete list for the whole country, shall be sent to any one willing to make good use of it. I may add that an influential committee of the British Association has been appointed to superintend and assist in my investigations, and that they cordially support my present application. The committee is composed of J. Glaisher, Esq., F.R.S., Lord Wrottesly, F.R.S., Prof. Phillips, F.R.S., Prof. Tyndall, F.R.S., Dr. Lee, F.R.S., J. F. Bateman, Esq., F.R.S., R. W. Mylne, Esq., F.R.S. and Mr. J. Symons."

METALLURGY, MINERALOGY, AND MINING.

The determination of the Percentage of Mine-Gas in any mixture can be accomplished with accuracy by means of an ingenious instrument, which has been devised by Mr. Ansell. The apparatus, when complete, is not larger than an old-fashioned watch, and may with convenience be carried by mine overseers into the gallery of mines. It consists of a small aneroid barometer, the case of which is made perfectly air-tight, but the interior of which may be placed in communication with the external air by opening a small screw fastened on the handle. The brass back of the barometer is replaced by a thin plate of porous earthenware, and may be covered with a brass cap or back placed on a hinge like that of a watch. Under ordinary circumstances the screw remains open, but when it is required to test the gas in a mine, the screw is closed and the cap removed from the porous plate. Immediately diffusion takes place, and the pressure increasing, causes a corresponding movement of the hand of the barometer. In about 45 seconds the maximum effect is produced, when the position of the hand indicates, by means of a vernier, the percentage of mine-gas present. If the apparatus be left for a sufficient time, the internal pressure forces the excess of gas through the porous plate, and the needle returns to the zero point. On subsequently allowing diffusion to take place into pure air, the index retrogrades to the same extent (if the mixture does not contain more than 10 per cent. of mine-gas or "fire-damp" to which it had previously advanced.—Vide *Chemical News*, Dec. 15.

A new Iron Ore is described by Mr. John Sutherland, of Glasgow. It has much of the characteristic appearance of plumbago, and leaves a black, greasy stain when rubbed between the fingers. It is comparatively soft, and, when scratched with a knife, falls off the mass in beautiful shining particles, having a metallic lustre, and not unlike powdered mica. The mineral is said to have been obtained in Ireland, near the surface, underlying about fifteen feet of peat. The following is a rough analysis of it :—

Matter insoluble in HCl and NO_5	9·5
Ferric oxide	90·5
	100·0

It is quite unacted on by the blowpipe, and contains no carbonaceous matter whatever.

Wad: a Manganese Ore.—This ore has been described by Professor Henry How, in an article published in the "Transactions of the Nova Scotian Institute of Natural Science." It is a black earthy substance, which is found in rounded lumps and grains. It was sent from Parrsborough, and from another locality to the east of Halifax, where it is found in lumps mixed with stones ; the sample examined contained a great deal of water, and, when dried, 56 per cent. of binoxide of manganese, with the traces of cobalt which are usually found in this species. Neither of these would be valuable as ores of manganese, but they would probably serve as paints. Bog manganese is often mixed with bog-iron ore, and then forms deposits of a brown or chocolate colour, called ochres or mineral paints. The paints of Bridgewater and Chester furnish examples. In the first of these Professor How found only eleven per cent., and in the second about twenty per cent. of binoxide of manganese. It is said to be useless to send to (the English) market ores containing less than 65 per cent. binoxide.

The Allotropic Conditions of Iron.—In a recent memoir laid before the French Academy, M. De Cizancourt put forward some very curious views relative to the constitution of iron. Metallic iron he believes to exist in two different states, just as phosphorus and sulphur do. The metal contained in the ores of the *pro*toxide he terms *Ferrosum*, and those in the anhydrous *per*oxide ores he styles *Ferricum.* Black and grey cast irons are not physical conditions determined by a collection of identical molecules. They are simply ferricum, preserving a part of its properties, and depositing, when slowly cooled, the carbon with which the reaction had charged it while hot. In grey cast-iron ferricum is generally predominant; in mottled cast-iron the two irons are present with their characteristics ; ferrosum gives the white portions and the carbon combined ; ferricum gives the grey portions with a carbon deposit. Malleable irons are formed of mixtures in varying proportions of two irons of different origin, both in the state of ferricum. Ferrosum in this state always partially preserves its hardness and power of returning to its original form. The variety found in the irons of commerce depends on the number of mixtures possible.—Vide *Comptes Rendus*, 9th October.

A New Furnace has been described in the *American Artizan.* It consists of a smelting or reduction fire in combination with a combustion-chamber, ith tuyères for admitting air, and openings in the division-wall. The combination is so arranged as to permit the ignited gases at a high temperature to act directly upon the ore while it is in contact with the carbonaceous fuel within the reducing fire; the gases being at the same time aided in their passage through the openings in the division-wall by a vacuum in the upper portion of the reducing fire by means of a steam jet or any equivalent device. This smelting or reducing fire may also be combined with a reverbatory furnace and a balling-hearth, so that the converted ore, in a metallic state, can be separated from the cinder or slag, and be balled ready for the shingling-hammer, while the escaping gases from the grate of the reverbatory furnace, having been applied to the balling-hearth, are conveyed to the gas-chamber, and after receiving a second portion of oxygen are made to aid in smelting and deoxydizing the ore; thus greatly reducing both the consumption of fuel and the labour in the process of making wrought iron.

The Presence of Didymium in Churchite has been ascertained by Mr. Greville Williams, F.R.S. In the course of some experiments upon the preparation of pure cerium, he found by Gladstone's optical test that Mr. Church's mineral always contains didymium. The lines in the spectrum showing themselves most distinctly, Mr. Williams looked for lanthanum, but unsuccessfully. He thinks that some time will probably elapse before sufficient Churchite is obtained to determine the presence of lanthanum, chemically. The mineral has received the name of Churchite from Mr. Williams, in compliment to Professor Church.

New Cornish Minerals.—At the meeting of the Chemical Society, held on the 2nd of November, Professor A. H. Church gave an account of his investigation of some new minerals from Cornwall. Three of them were of especial interest. These were:—1. hydrated phosphate of cerium; 2. hydrated phosphate of calcium and aluminium; 3. hydrated arseniate of copper and lead. The formulæ deduced from the analytical results proved that the minerals were distinct varieties of well-known species; and with regard to the first of the series, the author stated that it furnished the only instance on record of the occurrence of the rare metal cerium in Great Britain. The crystallographic characters of the new minerals were remarked upon by Professor Maskelyne, who brought with him some specimens from the national collection for comparison.

American Mineral Oil.—According to a recent calculation, there are in America 1,457 companies engaged in the production of petroleum, and representing a capital of 4,547,970,000 francs.—*Les Mondes*, Nov. 23.

Graphite near the Sea of Azof.—A French journal states that a vein of graphite has been discovered in the above locality, and of a quality equal to that of Siberia. The same authority alleges that a source of petroleum has been found in the state of Archangel, near the course of a stream which falls into the Betchora.

Composition of Okenite.—This mineral, dedicated by its name to the celebrated naturalist Oken, was established by Kobell in 1828. It is found in the island of Disco, near Greenland, and in the Faroe Isles, and is met with in some collections under the name of *fibrous zeolite*. It is white and transparent, and its powder attracts moisture strongly. This latter heated to 100° Centigrade loses 12 to 13 per cent. of its weight. Its specific gravity is 2·324. The recent analysis of M. E. Schmidt gives the following as its composition :—

Silicic acid	57·846
Lime	26·090
Magnesia	1·576
Soda	0·231
Loss by calcination	13·975

—Vide *Cosmos*, Nov. 29.

Mine of Cinnabar.—The correspondent of one of the San Francisco journals states that he has seen specimens of cinnabar containing 90 per cent. of mercury, which was taken from a mine in North Almaden, which was opened in July last. The mine is situated in the side of the valley opposite the celebrated mine of New Almaden.

PHOTOGRAPHY.

The Action of Light on Bichromates with Gelatine.—The British Journal of Photography, published on the 25th of August last, stated in the course of an editorial article, that the fact of a film of bichromated gelatine becoming insoluble after it had been dried and exposed to light, was "one of the numerous discoveries of Fox Talbot." This statement remained unquestioned either in that or in any one of the five Photographic journals now existing ; but when we repeated the same *fact* at page 174 of our last issue, it was immediately pounced upon by *The Journal of the Photographic Society*, and denounced, with most intemperate language, in an unsigned article, as a "ludicrously silly blunder." Not content with commenting offensively on our supposed ignorance of what was affirmed to be the universally admitted and incontrovertible fact that Mr. Mungo Ponton, of Edinburgh, was the author of this discovery, the writer characterized our statement to the contrary as "preposterous," "lamentable," and "comical." Our summary was described as "without discrimination," "displaying petty spite and personal feeling," "possessing no scientific interest," &c. &c. ; while we ourselves were with equal politeness written down as "ignorant," "incompetent," and "incapable." These and other adjectives no less select or flattering were crowded into a few lines, which most certainly have even less "scientific interest" than any article we have written for these pages could possibly have had. We cannot characterize such criticism as either just, gentlemanly, or devoid of "petty spite and personal feeling," but we shall not emulate the example it gives, and trust our readers will pardon us if we devote a little of our, or rather their, space to show our angry critic how unwise he has been.

The editor of the *Photographic News* has fallen into the same error. But we are happy—for the credit of Photographic literature—to say that this gentleman expresses himself in decent and courteous language. After admitting that "the records of the early history of Photography are of a somewhat scattered character," he states that "Mr. Mungo Ponton published his discovery in 1838," whereas Mr. Talbot's process was not published until 1852. By way of conclusive evidence, our opponent then shows—*cui bono ?*—merely that many eminent photographic writers and experimentalists have directly and indirectly credited Mr. Ponton with this discovery, a fact which we have no intention of disputing.

Letters *pro et con* have also appeared in the photographic journals, and one in *Le Moniteur de la Photographie* is amusing from the extreme oddness of its misstatements. The editor of *The British Journal of Photography*, referring to our assertion," says, "Talbot *was* the discoverer of the property referred to and not Ponton, and adds, significantly, "there is no fear of Talbot's reputation being at all affected by any kind of detraction, whether accidental or intentional." A correspondent writing in the same journal under the signature "A member of the Photographic Society," says, "I have, in common with other photographers, always hitherto understood that we are indebted to Mr. Fox Talbot for the discovery, that if gelatine be mixed with an alkaline bichromate, and exposed to light, it is rendered insoluble." Another correspondent says, "From the time when the London Photographic Society opposed the renewal of Mr. Talbot's patent in 1854, that gentleman's position has been with consistent ingratitude ignored in its journal. But I was nevertheless astonished at the degree of virulent feeling displayed against a writer in the *Popular Science Review*, merely because that writer stated what is undoubtedly true," &c.; and concludes by asking, as well he might, "why was so much angry feeling displayed ?"

The simple facts stand thus. Mr. Ponton discovered the photographic properties of the salt in question, and Mr. Talbot first discovered the property of insolubility it conferred on gelatine when used as above described. Mr. Ponton's discovery was first published, not in 1838, as the editor of the *Photographic News* states, but in the May of the year following. It was communicated in a paper, entitled a "Notice of a cheap and simple method of preparing paper for photographic drawings, in which the use of any salt of silver is dispensed with," which was read on the 29th of the month, before the Royal Scottish Society of Arts, and published in the journal of that institution, where, of course, it may still be read. In no part of Mr. Ponton's paper is there the slightest allusion to the use of any gelatinous substance; he confines himself simply to demonstrating the photographic applicability of the bichromate when washed over a sheet of paper and exposed to light.

In thus gathering facts and dates for our reply to the editor of *The Journal of the Photographic Society*, we have been subjected to some inconvenience and trouble, which we were scarcely justified in submitting to in controversion of statements so offensively advanced. To dispute as, Plato says, "friends dispute," namely, "for their better instruction," is wholesome and desirable; but, as the same great philosopher says, those who "quarrel to destroy each other" *are enemies*, and for their discordant strife we do not think the pages of a scientific journal, whether photographic or otherwise, are the proper place. Courteous opposition, however vigorous or trenchant, we shall respectfully and courteously resist.

But for the future we shall not feel called upon to notice *ex cathedrâ* statements associated with coarse personalities and vindictive abuse.

North-Eastern Photographic Exhibition.—Mr. H. P. Robinson, one of the exhibitors and jurors of this exhibition, whose contributions were noticed critically in our last, writes denying the truth of our descriptive remarks on the jury awards. All the statements we made had been previously and repeatedly published in *The British Journal of Photography, The Photographic Notes, The Photographic News,* and *The Journal of the Photographic Society.* We must, therefore, refer him to their pages as a more suitable medium for discussing such a subject in. Our business is merely that of chronicling historical facts.

New Lenses.—A very remarkable new photographic lens is about to be introduced by the well-known optician Herr Steinheil, of Munich, which he calls the Periscopic. It was first described at a *séance* given by the Académie des Sciences of Berlin in July last, and its chief novelty is that of being constructed of crown glass only, and yet being, on the authority of the continental scientific press, and the statements of reliable authorities, *perfectly achromatic!* The editor of *The Photographic News*, however, states that it is non-achromatic; but as he confessedly speaks from hearsay, and adds that he "looks with interest for more definite information" than he has yet received, we presume he has no other means of testing the truth of the assertions made than we ourselves possess. Two symmetrical crown glass meniscus lenses, so deeply curved as to resemble, when placed with their concave surfaces outside and a little apart, the form of the globe lens, may, by the aid of a small stop in the centre of the space between the glasses, give images in which the chromatic aberration will be scarcely visible: but it will still exist. The use of so small a stop, and the length of exposure it would render necessary, would, however, affect the character of the photographs produced, and in those taken with this instrument, exhibited at the last meeting of the Photographic Society, there is no evidence to warrant us in adopting such an idea of Herr Steinheil's novelty. This new lens is to be manufactured by Voigtländer; it is very small, is said to be perfectly free from distortion, and its angle of view is so great that a lens of sixteen inches focus covers a field of thirty-two inches! The Paris correspondent of the *British Journal of Photography* states, "that the non-completion of the French and English patents may cause delay in placing these lenses in the market," and tells us that "the time of exposure is not more than with the ordinary globe lenses." We presume the new instrument will be considerably lower in price than those of the usual construction.

Another new lens, of which report speaks highly, is termed the Pantoscopic lens, first exhibited, we believe, before the Photographic Society of Berlin, by Herr Busch. It is a globe lens, with a field of 95°, and it is said to give images free from distortion.

New Photographic Papers.—For years past there have been continual complaints published with regard to the bad character of the paper supplied for photographic purposes, for which reason we are glad to find that within the last three months three new papers have been announced. One in Paris by M. Lœwe, in which the unsatisfactory use of albumen is dispensed with, in favour of a new substance so closely resembling it, that chemical analysis cannot detect the difference, but which is yet said to be quite free from the chief defects of albumen. A second, from America, concerning which there has been much extraordinary trumpeting, and which is called "Porcelain Paper," in consequence of its hardness, whiteness, and freedom from the objectionable glare of albumen. A third, in America, by Mr. Follet, concerning which we have as yet been able to gather no special facts.

Photographs and Book Illustration.—The Legislature of Massachusetts has been the means of publishing a supplement to the late Professor Hitchcock's "Geology of New England," illustrated by photographs from nature. This book will be a valuable addition to scientific libraries. A cheap medical work of great interest on the application of phenic acid in medicine, illustrated with photographs, has been published in Paris. Mr. Stephen Ayling, of Oxford-street, is publishing a most valuable collection of beautiful photographs, from sketches by A. Welby Pugin, in which some of the greatest difficulties to be met with in the art of photographic reproduction have been encountered and surmounted with consummate skill and ability. Professor Hoffman has recently issued an excellent manual of "Modern Chemistry," illustrated from photographs, and Mr. A. W. Bennett is also issuing some beautiful photographic gift-books. This branch of art will doubtless receive a new and extraordinary impetus from the introduction of Mr. Walter Woodbury's new process of printing in relief. At the last meeting of the London Photographic Society, one of the most crowded we have yet had the pleasure of attending, the whole of this process was gone through before those present, and elicited universal marks of approbation, although some of the members appeared to be unusually slow in comprehending the simple details of this beautiful process, and rendered Mr. Woodbury evidently nervous by their persistency in repeating the same questions, and misunderstanding the clear and explicit replies they received.

Astronomical Photography.—The partial eclipse of the moon on the 4th of October was chronicled by Mr. De la Rue in a series of seventeen photographs. A late eclipse of the sun was photographed by Mr. Thomas P. Shepard, of Philadelphia, with considerable success. The American correspondent of *The British Journal of Photography*, describing this photograph, says, "The sun itself appears as a small bright crescent, surrounded by a dark circle of at least twice its own diameter. That, again, is in the centre of an irregular mass of very bright clouds, which are themselves surrounded with darker ones. The whole effect is exceedingly curious, and it is very difficult to account for the dark circle immediately around the sun, which is not concentric with it, but with that part of the sun's limb which is farthest from the moon. The light crescent has a pretty well-defined border, but the darker circle is much less defined." Mr. A. Brothers exhibited early in October, at the Photographic section of the Literary and Philosophical Society of Manchester, a valuable series of instantaneous photographs, taken during the progress of the recent eclipse of the moon on October 4th. These were twenty in number. The first was taken at 8·45, when the moon was nearly full, and the last at 12·45, the remainder having been exposed at regular intervals of fifteen minutes. These were taken with an equatorial telescope of five inches aperture and six feet focal length, with clockwork driving arrangement; and considerable time was occupied in calculating the allowance to be made for the difference between the chemical and visual foci of the object-glass. An attempt was made by the exposure of one plate for a quarter of an hour, to obtain the darkened limb of the moon, but no impression was obtained. But the most magnificent photograph of the moon yet taken is said, on the authority of some of our scientific contemporaries, to be one taken in America, in March last, by Mr. Lewis Rutherford, an amateur astronomer of repute. This production was exhibited at the last *séance* of the Academy of Sciences, Paris, by M. Foucalt, and excited great interest. The *Photographic News* has published some curious statements with regard to the instrument with which this photograph was taken. These inform us that Mr. Rutherford was at considerable pains to spoil a costly telescope, by taking out and *re-grinding* the lenses, in order to render their chemical and visual foci perfectly coincident. Considering the simple and easy methods by which such an end might have been gained, without making any such "alarming sacrifice," we think such assertions must have been based upon some mistake or misconception. The photograph represents the satellite with one half the illuminated surface turned towards the earth. The surface is extremely rough, and a series of immense cavities correctly indicated with light and shade, having raised edges, and some lofty cones rising abruptly from near the centres of the hollows, form a kind of boundary-line between the illuminated and the shadowed sides, the character of which is very clearly marked and peculiarly interesting.

Registration of Earth-Currents.—The Astronomer Royal and Mr. Glaisher, of the Greenwich Observatory, have recently had some improved apparatus constructed to register by photography the power and direction of earth-currents, which we believe will be shortly tested. Of these electrical effects and their causes, very little is at present known, although the electric telegraph has fully demonstrated the frequency and power of what are called magnetic storms. The present mode of registering these currents is thus described :—Paper sensitive to light is fastened round a cylinder of polished ebonite, which withstands chemical action. This being placed in a dark box horizontally, is made by clockwork to revolve once in the twenty-four hours. A ray of gas-light which has passed through naphtha, shines through a hole in the lid of the box upon the centre of the slowly moving cylinder. Two wires running, the one to Croydon and the other to Dartford, are brought into this box, and connected with an astatic galvanometer. The one wire hangs as nearly as possible in the magnetic meridian, and the other at right angles to it. The earth currents are found to do the same with this apparatus as they do with the earth-plates and attached telegraph-wires, thereby moving the prepared astatic needles and photographing themselves on the sensitized paper. A small mirror is attached to each astatic galvanometer, which moving with the needle, reflects a ray of light from side to side on one half of the sheet of paper, and thus registers the direction of the magnetic meridian on one side, and currents at right angles to it on the other, with a fixed line between. The new and improved apparatus is from a design by Mr. C. F. Varley, engineer-in-chief to the Atlantic Telegraph Company. We hope to describe it in our next.

New Printing Process.—Mr. Palmer, of Stonehouse, Devon, by employing gelatine instead of collodion, as suggested by Mr. G. Dawson, of King's College, has perfected a very beautiful process of printing on paper or opal glass, which will take rank with the very best of the new printing processes recently introduced. Mr. Palmer's process is based on the suspension of chloride of silver in gelatine.

PHYSICS.

Physical Phenomena of the Hydrogen Flame.—Mr. W. F. Barrett, of the Royal Institution, has published some curious observations of the effect of contact of a hydrogen flame with various bodies. When conducting some experiments last spring, in which the hydrogen flame was directed against certain bodies, a peculiar blue colour was produced. A careful examination of this blue coloration showed that it occurred only when the flame came into actual contact with the substance, the colour being restricted with great precision to the place where the hydrogen was in combustion; accordingly, it gave in section a faithful image of the construction of the flame. This singular appearance was invariably of a rich blue tint; its production was instantaneous, but its duration was generally short, for it disappeared after a few seconds' exposure when the flame continued to play upon one spot, although it was immediately restored by shifting the position of the jet to an untried portion. A classification of the substances employed yielded no satisfactory clue to the cause, even blocks of ice exhibiting the peculiar colour. Several experiments were made in vain to discover the source of the phenomenon, till at length an accident revealed it. "Amongst the various substances I examined," says Mr. Barrett, "I found round that vulcanized india-rubber, when exposed to the flame, exhibited the blue colour with great brilliancy. But here I had reason to believe the blue colour was occasioned by the combustion of the sulphur with which the india-rubber is associated. To see if such were the case, a plate of platinum had its surface rubbed with a stick of sulphur, and was then exposed to the flame. Although no blueness was visible before, yet after the rubbing the coloration shone out brightly for a short time, having in every respect the same appearance as the luminosity seen on granite, &c. Afterwards I found that the slightest contact of sulphur, or a body containing it in the free state, was sufficient to impart to any substance the power of showing the blue coloration beneath the hydrogen-flame. When a plate of platinum which showed the blue colour from being wiped over with a piece of vulcanized rubber, was examined with a high power under the microscope, some spots were seen which were unaffected by a drop of water, but which readily dissolved in bisulphide of carbon. These and other experiments convinced me that, at any rate, the chief part of the phenomenon must be attributed to the presence and combustion of minute quantities of sulphur." The writer concludes by supposing that sulphur being present in the atmosphere, the various substances examined by him became impregnated with it."—Vide *Philosophical Magazine*, November.

Pressure and Temperature of the Air in Mines.—M. Simonin's experiments do not enable him to establish any general laws, but the mean of four experiments at the coal-mines of Creuzot and Epinac gave a rise of one degree (C.) of temperature for every 45 metres of vertical descent, and a rise of one millimetre in the barometer for every $10\frac{1}{2}$ metres of vertical descent.—Vide *Comptes Rendus*, Dec. 4.

A new Insulating Material.—Mr. W. A. Marshall, Leadenhall-street, London, has invented an isulating material for telegraphic and other purposes. It consists in the employment of asbestos or amiantus (amiante) for insulating purposes. The invention also consists in protecting and completing the insulation of telegraphic wire, especially for submarine and subterranean purposes, previously covered with the asbestos or amiantus by surrounding or inclosing it in a metal tube, by preference of tin.

Simple Form of Filter.—A very simple and perfect form of filter has been devised by the *Apparateur* of the College of France, and deserves attention. It is made by placing in a tank of impure water a vessel so arranged that a sponge which it contains shall lap over its edge and dip into the water of the tank. The sponge gradually sucks up and purifies the water in the reservoir, and allows it to drop into the smaller vessel or receiver, from which it may be drawn off by a tube. By placing a few lumps of charcoal in the bottom of the receiver, filtration of the most perfect kind may be effected.

Electricity in Sounding.—A very ingenious instrument for obtaining the accurate soundings of deep water has been devised by M. Hédouin, of Lyons. The difficulty which presents itself in the case of the apparatus at present employed is to ascertain the exact moment at which the lead touches the bottom. This obstacle is removed by M. Hédouin's invention. In his contrivance the sounding-line is a kind of light telegraph cable inclosing two perfectly insulated wires, both connected at one extremity with the lead, and at the other with the two poles of a galvanic battery. The lead is so arranged that on touching the bottom, contact is made between the ends of the two wires; thus a current is established, and this, by ringing a bell placed in connection with the battery, announces the exact moment at which the lead touches the sea-bottom.

Spectrum Analysis in the Detection of Chlorine, Iodine, &c.—The difficulty of recognizing small amounts of iodine, bromine, and chlorine in a mixture of haloid salts is well known. Hitherto it has been found impossible to detect these elements in such mixtures, when exceedingly small quantities were present. Herr Mitscherlich has, however, discovered a method of detecting them by the spectroscope, and he gives it in a late number of *Poggendorff's Annalen.* It is as follows:—The substance to be examined, well dried, is intimately mixed with half its weight of sulphate of ammonia and one-tenth its weight of oxide of copper. This mixture is placed in a globular enlargement of a combustion-tube, one end of which is connected with a hydrogen gasometer, the opposite end being open. A stream of hydrogen is passed through the tube, and heat graduallly applied to the mixture. The hydrogen being ignited, the first appearance seen in the spectrum apparatus is a brightness in the green, in which, however, no definite spectrum can be perceived;

but afterwards the spectrum of the haloid salt of copper is distinctly visible.

Observation on the Dip of the Magnetic Needle.—Mr. P. E. Chase gives the following as the result of his observations :—

1. The lines of equal dip are arranged in approximate parallels, around the two (principal) magnetic poles.

2. In consequence of this parallelism, they are convex towards the north in the Pacific Ocean, and towards the south in the Atlantic Ocean.

3. The magnetic parallels also approximate to the isothermal parallels, both in direction and in position, but with some important departures.

4. In South America, the magnetic equator is depressed nearly 30° south of the isothermal equator ; it is, however, nearly equidistant from the (principal) north and south magnetic poles.

5. The magnetic parallels near the magnetic poles are more convex than the isothermal lines, but they present some interesting instances of parallelism to the ocean currents, which are indisputably gravitation currents.

6. This parallelism is specially observable in the regions of the equatorial currents, the Gulf Stream, and the North Pacific and Japan currents.

7. If a series of waves were propagated through the air, from the magnetic poles to the equator, with slight deflections by the continental contours and ocean currents, they could be represented with great accuracy by the magnetic parallels.—Vide *Proceedings of the American Philosophical Society*, vol. X. No. 73.

Peculiar Phenomena of Efflorescence.—Herr Pape's investigations on the efflorescence of crystals are continued in *Poggendorff's Annalen.* The writer's object is to show that this action is not propagated, as might have been supposed, irregularly, but in spots of a certain determinate form, generally partaking more or less of the ellipsoid. The relative proportions of the diameters of these figures are, he states, intimately connected with the form of the crystal. He mentions the well-known fact of the difference in the heat-conducting powers of a crystal in different directions, which he considers to be somewhat akin to the phenomenon he describes. In some substances—for example, newly-formed crystals of Glauber's salt—large elliptical spots may be noticed within five or ten minutes after their removal from the mother liquor. In sulphate of zinc the same thing may be observed after the lapse of a day or so, the isolated spots having a regular and sharply-defined outline. The efflorescence takes place with greater rapidity in the direction of the shorter axis of the crystal, and slower in that of the longer axis. The form, then, of the efflorescence-figure of any particular face of the crystal depends on its position with regard to the axis. He suggests that this fact may be found useful in determining the system to which a crystal belongs when the ordinary method fails to give satisfactory results. The same law may probably hold good during the separation of other substances besides water, such as carbonic acid or ammonia from crystals containing these compounds.—*Reader*, Dec. 2.

A New Mode of Barometric Registration is proposed by Mr. Edward Crossley, in a letter addressed to the *Chemical News* of November 3rd. Without doubting that the photographic registration of the barometer is capable of great accuracy, he thinks that there is another method by which as great accuracy may be obtained without the uncertain friction of a float, less liable to get out of order, and, consequently, more useful in the hands of the public. The principle is that of an independent, vertically-moving rod, registering instantly the point at which it comes into contact with the mercury of the barometer by thus forming an electric circuit. As an ordinary modification, he suggests that every hour the rod should be lowered through the whole range of the barometer by clockwork. On the formation of contact, an electro-magnet, by means of an armature, would cause a point carried along with the rod to be indented into the registering paper, or other material, on a revolving drum, similar to those already constructed for the purpose, to go for a week at a time. For more accurate purposes still the drum might be made larger,—say five inches in diameter, and fourteen inches long, and divided vertically into two inches for every day. In this case the drum would have to be moved upon its vertical axis every time, through a division equal to the interval of registration,—one-twelfth of an inch for one hour, for instance—and the recording-point would remain stationary, except when acted on by the magnet. At the hour, a simultaneous motion would have to be given to the rod and the drum,—the first vertical and descending, the other horizontal and revolving—so that one inch and a half of the one would be equal to fifteen inches circumference of the other. The electric current, by means of the magnet as before, would, at the instant of contact, record the point at which this took place, and, consequently, the height of the barometer at that time.

The Physics of Absorption.—The curious fact pointed out by Pouillet in 1822, that when a fluid is absorbed by a porous substance, a rise in temperature occurs, has given origin to some strange explanations and discussions. The subject has recently been taken up by Jungk, who attributes the alteration in temperature to the formation around each particle of the porous body of a thin layer of fluid, " in which the individual molecules move with much less freedom ; thus pointing to a condensation of the fluid in those parts." In support of his theory, he quotes a paper by Rose, on the errors which arise in the determination of the specific gravity, when the substance is weighed in a state of fine subdivision. The finer the particles of the body under examination, the greater will be the resulting specific gravity. He proceeds by assuming that the temperature of a body rises or falls when, by any external means, it is caused to assume the condition induced by the subtraction or addition of heat respectively. Applying this in the case of water, it would follow that when it is absorbed by a porous substance, the temperature should either rise or fall according as the water is below or above 4° C.—the point of maximum density. This, in fact was found to be the case, and the results of his experiments may be shortly stated as follows :—1. The temperature of water, when absorbed by sand, is raised or lowered, according as it was previously either above or below 4° C. 2. Water at 0°, when absorbed by snow, is lowered in temperature. 3. The phenomenon may be regarded as a consequence of the condensation of the water on the surface of the absorbent body.—Vide *Poggendorff's Annalen*, No. 6, 1865.

ZOOLOGY AND COMPARATIVE ANATOMY.

The Relations of the Brachiopoda.—In a memoir just published, M. Lucaze-Duthiers controverts the current opinion regarding the zoological position of this class. He has pointed out that, contrary to the beautiful inquiries of Professor Huxley and Mr. Hancock, the Terebratula is not closely allied to the Molluscoida, but has closer affinities with the Bivalves. The horse-shoe process is almost the only structure resembling that of Molluscoida. He corroborates Professor Huxley's statement that the intestine of Terebratula is cœcal, and thus arrives at a very different conclusion from that put forward by Professor Owen.—Vide *Comptes Rendus*, Nov. 6.

The Development of the Axolotl.—At a late meeting of the French Academy, M. Aug. Duméril described the results of his observations upon the development of the Axolotl (*Siredon Mexicanus*). At a former meeting (April last) he described the first changes which the ova undergo. He has since carefully watched the several metamorphoses exhibited by the specimens in the Ménagerie of the Museum of Natural History. Having described the external changes of form which these interesting reptiles underwent, M. Duméril asserted that a corresponding series of internal modifications accompany the outer ones. "The scarcity of specimens prevented my following through their progressive course the changes presented, by the hyo-branchial apparatus, but the anatomical examination of their structure in one of the specimens showed that the three internal branchial arches had disappeared; there remained only the most external one, which, deprived of its dentated membrane, and united by an articulation with the *cornu* of the thyroid cartilage, constituted a sort of posterior joint. Behind this piece was seen on each side the anterior branch of the hyoid bone. The median or basihyal piece was well developed, and, as in the other parts of the hyoid, ossification had commenced. The bodies of the vertebræ were less concave on the posterior surfaces, but especially so upon the anterior.

The Ooze from the Bottom of the Atlantic has been described by Mr. Sidebotham in a paper read before the Manchester Philosophical Association. In the unsuccessful attempts made to raise the Atlantic cable, the grapnels and ropes brought up with them a quantity of ooze or mud, some of which was scraped off and preserved. He obtained specimens of the deposit from Mr. Fairbairn, and submitted them to microscopic examination. In appearance the deposit resembles dirty clay, and reminds one of the chalk of Dover; indeed, it presents such appearances as would lead to the inference that a bed of chalk is now being formed at the bottom of the Atlantic. It was composed entirely of minute organisms, which exhibited a very fragmentary condition.

The Back-bones of Men and Apes.—A most important and noteworthy memoir has been published by Mr. St. George Mivart, in which the writer shows the relation which exists between the vertebral columns of the primates. The latter group he regards as divisible into four separate sections, which are represented respectively by (1) *Simia*, (2) *Cercopithecus*, (3) *Nycticebus*, and (4) *Lemur*. The affinities of these sub-types he has ingeniously represented in a sort of arborescent scheme, in which the several branches correspond to separate genera.

Rinderpest in the French Zoological Gardens.—The *Times* (December 9), quoting the *Echo Agricole*, states that the cattle plague is spreading among the animals of the Zoological Gardens of the Bois de Boulogne. It has attacked the goats, four of which were killed on Tuesday, making eighteen deaths among the animals since the arrival of some gazelles from London. Fortunately the disease has not been observed outside that establishment, and the greatest precautions are taken to prevent it from spreading. All animals suspected of being infected are immediately killed.

The Moa's Egg.—Since our last issue a splendid specimen of the egg of the Dinornis has been exhibited in this country, put up to auction, and "bought in" by the proprietors for £125. Some interesting details concerning the history of gigantic bird's eggs have been supplied by a contemsporary, and we quote them for our readers :—

In 1854, M. Geoffroy de St. Hilaire exhibited to the French Academy some eggs of the Epyornis, a bird which formerly lived in Madagascar. The larger of these was 12·1 inches long, and 11·8 inches wide ; the smaller one was slightly less than this. The Museum d'Histoire Naturelle at Paris also contains two eggs, both of which are larger than the one recently put up for sale, the longer axis of which measures 10 inches, and the shorter 7 inches In the discussion which followed the reading of M. de St. Hilaire's paper M. Valenciennes stated it was quite impossible to judge of the size of a bird by the size of its egg, and gave several instances in point. Mr. Strickland, in some "Notices of the Dodo and its Kindred," published in the *Annals of Natural History*, for November, 1849, says that in the previous year a Mr. Dumarele, a highly respectable French merchant at Bourbon saw at Port Leven, Madagascar, an enormous egg, which held "*thirteen wine quart bottles of fluid.*" The natives stated that the egg was found in the jungle, and "observed that such eggs were *very, very rarely* met with." Mr. Strickland appears to doubt this, but there seems no reason to do so Allowing a pint and a half to each of the so-called "quarts," the egg would hold 19½ pints. Now, the larger egg exhibited by St. Hilaire held 17¾ pints, as he himself proved. The difference is not so very great. A word or two about the nests of such gigantic birds. Captain Cook found, on an island near the north-east coast of New Holland, a nest "of a most enormous size. It was built with sticks upon the ground, and was no less than six and twenty feet in circumference, and two feet eight inches high."—(Kerr's *Collection of Voyages and Travels*, xiii. 318.) Captain Flinders found two similar nests on the south coasts of New Holland, in King George's Bay. In his "Voyage, &c.," London, 1818, he says, "They were built upon the ground, from which they rose above two feet, and were of vast circumference and great interior capacity ; the branches of trees and other matter of which each nest was composed being enough to fill a cart.—Vide *The Reader*, Dec. 2.

The Muscular Force of Insects.—At the meeting of the Royal Society of Brussels, held on the 4th of November, a report was read on M. Plateau's memoir on the above subject. The author, by means of very ingenious experiments, attempts to show that the muscular force of insects compared with that of the vertebrates is enormous. The common cockchafer is capable of exerting a tractile force equivalent to fourteen times the weight of his body, whilst the drawing power of a horse is only ·67 of his weight. As the result of 500 experiments on different insects, he states generally that the power exerted is inversely proportional to the weight of the insect. This interesting paper was ordered to be printed in the *Bulletin*.

Historic Age of the Dog.—M. Quatrefages has presented to the Academy a curious memoir on the origin of the race of dogs. In China, he states, the exact period of the introduction of the dog is well known. It was in the year B.C. 1122, that is about 3,000 years ago, or about the period of the siege of Troy. The dog appears, from what the writer asserts, to be a domesticated jackal, and the jackal a savage dog.

Do Male or Female Moths first emerge from the Pupa?—This query is replied to by Mr. E. Birchall, of Bradford, who concludes that a few females are the first to appear; that about the middle of the flight the numbers of sexes are equalized, and that the males continue to appear for a day or two after all the females have emerged from the pupa; and this appears to be an arrangement admirably calculated to provide a partner for every female. From various causes female moths appear to be less numerous than males, but he believes this to be only in appearance: the female has more important business in hand than sipping sugar, or flying round a lamp, and is also more lethargic in her habits. He has been struck with the equal division of the sexes in broods reared from the egg; for instance, in the large brood of L. caniola reared this year, the number of each sex is exactly the same; whereas at large he has never captured more than one female for ten males of this species.

The Zoological Society's Gardens.—In the list of the vertebrated animals, published recently, the distinguished editor, Dr. Sclater, gives the subjoined table, which is quite sufficient to show the prosperous condition of the association, and its efforts to promote the interests of science:—

January 1st.	1855.	1856.	1857.	1858.	1859.	1860.	1861.	1862.	1863.	1864.
Quadrupeds.	387	394	443	379	285	364	467	450	485	567
Birds.........	768	770	802	775	881	819	931	843	1114	1063
Reptiles	104	118	156	137	156	137	192	121	149	100
Total	125	1282	1401	1291	1322	1320	1590	1414	1748	1730

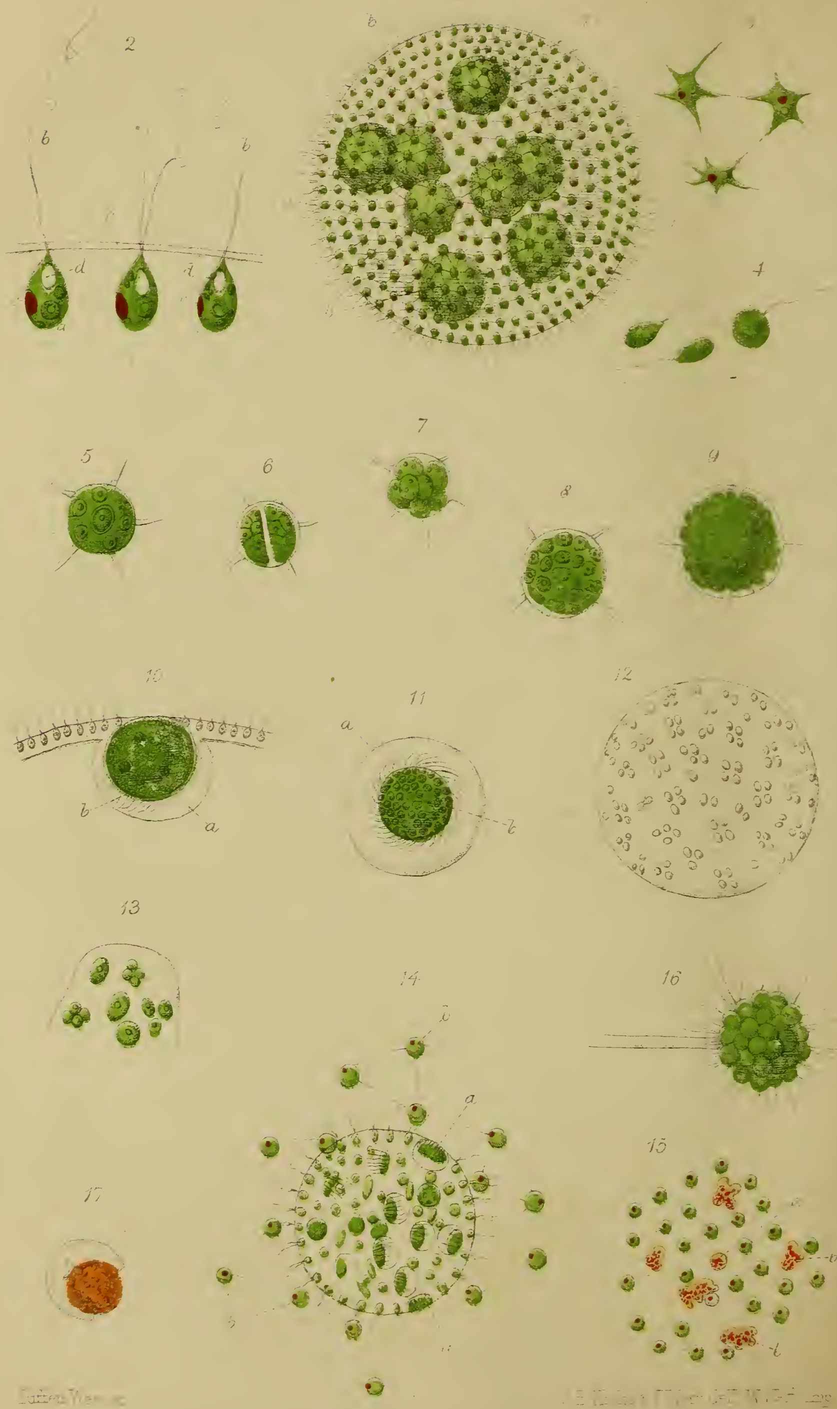
The Microscopic Anatomy of the Hydrozoa.—Professor Kölliker has published his researches upon the histology of the hydrozoa, in the *Natural History Journal of Wurzburg*. In these animals he distinguishes three kinds of connective tissue. One forms the tentacles of the hydroid polyps, and all the solid tentacles of the Medusæ. It presents the appearance of a series of cells (*muscular cells* of Keferstein) occupying the axis of the tentacle. These cells possess no contractility; at least, the tentacles of the Æginidæ and Trachynemidæ which present this structure are rigid. The contractile tentacles owe their contractility to a muscular layer situated between the cellular axis and the external epithelium. This cellular axis is only a dependence of the internal epithelium which lines the digestive cavity (Hydroids), or the marginal canal (Medusæ). It probably acts as an elastic organ antagonistic to the muscular layer. The second kind of connective tissue is a substance destitute of cells, which forms the umbrella of all the simple Medusæ, including the gelatinous substance of the natatory bells and covering laminæ of the Siphonophora. Sometimes this substance is entirely homogeneous, sometimes it is traversed by numerous fibres very like the elastic fibres. In an Æquorea these fibres are attached to a membrane capable of isolation, placed beneath the epithelium of the convex surface of the umbrella. The third form is the well-known gelatinous substance, with disseminated cells, of the umbrella of the higher Medusæ. Professor Kölliker agrees with Professor Virchow in denying the existence of these cells in *Cyanœa capillata*.—Vide *The Quarterly Journal of Microscopical Science*, No. XX.

The Episternal Apparatus of Mammalia.—Herr Gegenbaur has published a valuable essay upon the episternal bones of mammals, which has been translated in the *Natural History Review* (No. XX.). He considers that there are three principal varieties in the conformation which these bones assume in quadrupeds. The first, which may be regarded as the most complete, is that in which the episternal consists of a median piece connected with the sternum, and carrying two lateral transverse portions. The second form is characterized by the presence of the median piece alone, and is seen in the frog and crocodile. The third form is characterized by the absence of the median piece, the two lateral portions being still visible. The whole structure seems here to be dependent upon the presence of a clavicle, and from its appearance, with few modifications, it constitutes a connecting medium between the clavicle and the sternum.—Vide the *Jenaische Zeitschrift für Medecin*, vol. I. p. 175, and *Natural History Review*, as above.

The Transformations of Chloëon dimidiatum have been most carefully observed and detailed in a memoir written by Sir John Lubbock, F.R.S. This insect is one of the Ephemeridæ or day-flies. The larva, in the earliest stage observed by Sir John Lubbock, is a minute, transparent, active creature, with a large head, a tapering abdomen, and two long caudal appendages. It spends about a year in the water, during which time it increases in size, and alters considerably in appearance. The changes, however, are produced quite gradually, the insect going through about twenty changes of form, each accompanied by a change of skin. The antennæ increase in length and in the number of segments at each moult, and it is remarkable that this increase is not produced by a growth of the entire organ, but by a rapid development and division of the third segment, counting from the base. In the first stage, the larva has no respiratory organs, either external or internal. After the first change of skin, however, the posterior angles of several abdominal segments become elongated, and after one or two more moults, these elongations have taken the form of the gills or branchiæ characteristic of the species. At the same time, the tracheæ make their appearance. So far as the author is aware, no other insect has yet been observed which is entirely distitute of tracheæ. After the first one or two moults, a minute knob appears between the two caudal appendages, and with each moult this knob increases in length, so that the larva, which had originally two tails, finally possesses three. After about eight moults have taken place, it may be observed that the posterior mesothoracic angles are slightly elongated. At each change of skin, these, the first rudiments of the wings, become more apparent, and when the insect finally leaves the water, these rudimentary wing-cases cover the first two or three abdominal segments. The external sexual differences commence to manifest themselves at the eighteenth stage. They consist principally of the rudiments of the pillared eyes, and of the processes on the under side of the penultimate abdominal segment, both of which are characteristic of the male sex.

The Birds of Siberia.—In an important treatise, published under the patronage of the Imperial Geographical Society of St. Petersburg, and which is the second of a series intended to be issued on Siberian zoology, the author, Herr Radde, not only records the species, but gives an account of the periods of the migration of Siberian birds. He gives a list of 368 species, which he refers to the following orders :—Rapaces, 36 ; Scansores, 19 ; Oscines, 140 ; Gallinaceæ, 18 ; Grallatores, 74 ; and Natatores, 81. Concerning the migration of birds, Herr Radde confirms the result arrived at by Von Middendorf in his learned memoir "Die Isepiptesen Russlands ;" the most important of them being, (1) that the high table-land of Asia and the bordering ranges of the Altai, Sajan, and Dauria retard the arrival of the migratory birds ; (2) eastward of the upper Lena, towards the east coast of Siberia, a considerable retardation of migrants is again noticeable ; and (3) the times of arrival at the northern edge of the Mongolian high steppes are altogether earlier than those of the same species on the Amoor.

Plate VIII.



The structure & development of Volvox globator.

ON THE VOLVOX GLOBATOR.

BY J. BRAXTON HICKS, M.D. LOND., F.R.S., F.L.S., Etc.

EVER beautiful and fresh are the varied attires in which Nature clothes herself; beautiful both in form, as well as in fitness of adaptation to surrounding circumstances, and fresh in ever-recurring alternations. In these the lover of Nature finds an inexhaustible mine of delight; and to him who, like Humboldt, possesses the soul to enjoy its external expression, and can claim a knowledge of the intimate phenomena which attend these changes, they shadow forth the wonderful laws by which they are guided, giving him a constant stimulus to unravel the whole history of the life of each object.

And, perhaps, to the microscopist these things have a deeper interest than to the mere outward observer of form, because by his instrument he is enabled to penetrate deeper into the transactions of the laboratory of Nature, learning, at any rate, the modes employed in hewing out the stones of which all animal and vegetable life is built; albeit he is certain to find that there is a depth still beyond, which lures and entices him on, showing him something yet to be unravelled and something to be admired at every stage.

And thus each returning spring is hailed by the student with especial delight, because again he returns with vigour to his engrossing study, and because he finds the renewed energy of all life supplying him with numberless opportunities for observation, remarkable alike for variety of form and multiplicity of changes.

Of these remarks an excellent instance is to be found in the "Volvox Globator," the subject of the present article and the delight of every beholder.

Though now classed under the Confervoid group of the Algæ (of which position every succeeding observation increases the propriety), it was for a long time regarded by naturalists as belonging to the lower groups of the animal kingdom; and, indeed, with a good show of reason, so long as motion was looked upon as the peculiar and distinctive mark of animal life. But, since it has been indubitably shown by numberless examples, that motion also belongs to vegetable life as well as to the animal, it was transferred to the botanists—not, however, until after exhaustive and prolonged argument—the motion produced by the cilia and a certain movement of the cells (both hereafter to be described), being the only points it has in common with the animal kingdom.

Thus, as before remarked, it has been made a "conferoid" of the family Volvocineæ, the most striking feature of the group being that it consists of a family of green cells, having the power of motion by means of fine cilia, or hairs, and held together by a delicate and more or less spherical membrane.

The Volvox Globator is the largest species in the family, and is by no means rare, being found in open, clear ponds, where the water is free from sewage; and particularly in those ponds whose water is not exhausted during summer nor flooded during winter, though it is, doubtless, found in somewhat transient pools. We are more likely to meet with it on the sunny margins, especially if we seek it during the earlier months. If, in such situations, we dip a wide-mouth phial into the water near the surface, and hold it up against the light, a little green ball may be observed slowly moving about, the nature of which is readily recognized by the assistance of a pocket-lens; indeed, although pond water presents many green balls moving about which are not Volvoces, still the experienced naked eye may, without difficulty, recognize them from their being less opaque. The best manner of securing Volvox Globator is to pass a small muslin net through the water gently, and then to invert it into the water of the wide-mouthed bottle, when a slight shake will detach them; this can be frequently repeated till a sufficient number are secured. To place them in the live box for observation, the best plan is to use the glass dipping-tube in the mode described in books on the use of the microscope.

Let us now proceed to the more minute description of this exquisite organism. It averages about the fiftieth of an inch in diameter; but considerable variation occurs in size. It is a symmetrically-formed sphere (fig. 1), composed of perfectly colourless transparent membrane, with colourless watery contents, without any aperture; resembling a very thin glass bubble filled with water. But it is studded all over at equal distances with small green spots (fig. 1, *a a*) in quantity varying from thirty, to ten times that number; to which the whole body owes its green colour, resembling, under a low power of the microscope, a glass ball studded with emeralds. These green spots, seen in profile, are drop-shaped (fig. 2, *a a a*), the pointed end just penetrating the transparent sphere (fig. 2, *c*); while the large end points to the centre, and is entirely within the cavity (fig. 2). If this drop-shaped green body, or, as it is called, "zoospore," be carefully examined by a ¼-inch object-glass, it will be noticed that one or two delicate, colourless hairs, or "cilia" (fig. 2, *b b*), are attached to the point which just projects through the membrane. It will also be seen that these "cilia" move about with more or less rapidity. Their length is considerable—three or four times the length of the zoospore—and to the associated movements of all is due the easy rolling motion of Volvox. By placing some carmine in the water, the direction of the currents produced by the "cilia" can be well seen—the granules of the carmine in one part rushing towards, in another away from, the Volvox. To what, then, is this movement owing? If we observe the action of "cilia" in even animal bodies, we have reason to believe that it is owing to chemical changes within, rather than to nervous power; for, after the death of the animal—for instance, the common mussel—for three hours, and even to commencing putridity, the action of the cilia of the beard or gills has been observed. One can hardly doubt but that in Volvox they act in concert, when we observe the steadiness with which the total movements take place; for at one time it slowly moves across the field of the instrument—then it stops and simply revolves—then it combines both rotation and progression; but we are ignorant as to what regulates and controls this action.

It may be observed by an oblique light, if not otherwise readily seen, that there are lines of communication between all the green bodies (fig. 1, *a a*). The origin of these was at first rather puzzling, but observers noticed that in some Volvoces the "zoospores" were not always drop-shaped, but somewhat star-shaped, the rays of each touching the rays of the adjoining zoospores (fig. 3). Ultimately these rays were retracted, a little line of clear matter only remaining between them, while the green body became drop-shaped. This peculiar shape of the zoospore is occasionally so marked as to lead the early observers to conclude that it characterized a distinct species, which was named "Volvox stellatus;" but all the intermediate stages may frequently be seen.

Let us pay a few moments' attention to this drop-like "zoospore" (fig. 2, *a a a*), using still the higher magnifying powers. Formerly they were considered as "animals," and were classed as "Monads;" being like them supposed and so described, as possessing an eye, mouth, and several stomachs. But really no such organs exist. It is true there is frequently a bright red spot (fig. 2, *e e e*), which was called the eye; and hollow spaces (fig. 2, *d d d*), which were called stomachs; but no aperture is perceptible which might have been mistaken for a mouth, and constant observation has failed hitherto to detect the entry of any extraneous body into the interior of the zoospore. The cavities or "vacuoles" do, however, possess a curious power of contracting at intervals of about forty seconds. This feature was first described by Mr. Busk. Had the earlier observers noticed it, they would have looked upon it as an additional evidence of the animal nature of Volvox. But this peculiarity has been observed in other plants; it is probably owing to certain chemical changes going on within, connected with the process of nutrition, &c.

Those who have been accustomed to the examination of the Algæ, and other of the lower tribes of plants, will easily recognize in the zoospore of the Volvox, the strongest similarity to the ordinary zoospore, of which fig. 4 gives the common appearance. If one of the drop-shaped bodies of Volvox were detached and set free, it would be precisely similar to them. The zoospore of the Algæ is formed out of the contents of the cells, the outer wall of which after a time dissolves or bursts, and sets free the "zoospore." The latter now liberated, by the aid of two cilia, similar to those of the Volvox, is vigorously impelled forward by a process something like that of the screw of a steam-ship. Hence we may describe Volvox as a family of "zoospores" which has a power different from others hitherto known, of continuing to reproduce itself for many generations. And this latter feature brings us to the consideration of an appearance which really is the most noticeable and striking of all. Upon the most casual observations of Volvox, round green balls (fig. 1, *b b*) of varying size may be seen within, either still attached to the inner surface of the outer membrane, or free in the interior, revolving there as if they were external. These are readily seen to be like the parent, only more green, and much smaller. These are the progeny—"daughters," as they have been called. Their number varies from two to ten; six to eight being the more frequent. The darker colour is owing to the distance between the zoospores being less than in the parent at that time. However, as the young sphere enlarges, the distance is increased, and a greater transparency ensues. Now, each of these young Volvoces originally springs from a zoospore. Nor is it so infantile but that it has already begun to rear "granddaughters." And it is in these latter that the process of development can be easily traced. Let us, therefore, for a moment, attend to the mode of growth.

In the youngest "daughter," you will find that some of the "zoospores" are larger than the others (fig. 5). It is from these that the future offspring arises. The changes are as follows:—first, generally the cell is divided by a septum (fig. 6) into two parts by the process known to botanists as "binary" cell-division, or segmentation; or it may commence by the separation of the whole mass at once into as many as ten smaller portions (fig. 7), each of which becomes a cell by the process of "free cell-division," as it is called. Or this latter mode may occur after the division. In any case, after the division has proceeded thus far, the secondary cells again divide so as to form a round ball (fig. 9), containing, after the final division, as many green cells (figs. 10-11) as there are zoospores in the future Volvox. At this time the cells become possessed of cilia (figs. 10-11), which, in this state, are very close together, and very readily perceptible by their waving. At this time the whole is inclosed in a delicate layer of colourless mucus (figs. 10-11, *a a*), which, before long, becomes dissolved. Up to this time the young Volvox is still attached to the interior surface, without causing any bulging of the parent wall, of which we may consider it as a "gemma," or *bud*. It continues to grow, and after a time becomes detached from the wall, proceeding to move about in the interior of the old Volvox in the same manner as the latter does in the vessel. It is ultimately released from within by the dissolution of the parent, when it becomes completely independent; but by that time the same changes have been going on within it, so that the third generation can be already detected. This, then, is the mode of growth in the typical Volvox, and these phenomena may be repeated in the same way, for an indefinite period throughout the summer.

But there are some other appearances which may be observed in this plant not unfrequently towards the end of summer, which are to physiologists of a highly interesting character, although they are at present unable to determine their entire value.

The first is that described by Cohn, where the segmentation, or division of the spores, instead of going on to the formation of a Volvox like its parent, divides into small spindle-shaped ciliated bodies, disposed in a disc-shaped group (fig. 14, *a a a*). These he looks upon as equivalent to the antherozoids of the Algæ and most flowerless plants, which are the analogue of the pollen in the flowering plants. Indeed, he says he has observed that they become diffused through the interior of the Volvox, and then coming in contact with some of the cells which are larger than the rest, and which he calls the *germ-cells* (the analogue of the seed of flowering plants), they become blended with the latter, which, in course of time, become covered by a hard thick membrane, while the interior is changed to an orange-coloured oil (fig. 17). These red bodies, which have been called *oospores*, or eggspores, may be observed in Volvox frequently at the end of the summer, and in autumn, producing a very marked and pretty appearance when combined in the same Volvox with the other kinds.

But Mr. Busk considered these analogous to what has been called, in other kindred plants, as the "resting" or winter spore, which are well known to become red at the latter part of the year. I think, that at present, notwithstanding the opinion of so excellent an observer as Cohn, the exact nature of these ciliated spindle-shaped bodies is hardly settled, because we know that similar forms are produced by the lower vegetable life, which are certainly not of the nature of antherozoids.

The next point of interest to be mentioned was described by the writer in the *Microscopical Journal*, 1861, and shows in a marked degree the affinity of Volvox to the vegetable world.

It is this, that after the zoospores have divided to a certain degree towards the formation of the ciliated zoospores, instead of accomplishing the later divisions, each segment throws around itself a colourless jelly, thereby separating them to a distance, producing a mass of jelly studded with green cells, which have been named by the writer "statospores," or quiet spores (fig. 12). These again divide into two or four secondary cells, or they grow into cells of a much larger size (fig. 13), resembling the processes which were described by the writer in the January number of this Review of last year as seen in the green cells of lichens, mosses, &c. There is another curious feature worth notice, also described by the writer, and seen towards the end of the summer. When the activity of the plant is becoming less, and all vegetable life is preparing for the coming cold by assuming a state of rest, we find some of the zoospores increase in size, and change colour to a reddish buff (fig. 15, *a*). After a time these become detached, and move about, not by means of the cilia, but by a curious change in their form, bulging out first in one direction then in another, whereby a certain amount of progression ensues (fig. 15, *b*). This mode of movement has been sometimes known to occur in the lowest groups of the animal kingdom, and in particular in the "Amœbæ;" hence this motion in the vegetable cell has been called "Amœboid." The writer has noticed the same motion in some of the immature cells of the Volvox at an earlier period. But the Amœba proper, in pushing out its processes, includes foreign bodies, the soluble portion of which it dissolves, employing it therefore as food. But whether the Amœboids do the same cannot be at present affirmed; at any rate, they have not been seen so to do. This peculiar movement has been noticed by other observers, so that we may conclude that under certain circumstances vegetable matter has a power of movement. In all probability, it is owing to certain chemical changes going on within.

Again, some of the zoospores at the end of the year divide into a mass of ten to twenty cells, each provided with cilia at its outermost extremities (fig. 16). These ultimately become released from the parent, but their future history is unknown. These are the principal phenomena which have yet been observed in the Volvox Globator. Some similar have been noticed in the allied forms, and in that one found in rain-water called Protococcus pluvialis, which has only one zoospore to the transparent sphere, the change from the still to the moving sphere has been observed; but in Volvox Globator that has yet to be discovered.

To those who, living in a good locality, have an opportunity of watching this beautiful "rolling sphere" and its surroundings, what an opportunity there is for opening out this life-history, already well begun; whereby, not only in this particular plant increased knowledge will be matured, but a key given by every advance to unravel the mysteries of other forms of lower life, of the knowledge of which we possess so little. How frequently do we hear the complaint of younger observers, "what is there left for me to work at?" And yet in this field alone there is opportunity for unlimited research, enough if honestly worked to bring scientific reputation to not only one, but numerous observers. The phenomena called by Braun the "Rejuvenescence of Nature," in the vegetable world, and the "Alternations of Generations," by Steenstrup, in the animal kingdom (Ray Society's publications), point out facts which give to the modern inquirer an interest far beyond that which the older observer possessed, who confined himself merely to the description of each individual form he discovered, without tracing its relationship beyond. And they show further that we must consider the individualities of a plant not so much by its more prominent features, as by the series of changes through which it passes,—each one as important as the other, each change a link in the chain,—so that when wes peak of Volvox Globator, we must conceive of it, not so much as a rolling crystal studded with emerald spots, but as a circle of changes of which that is one; certainly the most prominent, and beautiful æsthetically considered, but physiologically not of more import than the rest.

It is quite certain that the Volvox does not remain as Volvox through the winter. You may search for it assiduously, but you will not find it; therefore we may fairly assume that it takes on some quiet condition, possibly more than one, perhaps so unlike its summer shape, as to have deceived the most careful observer. It would not be difficult for a great number to be collected and placed in a large body of pure water, covered with muslin to keep out other bodies, and exposed to the sun and air, at the end of summer, and the whole to be closely watched: some new points will I am confident be obtained.

DESCRIPTION OF PLATE.

Fig. 1. Ordinary appearance of Volvox Globator. — *a a*, Zoospores; *b*, Gemmæ, or young Volvoces.

„ 2. Zoospores magnified.—*a a*, Zoospore; *b*, Cilia; *c*, Membrane of the sphere; *d*, Vacuole; *e*, so-called Eye-spot.

„ 3. Stellate shape of Zoospores.

„ 4. Zoospores of the Algæ.

„ 5. Enlarged Zoospore before dividing.

„ 6, 7, 8, 9. Different stages of division.

„ 10, 11. Ultimate division.—*a*, Enveloping mucus; *b*, Cilia.

„ 12, 13. Stato-spores, or quiet spores.

„ 14. Young Volvox producing Antherozoids.—*a a*, Antherozoid still retained in the mucus envelope; *b b*, Zoospores of parent.

„ 15. Shows the Amœboid change. — *a*, Commencement; *b*, Moving Zoospore.

„ 16. Ciliated group of cells in autumn.

„ 17. Winter-spores.

ENGRAVING WITH A SUNBEAM. WOODBURY'S RELIEF-PRINTING.

BY J. TRAILL TAYLOR.

WHEN, twenty-four years ago, the first specimens of Photographic Art on paper were handed round among the *savans* of the period, speculation was rife concerning the probable effects which the new art would produce on miniature painting; and the results which, generally, would accrue from its introduction. But wild as were then deemed some of the conjectures formed concerning its future, and visionary as were supposed to be the dreams of those who hazarded opinions concerning its probable bearings and results, it must now be admitted that in many respects, if not quite in the manner expected, Photography has, even at the present time, not only fulfilled, but surpassed, the wildest dreams of those who watched by its cradle, and has more than realised the expectations, now no longer considered Utopian, of its projectors. Consequent upon its introduction, new facts in Chemistry have been discovered, and an entirely new path of investigation in Optical science laid open. Advancing with rapid strides, it has been the means of causing kindred sciences to advance along with it; and the pages of the POPULAR SCIENCE REVIEW have from time to time borne testimony to the aid thus rendered by Photography to cognate sciences.

After the persevering efforts and assiduous application of Mr. Fox-Talbot to perfect his process of Photography on paper had been crowned with a degree of success not long before considered quite unattainable, that gentleman made the unpleasant discovery that photographic pictures were far from being permanent; that, called into existence, as it were, in consequence of the instability of certain metallic salts, the same causes by which they were produced operated in inducing their destruction; and the elements of decay could not with certainty or satisfaction be eliminated from the finished picture, notwithstanding the care and pains employed in the endeavour to obtain this desideratum.

A brief glance at the cause and nature of this decay or fading of photographs may not here be improper, seeing that it was the means of leading to important results, to a description of one of which we have devoted this article.

The blacks of photographic prints on ordinary unsized paper consist of silver. To aid in the proper fixing of a photograph, or destroying its further sensitiveness to light, hyposulphite of soda in solution is employed. The action of this salt on the silver in the pores of the paper is of an extremely complex nature, and long washing is requisite to secure its removal. If not thoroughly removed, an action continues to be exerted which ultimately results in the destruction of the picture, the blacks of which are converted into a sulphide of silver. But the sulphurous gases with which the atmosphere is impregnated, joined to the complex effects produced by the albumen (with which photographic paper is usually prepared) acting on the silver in a manner not yet clearly understood, exert a destructive iufluence on photographs. The introduction of gold-toning has mitigated this evil to a considerable extent, but an inspection of some recent pictorial productions of photographers of reputation suffices to show that it still exists, notwithstanding the known care taken by them to obviate it.

It was this knowledge of the liability of silver prints to fade that induced Mr. Talbot, upwards of fourteen years ago, to search through the arcana of science for a more stable substance than silver of which to form the photographic image, his search being accelerated, as he informed the writer, by the fact that even the paste by which the pictures in his *Pencil of Nature* (the first illustrated photographic work ever published) were attached to the mounting board had set up a process of decomposition.

The most stable substance which presented itself to him was *carbon;* but, eminently unaffected by light as it was, the question of how to utilise it in the production of a photograph was one that occupied much time and involved much labour in answering. The ink used by the engraver, he considered, was permanent ; and if means existed by which a photograph could be automatically engraved on a metal plate, then would the product of this plate be permanent when printed with a carbonaceous ink. Hence resulted a discovery of infinitely more importance than he himself could possibly have foreseen, from which have proceeded numerous ramifications, one of the latest and possibly most important of these being Woodbury's method of photo-relief printing, to the elucidation of the principles and practice of which we now address ourselves.

In his endeavour to obtain an engraved plate by means of photography, Mr. Talbot availed himself of the discovery of the photogenic properties of bichromate of potash which had been made a short time before by Mr. Mungo Ponton. From the apparently trivial discovery of this gentleman, that paper which had been washed with a solution of this salt became darker in colour when exposed to light—a discovery followed by some researches by M. Becquerel into the nature and cause of this action—the active and practical mind of Mr. Talbot at once led him to see how this discovery might be turned to a valuable and practical issue. Accordingly the scientific world was startled and gratified by the announcement in the *Athenæum*, in 1853, that the problem of permanent photographic printing had been solved by this gentleman's discovery of a method by which photographs could be printed from an engraved steel plate in the usual carbonaceous ink of the copperplate printer. Some of the specimens shown as the result of this discovery possessed great delicacy and beauty; and we have scientific journals which have been illustrated by engraved photographs of natural scenery effected by the process in question, which is based on the fact that bichromatised gelatine, gum, and other organic bodies become, after exposure to light, insoluble in water, and that an etching ground thus composed may be dissolved away in all those parts from which the light has been debarred access.

This was the original discovery, but who can estimate the magnitude of its results? For, arising out of it, and based on its simple principles, are the numerous varieties of photo-lithography, photo-zincography, photo-galvanography, photographic engraving in its now numerous phases, carbon printing, vitrified or enamelled photographs, surface block-printing, and, lastly, the process of relief-printing, now more immediately under consideration.

Gelatine is the principal agent in relief-printing; and several previously unknown properties possessed by this substance have been brought to light through the agency of its photographic application. But before entering on the subject in detail, a synopsis of the process had better here be given.

Woodbury's relief-printing is based on the fact that, if a layer of any dark-coloured transparent material be placed upon a white sheet of paper, the colour transmitted to the eye will be light or dark in proportion to the thickness of the material; if extremely thin, then the paper will appear white or almost so, every increase in the thickness causing the colour to appear deeper. If now a mould be prepared in intaglio, and it be filled with a coloured transparent body, such as gelatine, containing a dark pigment mixed with it, a sheet of paper pressed on this mould by means of a flat plate of metal would cause all the superfluous gelatine to be expressed at the edges, but as soon as the gelatine becomes set, the paper will, on being raised from the mould, carry with it the gelatine cast, which will be a faithful register of the mould, the heights and depths in which being thus translated into colour. As will readily be supposed, the preparation of the intaglio mould used in this process is an operation of the highest importance, for on the delicacy and accuracy of its gradations evidently depends the beauty of the finished picture; and it is in the preparation of this mould that the wonderful properties of bichromatised gelatine become apparent.

The particular kind of gelatine employed in the preparation of a mould is of more importance than would at first be supposed. That found by experience to be best for this purpose is known as *Nelson's Opaque Gelatine*, an ounce of which is placed in five ounces of water, allowed to remain until it swells, and liquefied by setting the vessel that contains it in hot water. To each ounce of this solution must be added fifteen grains of bichromate of ammonia, previously dissolved in about a drachm of warm water. The mixture should be carefully filtered, and kept in a dark place for use. This bichromatised gelatine possesses some curious properties, the nature of some of which will be ascertained from the following experiment :—Coat a plate of glass on one side with the solution, and when dried, which must be done in a feebly lighted place, cover it with a paper containing ordinary printed matter on one side, press in intimate contact with the surface of the glass by means of a second glass plate, and expose to sunlight (through the paper) for a few minutes. On examining the plate in a subdued light, those parts on which the light was allowed to act, corresponding with the white paper, will be found to be deeper in colour than the parts which were shielded from luminous action by the black letters. The bichromate of ammonia has been decomposed by the light, and chromic acid has been liberated, which, acting on the gelatine, has so modified its nature as to cause it to be no longer soluble in water. If now the plate be immersed in cold water and quickly withdrawn, it will be found that the parts on which the light has been allowed to act are, to some extent, repellant of the water. A prolonged immersion in water causes the unaltered parts of the surface to swell and stand out in relief, those parts in which the chromic acid has been liberated apparently undergoing no change.

It will readily suggest itself to a reflective mind that a difficulty will exist in the way of securing a series of gradations in a photographic negative having their proper effect produced when thus attempting to print on the surface of a sensitive gelatine film. The possibility of obtaining half-tones is dependent upon the power of the light to penetrate the yellow coating of bichromate and gelatine by which it is rendered more or less insoluble, but the impermeability to light of this layer long stood in the way of the best results being obtainable, until Mr. Burnett, of Edinburgh, solved the difficulty by printing on the under instead of the upper surface, and since that time no more difficulties have intervened in the way of producing photographs in relief in solid gelatine. Bearing this principle in view, we shall see how it is applied by Mr. Woodbury to aid him in securing a mould.

A sheet of talc of the size of the picture required is affixed to a plate of glass by means of a little gum or water, and after being placed on a levelling-stand, some of the bichromatised gelatine—prepared as previously intimated—is poured on to its surface so as to form an even coating. When it has become quite dry, the talc, by means of a sharp knife, is removed from the glass, and the exposed surface of the gelatinised talc carefully cleaned and placed in contact with the negative of the subject that is to be reproduced. The surface of the gelatine is protected by means of a sheet of blotting-paper, after which it is covered over with a glass to ensure uniform pressure and close contact between the talc and the negative. After exposure to the light of the sun for about an hour, the film must be placed face upward in a dish of hot water, by which means all the gelatine unacted on by the light will be dissolved away, leaving a picture in relief the height of which depends upon the penetrating power of the light through the negative, the parts most acted upon standing in highest relief. When no more gelatine will dissolve from the film, it is dried by a gentle heat up to a certain stage, after which the drying is allowed to be completed spontaneously. This precaution serves to prevent the gelatine film from splitting away from the talc.

Reliefs obtained in the manner described may be kept in a portfolio for any length of time, and are always ready for the next operation, that of securing an intaglio impression in metal. To obtain this impression, the electrotype process at once suggests itself as the most suitable one for the purpose, and in the early days of the process—if such a phrase be applicable to that which has not yet been a year in existence—the moulds were obtained by electrical deposition. This, however, was attended by a loss of time which it was desirable should be avoided; accordingly, after some experiments, Mr. Woodbury found that when the gelatine "relief" had become thoroughly dried, it was hard enough to be impressed in soft metal, faithfully transmitting its most delicate details, and, curiously enough, still remaining uninjured after having done so. This discovery at once shortened the preparatory process of printing by some days; for the time occupied in producing a perfect mould in metal does not now occupy a minute. The metallic intaglio is produced in the following manner:—On the flat bed of a hydraulic press is placed the gelatine relief, talc side down, over which is placed a clean sheet of metal, composed, by preference, of a mixture of type metal and lead. A perfectly flat plate of steel is placed over this, and the whole subjected to a degree of pressure which varies with the hardness of the metal employed. For a picture of the size of the portraits of Baron Liebig or Professor Huxley, which serve as illustrations of the process in the present number of this work, a pressure of upwards of fifty tons will suffice to impress every detail in the type metal. There is no limit to the size of the plate that may thus be produced; but, in proportion as its area increases, so must the pressure also be increased. In the mean time, with metal of a suitable degree of hardness, the amount of pressure may be approximately stated as four tons to the square inch. In obtaining this metal intaglio it is of the greatest importance that it should be absolutely flat, and for this purpose it is necessary to employ two flat polished plates of steel of a thickness sufficient to prevent their bending or yielding when in the press. One of these should be laid on the bed of the press, and on its face should the gelatine mould be placed, the other, as just stated, serving to act as a cover. It might be thought that, by passing the two steel plates with their intervening contents between a pair of large rollers, pressure would be communicated in an equally advantageous manner to that obtained in the hydraulic press, and at a less expenditure of mechanical means. Careful experiment has, however, determined that the momentary and local pressure obtained from rollers will not yield such perfect moulds as are obtainable by hydraulic agency. The cause of this may be found in the elasticity of the mould, and, possibly, in a lesser degree, in that of the metal also. Simple percussion fails to yield details in a mould so made; but even a lesser amount of force expended over an appreciable time, say one second, will not fail to cause every detail to be impressed in the metal.

One important advantage in this process is found to arise from the fact that the gelatine mould is in no wise deteriorated by its having communicated its details to a metallic surface, but, where a large number of prints are required, will serve to produce several moulds ready for printing, and this, too, in a space of time not exceeding one minute for each.

The process of obtaining prints from the mould is simple, and is conducted in the following manner :—A press is made in the form of a very shallow box, with a hinged lid. In the bottom of the box is placed a thick plate of glass, a similar glass plate forming the lid. The bottom plate rests on four screws, which serve to adjust the plate to any height. On this plate is laid, face upwards, the metal intaglio mould, and the lid being closed down, the screws in the bottom are so adjusted as to bring the upper surface of the mould in equal contact with the glass lid. The cover being again raised, a small quantity of ink is now poured on the centre of the mould, the sheet of paper destined to receive the impression is then laid down on the top of the small pool of ink, and the lid having again been closed down, the ink is spread out between the mould and the paper, filling up the cavities in the former, and the superfluous portion escaping over the edges. The lid should remain closed for nearly a minute, or until the ink sets sufficiently to allow of its being removed in contact with the paper, to the surface of which it is eventually found adhering. The conditions required in a suitable ink are fluidity with rapid setting, transparency, and facility for removal from the mould with perfect adherence to the paper. These conditions are fulfilled in gelatine, to which any colouring matter may be added; and as the range of transparent pigments is very extended, so are the colours in which prints may be produced by the process in question. The gelatine is dissolved in the same manner as that described in the preparation of the mould, and a small quantity of a suitable pigment mixed with it. The lampblack of the ordinary capsuled tin colour-tubes, with the addition of a little carmine or crimson lake, forms an agreeable tint; but this is entirely dependent upon the taste of the operator or the nature of the subject. A picture may be printed either in the most sombre black, the most intense red, or the richest violet or blue. The most suitable thickness of the gelatine ink is best determined by experience, and it will generally be found necessary occasionally to add to it a little water. The ink must be kept warm by means of a gas stove or otherwise, the heat and strength of the gelatinous ink being such as to ensure its setting in the mould in a reasonable time. To prevent the ink from adhering to the mould or parting from it readily, the latter must, from time to time, be slightly moistened with a sponge or pledget of cotton charged with oil.

When a suitable time has elapsed—usually from half a minute to a minute—the lid is raised and the paper removed from the mould, taking with it the whole of the coloured gelatine, which at this stage forms a picture on the paper in relief, and to which peculiarity the name of the process—

"relief-printing"—owes its origin. It is only in relief, however, for a very short time, for as it dries this peculiarity disappears, until, when it has become quite dry, no trace of relief is apparent. From the fact that the print must remain in the press for nearly a minute ere it is ready for removal, it is expedient that one operator should have several presses to work so as to fill up his time. By adopting this plan a skilled printer will be enabled to produce prints at the rate of from 150 to 200 per hour.

To prevent the print from sustaining any damage from moisture, gelatine being readily susceptible to hygrometric influences, the prints before being mounted are fixed,—an operation performed in a very simple manner, viz., by immersing them for a short time in a solution of alum. By this means the image is rendered insoluble, so that when it is again dried it is found to be impervious to moisture, and its mechanical condition, too, is improved.

The cost of photographs printed in the manner described is very moderate. The ink and paper combined will not amount to a farthing, each print of a size suitable for average book illustration, and all the waste ink recovered from the superfluity around the edges of the mould may be instantaneously utilised by being again returned to the vessel from which the warm and melted ink is poured; and thus the economy of the process is in no way affected by the quantity of ink that may be poured on to the surface of the plate during the operation of printing.

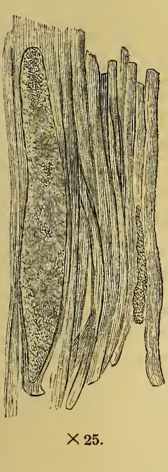
From what has been said it will have been seen that Mr. Woodbury, in the process described, has introduced an entirely new principle in printing—a principle by which the most perfect gradation is obtained, differing in this respect from any other kind of press-printing. When a suitable paper is employed to receive the image, details almost microscopic in their minuteness are found in the finished picture, and this combined with brilliance and vigour. If the impressions be received on a plate of opal glass instead of on paper, transparencies of the richest and most delicate nature are obtained, rivalling the choicest productions of Feriér and Souliér.

PLATE XI.

FIG 1.

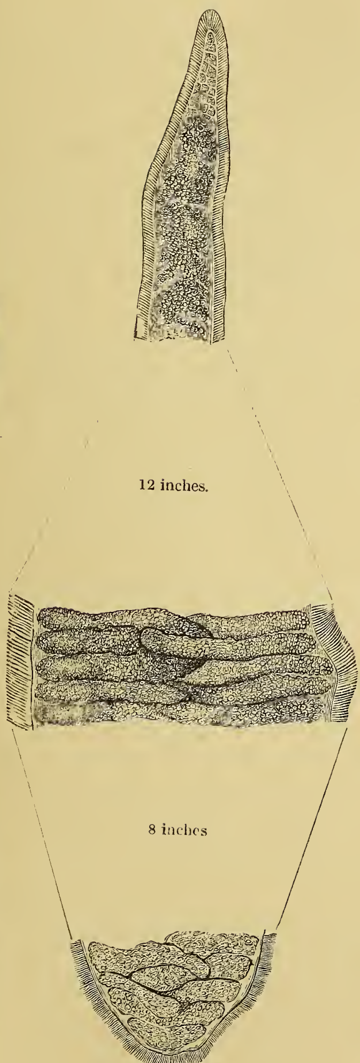
× 25.

FIG. 2.



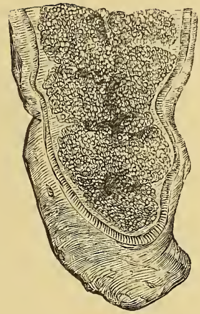
× 25.

FIG. 4.



× 215.

FIG. 3.

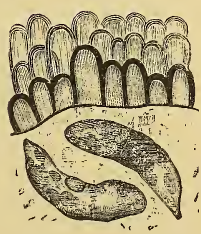


× 215.

FIG. 5.

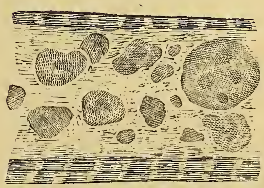
× 1000.

FIG. 6.



× 1800.

FIG. 7.



× 2800.

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ENTOZOON-LIKE BODIES IN MUSCLE.

ENTOZOON-LIKE BODIES IN THE MUSCLES OF ANIMALS DESTROYED BY CATTLE PLAGUE.

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ALTHOUGH the bodies I am about to describe are not peculiar to the muscles of animals which have died from the Cattle Plague, they are present in such large numbers, and are so very frequently met with, that it is desirable to inquire into their nature and origin. They are most numerous, but not most perfectly developed, in the muscular tissue of the heart. In this and other muscular tissue of ruminants slaughtered by the butcher, as well as in that of other animals, they were seen and imperfectly described more than five-and-twenty years ago by several German observers. They have never been found in the human subject.

And it may be remarked that these bodies which are so frequently found in the muscular tissue of the sheep's heart, and to a less extent in the hearts of oxen in apparently fair health at the time of death, are not generally met with in the muscles of the body. Indeed, I have very frequently sought for them in vain in good mutton and beef; while, on the other hand, in the muscles of the system of animals dead of the Cattle Plague they are seldom absent, and they frequently attain a size and structure which are remarkable.

It is most probable—indeed, it is almost certain—that these bodies are not directly concerned in the production of any of the phenomena characteristic of Cattle Plague, but it is not unlikely that the animals infested by them are the least vigorous, and therefore in some measure predisposed to take this or other highly contagious malady.

But, if it could be shown that these bodies had nothing whatever to do with the cattle disease, directly or indirectly, it would nevertheless be important that they should be studied; for would it not be absurd to suppose that such organisms were conducive to the well-being of their hosts, or in any way necessary to their existence in the face of the fact that they are not present in the majority of healthy beasts? On the other hand, it seems more probable that the development of such bodies in the elementary fibres of the muscles may be an indication that the beast has not been brought up under the conditions most favourable to health and vigour.

There is reason to believe that the nutrition of our cattle is far too much artificially forced; and, as a consequence, many of them die, cut off by disease, long before they have attained their full growth, and are fit for the butcher. It is scarcely necessary to observe that scientific inquiries in connection with the health and nutrition of cattle are likely to lead to important practical conclusions, and it is possible that very careful and detailed observations upon these entozoon-like bodies might lead to results, not only of scientific interest, but of some practical importance.

Although, as I have said before, the existence of these bodies has been known, no helminthologist has yet succeeded in determining their nature. Indeed, it is not yet decided if they should be regarded as animal or vegetable, though the structure of the largest and most fully developed seen in the voluntary muscles is hardly such as would justify any one in regarding them as of a vegetable nature (pl. XI., fig. 4).

Attention was first called to these curious, worm-like bodies in connection with the Cattle Plague by Dr. Fenwick in the *Times* of January 3rd, 1866. And, although some of his statements have since been called in question, the main facts he stated were correct, and have been confirmed.

These bodies are exceedingly distinct; and I have found them in the muscles of every animal dead of Cattle Plague which I have examined, with one exception. And in all the different muscles examined from a single carcase many have been found. They vary much in size, but exhibit the same general characters (pl. XI., figs. 1 to 4). Those found in the heart, however, do not exhibit the characteristic peculiarities invariably present in the worm-like bodies (excepting the youngest) in the voluntary muscles. There is little difficulty in finding them if only very small pieces of muscular tissue be subjected to examination; but, being very transparent, they are easily hidden from view if surrounded by several elementary muscular fibres, and may thus escape detection. They vary in number, and I should think that, in some cases, I have seen them as numerous as one to (at the most) twenty muscular fibres; while in others, perhaps, they may not be found in greater number than in the proportion of one to a hundred muscular fibres. The smallest are oval; but, as they grow, they become spindle-shaped, and usually one end is pointed, while the opposite extremity is more or less rounded. In some there are slight projections from different parts of the surface, as if there were a tendency to the formation of segments and lateral pores. But in the larger ones the outline appears perfectly uniform. In all there is a distinct investing membrane of a peculiar structure, varying in thickness in bodies of different sizes, the outer surface of which is in contact with the sarcous tissue (pl. XI., fig. 3), or with the sarcolemma, save in the few instances in which the bodies are free. Even when the peculiar bodies lie embedded in the sarcous tissue, being surrounded on all sides by a thin layer of it, the transverse markings of the contractile material are perfectly distinct. The masses of germinal matter of the affected tissue are not larger than those of adjacent muscular fibres. There is no evidence of granular, fatty, amyloid, or other form of degeneration; and, whatever these peculiar bodies may eventually be proved to be, it is certain that they grow within the contractile material, and by their growth excite no irritation. The muscular tissue in contact with them seems, as it were, slowly to make way for their increased bulk, without the occurrence of inflammation or any other morbid change.

Structure of the investing membrane.—Not the least interesting point in connection with these curious bodies is the investing membrane; and it is very desirable to draw the attention of helminthologists to its anatomical characters.

The peculiar structure of the external investment, covering, sac, or sheath, will be understood by reference to figs. 4, 5, and 6 *a*, and I shall not here enter into a very minute description of it. The tissue is transparent, and varies in thickness in different parts. It appears to exhibit delicate transverse markings, but upon careful examination it is found that these are caused by the linear arrangement of minute, hair-like fibres. These processes of the investing membrane were described by Mr. Rainey in his paper in the *Phil. Trans.* for 1857.* He says they increase in size and distinctness as the animal grows larger. "They have not the sharp and well-defined outline of true cilia, nor are they pointed like setæ, or curled like cirri." In a specimen in my possession, however, the bodies in question are certainly pointed, and the whole appearance under a power of 1,000 diameters is such as would result if the investment consisted of very delicate transparent conical hairs, terminating outwards in pointed

* "On the Structure and Development of the Cysticercus Cellulosæ, as found in the Muscles of the Pig."—*Phil. Trans.*, vol. 147, p. 111.

processes. After lying in water for some time, the projecting filaments exhibited the usual characteristics of cilia, and would, no doubt, have been termed cilia by any naturalist. The structure of this membrane is so beautiful and delicate that it might be employed as a "test object" for ascertaining the defining power of object-glasses. I regard it as a peculiar formation, and feel quite certain that the appearances do not result from any modification occurring in the layer of sarcous matter which was immediately in contact with the body under consideration during its increase in size.

Of the contents of the Entozoon-like body.—The contents of these spindle-shaped bags, cysts, or investments, without doubt, form the most important part of the mass, and are well worthy of the most attentive consideration. When examined under a low power, the matter occupying the cavity appears granular, and there are distinct indications of the mass being subdivided into smaller portions, the divisions being most distinct transversely (fig. 4). I do not think there are distinct septa, but the appearance is such as would result if each of a number of masses of germinal matter in the interior of a cavity with extensile walls were to divide and subdivide into numerous masses which were capable of growth and multiplication. The appearance is given in figs. 3 and 4. The entire contents of every one of these bodies I have seen exhibit the same characters. There is no indication of alimentary canal, ovary, secreting gland, or other organ. It is, therefore, only necessary to call attention to the small individual particles of an aggregation of which each of the peculiar bodies in question entirely and invariably consists.

These particles are, for the most part, of an oval form or spindle-shaped. When perfectly mature, the body is curved, one extremity being rounded, while the other is almost sharp, as represented in fig. 6, *b*. They are flattened, and apparently consist of a transparent material, which exhibits here and there spots differing in refraction from the rest of the substance. These are irregularly disseminated through the mass, and give to it a granular appearance when it is examined by low powers; but, under the influence of high magnifying powers, the appearance is such as to render it doubtful if, at least in all cases, these are actual granules distinct from the general mass.

The bodies approximate to one another very closely in dimensions, but it is difficult to find two of precisely the same figure; and it seems to me most probable that they change in form when they escape into the surrounding fluid by the rupture of the investing membrane or sac. In their general appearance these bodies so closely resemble the nuclei of tissues that, under low powers, one might easily be mistaken for the other. But upon careful examination by the highest powers, it will be found that the outline is sharper, that the general mass is more uniform, while the alterations in form are greater than are observed in muscle-nuclei. Moreover, these bodies are often seen in such great number (fifty or a hundred, or more, being in the field at one time), that they cannot be mistaken for nuclei. They are also smaller than the nuclei of muscle, and very much smaller than the greatly enlarged muscular nuclei seen in the muscles of animals destroyed by Cattle Plague.

Upon the whole it seems to me almost certain that each of these little bodies is capable of giving rise to others like itself by division and sub-division, and these to more in the same way. To what extent this process is capable of being carried I can form no idea. The spindle-shaped elongated cysts in which these particles grow and multiply, sometimes reach a very great length. In a specimen of muscle I received from Dr. Eade of Norwich, I found two as much as a quarter of an inch in length, and yet so narrow that the muscular fibre in which they lie still exhibits its normal diameter. Up to a certain size, however, as the bodies increase in length, they also increase in width; and I have seen some twice the diameter of a muscular fibre. In some of the largest of these the walls were not so thick as in many smaller ones which have fallen under my notice. From the facility with which the contents of many of these bodies escape,—very slight pressure of the thin glass being often sufficient to rupture the cyst,—I think it probable that if the aggregate mass had attained the size somewhat larger than those delineated in my drawings, the sac would have burst, and thus hundreds of thousands of the small oval bodies would haye beeu set free among the vessels, nerves, and connective tissue, lying between the elementary muscular fibres. But this is only an opinion, and at present I have no data to enable me to decide what becomes of these particles supposing them to be set free. The death of the animal always seems to occur before this catastrophe happens. There is, however, another mode of escape of the bodies contained in these spindle-shaped cysts that is possible. Although I have never seen a distinct pore or aperture in any part of the cysts, it seems not improbable that an orifice might be formed at one or other extremity, or at a point of the body where the external wall is thinner than in other parts. In this way the escape of these bodies from their parent cyst, a few at a time, would be effected, while the process of multiplication still going on within would not be interfered with. But whether the individual masses are able to migrate from one part of the body to another, or, after having been produced in enormous numbers within the cyst, they are destined to remain dormant until, by the death of the animal, opportunity for a far more distant migration is provided, or whether, as is perhaps upon the whole least probable, from the collection already described, a true entozoon is evolved, must be determined by future research.

Tenacity of life.—The little bodies in question are very tenacious of life, and they are not permeated by the carmine fluid till long after every mass of germinal matter (nucleus) of the muscles, vessels, and nerves, has been deeply coloured—a fact which shows that at any rate these bodies are quite distinct from the muscle-nuclei, and have not descended from them. After remaining for many hours in the carmine fluid they take the colour like every other kind of living matter, and several specimens exhibited one spot darker than other parts.

Conclusion of previous observers.—Prof. Siebold states that these peculiar entozoon-like bodies were first discovered by Miescher in the muscles of a mouse in 1843. Hessling* found them in the muscular fibres of the heart of the sheep and ox. They have been also found in the deer. By Siebold and Bischoff they have been seen in the muscles of the mouse and rat. The latter observer found them in all the muscles of a rat in 1845. In 1855 Rainey† found and figured similar bodies in the muscles of the pig, and inferred that they represented the early period of development of the *cysticercus cellulosæ* of that animal, but later writers do not consider the evidence upon which this inference rests at all conclusive.‡

The form of the body, and the peculiar structure of the external investing membrane, would incline one to regard the bodies as some species of entozoon in an imperfect stage of development, but from the character of the contents it is possible that some zoologists might consider them more closely allied to the Gregarinæ or Psorospermiæ. There is I think no doubt that these bodies are of an animal nature. I am not aware of any gregariniform body exhibiting either the form, very considerable size, or general characters of those in question. There is, I think, no character rendering it very probable that they belong to the vegetable kingdom.

Of the probable manner in which these bodies reach the

* Siebold and Kölliker's Zeitschrift, Band v. p. 195.

† "On the Structure and Development of the Cysticercus Cellulosæ, as found in the Muscles of the Pig," by George Rainey, M.R.C.S.—*Phil. Trans.*, vol. 147, p. 111; 1857.

‡ For a full account of the literature of the subject the reader is referred to a paper by Dr. Cobbold in the *Lancet* for January 27th, 1866, which is reprinted by Professor Gamgee in his work on the Cattle Plague.

muscles.—From the foregoing observations it seems almost certain that these bodies are special organisms derived from organisms of a like kind, and that they did not *originate* within the body of the animal they inhabit.

I have very recently succeeded in demonstrating the changes occurring in the minute mass soon after its entrance into the muscular fibre. The germinal matter undergoes division and subdivision within its envelope and the whole gradually increases in length and breadth.

The demonstration of a fissure leading from the external surface of the fibre to its central axis, where the organism is situated, shows conclusively how the body reached the sarcous tissue, and renders it almost impossible to resist the inference that a minute germ, perhaps less than the $\frac{1}{10000}$th of an inch in its smallest diameter, made its way through the sarcolemma into the sarcous tissue, and grew there into the remarkable structure described and figured.

The smallest I have been able to demonstrate with absolute certainty is not more than the $\frac{1}{1200}$th of an inch in length. Another, a little larger, had already attained its peculiar form, and the little bodies within were less than the $\frac{1}{10000}$th of an inch in diameter, but were already multiplying by division. The very minute particles represented in fig. 7 magnified with the $\frac{1}{50}$ are probably these bodies at the earliest stage of existence.

The difficulty of observing the earliest changes taking place in such a minute mass in the centre of an elementary fibre must necessarily be much increased by the circumstance of the multiplication of the muscular nuclei themselves in those cases in which the bodies in question are observed. I have indeed seen many specimens which I might have fairly adduced as the earliest stage of the intramuscular existence of the organism, but have refrained from figuring these because I could not positively affirm that they were not collections of three, four, or half a dozen muscular nuclei.

All the evidence yet obtained is indeed strongly in favour of the view that one of the very large bodies figured is developed from a very minute mass as I have described, and it is probable that a vast number of these have made their way into many of the elementary fibres of the different muscles.

The germs have no burrowing organs or hooklets, but from their extreme minuteness and motor power could easily make their way through the sarcolemma if they reached its surface. It is most probable that the germs enter the blood and perhaps may make their way directly from the cavity of the heart into its muscular walls, while others being carried to the capillary vessels of the muscles migrate into the elementary muscular fibres of various muscles of the system. Whether the germs are introduced into the organism of the animal in the food or water, or even carried by the air is unknown. Nor have we yet been able to learn if these simple bodies are the larval or imperfect state of development of higher and more complex organisms.

Conclusions.—The facts concerning these entozoa (?) may be summed up as follows :—

1. That in almost all, if not in all, animals dying of Cattle Plague, entozoon-like bodies exist in considerable number in the voluntary muscles of the system and in the heart.

2. They are occasionally found, but in comparatively small numbers, in the muscles of the system of animals apparently in perfect health when killed.

3. These or closely allied species have been known for more than twenty years, but their nature has not yet been determined. They have been found in the ox, sheep, deer, pig, rat, mouse, and perhaps other animals.

4. In the muscles of a calf killed by Cattle Plague, under *six months* of age, these bodies were found in immense numbers.

5. They vary in length from less than the $\frac{1}{1200}$th of an inch to at least a quarter of an inch in length. They are, for the most part, imbedded in the contractile material of the elementary muscular fibre, but they are occasionally found free.

6. They are for the most part spindle-shaped, and the external investment or envelope exhibits a very delicate and peculiar structure, being completely covered with delicate hair-like processes.

7. The mass within appears granular to low powers, and exhibits a division into numerous segments, but it is found to consist entirely of minute bodies resembling one another, possessing very definite characters, less than $\frac{1}{2000}$th of an inch in their longest diameter, and of peculiar form, being oval, flattened, the body slightly curved laterally, with one extremity blunt and the other almost pointed.

8. The entire mass increases in size as these small bodies increase in number, probably by division and subdivision, within the cyst.

OUR HOUSE SPIDERS.

BY JOHN BLACKWALL, F.L.S.

SO little attention has been bestowed on the natural history of the *Araneidea* in this kingdom that even the familiar term house spider is usually employed in so vague a manner as to convey no definite idea to the understanding. The cause of this neglect must be attributed to the numerous and peculiar difficulties inseparable from the study of this department of arachnology, and to the inveterate antipathy inherent in the minds of most persons towards the animals comprised in it. In the hope of inducing a feeling of interest where one of prejudice at present prevails, I shall proceed to offer a few remarks on the structure, habits, and economy of the spiders observed to inhabit the interior of our houses.

TRIBE OCTONOCULINA.

Family Drassidæ.

One species only belonging to this family, the *Drassus sericeus* of Sundevall, is of frequent occurrence in dwelling-houses, preferring such as are old and dilapidated; it secretes itself behind window-shutters and curtains, in the crevices of walls, among bed-furniture, and in other obscure places, constructing in those situations a short silken tube to serve as a domicile, with which it connects a lenticular cocoon of white silk of a compact texture, containing from fifty to sixty whitish spherical eggs, not agglutinated together.

Drassus sericeus is decidedly nocturnal in its habits, rarely quitting its retreat in quest of the insects on which it preys before the commencement of twilight; it is an active spider, and is enabled to run with celerity on the dry, vertical surfaces of polished bodies by the agency of a viscid secretion emitted from numerous hair-like papillæ distributed on the inferior surface of its tarsi. Its spinners, which are rather prominent and cylindrical, do not become fully developed till the spider has undergone its final change of integument; the two intermediate ones are united at their base, and the spinnerets connected with the short terminal joint of each inferior spinner are usually eleven in number in adults; two, very much smaller than the rest and nearly contiguous, being situated on the inferior surface, at a greater distance from the extremity than the others. The nine spinnerets of larger dimensions are probably used by the spider chiefly in the construction of its cocoon, the compact texture of which is best explained on the supposition that a copious supply of a viscid secretion, in a state of fluidity, is employed in its fabrication.

Family Ciniflonidæ.

The spiders of this family, known to inhabit our dwellings, are *Ciniflo ferox, Ciniflo similis,* and *Ciniflo atrox,* and so close is the resemblance they bear to each other in form, colour, and economy, that arachnologists have experienced some difficulty in ascertaining the specific characters by which they are distinguished. Their favourite places of resort are the corners of windows, the angles formed by the intersection of walls, fissures in plaster, and other retired situations in which they can conceal themselves, a preference being given to cellars and rooms that are little frequented.

As the organization and habits of these spiders are very similar, it will suffice to direct attention to that species which is most familiarly known, namely, *Ciniflo atrox.* On the objects surrounding its retreat it extends to a considerable distance, but without any apparent regularity or design, a number of fine glossy lines, intersecting one another at various angles, to which it attaches fasciculi of filaments of a complex structure. These compound filaments, or flocculi, are arranged on the first spun glossy lines both in longitudinal and transverse directions, and, when recently produced, are capable of retaining effectually such insects as come in contact with them. A communication between the snare of this spider and its retreat is established by means of a funnel-shaped tube of a slight texture; and not unfrequently two tubes occur in the same web, by one or other of which the spider usually effects its escape when disturbed.

If a newly-formed flocculus be examined under the microscope it will be found to consist of four lines and two delicate bands; two of the former are straight and exceedingly attenuated, and on each is distributed a tortuous line, inflected into short curves and loops, like a ravelled thread of fine silk. On each of the tortuous lines a white band, faintly tinged with blue, is disposed in numerous irregular curvatures, which are more widely extended than the flexures of those lines; and these bands, by their tenacity, constitute the most important part of the snare. The following description will serve to convey some idea of the manner in which the flocculi are fabricated, and of the curious apparatus employed in the process.

There are on the metatarsi of the posterior legs of *Ciniflo atrox* two parallel rows of spines, moveable at the will of the animal, which are situated upon a ridge on the abdominal side of the superior surface of the joint, commencing a little below its articulation with the tibia, and terminating at a strong spur near its extremity. The spines composing the upper row have a considerable degree of curvature, and taper gradually to a fine point; those of the lower row being stronger, more closely set, and less curved. This remarkable appendage, which has received the name of *calamistrum*, constitutes a striking character of the spiders included in the family of the *Ciniflonidæ*.

When the spider purposes to form a flocculus, it presses its spinners (which in the case of the *Ciniflonidæ* are eight in number, the inferior pair supplying the material of which the delicate bands connected with the flocculi are fabricated) against one of the glossy lines constituting the foundation of its snare, and emitting from them a small quantity of the secretion of which its silken filaments are composed, attaches to it several fine threads, drawn out by advancing the abdomen a little, and kept distinct by a lateral motion of the spinners. The posterior legs are then raised above the plane of position, and the foot of one of them is applied to the superior surface of the metatarsal joint of the other, a little above its articulation with the tarsus, and the *calamistrum* is brought immediately beneath the spinners, at right angles with the line of the abdomen. By a slight extension of the joints of the posterior legs, the *calamistrum* is directed backwards across the spinners, the diverging extremities of which it touches in its transit, and is restored to its former position by a corresponding contraction of the joints. In proportion to the continuation of this process, in which the *calamistra* are employed alternately, the inflected lines and bands of the flocculus are found to be produced, the spider making room for them as they accumulate by elevating and at the same time advancing the abdomen, which it effects by slightly extending the joints of the third pair of legs, and contracting those of the first and second pairs. The flocculi thus elaborated are attached to the first spun glossy lines by the agency of the spinners, and in this manner the spider proceeds with its labours till the snare is completed. As this operation is generally performed in the night, it can seldom be seen to advantage, unless artificial light be employed, some skill in the management of which is required in order to avoid disturbing the spider. The *modus operandi* appears to be this:—the points of the lower row of spines in passing over the extremities of the spinners draw from them lines which run into numerous flexures, in consequence of not being kept fully extended, and the purpose subserved by the upper row of spines seems to be the detachment of these lines from the spines of the lower row by an upward motion. Should the efficiency of the flocculi become much impared they are either replaced by others or a new snare is constructed.

In the month of June the female of this common species deposits about seventy eggs, of a pale yellow colour, not agglutinated together, in a cocoon of white silk of a loose texture, measuring $\frac{7}{24}$ths of an inch in diameter; it is nearly of a plano-convex figure, and is connected with the interior surface of an oval sac of white curled silk, on the outside of which particles of mortar and other extraneous materials are distributed. This sac is generally constructed in or near the spider's retreat.

The admirable adaptation of the structure and disposition of the *calamistra* to their action on the spinners, by which, under the directing influence of instinct, the curious snares of the *Ciniflonidæ* are perfected, affords such obvious evidence of design as to supersede the necessity of alluding more particularly to the subject.

Family Agelenidæ.

Several species of the genus *Tegenaria,* included in the family of the *Agelenidæ,* are most commonly denominated house spiders, from the circumstance of their prevalence in the interior of buildings; the webs that they construct in the angles of the walls and windows of such as are inhabited, proving a source of perpetual annoyance to tidy housekeepers. These species, *Tegenaria domestica, Tegenaria atrica,* and *Tegenaria civilis,* present marked differences in size, and in the designs formed by the distribution of their various colours; but in habits and economy they so closely resemble each other that remarks on those of *Tegenaria civilis,* the most widely distributed and best known species of the three, and that also to which the appellation of house spider is most generally applied, will serve to illustrate the proceedings of the other two.

The snare of this spider, consisting of a horizontal sheet of web, of a fine but compact texture, is most commonly attached by its lateral margins to walls and beams, forming by their transverse junction an angle in which a short tube, open at both extremities, is connected with the web; this tube is usually occupied by the spider, to which it affords a retreat and a ready medium of communication with every part of its snare. During the summer and autumn the female constructs several lenticular cocoons of white silk of a fine texture, measuring about $\frac{3}{10}$ths of an inch in diameter, in each of which she deposits from fifty to sixty spherical eggs of a yellowish-white colour, not adherent among themselves; these cocoons are attached to objects in the vicinity of her snare, and have generally particles of plaster, whitewash, or mortar disposed on their exterior surface.

The following remarkable physiological facts in connection with *Tegenaria civilis* have been ascertained by observation and experiment; namely, that both sexes change their integument nine times before they arrive at maturity, once in the cocoon and eight times after quitting it; that a leg of a young individual, detached at the coxa six times consecutively, may be reproduced at each succeeding ecdysis after the infliction of the injury; that the life of this species extends through a period of four years; that the reproductive system of the male is connected with the digital joint of the palpi; and that the female, after one impregnation, is capable of producing nine sets of prolific eggs in succession, more than two years elapsing before all are deposited, and ten months nearly intervening sometimes between the deposition of two consecutive sets.

All our native *Tegenariæ* have the superior pair of spinners triarticulate, the spinnerets being disposed on the inferior surface of their elongated terminal joint. The principal purpose subserved by these organs, when thus modified, appears to be the binding down of the filaments emitted from the intermediate and inferior spinners with transverse lines distributed by means of an extensive lateral motion, by which process a compact tissue is speedily fabricated. The opinion, formerly prevalent, that the function exercised by the superior spinners, when triarticulate and considerably elongated, is simply that of touch, and that they are employed solely in regulating the application of the true spinners to appropriate objects, must therefore be regarded as decidedly erroneous.

The spider alluded to by Mr. Jesse in his "Scenes and Tales of Country Life," p. 339, as being peculiar to Hampton Court, and there named the *Cardinal*, most probably is *Tegenaria domestica*.

Family Theridiidæ.

In ancient mansions, situated in the south of England, a spider of this family, remarkable for the length and delicacy of its legs, and for the singular structure of the palpi and palpal organs of the male, is of frequent occurrence in the corners of rooms, constructing therein a slight, irregular snare consisting of a few fine lines, intersecting one another in different planes and at various angles. This spider is the

Pholcus phalangioides of authors, and the only species of the genus indigenous to Britain. The female may be seen in summer with her ova grouped in a globular form under her sternum, in which situation they are sustained by the instrumentality of the falces and palpi.

The spider referred to by Mr. Jesse in his "Scenes and Tales of Country Life," pp. 202, 203, as being remarkable for the rapidity of its vibratory motions when disturbed, is undoubtedly *Pholcus phalangioides*, which, like *Epëira diadema, Theridion quadripunctatum,* and some other species, has the habit of violently agitating itself when anything suddenly touches its lines. This vibratory motion, which in the case of *Pholcus phalangioides* appears to acquire its maximum velocity, is produced by the partial contraction and extension of the joints of the legs in quick succession, as may be ascertained by occasioning specimens of this spider, or of *Epëira diadema,* to continue the action till it becomes so slow, in consequence of the fatigue experienced by the animals, that there is no difficulty in determining the manner in which it is effected. This singular proceeding is evidently intended by the spider to communicate motion to its snare, and thus to cause the struggles of any insect entangled in it, by which means it is directed with certainty to its victim.

Family Linyphiidæ.

On the inferior surface of a small horizontal sheet of web, of a slight texture, constructed in corners of the windows of rooms that are unoccupied, or but little frequented, a small active spider may be seen to take its station in an inverted position, patiently waiting in that situation till some unfortunate fly or other minute insect suitable for food, shall become entangled in its snare. This spider, which, from the circumstance of its frequent occurrence in houses, has been named *Linyphia domestica,* is the *Linyphia minuta* of the "History of the Spiders of Great Britain and Ireland," and was originally described under that appellation in the "London and Edinburgh Philosophical Magazine," third series, vol. iii., p. 191.

In September, the female fabricates several subglobose cocoons of white silk, of a loose texture, the largest of which measures about one-fifth of an inch in diameter, and contains from thirty to forty spherical eggs, of a yellowish-white colour. The cocoons are commonly attached to objects near the snare. Adult individuals of this species are liable to be infested by the larva of the *Polysphincta carbonaria* of Gravenhorst, an insect of the family *Ichneumonidæ,* which feeds upon their fluids, and ultimately occasions their death.

Another species of this genus, the handsome *Linyphia crypti-*

colens, selects cellars, vaults, and other gloomy places, in which to procure its prey and provide accommodation for its progeny. In June or July the female constructs a globular cocoon of yellowish-brown silk, of a slight texture, measuring one-sixth of an inch in diameter; it is usually attached to her spinners by fine lines, and contains about ninety-eight spherical eggs of a brown colour, not adherent among themselves.

Family Epëiridæ.

The favourite resorts of *Epëira fusca*, a large species belonging to this family, are cellars, and damp places imperfectly illuminated, in which it constructs an extensive and elegant snare, consisting of an elastic spiral line, thickly studded with minute viscid globules, whose circumvolutions, falling within the same plane, are crossed by radii, converging towards a common centre, which is immediately surrounded by several circumvolutions of a short spiral line, devoid of viscid globules, forming a station from which the toils may be superintended by their owner, without the inconvenience of being entangled by them. The radii are unadhesive, and possess only a moderate share of elasticity, but the viscid spiral line is elastic in an extraordinary degree. Now, the viscidity of this line depends entirely upon the viscid globules with which it is studded, for if they be removed by careful applications of the finger, a fine glossy filament remains, which is highly elastic, but perfectly unadhesive. By this property of extreme elasticity the viscid spiral line is accommodated to frequent and rapid changes in distance that take place among the radii when agitated by disturbing forces, and by it insects, which fly against the snare, are more completely entangled than they otherwise could be without doing extensive injury to its frame-work.

For a description in detail of the complicated processes by which the symmetrical snares of the *Epëiræ* are produced, the reader is referred to the *Zoological Journal*, vol. v. pp. 181-188; and to "Researches in Zoology," pp. 253-270, the subject being too extensive to be introduced in this place.

In autumn the female of *Epëira fusca* fabricates a large oviform cocoon, of white silk, of so delicate a texture that the eggs, connected together by silken lines in a globular mass, one-fourth of an inch in diameter, may be seen distinctly within it; they are between four and five hundred in number, spherical in figure, and of a yellow colour. The cocoon is attached to walls and ceilings, by lines forming a pedicle at its smaller extremity.

The haunts of *Epëira antriada*, another species of the family of the *Epëiridæ*, are similar to those of *Epëira fusca*, from which it differs somewhat in its economy. In summer the female attaches to objects near her snare a subglobose cocoon of white silk, of a loose texture, measuring half of an inch in diameter, in which she deposits upwards of two hundred eggs, of a yellow colour, agglutinated together in a lenticular form.

This spider spins an extensive snare with an open circular space at the centre, which it usually occupies when watching for its prey; from this station it drops quickly on being disturbed, regaining it, when the danger is past, by means of a line drawn from the spinners in its descent, and previously attached to the circumvolution of the unadhesive line bounding the central aperture.

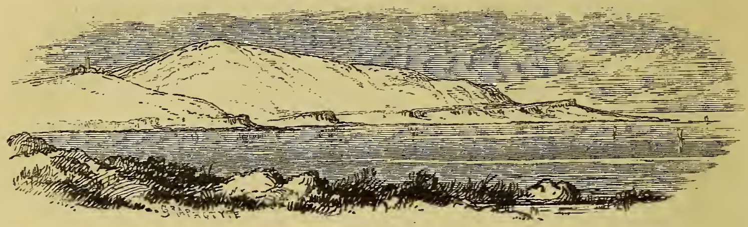
When immature, *Epëira antriada* is subject to be preyed upon (like *Linyphia minuta*) by the larva of *Polysphincta carbonaria*.

TRIBE SENOCULINA.

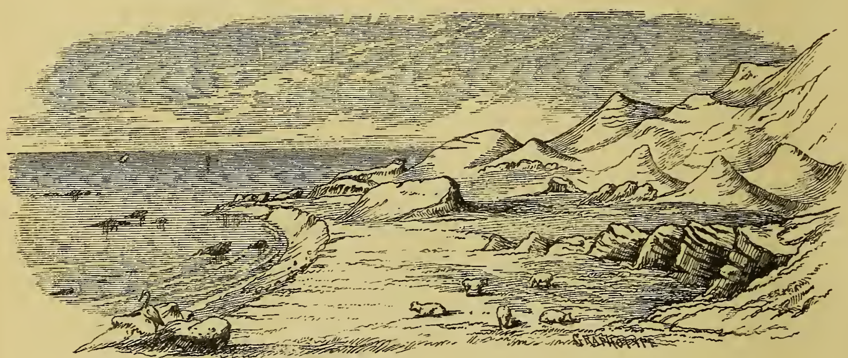
Family Scytodidæ.

Scytodes thoracica, our only indigenous species of the genus *Scytodes,* is of very rare occurrence in Britain. It is slow in its movements, and spins in the corners of rooms a few fine lines attached to each other without any apparent order. According to M. Lucas, it constructs a globular cocoon of white silk, of a compact texture, in which it deposits nine eggs, of a yellowish-white colour; whereas M. Walckenäer states that the cocoon is of a loose texture and comprises about thirty eggs. The female manifests a strong attachment to her cocoon, supporting it under her sternum by means of the falces and palpi, and conveying it with her wherever she moves.

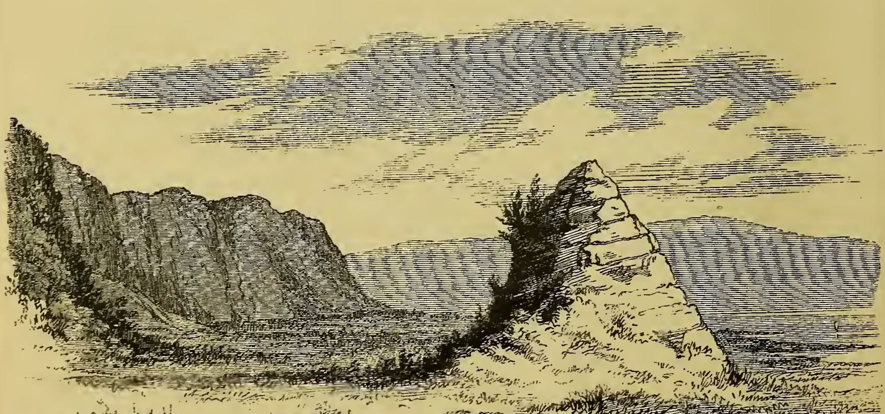
Various species of spiders, on the approach of winter, seek a refuge from the decreasing temperature of the atmosphere in the interior of houses; but these should not be confounded with such as, in the exercise of the instinctive propensities and physical powers with which they are respectively endowed, habitually pass their lives therein. Care must be taken, also, not to employ the term house spiders in too unqualified a sense, as the haunts of those species to which it may be deemed most applicable (not excepting even *Tegenaria civilis*) are by no means restricted solely to buildings, but are considerably diversified.



VIEW OF RAISED BEACHES, EAST OF LARGO BAY, FIFE.



RAISED BEACH (30 ft.) ON THE WESTERN COAST OF CANTYRE.



RAISED BEACH, WITH OLD "SEA STACK" ON IT, ARDSCALPSIE POINT, BUTE.

ENGRAVED BY GRAPHOTYPE PROCESS.

RAISED BEACHES AND THEIR ORIGIN.

BY EDWARD HULL, B.A., F.G.S.

THAT the coasts of our continents and islands change their level, while that of the ocean remains unaltered, is a fact in physical science first demonstrated by Sir C. Lyell in his celebrated work, "The Principles of Geology." The former proposition is capable of demonstration by a direct appeal to phenomena within the reach of all observers; but the latter is a deduction arrived at by a process of reasoning. The immobility of the earth, which finds its popular expression in ancient literature, whether sacred or secular, is indeed only relative; for, neglecting for a moment the local and sudden paroxysms of earthquake-waves, we now know that the only changeless level on the face of our globe is that of the ocean.

On the other hand, the earth on which we build our temples and palaces, and pierce with our deepest mines, is in some part or other undergoing a process of elevation or subsidence. The law of change has therefore been implanted in the material as well as the moral world; but it is mercifully ordained that in both cases—with occasional exceptions—the process should be slow, and frequently imperceptible, even through generations. The vertical movements of the land, though unfelt, are not the less real; for they can be proved by an appeal to marks and monuments of ancient sea-action, to be found at intervals along our coasts, and at elevations far beyond the reach of the highest tides. Of the process of elevation now in progress, the shores of the Baltic offer the most interesting example; and of depression, the northern coast of Egypt;* but for evident reasons, the latter is less capable of direct proof than the former.

The action and effect of waves acting along various parts of our coast are familiar to almost every observer or inhabitant of our isles, now that there is a periodical migration from the interior to the sea-side. In most cases, the limit of the highest tides is marked by a precipitous bank or cliff (depending on the nature of the rock which forms the coast), from the base of which the shore descends with a gentle

* See Lyell's "Antiquity of Man," p. 35.

slope down to the level of low-water, beyond which the inclination is often very gentle. If the coast is rocky, the warfare of the waves and the stubborn resistance offered to their advance is marked by many a breast-work or projection, sometimes by an isolated fort (or sea-stack), which has withstood the assault longer than its companions (see plate) ; but when the coast is formed of some softer material, such as clay or shale, the shingle beach is generally bounded by a bank presenting few irregularities of outline. How varied is the aspect of our coast at different points, it is almost unnecessary to remark; yet it is essential to the proper understanding of our subject that this be borne in mind, because similar variations are to be found in the ancient coast-lines and raised beaches of which we shall come to speak presently. Along the coasts of Devon and Cornwall, the highlands of Wales and Scotland, and the north and west of Ireland, walls of massive rock descend sheer down into the surging waves. In other places, as in Lincolnshire—but on a larger scale in the Netherlands—the descent from the land to the sea is so gradual, that, except where the boundary line has been rendered distinct by art, the passage from the domain of the land to that of the sea could only be recognised by the absence of vegetation. Other parts of the coast, however, partake of an intermediate character. Here the limits of tidal action are defined by a low line of cliffs, or a steep bank and a slightly shelving strand. These different forms of coast-line have an intimate relationship to the strength and arrangement of the rock or formation, and the configuration of the interior. Where the chalk of Flamborough Head, the South Downs, and the Isle of Wight, rises into hills inland, it terminates in the white walls of our "Albion," while the softer clays and sands of Sussex and Essex subside into a featureless shore.

All the while that the land remains at a certain level the sea is at work, sapping and mining the shore, and, by its currents, carrying away the materials to be spread over its bed. The strand has a general tendency to assume the form of a flat plain, on account of the levelling action of the breakers, which is confined to a vertical limit of a few feet. Sometimes deep fissures are hewn in the rocks of the coast, along lines of jointage; in other cases, isolated pillars, or masses of rock of every conceivable shape are found, and, less commonly, caves are hollowed out. Fingall's Cave, hewn out of cliffs of basaltic columns, is a well-known example ; and if the western coast of Scotland were suddenly elevated, perhaps thirty or forty feet, the entrance of the cave would be at the side of an inland cliff, with a terrace stretching from its base to the shore. This cliff would mark the present limit of tidal action, and the terrace would form a raised beach, in the true sense of the word.

We must be careful to note the distinction between the beach and the cliff (or bank) which forms its inshore boundary. Both are frequently found together, and in cases, some of which I shall cite, several of these cliffs, with their attendant beaches, are now to be found elevated far beyond the present limits of the tides. At the same time each may be found without the other. There are instances where, in the same cliff which is now washed by the waves, the former sea-level is marked by caves which are now beyond the reach even of the spray. The probabilities are, however, that at the period of elevation, a beach of shingle descended from the entrance of most of these caves, which has since been worn down and removed by tidal action; and thus the old and the new coast-lines are united. It is evident that the further action of the waves would, in process of time, obliterate all traces of the earlier coast-line. On the other hand, remains of old sea-beaches, in the form of gravel and sand, with shells, are sometimes found in isolated patches, in places where the former coast-line is so far distant as not to be recognised. In cases where there are several cliffs, with their terraces rising in tiers, one above the other, such steps show (as Sir C. Lyell has pointed out) so many pauses in the process of elevation of the coast. Had the rise of the land been continuous and uniform, there would have been no prominent line of cliff, supposing the rock to be of uniform texture; for every portion of the surface having been in its turn, and for an equal period of time, a sea-shore, no part could be more indented or eroded than another. But if pauses occur during the upheaval, the waves and currents have time to undermine and remove masses of rock at certain stages, and thus produce ranges of cliffs with terraces at their base.

The evidence of the former action of the sea along lines of coast now far beyond the reach of the waves, is of so satisfactory a kind, from the indirect evidences we have been considering, that it is scarcely strengthened by the presence of sea-shells, corals, and crinoids in the gravels of the raised beaches. These, however, are not uncommon; and what is still more interesting, works of art and human remains have also been found associated with them, attesting that in some cases the elevation of the land has taken place since the time that man was an inhabitant, and navigated the shores and creeks in his canoe. Sir H. De la Beche has mentioned in his "Report on the Geology of Devon and Cornwall," that in mining gravel for tin, at Pertuan, in Cornwall, skulls and works of art were found lying at a depth of 40 feet from the surface, under gravel containing marine shells of living species. Near Peterborough there is a deposit of estuarine gravel, containing, in alternate layers, fresh-water and sea shells, occupying a position about twenty-five feet above the sea. In Gloucestershire, near Cheltenham, there is an old sea-shore gravel-bed stretching to the base of the Cotteswold hills, and forming a level terrace, at an elevation of about forty feet. Higher up, on the flanks of the same range, there is a gravel-bed clinging to the sides of the hills, at an elevation of about 600 feet; and which, from its distinctly bedded arrangement, would appear to have been deposited in water at a time when the sea washed the base of the oolitic cliffs of the Cotteswold range. The two most marked raised beaches of the coast of Scotland (see plate) both contain marine shells. Those which are found in the twenty-five or thirty-feet beach, being all of recent species, and associated with works of art; while some of those in the forty-feet beach, the more ancient of the two, are of extinct species. In this latter beach no certain traces of human remains or works of art have yet been discovered.

The shores and fiords of Scandinavia present some of the most interesting examples of raised beaches with which we are acquainted. Sir C. Lyell has shown that, near Stockholm, there occur, at slight elevations above the sea level, horizontal beds of sand, loam, and marl, containing the same peculiar assemblage of testacea, which now live in the brackish waters of the Baltic. Mingled with these, at different depths, various rude works of art, and vessels built before the introduction of iron, have been detected. The level of this beach is about sixty feet above the surface of the Baltic; and in the same neighbourhood, at higher levels, more ancient beaches, with the same shells, but without any traces of the remains of man or his workmanship have been traced.* On the western coast, portions of raised beaches, containing shells of the species inhabiting the German Ocean, may be traced, lining the shores and winding along the sides of the deep inlets and fiords up to levels of 600 feet above the ocean. What renders these littoral phenomena of Scandinavia of unusual interest, is the fact that the land is not only actually rising, but that attempts have been made, with some success, to measure the rate of elevation, which, at the North Cape, is considered to be equal to five feet in a century. On the coast of Denmark, however, this rate, according to M. Puggaard is only equal to two or three inches in a century.

The floors of caves, especially in limestone districts, are

* Lyell: "Principles of Geology" and "Antiquity of Man."

sometimes lined with shingle containing shells of species living at the present day in the neighbouring seas, together with bones of animals which inhabited the country either at the time the cave was in course of formation, or subsequently. The shores of the Mediterranean sea afford many illustrations of these and other kinds of raised beaches. In the island of Sicily there are caves of this kind so recently elevated that *serpulæ* are still found clinging to their walls. Of these, the cave of San Ciro, near Palermo, is a good example. It is about twenty feet high, ten wide, and 180 above the sea. Within it is found an ancient beach of pebbles of various rocks, many of which must have come from places far remote. Broken pieces of coral and shell, especially of oysters and pectens, are intermingled with the pebbles; and immediately above the level of this beach, *serpulæ* are still found adhering to the rock, while the walls of the cave are perforated by *lithodomi*. The number of species of shells in this beach examined by Dr. Phillipi was about forty-five, all of which, with two or three exceptions, now inhabit the adjoining sea; while overlying this shell-gravel is a deposit of bone-breccia, containing the remains of the mammoth, hippopotamus, and several species of deer.

The eastern shores of the same island present many striking instances of inland cliffs, and sea-beaches, sometimes carved in solid white limestone. Amongst the most interesting are those of the Gozzo degli Martiri. Here the terraces rise above one another in a succession of semi-circular steps resembling a Roman amphitheatre. Another ancient sea-wall of noble proportions runs along the coast both north and south of the town of Syracuse, varying in height from 500 to 700 feet, and between its base and the sea is an inferior platform, the whole composed of solid limestone rock. Similar cliffs, with terraces at their base containing marine shells, are to be observed in the Morea, rising one above the other from the shores to elevations occasionally exceeding 1,000 feet. These cliffs are sometimes penetrated by caves, the floors of which are paved with a breccia (or angular gravel) cemented into a solid stratum, and containing fragments of shells of species now living in the adjoining seas, such as *Strombus* and *Spondylus*. Caves and beaches, precisely similar, are now forming along the present shores, and if the coast were now to be still further elevated, another raised beach, in all respects similar to those described, would be the result. The evidence of the shells found in these beaches goes to prove that, *geologically* speaking, this age is but as yesterday, yet it is doubtful whether the youngest of them had not been lifted beyond the reach of the waves when Agamemnon and his host sailed forth for the shores of Troy.

The "lateritic" formation of Madras and North Arcot in India, affords an example of a raised beach on a large scale, and one which has recently excited considerable interest from the discovery by Mr. Bruce Foote, of the Geological Survey, of stone implements similar to those found in the valley-gravels of Europe. Mr. Foote considers that the laterite, consisting of sand and gravel, was deposited at the bottom of a shallow sea studded with mountainous islands, between which flowed strong currents. Unfortunately no shells have as yet been discovered in this gravel; but the works of human skill show that the bed of the sea has been elevated into dry land along the shores of Southern India since the appearance of man.

I shall now request my reader to accompany me to the shores of the New World, and examine one or two remarkable cases of raised beaches there. Entering the Gulf of St. Lawrence we find the islands and coast presenting remarkable examples of these, together with sea-stacks and isolated masses of rock of the most fantastic forms, enough to employ the pencil of the artist and, we may add, the camera of the photographer for many a day to come. Captain Bayfield has published drawings of a group of sea-worn rock-pillars called "the flower-pots," in the Mingan Islands—the furthest from the shore being sixty feet above the reach of the highest tide; and Sir C. Lyell (in his "Manual of Geology,") gives a drawing of another group of limestone pillars in Niàpisca Island, belonging probably to the same level. Other examples are described in the works of the States Geological Surveys.

But the shores of South America afford perhaps the most stupendous examples of old coast-terraces that are to be found in any part of the world. They occur along the sea-border of Chile, Tierra del Fuego, Patagonia, and La Plata, throughout a coast-line of several thousand miles. At Coquimbo, Mr. Darwin in his "*Voyage of the Beagle*," describes five narrow, gently sloping, fringe-like terraces, formed of shingle, rising one behind the other, and sweeping up the valley for miles from both sides of the bay. At Guasco, north of Coquimbo, these phenomena are displayed on even a much grander scale. The terraces expand into plains, and line the valley for a distance of thirty-seven miles from the coast. Shells of many existing species lie on the surface of these terraces, or are imbedded in a friable calcareous stratum of which they are formed. Along the eastern coast, the same distinguished naturalist has traced a raised beach from the Rio Colorado for a distance of 600 or 700 nautical miles southward. This beach spreads itself over the plains of Patagonia for an average distance of 200 miles inland from the coast. He considers that the land, from the Rio de la Plata to Tierra del Fuego, a distance of 1,200 nautical miles has been raised in mass, in some parts to a height of 400 feet, within the period of the existing sea-shells, as these are found sometimes on the surface of the terraces partially retaining their colours! The uprising movement was interrupted at least eight times, during which the sea ate deeply back into the land, forming at successive levels, lines of cliff, or escarpments, which separate the different plains as they rise like steps one above the other. The lowest plain is ninety feet above the sea level, and the highest ascended by Mr. Darwin near the coast 950 feet, of which only relics are now left. The author to whom we are indebted for these details observes, that the elevatory movements and the erosive action of the sea during the periods of rest, have been equable over long lines of coast, for he found to his surprise, that the step-like plains stood at nearly corresponding heights at far distant points.

These illustrations, drawn from both hemispheres of ancient sea margins and raised beaches, will probably suffice for the purpose of this paper, and there remains only one more subject of prominent interest to discuss, namely, the date of these elevations in regard to the age of man. That all the raised beaches we have been considering are extremely recent, geologically speaking, is proved by the fact of their containing shells of living species almost exclusively; yet, it by no means follows that some of them are not of more ancient date than the appearance of the human race. On the other hand, others, as we have seen in the case of the laterite of Southern India, and the thirty-feet beach of Scotland, are more recent, as they contain works of art. The most recent instance, perhaps, of coast elevation is that of the Bay of Baiæ, which, as shown by Sir C. Lyell in his "Principles of Geology," has been partially submerged, and re-elevated within historic times. The Temple of Serapis was partially entombed in a beach now raised twenty-five feet above the sea, consisting of clay and volcanic matter, and containing pottery, portions of buildings, and numbers of shells of existing species in the bay. The emergence can be proved to have taken place since the beginning of the sixteenth century.

The age of the most recent of the raised beaches of Scotland, the thirty-feet beach, has occasioned a lively controversy. That it is more recent than the habitation of the country by the ancient Celtic tribes is attested by the canoes which have been found under the streets of Glasgow and further inland, imbedded in strata of sand, clay, and gravel, along with remains of whales, seals, and porpoises; but beyond all this it seems highly probable (if indeed not absolutely certain) that the elevation of this beach has taken place since the date of the

Roman occupation of the country. The evidence is as follows: On the south shore of the Firth of Forth, there is a small stream near Falkirk, and several miles up this stream, and considerably beyond the reach of the tides, the foundations of old Roman docks were discovered and described by General Roy. These docks were built near the termination of the wall of Antoninus, which stretched across the island from the Firth of Forth to that of the Clyde. When these docks were built they stood of course on the banks of the sea, which never reaches the spot now. Another branch of the evidence has been ably elucidated by Mr. A. Geikie, and seems satisfactory. The wall of Antoninus, built by the Romans to keep out the tribes on the north side from the territory they occupied, was, we may infer, carried from sea to sea at both ends, beyond which the sea itself would form a protection. Its eastern termination is recognised by most antiquarians as having been placed at Carriden, on the top of a considerable cliff overlooking the flat "carse" of Falkirk, which stretches down to the sea. Its western extremity, not having the favourable site offered by a cliff, terminates a short distance back from the sea-margin of the Clyde. Now we must give the Roman engineers credit for more sagacity than to suppose they would carry their wall across the country, and leave a level space at each end, which the Celtic warriors could easily steal round on a dark night and thus turn the flanks of these laborious lines of fortification. It is clear, therefore, that the wall was originally carried down to the water's edge, and probably some distance into both seas; and the subsequent elevation of the land appears to be a satisfactory explanation of the relation of the ends of the wall to the shores, especially when taken in connection with the position of the Roman docks near Falkirk already described. To those therefore who have witnessed the rapid waste going forward along some portions of our coast, it may be some consolation to know that, since the Roman occupation, millions of acres have been added to the land of Great Britain by the upheaval of that fringe of level land known as "the twenty-five or thirty-feet" beach of Scotland.

EXPLANATION OF PLATE.

These sketches (executed by the graphotype process) represent one or more raised beaches on the western coast of Scotland. Two of them—on the coast of Fife and Arran—are by the pencil of Mr. A. Geikie, F.R.S. The former showing three raised beaches, the lowest of which is the "30-feet," or most recent; the sea-stack of old redsandstone on the coast of Arran stands on the same beach. The third sketch is taken on the western coast of Cantyre, and shows the relative position of the "30-feet" raised beach to the present coast-line. Along this terrace, the road from Campbelton to Tarbet is carried, and on it most of the villages are built.

ON MILK AND ITS ADULTERATION.

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THE public is indebted to Mr. J. C. Morton for much useful and interesting information on the production and consumption of milk in London.

The painstaking and intelligent editor of the *Agricultural Gazette* has lately collected, with praiseworthy zeal and self-denying labour, a vast amount of statistical facts, having reference to the quality of milk produced in London and in the country, the quantity annually imported by the metropolitan railways, the consumption of milk in London in comparison with that of other towns and of various country districts. These facts, together with an account of Mr. Morton's numerous visits to the London cow-sheds and suburban dairies, and much incidental, interesting information, were brought before the Society of Arts last December, in a paper on London milk, which was subsequently published in the Journal of the Society. This paper will well repay a careful perusal, for it contains a great deal of valuable and trustworthy information on a variety of matters important to the producer and consumer of milk.

It is not, however, my intention to review Mr. Morton's paper in detail, or to present the necessarily dry statistical data in which it abounds, in a shape in which they may be offered to the general reader with a fair chance of being read and inwardly digested.

The main object of the present paper is to give a short account of the chemical and physical character of good, bad, indifferent, and adulterated milk, and of a ready means of ascertaining, with at least some degree of accuracy, the extent of adulteration to which milk is frequently subjected, more particularly in London and other large towns.

When Mr. Morton's paper was read before the Society of Arts, the discussion that followed the reading of it chiefly turned upon the question whether country or town milk is, or ought to be, the better of the two, and as considerable differences of opinion appear to exist on this question, it may not be amiss to offer a few remarks on it, after having placed in the hands of the reader the materials from which he may safely draw his own conclusions. The question in dispute does not so much depend on mere opinions as on facts, which can be readily ascertained by any one who will take the trouble to investigate carefully the various conditions which affect more or less appreciably the quality of milk.

Good milk is a whitish liquid, of an agreeable sweetish taste, and faint but pleasant odour. It is essentially an emulsion of fatty particles in a solution of casein and milk-sugar. The fatty matter, however, is not contained in milk in a free condition, but enclosed in little cells consisting of casein, a substance which exists also in a state of solution in milk, and is precipitated spontaneously when milk gets sour; in other words, the fat or butter occurs in milk encased in curd. Viewed under the microscope, milk appears as a transparent fluid full of small round or egg-shaped bodies, the so-called milk-globules. When milk is left undisturbed for some time these milk-globules rise to the surface, and may be removed in a great measure in the shape of cream.

The remaining skimmed milk has a bluer colour and is more transparent than new milk, containing its full share of milk-globules, or cream, or butter globules, as they may be called with quite as much propriety.

However long milk may be left at repose, it is not possible to skim off all the milk-globules, and hence the skimmed milk always contains some cream, which renders it more or less opaque. Were it possible to remove the cream-globules altogether, we should obtain a perfectly clear, watery liquor.

On adding rennet or an acid to milk, curd separates, to which chemists give the name of casein, from its forming cheese; and when the whey of milk, from which the curd and butter have been completely removed, is evaporated to dryness, a colourless, crystalline, sweet substance is obtained, which is known by the name of sugar of milk.

When the curd is removed from milk by rennet, and the clear whey is heated to the boiling point of water, a substance identical with white of eggs or albumen separates in white flakes. Milk dried and finally burned in the air leaves behind a quantity of ash, which is rich in phosphate of lime or bone-earth and alkaline salts—constituents largely required for the formation of bone and blood in the young animal.

The curd and albumen of milk contain 15½ per cent. of nitrogen in round numbers, and in other respects resemble intimately in composition animal fibrin and gluten, which may be termed the fibrin of wheaten flour. Like the latter, curd and albumen of milk are used in the animal economy for building up the muscular parts of the body. Milk-sugar and the fatty matters, or butter, on the other hand, are free from nitrogen, and are used in the animal economy to feed respiration and with it to keep up the usual warmth of the body, which varies but little throughout the year.

Milk may be looked upon as a kind of model food; and hence it is of great importance that especially the young should be supplied with the unadulterated fluid, which, it is to be feared, is regarded by many of the poor more as an article of luxury than one of necessity.

Breeders of high-priced short-horn bulls and cows know full well how essential it is to the early development of a sound and strong frame, round which the flesh and fat may be afterwards deposited in symmetrical forms, not to stint the calf in milk, for they now very generally keep cows as nurses, for the especial purpose of providing an extra quantity of milk to their young stock.

There can hardly be any doubt that the quantity of milk which the poor folk in town and country are in a condition to allow to their families is miserably deficient. It is well to remember that the foundation of the adult is laid in childhood and youth, and to take care that the scanty allowance supplied to the poor by the retail dealer should be of good quality, and not, as is generally the case, shamefully adulterated with water.

A variety of conditions affect materially the quantity and quality of milk.

Thus the season of the year and the amount and kind of food given to cows influence the yield and quality of their milk; again the race or breed and size of the animal to a great extent affect the yield and quality of milk.

Generally speaking, small races, or small individuals of the larger races, give the richest milk from the same kind of food. Where good quality is the main object, Alderneys or Guernseys unquestionably are the cows that ought to be kept, for they give a richer cream than any other kind in common use in this country; but of course Alderneys are not the most profitable stock for cow-keepers in towns, with whom the Yorkshire cow, essentially a short-horn, is the favourite breed, as it surpasses all others for the quantity of milk it yields. The milk, however, compared with that of the Alderney or Ayrshire cow, is more watery and less rich in butter, and therefore not well suited for dairies in which butter and cheese are made.

In the spring of the year, and the early part of summer, milk is more abundant, and the butter made from it of a finer flavour. As the season advances, the supply diminishes, but becomes richer in butter. The influence of food on the quality of milk is very striking. A half-starved cow not only yields but little milk, but what it yields is miserably poor. On the other hand, the liberal supply of food, rich in nitrogenous and phosphatic elements of nutrition, tells directly on the milk.

Nothing, therefore, can be more injudicious than to stint dairy cows in food.

The finest flavoured milk and butter, I need hardly say, are produced by cows fed in summer entirely on the grass of rich permanent pastures, and in winter on nothing else but hay made of fine short sweet grass. Eleven or twelve lb. of grass produce about one lb. of milk, or a ton of good hay produces as nearly as possible one hundred gallons of milk. Few persons, however, having the opportunity of keeping cows for their own use, can afford to feed them in winter entirely upon hay. Turnips, mangolds, meal, brewer's grain, bran, or oil-cake, with more or less straw-chaff, in a great measure have to take the place of hay as a winter food.

Turnips give a disagreeable taste to the milk, and moreover produce very watery milk.

Mangolds are less objectionable, but should not be given to milk-cows without an allowance of three to five pounds of meal. Of all kinds of meal, none is equal in milk-producing qualities to bean-meal—a fact which finds a ready explanation in the circumstance that bean-meal contains as much as twenty-eight per cent. of flesh-forming matters, or the same class of compounds to which the curd and albumen of milk belong, and that it is also rich in phosphates, or bone-earth. Pea-meal or Egyptian lentils closely resemble bean-meal in composition, and may be used with equal advantage as an auxiliary and excellent food for milk-cows. It is not a little remarkable that in leguminous seeds, which are always rich in flesh-forming matters as well as in other articles of food, a large percentage of nitrogenous or flesh-forming compounds usually is associated with a large percentage of phosphates or bone-earth. There exists thus naturally an admirable provision in food, specially adapted for milk-cows, or young and growing stock, to supply the animal not only with the material of which the curd of milk or the flesh of young stock consist, but likewise to supply bone materials, for which there is great demand when growing stock has to be maintained in a thriving state, or cows have to be kept in a condition in which they may be expected to yield much and good milk. Oil-cake produces much and rich milk, but seriously injures its quality by giving it a bad flavour.

Bran, on the other hand, is a good food for milk. Indeed, nothing can be better as an auxiliary winter food for milk cows than four lb. of bran made into a thin mash, to which should be added four lb. of bean meal. Along with this about twenty-five lb. of mangolds, and about fifteen lb. of hay, and fifteen of straw-chaff, should be given per day to each cow.

Cows fed upon such a daily allowance of bran, bean-meal, mangolds, hay, and straw-chaff, during the winter months, yield much more milk of a superior flavour than cows fed upon turnips and most other kinds of auxiliary food.

When brewers' grains can be obtained at a reasonable price, they will be found one of the cheapest and best foods that can be given to milk cows. Brewers' grains, I find, are much more nutritious than their appearance seems to warrant. Even in the wet condition in which grains are obtained from breweries, a condition in which they hold from 75 to 77 per cent. of water, they contain a good deal of ready made fat and flesh-forming matters. When air dry, brewers' grains, I have recently discovered, contain from 7 to 8 per cent. of oil and fatty matter, and in round numbers 15 per cent. of nitrogenous matters, and in this state are more nutritious and a more useful food for milk cows than barley meal in the same state of dryness.

During the last ten years I have made a great many milk-analyses, from which I select a few for the purpose of illustrating the natural variations which may occur in the composition of equally genuine milk. The results are embodied in the following table, showing the composition of four samples of genuine new milk obtained and analyzed by myself in the country.

COMPOSITION OF FOUR SAMPLES OF NEW COUNTRY MILK.

	1	2	3	4
Water	85·20	87·40	89·95	90·70
Fatty matter (pure butter)	4·96	3·43	1·99	1·79
Caseine (curd) and a little albumen	3·66	3·12	2·94	2·81
Milk-sugar	5·05	5·12	4·48	4·04
Mineral matter (ash)	1·13	·93	·64	·66
	100·00	100·00	100·00	100·00
Percentage of dry matters	14·80	12·60	10·05	9·30

The analyses of these four samples exhibit a wide range of variations, which I found in equally pure and genuine country milk. The first analysis represents the composition of a sample unusually rich in butter; the second shows the composition of milk of average good qualities; the third of poor, and the last of very poor country milk. The richness of the first I ascribe to the extremely good pasture upon which the cows were fed at a season of the year when milk generally becomes richer in quality, but less in quantity—that is, in September and October, up to November. The last sample was also September milk produced on the Agricultural College farm, Cirencester. The cows were then out in grass, but the pasture was poor and overstocked, so that the daily growth of grass furnished hardly enough food to meet the daily waste to which the animal frame is subject, and was then not calculated to meet an extra demand of materials for the formation of curd and butter. The poverty of this milk thus was evidently due to an insufficient supply of food. In the same month (September) I procured samples of milk from two other farms, on which the cows were out in grass, having an abundant supply of grass of good quality. The morning and evening milk from each farm on analysis furnished the following results:—

	1		2	
	Morning's Milk.	Evening's Milk.	Morning's Milk.	Evening's Milk.
Water	87·07	87·20	87·50	87·70
Fatty matter (pure butter)	3·44	3·76	3·10	3·59
*Caseine (curd) and a little albumen	3·37	3·35	3·45	3·37
Milk-sugar	5·38	4·98	5·18	4·57
Mineral matter (ash)	·74	·71	·77	·77
	100·00	100·00	100·00	100·00
*Containing nitrogen	·53	·54	·52	·54

These analyses do not show any great difference, and prove that the quality of the September milk was good, and nearly the same on both farms; but compared with the September milk of the cows on the Agricultural College farm, striking differences manifest themselves, indicative of the influence of food on the quality of the milk. Thus, on the farms on which the cows were provided with abundance of grass, the amount of solid matter, on an average, was about 12½ per cent.; and in this dry matter we have 3½ per cent. of pure butter, and about the same quantity of curd; whereas a scanty supply of grass produced milk containing little more than 9 per cent. of solid matter, and in this only 1¾ per cent. of butter.

It will be seen that the variations in the amount of curd and milk-sugar in good and watery milk are far less striking than those in the amount of butter. A very good judgment of the quality of milk may therefore be formed from the amount of butter which it yields on churning, or from the amount of cream which it throws up on standing. Instruments, adapted for measuring the quality of cream thrown up by different samples of milk, are called creamometers. These instruments are simply graduated glass-tubes, divided into 100 equal degrees, in which milk is poured up to the division marked 0, and is kept at rest for twelve hours. Although the creamometer does not furnish results which correctly represent the real amount of butter in different samples, it nevertheless affords a ready means of ascertaining whether milk is rich or unusually poor in butter, in other words, whether or not milk has been skimmed to a considerable extent. Good milk, of average quality, contains from 10½ to 11 per cent. of dry matter, and about 2½ per cent. of pure fat. It yields from 9 to 10 per cent. of cream. Naturally poor milk contains 90 or more per cent. of water and less than 2 per cent. of pure fat, and yields only 6 to 8 per cent. of cream, or even less.

Experiments on a large scale have shown me that the thickest cream does by no means give most butter, and that the cream which rises from different kinds of milk often varies greatly in composition. The indications of the creamometer, therefore, are fallible when samples of milk, produced under very different circumstances, have to be tested. Milk sent by rail is necessarily subject to a good deal of agitation, and throws up less cream than that which has been less disturbed. A direct experiment shows this very distinctly:—

One hundred measures of new country milk, after standing for twenty-four hours at 62° F., gave me 12 per cent. of cream by measure, whilst at the same time, a like quantity of the same, after having been gently shaken in a bottle, threw up only 8 per cent. of cream. We learn from this experiment that the shaking to which milk is subject when sent by railway has the effect of breaking some of the cream globules; in consequence of which, either the fatty matters remain suspended in the milk, or more probably the cream thrown up gets richer in fat. Mr. Morton informs us that dealers in milk will give from 4d. to 6d. per barn gallon more for town-shed milk than for what is delivered by the railways. London milk in London, in other words, is worth more by a ½d. to ¾d. a quart than country milk in London. Mr. Morton founds on this fact an argument for the opinion which he entertains that country milk is generally inferior to London milk. Although it cannot be denied that the milk delivered by the metropolitan railways occasionally does not arrive in the best condition, probably the true reason why milk dealers pay a higher price for town-shed milk than for country milk is that they cannot take off so much cream from milk after having been violently agitated during its transmission to town, than for the town produce. As far as the consumer is concerned, he may therefore, after all, be better served when he is supplied with country milk than with the higher priced town-shed milk.

In large towns and all places where the demand for milk at times is greater than the supply, its quality is not so good as it might be. The inferiority, however, arises simply from a deficiency of cream and an extra quantity of water. When undiluted and not skimmed, a condition in which milk unfortunately is rarely retailed by London cow-keepers, town milk, I believe, generally is richer in cream and on the whole better than country milk.

This no doubt is due to the fact that London cow-keepers, for the most part sharp men of business, are fully alive to the advantages of providing a liberal supply of food specially adapted to the production of milk rich in fatty matters, whilst farmers too frequently overstock their land and hesitate to lay out any money in the purchase of bran, oilcake, bean-meal, grains, and other food, which would be amply repaid by an increased quantity and better quality of milk.

However, London milk as generally sold to the consumer is usually skimmed once and diluted with about 30 per cent. of water. A great deal has been said and written about milk-adulteration. Sheep's brains, starch paste, chalk, and other white substances, which are said—on what authority nobody has ever decided—to have been found in milk, only exist in the imagination of credulous or half-informed scientific men. It is difficult to understand where all the sheep's brains should come from and how they could be amalgamated with milk, nor is it at all likely that chalk, a substance insoluble in water and not easily kept in suspension, should be employed for adulterating milk. As a matter of fact I may state that I have examined many hundreds of samples of milk and never found any chalk nor any adulterating material except an extra quantity of water, and that I never met as yet with a chemist who has found any of the clumsy adulterations which popular treatises on food describe as having been detected in London milk.

The whole question of milk adulteration and means of detecting them, resolves itself into an inquiry into the character of good, bad, and watered or skimmed milk, and the mode of recognizing these with precision.

As the result of my own experience, founded on the examination of many samples of milk produced under the most varied circumstances, and purposely adulterated with known quantities of water, I may state that milk may be considered rich when it contains from 12 to 12½ per cent. of solid matters, 3 to 3½ per cent. of which are pure fatty substances. If it contains more than 12½ per cent. of solid matter, and in this 4 per cent. or more fat, it is of extra rich quality. Such milk throws up from 11 to 12 per cent. of cream in bulk on standing for 12 hours at 62° F., and has a specific gravity varying from 1·028 to 1·030.

Good milk of fair average quality, as has been stated already, contains from 10½ to 11 per cent. of dry matter, and in this about 2½ per cent. of pure fat. It yields 9 to 10 per cent. of cream and has a specific gravity of about 1·030.

Poor milk contains 90 per cent. or more water and has a lower specific gravity than 1·027. Such milk yields not more than 6 to 8 per cent. of cream.

Skimmed milk throws up still less cream, has a bluer colour, and is more transparent, and when undiluted with water has a slightly higher specific gravity than new milk.

Good skimmed milk has a specific gravity of about 1·033, and poor skimmed milk 1·028 to 1·030.

Milk purposely watered yields only 5 to 6 per cent. of cream, and *invariably* has a lower specific gravity than 1·025.

If milk is both skimmed and watered it yields less than 4 per cent. of cream, and possesses as low a specific gravity as 1·025 to 1·026.

A great many experiments have led me to the conclusion that within certain limits the specific gravity is the most trustworthy indicator of quality, and that for all practical purposes an ordinary hydrometer float, by means of which the gravity of liquids can be ascertained with precision, and a graduated glass tube, divided into 100 equal degrees, constitute the safest and readiest means for ascertaining the quality of milk so far as it is affected by the relative proportions of the normal milk constituents.

A set of such instruments or lactometers, one being a graduated glass tube for measuring the proportion of cream thrown up on standing, and the other a gravity float or hydrometer, with plain printed directions for use, can be obtained from Messrs. Negretti and Zambra at the cost of a few shillings.

In using these lactometers no chemical skill whatever but only ordinary care and intelligence are required on the part of the operator, and as the practical indications of these instruments are perfectly reliable, Messrs. Negretti and Zambra's lactometers can be confidently recommended to managers of country lunatic asylums, workhouses, hospitals, public schools, charities, and all institutions in which large quantities of milk are annually consumed.

A few years ago I made some accurate gravity determinations of pure milk before and after skimming, and of samples mixed purposely with 10 to 50 per cent. of water, and as the results may be useful in comparing them with others, I have incorporated them in the subjoined table :—

	Specific Gravity at 62° F. before Skimming.	Specific Gravity at 62° F. after Skimming.
Pure milk	1·0314	1·0337
" " + 10 per cent. of water	1·0295	1·0308
" " + 20 " "	1·0257	1·0265
" " + 30 " "	1·0233	1·0248
" " + 40 " "	1·0190	1·0208
" " + 50 " "	1·0163	1·0175

In illustrating the utililty of these lactometers I may give several complete analyses of London milk and partial determinations which I recently made.

The samples from the Strand district were all obtained from retail dealers in different courts and poor quarters in that locality.

Those from Camden Town from respectable shops, and those from Kensington from shops and dealers who principally supply the wealthier inhabitants of the parish.

Composition of Five Samples of Milk.—Strand District.

	1	2	3	4	5
Water	93·75	93·04	90·98	93·32	88·38
Pure fatty matter	1·72	2·25	2·58	1·69	3·84
*Caseine (curd and a little albumen)	1·75	1·75	2·50	1·69	3·18
Milk-sugar	2·13	2·57	3·41	2·64	3·90
Mineral matter (ash)	·65	·39	·53	·66	·70
	100·00	100·00	100·00	100·00	100·00
*Containing nitrogen	·28	·28	·40	·27	·51
Per-centage of cream by volume	4	6½	6	4½	12
Specific gravity of milk at 62°	1·019	1·017	1·021	1·020	1·030
Specific gravity of skimmed milk at 62° F.	1·020	1·019	1·023	Not determined.	

Partial Analyses and Determinations in some Samples of Milk.—Strand District.

	6	7	8	9
Specific gravity of milk	1·018	1·022	1·021	1·021
Percentage of cream by volume	5½	7	6	5

Samples from Camden Town, N.W.

	1	2	3
Water	93·26	90·32	90·96*
Pure fatty matter	2·16		
Caseine	2·08	9·78	9·04
Milk-sugar	2·06		
Mineral matter (ash)	·44		
	100·00	100·00	100·00
Specific gravity	1·019	1·026	1·030
Percentage of cream by volume	5	7¼	10

Samples from Kensington, W.

	1	2	3	4
Water	91·18	90·96	—	—
Dry matter	8·82	9·04	—	—
Specific gravity	1·025	1·023	1·029	1·026
Percentage of cream	5	9½	9	8½

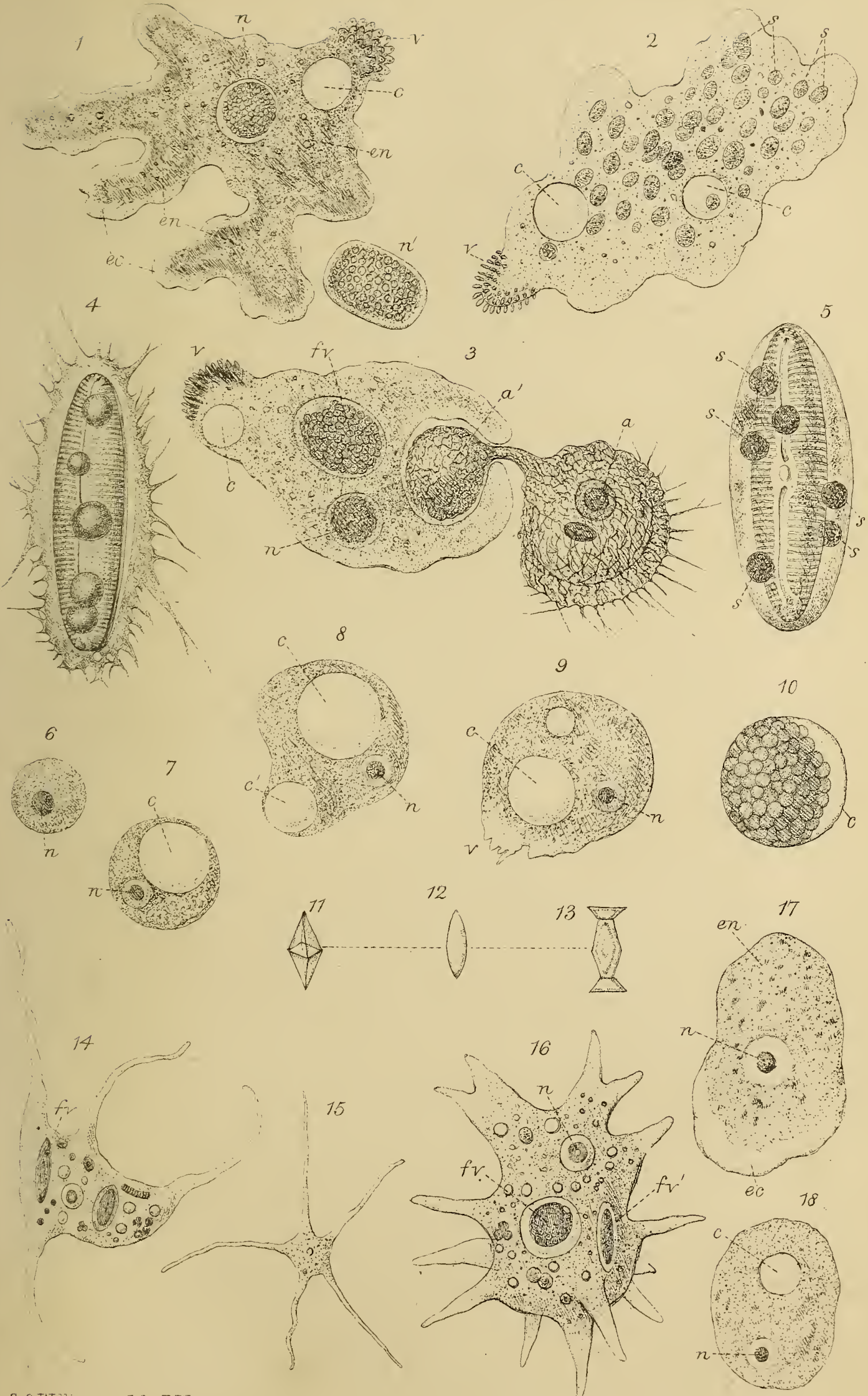
The preceding analyses furnish unmistakable proofs of the fact that nine milk-men supplied the poor of the different courts and poor quarters of Strand districts with milk adulterated with 30 to 40 per cent. of water, and only one sold pure, genuine, and good milk. It further appears that only one of the samples from Camden Town and one from Kensington were genuine, and the rest more or less mixed with water. Notwithstanding the high per centage of cream (12 per cent.) in the genuine milk sold in the Strand district, the specific gravity of that milk was 1·030, and throughout the samples poorest in cream also had the lowest specific gravity. These facts afford a conclusive answer to the objection that no dependance can be placed on the gravity test. The fact is, cream, though lighter than skimmed milk, is denser than water, and any amount of water worth adding at all to milk can readily be detected by the direct lowering of its normal specific gravity.

THE AMŒBA: ITS STRUCTURE, DEVELOPMENT, AND HABITS.

BY PROFESSOR W. C. WILLIAMSON, F.R.S.

THE peculiar direction which modern microscopic inquiries have taken has brought several hitherto obscure objects into prominent notice, because they happen to sustain a typical relation to an entire class. The Amœba is one of these. The change which it effects in the outline of its gelatinous substance long since led to its acquiring the name of the Proteus animalcule; but it was only when the study of Sponges and Foraminifera drew more general attention to the rhizopodous class that the true significance of the creature was recognized. It now runs no risk of being neglected, having already been the subject of many elaborate memoirs, as it doubtless will be of many more. The last few years have added much to our knowledge of this little creature, especially in consequence of the careful inquiries of Dr. Wallich and Mr. H. J. Carter. Nevertheless, we still require much more to be done before we can possess a correct view of the structure of the animal, since in some important points the two able observers referred to have arrived at different conclusions; and when this is the case with naturalists who have given such persevering attention to the subject, both at home and abroad, those whose knowledge of it is less practical are scarcely in a position to arrive at decided opinions. Nevertheless, we may venture to analyse their labours, and endeavour to ascertain the present position of the question.

There are several points on which all naturalists are agreed; whilst others must be regarded as moot questions. That the Amœba is a microscopic jelly-like animalcule, common in fresh, and occasionally seen in sea water, is well known. Equally familiar is the tendency which the creature exhibits to incessant changes of shape, by pushing out some parts of its gelatinous substance and retracting others, so that of all known animals it best merits the designation of Proteus (figs. 1, 14, 15, 19). But behind these conspicuous phenomena are a multitude of



S. C. Williamson del. T. West sc.

W. West imp.

The Amœba.

other, and more obscure ones, which possess the highest physiological interest.

The animal substance forming the body of the Amœba is *sarcode*, similar, in many respects, to that investing the living Sponges, and producing the calcareous shells of the Foraminifera. In the Amœba this sarcode is separable into two parts, an outer and an inner one. To the first the convenient name of ectosarc (fig. 1, *ec*) has been given; whilst that of endosarc (fig. 1, *en*) has been applied to the second, or inner substance; and as these appear to be the best names hitherto suggested, I shall employ them in the following remarks. The ectosarc is clear, transparent, and colourless, containing permanently few or no granules, or foreign bodies of any kind. This transparent aspect has led Mr. Carter to apply to it the name of diaphane. The tissue is capable of extension and contraction, being sometimes prolonged into radiating pseudopodia, which at others are drawn back into the central mass of the creature. But here we at once enter upon debateable ground. Mr. Carter affirms that this ectosarc is invested, in some instances, by a very thin transparent pellicle, which is elastic and tenacious, admitting of rupture and readily healing again, whilst from iodine communicating a violet tinge to it, he assumes that in its chemical composition it is related to starch. On the first of these points, viz., the existence of a pellicle, Auerbach entertains a similar view. On the other hand, Dr. Wallich has never been able to discover any true pellicle, and he describes some experiments which indicate that, in this instance, the iodine proof is fallacious. I have never detected any pellicle, and am disposed to doubt its existence. The nature and origin of the ectosarc are also debated questions; but before noticing the points in dispute, we may glance at the endosarc. This is a modification of sarcode, which is darker than the ectosarc, apparently from its being crowded with minute molecules, as well as with various organs belonging to the animal, and with foreign particles which have been incepted or introduced into its interior as food. In the midst of these are often found some angular crystalloid bodies (figs. 11, 12, and 13) of doubtful origin, which Mr. Carter thinks may be oxalate of lime, and analagous to the raphides of plants; as well as some refractive oily-looking atoms, which he regards as fat globules; whilst in one case Auerbach is said to have found starch. But, besides the above elements, we have some more peculiar objects usually present in the endosarc, especially nuclei, contractile vesicles, and food vacuoles.

One, or occasionally more nuclei are usually present in each Amœba (fig. 1, *n*). The nucleus is a small granular body, believed by Dr. Wallich to be inclosed within a true capsule (fig. 10, *c*). It usually appears surrounded by a translucent ring (fig. 17, *n*), which looks like a nucleated cell; but here again there exists doubt as to the true nature of the structure, partly, perhaps, arising from some want of exactness in the use of terms. Writers speak of a *nucleolus* within the nucleus, but Dr. Wallich affirms that this is merely the central portion of the nucleus, rendered more clear by the partial or total absence of the contained granules, which are crowded together at the circumference of the organ. The contractile vesicle (fig. 1, *c*) is a permanent and specialized vacuole of a remarkable character. Usually, there is but one present in each Amœba; but in some circumstances there are more (figs. 2 & 8). This vesicle exhibits a rhythmical expansion and contraction, at intervals varying from half a minute to five minutes; but in some instances the expanded, or diastolic, condition has been observed to continue above an hour. Mr. Carter seems to regard the vesicle as a cell with a proper wall. Dr. Wallich denies this interpretation, believing that the wall of the vesicle differs little, if at all, from the ectosarc. The vesicle evidently discharges some fluid at each systole, or contraction, but only does so at one point of the Amœba (fig. 1, *v*), where an anal outlet has been supposed to exist. When the vesicle contracts, it may wholly disappear, but always reappears at the same point. When the internal cavity has thus disappeared, its position may still be recognized by the aggregation of a number of minute villi, forming its outer surface, and which, when the vesicle is fully expanded, only appear at minute points. Some of these villi occasionally become distended, after a contraction, forming a series of vacuoles around the central vesicle and which either burst into each other or into the primary cavity; but sometimes one or two of these may become detached from the parent one, and float away into the sarcode. If these meet, they may burst into each other, as two soap bubbles would do, or they may return to the parent vesicle and burst into it; but under no circumstances do they appear to contract until they have returned to the posterior, or villous, part of the body of the Amœba (figs. 1 & 2, *v*).

The food vacuoles (fig. 1, 3, 16, *fv*) are irregularly extemporized cavities in the endosarc, within which particles of food are lodged, usually along with a drop of water. On coming in contact with any particle of organic substance on which the Amœba is inclined to feed, and they obviously have some choice in this respect, the sarcode proceeds to surround it (fig. 3, *á*), so that it is soon inclosed (fig. 3, *f v*), along with some water, within the endosarc. Most observers agree in believing that any part of the body may thus *incept* the food, though some have believed in an oral aperture. No such aperture has been discovered, and the evidence does not indicate its existence. It also appears indisputable that, when the Amœba has extracted the nourishment from the food, it ejects what remains, but not at the spot where the food entered. This is done at the posterior extremity of the body (figs. 1, 2, 3, *v*), where also the contractile vesicles discharge themselves. Writers speak of an anal outlet at this point, but there is no reason for believing in its presence. The particles appear to be simply forced out through the sarcode.

When water is present in these vacuoles, the food appears to be surrounded by a clear space (fig. 16, *f v*). This, however, is not always the case. At other times the endosarc immediately surrounding the vacuoles exhibits the same semiopaque aspect and numerous granules, as the rest of the endosarc. The nature of this clear area is open to the same doubt as that of the ectosarc itself, since Dr. Wallich and Mr. Carter are at issue on the point. Mr. Carter believes the ectosarc to be primarily and always a distinct tissue from the endosarc. Dr. Wallich on the other hand believes that the two tissues are mutually convertible. Thus the latter naturalist regards the transparent ectosarc, as endosarc which has been modified by prolonged contact with the surrounding watery medium, by a process analogous to coagulation. The result has been, as he supposes, that all the granules have been forced inwards into the more fluid endosarc. He accepts the same explanation of the diaphanous ring surrounding the food-particles, so far as that does not consist of mere water, regarding it as a consolidation of the endosarc through contact with the food and with the particle of water in which the food usually floats. Dr. Wallich explains in a similar way the disappearance of the food vacuole when the refuse food has been discharged from the hinder part of the body as above described. The food and water being no longer present to coagulate the endosarc surrounding the vacuole, it gradually returns to the state of ordinary endosarc. These are questions involving careful and widely extended observations on the part of many observers, and even in the ablest hands, assisted by the most perfect instruments, the solution of them is attended with extreme difficulty. This much, however, may be considered certain, viz., that the food vacuoles are extemporized and not permanent cavities; that their formation always commences at the surface of the animalcule; that such formation may take place at almost any part of the body, save at what has been termed the villous or excretory region; and that after they have discharged their effete contents at this region they finally disappear, never being reproduced at the same point, as is the case with the contractile vesicles. My own observations also confirm Dr.

Wallich's conclusion that the ectosarc gradually fades into the endosarc, and predisposes me to believe in their mutual convertibility.

The question of an internal circulation stands in close relation to that of the nature of the two parts of the sarcode. Apart from the deceptive changes in the *apparent* position of the internal organs, arising from the constant variations in shape which the Amœba undergoes, there is unquestionably a real movement in the interior of the endosarc. When the animal pushes out a lobe or pseudopodium, this sometimes consists only of a prolongation of the ectosarc (fig. 14), but in others the endosarc is also extended (fig. 1). In the latter case a rush of granules may be seen flowing in the direction of the new pseudopod, and we have already observed that contractile vesicles and food vacuoles move freely within the endosarc. All these circumstances prove that the endosarc possesses a much greater amount of fluidity than the ectosarc. Schultze believes that the movement of the granules is a true cyclosis, analogous to what takes place within the cells of Vallisneria, Chara, and other plants. But Dr. Wallich much more correctly regards it as a secondary and mechanical effect, consequent on the inherent vital contractility of the sarcode, which causes the particles to flow in the direction of the preponderating pseudopodian projections. He cannot discover any return stream, which would be readily observable were it present. Extensibility and contractility are obvious attributes of the sarcode, at least when it has been in contact with external media sufficiently long to secure its due consolidation.

Such are the ordinary features of the Amœba, and it will be readily perceived how few materials they furnish on which to found specific distinctions. Such attempts have been made by several writers, who have relied upon variations in the size and number of the pseudopodian processes, differences of colour or fluidity; the presence or absence of small external villous appendages in the anal region; vivacity or slowness of movements, and the presence or absence of crystalloids. But all these features are such as may merely represent different states of the same creature. Those who are familiar with the wide range of variation which all the lowest forms of animal and vegetable life exhibit, will be prepared to recognize similar phenomena in the Amœbæ, and they will not be disappointed when they apply their general conclusions to the special study of the animals under consideration. Dr. Wallich has shown most clearly that all the varieties known by the names of radiosa, diffluens, globularis, Schultzii, limax, princeps, guttula, verrucosa, quadrilineata, actinophora, and villosa are but different states of one species, since in one locality he found all these, together with such intermediate conditions as made their specific unity indisputable. Like many others of these Protozoa, the Amœbæ seem to be endowed with remarkable tenacity of life. That they can be dried up and yet retain their vitality has been proved by the experiments of Ehrenberg, Hicks, Balbiani, Samuelson, and Wallich. In some cases the Amœbæ appear to have survived the drying process and to have revived on being wetted again. In others only certain reproductive germs were preserved, the actual animals having perished. But in both instances we have provision for the perpetuation of the species, wherever a little water stands, or damp vegetation grows. The dried-up germs can be diffused by every wind, and develop into life wherever the needful moisture awaits their reception. Hence the universality of their occurrence.

This reference suggests the question of the actual modes of reproduction amongst the Amœbæ, and here we enter upon another perplexing subject. The simplest mode is by fission and germination. A creature merely contracts the middle of its body until the two ends become separated, and the divorced parts sail away to pursue an independent existence for the rest of their lives. In these cases each part usually contains a nucleus and a contractile vesicle; but sometimes the one or the other of these organs may be wanting in the newly-formed segments. Dr. Wallich has noticed that when the general fission of the animal was preceded by fission of the nucleus and vesicle, the creature was active, and moved briskly away as soon as the division was completed; whereas when either of the organs in question was absent, the separated portion so deficient remained torpid as if awaiting their reproduction.

Instead of the creature dividing into two nearly equal halves, a single pseudopodium may become detached in a similar manner. But this is a slow reproductive process compared with others to which attention has been drawn, especially by Dr. Wallich. He has shown that Amœbæ undergo a process of encystation, arising, as he supposes, from a prolonged contact of the ectosarc with the surrounding medium, and from a cessation, due to some unknown cause, of the mutual conversions of ectosarc and endosarc. Whatever may be the explanation of the action, there appears to be no doubt that the animal becomes torpid, preparatory to the evolution of important changes in its interior. Previous to this encystation, however, the creature extrudes from its sarcode all foreign particles, *except the frustules of Diatoms.* These Diatoms, Dr. Wallich believes to be retained as storehouses of nutrition during the encysting process. The external pseudopodia disappear. The nucleus, contractile vesicles, and food vacuoles are no longer traceable; circulation ceases, and the more conspicuous phenomena appear to be limited to the enclosure of one or more frustules of Diatoms (fig. 4) within the granular sarcode, the whole being contained within a defined capsule. This state is followed by the segregation of the sarcode granules into spherical masses (fig. 5, *s*), sometimes as many as eight in number, but usually not more than three or four. These granules appear to be identical with others which Dr. Wallich had previously observed and described under the name of sarcoblasts, and which evidently consist of the old sarcode of the Amœba, revivified, after a fashion seen amongst other organisms, by passing through a temporary stage of rest. But, before tracing the further development of these bodies, we must examine the growth of another class of sarcoblasts, whose origin is altogether different.

Both Dr. Wallich and Mr. Carter have noticed a segmentation of the nucleus. The result of some of these processes of segmentation is very doubtful, but in others it has been the wholesale production of broods of young Amœbæ. Mr. Carter found the nucleus, in one variety, to subdivide, until it consisted of more than seventy segments (fig. 2, *s*) of yellowish plasma, each being about $\frac{1}{1800}$th of an inch in diameter, the original nucleus, from which they sprang, having been about $\frac{1}{1200}$th of an inch in size. Dr. Wallich has never succeeded in observing this wholesale segmentation of the nucleus. He has found that the nucleus and its capsule become segmented together up to a certain point; but, according to his observations, a limit is soon reached, beyond which no further fission takes place. When fission has ceased a new action begins, which results in the production of a number of sarcoblasts *within* the body of the nucleus. There is some ground for doubting whether these two writers have had the opportunity of observing the same phenomena, which may account for the present disagreement of their conclusions. Mr. Carter says that each of the germs or sarcoblasts which he has seen formed by the segmentation of the nucleus is surrounded by a distinct capsule. Dr. Wallich recognizes the existence of the capsular covering of his segmented nuclei, wherever he has seen such; but these have always been few in number, and altogether different from his sarcoblasts, which never exhibit such a covering. Of course a discrepancy of this kind between the observations of two such practised observers requires further research for its elucidation. But looking at the Protean nature of these organisms, it is more than probable that not only these variations exist in their reproduction, but that many others remain to be discovered. This much is certain, that, however formed, whether within a capsule or not, the nuclei give birth to sarcoblasts, and we may now trace the further development of these bodies, as noticed by Dr. Wallich; for though he was not able to watch that development whilst the bodies were inclosed within the Amœba cyst, he had no difficulty in doing so, in the case of similar ones, which appeared identical with them, only floating free in the surrounding medium. It must be remembered that we are now about to speak of the changes that appear to affect two classes of objects, which have had a very different origin, viz., the free sarcoblasts derived from the aggregated granules of the sarcode during encystation, and those mulberry masses derived by some process or other from the broken-up nucleus. At first these sarcoblasts are densely granular, containing little of the fluid hyaline Protoplasm (fig. 6); the beginning of their further development is marked by an increase in this hyaline element, followed by the consolidation of the outer part of the sarcode, which now becomes differentiated into ectosarc and endosarc. But as yet, according to Dr. Wallich, there is no mutual conversion of the one into the other. We next find one or more contracting vesicles (fig. 7, *c*), making their appearance within the endosarc. These are at first exceedingly minute, but they gradually expand as the yet globular germ itself does, and at the same time the granular nucleus (fig. 7, *n*) also appears. The latter organ may have existed previously, but been obscured by the dense aggregation of the granules, whilst the separation or dilution of these granules attending the growth of the animal may have brought the organ into view. Up to this point no circulation of the granules occurs beyond the shifting of a few of them occasioned by the pressure of the growing contractile vesicle. "In short," Dr. Wallich observes, "the organism consists essentially of a quiescent spherical globule of sarcode containing granules, a contractile vesecle, and a nucleus." But a new phase of life now commences.

The contractile vesicle having attained to its normal dimensions, moves to one side of the germ, where it causes a protrusion from the circular outline (fig. 8, *c′*), and where it ultimately bursts through the ectosarc, this being the first of those operations which will continue to take place so long as the animalcule retains its vigour. At the place where the capsule broke through the ectosarc there now exists a minute mamelliform projection. The same phenomenon is soon repeated; the ectosarc having been weakened by the rupture of the first vesicle, apparently prepares the way for the bursting of a second at the same point, where the outline of the organism becomes still more irregular (fig. 9, *v*), and thus the foundation is laid for the production of what has been called the "villous region," the spot where the anal outlet has been supposed to exist; and where, beyond question, all the discharges, whether of the contents of contractile vesicles or of refuse food, take place. The occurrence of the phenomena which I have just described seems to supply the stimulus needed to stir up the young organism into all the manifestations of active life which characterize its more matured state. Movements of every kind now go on; it pushes out a pseudopod here, and only retracts it in order to protrude another there. These changes in its outward form cause the granules of the endosarc to flow hither and thither, as if afraid of being left behind in the slow race. Food is incepted; what remains of it after the meal is being expelled from the villous region. Slow locomotion occurs; what Dr. Wallich terms *Amœbasis*, or the mutual interchanges between ectosarc and endosarc commence, and all the phenomena which characterize mature Amœban life go on with little interruption, until at length the vitality again languishes, encystation occurs once more, and all the phases of existence just described are gone through anew.

Dr. Wallich has noticed another mode of reproduction in which there were extruded from the body of the parent Amœba, minute individuals which were already perfect as regarded all their essential characters. This appears to have been a viviparous reproduction.

But there are other features of Amœban life to which we have not alluded, because we conceive that we possess as yet too little information about them to state what they are with precision. On the one hand, Amœbæ appear to be convertible into Arcellæ, and on the other, into Actinophrys, whilst there are phases of plant-life in which Amœban creatures play an important part. Thus, the sporidium of Œthalium gives exit to a ciliated polymorphic cell containing vesicle and nucleus, but which loses its cilia, and becomes, for a season, a reptant Amœba. The Difflugia also exhibits some equally singular points of contact between the plant and the animal; but, as we have already observed, these points require much further elucidation before they can be regarded as settled.

The habitats of these creatures are as varied as their forms. Some of the varieties, especially that known as *A. Guttula* (figs. 17 and 18) occur almost universally wherever a few dead leaves have lain for some time in still water; but the discovery of the more remarkable varieties is usually an accidental thing. Sometimes they abound amongst Lemnæ; at others amongst damp moss or Confervæ. Wherever organic substances are undergoing disintegration in shallow pools or streamlets they may be successfully sought for, and especially in the slimy matter that often coats half decayed submerged leaves; but they appear to perish in putrescent water.

The observation of these atoms is sufficiently simple, since their slow locomotion makes it a much easier process than that of investigating the active Polygastrica or Rotifera. A common live box—such as is used for other animalcules—serves every purpose. By scraping off a little of the surface from decaying vegetation taken out of the water, and placing it in the live box, the student will rarely fail in discovering some form of Amœba; but the same end will be answered by placing the material in question on any glass plate along with a drop of water, and covering it over with another piece of thin microscopic glass.

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Fig. 1. Amœba princeps. After Carter.
ec. Ectosarc ; *v.* Villose region ; *n'.* an older and oval nucleus.
en. Endosarc ; *n.* nucleus ; *c.* Contractile vesicle.

„ 2. Amœba princeps; *s.* Reproductive granules (Sarcoblasts?). After Carter.

„ 3. Amœba feeding upon an Acineta. After Wallich.
n. Nucleus ; *c.* Contractile vesicle.
a. Portion of Acineta ; *á.* portion of Acineta being incepted ; *f. v.* food vacuole containing fragment of Acineta.

„ 4. Amœba investing a Pinnularia prior to becoming encysted. After Wallich.

„ 5. Amœba already encysted. After Wallich.
s. Sarcoblast.

„ 6. Sarcoblast in early stage of development. After Wallich.

„ 7. Ditto ; *n.* Nucleus ; *c.* Contractile vesicle.

„ 8. Ditto ; *c'.* Contractile vesicle preparing to burst through sarcode.

„ 9. Ditto ; *v.* Incipient villose region.

„ 10. Granular nucleus showing the capsule *c.* After Wallich.

„ 11, 12, 13. Crystalloid bodies. After Carter.

„ 14, 15, 16. States of Amœba radiosa ; in 14 *f. v.* and 16 *f. v'.* are incepted Diatoms.

„ 17. Amœba Guttula, with nucleus but without contractile vesicle.

„ 18. Ditto; *n.* Nucleus ; *c.* Contractile vesicle.

„ 19. Amœba princeps with numerous reproductive granules, as at *s* ; *v.* Villous extremity ; *c.* Contractile vesicle.

In all the above figures *ec.* means ectosarc, *en.* endosarc, *n.* nucleus, *c.* contracting vesicle, *f. v.* food vacuole, *v.* villous region, *s.* sarcoblast.

ON THE SOLFATARA AND FUMAROLES IN THE NEIGHBOURHOOD OF NAPLES.

BY PROFESSOR D. T. ANSTED, M.A., F.R.S.

ABOUT a mile and a half west of the ridge of volcanic tufa, pierced by the celebrated grotto of Posilipo, a ridge which is certainly part of a very old and much broken volcanic crater of large dimensions, we come to the small and picturesque Lake of Agnano, familiar enough to tourists and all visitors to the environs of Naples as the place where the *Grotto del Cane* is exhibited. Rather more than a mile further west is the *Solfatara,* almost equally familiar to the Naples sight-seer. Less than another mile, in the same direction, is the site of the Temple of Jupiter Serapis, dear to geologists, and where may still be seen, in use, old Roman baths of hot mineral waters. Another two miles beyond we come to the cone of Monte Nuovo; and half a mile further the classical Avernus, over which, in former times, no bird could safely fly. On the coast adjacent are the hot mineral springs of Baia and the hot vapour-baths of Nero. Just at the extremity of the ridge forming the headland of Posilipo there rises the small but picturesque island of Nisita, a simple crater long since extinct; and the coast abounds with hot springs and fissures or crevices, whence issue hot air and steam, quite to the extremity of Ischia.

Along this extended and familiar line of country, whose classical interest is so great as frequently to absorb every other feeling, there is everywhere abundant proof of some powerful forces still at work, unable to shake and split the earth, but quite sufficient to produce marked results by means of slow chemical action, of the same general nature as that which is recognized after systematic eruptions from or near the principal craters. This district, and the country to the north, is that of the celebrated "Campi Phlegræi," or Phlegræan fields. Above ground, the district terminates to the west in the island of Ischia, celebrated for its hot mineral springs, but it is not unlikely that subterranean communications may extend beyond that island towards the middle of the Mediterranean.

With scarcely an exception, the whole country alluded to consists of trachytic lava and tufa. By far the greatest part has been erupted into the air before falling on the earth,—in other words, is tufa rather than lava. The lava currents are numerous and extensive; but the heaps of tufaceous matter are immeasurably larger. The whole line of coast has certainly been subject to upheaval and depression.

One of the most singular and interesting spots in the district, and one in which the phenomena of chemical action are most strikingly displayed, is that known as the "Solfatara," an extinct crater about six hundred yards across, surrounded by low hills, pierced in various places, and on both sides, by small crevices, through which still issue considerable quantities of hot vapour, containing a very small admixture of sulphurous gases. Similar emanations of gas take place from the ground in the interior of the crater, which exhibits cracks and fissures, not very wide, but all yielding fumaroles or smoke-holes, emitting hot air and vapour. The name solfatara is clearly derived from the sulphur emitted; but the proportion of this mineral is very small, though perceptible. Arsenic is emitted with the sulphur vapours.

On ordinary occasions there is nothing to mark the site of the smaller fumaroles, which, indeed, are constantly changing their position. Everywhere, in certain directions, holes may be seen in the earth, into which a stick may be thrust to some depth. If a thermometer be introduced into these holes, the temperature will be found to be very high, varying according to circumstances, from 40° C. to 90° C. I have even seen the instrument mark 96° C.; reaching, therefore, nearly to the boiling-point of water. Besides these numerous small orifices, there are a few larger and more permanent, and it is to these that chief attention has been paid. Out of the principal one, in the basin of the Solfatara, there rises constantly, with a great rushing noise, a very large jet of steam. It proceeds from under a kind of roof a few feet below the ground. I endeavoured several times to approach closely to the point of emission, and even ventured down into the hollow, with the intention of taking the temperature of the steam jet, but was always driven back by the scalding heat and the acid fumes, which at once burnt and stifled me. Immediately adjacent, and to a distance of a couple of hundred yards towards the west, the ground was much cracked, and from every part of the cracks there proceeded similar emanations of scalding vapour, showing a heat of from 80° C. to 90° C., at the depth of little more than six inches below the surface.

In several caverns on the hill-side enclosing the crater to the north, there are similar issues of gas and hot steam, rendering the temperature inside the caverns almost unbearable; but these are not in a line with the *bocca principale*, or chief vent, which is marked by fissures and heated ground. The caverns have been used sometimes by the country people with great success for curative purposes; and they are, in fact, admirable natural vapour baths. They are called *stufe*. The quantity of steam issuing is very considerable, and the chief effect must arise from the violent perspiration into which the patient is thrown, and the absorption of the sulphurous and other gases into the system whilst the pores are open.

Caverns of this kind, some natural and others artificial, are accessible in various places. Thus, on the Lake of Agnano, where the celebrated Grotto del Cane is situated, there is a kind of establishment for this purpose, on the very rudest scale about a mile and a half due east of the Solfatara. The ruins of old Roman baths are still to be traced on the hill-side adjacent. The Grotto del Cane is a few hundred yards beyond the *stufe*, to the east; and between the two is another small cavern, now closed, where, it is said, ammoniacal vapours issue. This, however, is doubtful. About three and a half miles to the west of the Solfatara, or in the opposite direction, are the Baths of Nero, which are *stufe* of the same kind. Considerable eruptions of gas take place, both in the waters of the Lake of Agnano and in the sea on the shores of the bay, between Pozzuoli and Baia.

Besides the *stufe* in the caverns on the north side of the Solfatara, which, as I have said, are quite distinct from the fissure of the *bocca grande*, or great eruption of steam, I found, on crossing the hill and coming into the valley between the hills of the crater of the Solfatara and the remains of those that once inclosed the crater of the Lake of Agnano, satisfactory proof that the phenomena extended in this direction uninterruptedly. There is even a small hut used as a vapour-bath, or stufa, and though I could not obtain access to the interior, I found the vapour issuing at a high temperature from a kind of chimney constructed for that purpose. The place is not occupied except during the season. I found other indications of the same phenomena in the broken outline and colour of the ground, although there was no perceptible increase or heat on the surface of the rock. After some search, however, I noticed a very small opening surrounded with ants, not more than half an inch in diameter. Into this I carefully inserted the bulb of a thermometer, and found the mercury rise slowly. By dint of a little gentle force I succeeded in inserting the thermometer tube several inches through soft powdery earth, and found the temperature continue to rise till it showed 60° C.

There is a very curious result obtained at all these fumaroles. The vapour they emit is chiefly steam, with a small but perceptible proportion of gases, generally acid. The gases consist partly of sulphuretted hydrogen, as is evident by the smell. Occasionally there is sulphurous acid in the vapour. There is also carbonic acid, which, under certain circumstances, seems very abundant. In the grotto del Cane this is the principal gas, and it comes off readily at a temperature many degrees above the mean temperature of the air; so that the cavern in which the poor dogs are stifled for the amusement of tourists is itself a warm-air bath. Under ordinary circumstances the vapour is just visible; but when a lighted or smouldering match, the burning end of a cigar, or a piece of burning tinder is brought near and in contact with the issuing vapour, this vapour becomes visible, and fumes to an extent altogether inconsistent with the amount of burning material. At the great vent of the Solfatara, where the steam is always visible, a few twigs burnt at the entrance of the vent will produce a volume of rolling clouds of smoke rising to a considerable height and continuing for many minutes. As soon as the effect has subsided, it may be reproduced by the same means.

Fumaroles of the same nature I found to exist in great abundance on the walls of the craters formed during the great eruption of last year on the eastern slopes of Etna. They then occasionally emitted chlorine in sensible quantity, and the same may be remarked in the interior of the crater of Vesuvius, which was in a state of semi-activity at the time of my visit. They are familiar enough in all active volcanic districts, and are the small vents relieving the superficial and nearly exhausted energy, just as the great throats of Etna and Vesuvius belch out steam and gases, with a few scoriæ, from time to time, when the pressure in the larger and deeper cavities they are connected with becomes too great in the intervals between important eruptions.

But these gentle and long-enduring indications of subterranean fire are not without some result on the rocks adjacent. In the most recent cases, such as the cone of eruption of the last year just alluded to, the work is seen to be very rapid, and may easily be traced, though, of course, it is partial and confined to the part of the cone through which the gases have passed, We there see the nature and amount of the chemical action, and to the geologist there is no lesson more valuable and suggestive than this history of metamorphosis, with illustrations ready at hand.

The first thing that strikes the eye on mounting the cone and reaching the edge of a volcanic crater, either at the time or recently active, is the intensity of the colours exhibited in long streaks, which sometimes concentrate into broad bands. These colours include every variety of yellow, passing into the purest white on one side and into deep orange or brown on the other; occasionally, but more rarely, the colours include vermilion and other reds. The brilliancy is such that no pencil could imitate it, and the appearance can only be compared to the hues of the clouds during an autumn sunset in a warm climate. On a near approach, these lines of colour are found to mark accurately lines of crack or fissure in the soft mass of the cone, through which fumaroles are passing. One is at first inclined to believe that as sulphur seems so natural a companion to all volcanic phenomena, we have before us an unexplored mine of this mineral, and one wonders that any hesitation should be felt in making use of it. But there is perhaps hardly a specimen of native sulphur, whether crystalline or efflorescent, to be found. All these bright colours are evanescent, and we must be contented to admire them where they are. They are liable to be washed away by the first shower, though in that case they re-appear immediately. They would lose their beauty if exposed to ordinary air at ordinary temperatures. They are almost entirely deliquescent salts of ammonia, soda, and iron. They are also constantly changing their form and nature, and they seem to mark in some measure the particular chapter of the history of the eruption which lies open before us.

No one who comes into a volcanic country and looks at the objects before him with any attention will fail to see that he has an opportunity here of seeing something of Nature's chemical methods, just as in a country where there are glaciers or an exposed sea-coast, he may study the mechanical methods adopted to produce and modify rocks. A volcanic cone begins by being a mere heap of scoriaceous matter erupted and heaped round some part of a crevice or fissure opening from a considerable depth in the earth, and partly filled with melted rock. The cone is constantly becoming higher and higher as the eruption proceeds. It is hollow and funnel-shaped inside, communicating with the interior of the earth as long as the eruption lasts. Occasionally melted rock rises in it through this central funnel-shaped hole, and sometimes a flood of this melted rock issues from the top or side. In this case the remainder of the eruption takes place through hot and fractured stone walls only, the outside of the crater being then composed of the loose ashes and fragments ejected. But it is certain that all eruptions are accompanied by the issue of very large quantities of steam and gases struggling to escape, and these continue to be forced up through various crevices long after the eruption of lava and ashes has ceased from the larger fissures. It is the existence of such crevices in the mass of cooled lava covering rock still in a state of intense ignition, that enables the gases to escape and form the fumaroles. The actual crevices we see, those at the surface of the earth, are only the accidental and shifting points whence the gases issue most freely, and the whole of the spongy mass that forms the cone and conceals the lava must admit of the passage of some portion at least. Thus the whole mass of the cone, but the part where the fumaroles appear most especially, undergoes the action of acid vapours at a very high temperature, an action which tells immediately and incessantly on the mass erupted.

Let us now consider for a moment what is the nature and condition of this mass. It has certainly been formed originally by the fusion of the ordinary rocks and minerals that are present near the surface of the earth. It is a mixture, in other words, of quartz and alumina with lime, potash, soda, magnesia, a certain quantity of iron, and some other ingredients. Sulphur and phosphorus are not absent, though not very abundant. Sea-water and air have been at hand in the fusing. These materials, melted together at a high temperature under pressure, have produced a kind of glassy fluid paste, containing crystals varying according to circumstances, and often different in different volcanic districts. If the mass has cooled slowly or in flowing currents, it has become lava; if steam has passed through it rapidly at very high temperature, films or bubbles have been formed at the surface, and these have been ejected into the air as fine powder or small lumps. In this case volcanic ash, scoria, or tuff, has resulted, the latter expression being perhaps the most convenient, since these tuffs rather represent scum than either ash or cinder. They are very porous and light, but cement pretty readily by the passage of water through them, and then become tolerably solid.

Even the most solid lava, however, has been poured out in sheets or layers, and between two compact layers is generally a third full of air-holes. Even when this is not the case, there are often cracks and fissures, produced in cooling or in subsequent movements of upheaval and earthquakes; and thus the gases rise somehow or other towards the surface. Wherever they appear, they tend to produce change and metamorphosis. It is impossible to examine any variety of lava without recognizing this fact, and the numerous crystals contained both in the solid lava and in the small holes, once perhaps filled with gas or steam, afford ample proof of the nature and extent of the force. But it is the soft spongy tuff that is most rapidly affected. Directly the first violence of an eruption is over, and after lava has been poured out, the eruptive forces are once more kept in, pressed down as before by the weight of the whole overlying material, whatever that may be. While the lava is cooling—which it must do very slowly, some portion of these gases continues to escape, and immediately acts on the material through which it passes. It dissolves out the alkalies and the iron, causing them to enter into new combinations. For a time the gases that issue are intensely hot and distinctly acid. By degrees they change and even become alkaline, ammonia being emitted. They generally (perhaps always) contain free hydrogen and nitrogen, and at a certain period sulphuretted hydrogen seems to be the chief product. Towards the last, carbonic acid gas is given off almost in a pure state. It would take too long and involve details and statements too purely technical to explain minutely the course of proceeding and the resulting salts, nor am I indeed sufficiently well-informed on chemistry to venture a complete explanation. It is sufficient to say that various aluminous salts, several ammoniacal salts, chloride of sodium or common salt, chloride of iron, and occasionally sulphates of iron and copper, sulphuret of arsenic, and some rare salts, in which sulphur is the chief ingredient, are produced and destroyed, one set succeeding another with great regularity and rapidity. Thus are produced those curious and exquisitely beautiful appearances on the walls of a crater now or very recently in activity. In the old craters the yellows are far less common, though some still remain. The iron, always an important element in colour, becomes then converted into its peroxide, and assumes a red tint, which does not afterwards change. Examples of this of great beauty, and specimens of many of the permanent salts, are to be found, besides many that are deliquescent, in the interesting craters of the Monti Rossi, from which was erupted the lava-current that reached and partly destroyed the town of Catania, in Sicily, in the year 1669. Two hundred years have not sufficed to destroy all the marks of change produced by the fumaroles that sent gases through the erupted cone of ashes from the red-hot lava that once issued on the side of Etna, a few hundred feet below. The chemical action has been chiefly confined to this part of the cone, and it has helped to harden it, for it is much higher here than elsewhere.

In the hills behind the Solfatara, and in the caverns in the hills where the hot air issues, there is also abundant proof of chemical action. The hills, once composed of tuff, are now converted into a beautiful white earth, a large part of which is an admirable *kaolin*, or porcelain earth, capable of making the very finest varieties of porcelain, such as was once manufactured on the hill behind Naples, and is known to collectors under the name Capo di monti. The *kaolin* is still dug, though not in large quantities. Besides this there are large incrustations of common alum (a double silicate of alumina and potash), and the whole Solfatara crater has been inclosed with a view of manufacturing alum, taking advantage of the materials at hand and the heat of the steam jet. The caverns are entirely lined with exquisitely beautiful crystals, yellow, brown, and white, of which sulphur and the sulphates seem to form the principal part. I did not observe, however, any crystals or efflorescence of pure sulphur. The hills on the other side, near Pisciarello, are cut into at various points artificially, and are laid bare by the torrents that occasionally come down them. The rock is white and soft, and might certainly be more made use of than it is. It is also coated with aluminous crystals.

From the evidence afforded by the colour and composition of the rocks, it seems certain that the volcanic force under the Gulf of Naples, though it has chiefly found vent for the last several centuries in the immediate vicinity of Vesuvius, has not deserted the district between Naples and Ischia, where it once, perhaps, had its chief seat, and which, geologically, seems to be its principal axis. Naples is built in the broad valley between an old crater whose walls are pierced by the celebrated grotto of Posilipo, and the old crater of Monte Somma. Both are very old, using the term in reference to human dates and history, though, geologically, the phenomena are very modern. The crater to the west is, probably, the oldest. Just as Monte Somma has been broken by Vesuvius, so has this unnamed crater been destroyed by that of the Lake of Agnano, and that again by the disturbance that produced the Astroni and the Solfatara, both of which are much more perfect. Still newer and of known date, though hardly more perfect, is the crater of Monte Nuovo, formed about three centuries ago. It is small, and exhibits at present no signs whatever of chemical action. But the Solfatara, though so much older as a crater, is, as I have pointed out, in that state of activity which shows the near vicinity of hot lava, and the line of activity certainly extends the whole distance from Naples to Ischia, though, probably, not approaching the surface except at that point. It may be useful to mention that the levels of the bottoms of all these craters, except the Solfatara, were originally very little above the sea, though they are now filled up by débris. The bottom of the Solfatara is 235 feet above the sea.

The decomposition of the trachytic tufa by the vapours and gases that rise up through fumaroles, and its reduction to kaolin, is a fact of great interest to the mineralogist, as bearing on the cause of the production of this mineral from the felspars of granite. This result is generally attributed to the ordinary disintegration of particular varieties of felspar; but the absence of kaolin in the trachytic tufa, except when acted on in the way above described, would seem to render it likely that disintegration alone is not enough. Perhaps in Cornwall and other places where the china clays are obtained, it may be found that similar chemical action has taken place.

There are no fumaroles in the district east of Naples, except in the great crater of Vesuvius, and close to the lavas recently erupted. I noticed a few in the lava of 1857, at whose vents were deposits of common salt; but in the craters from which the late eruption took place, although there is much evidence of recent chemical action, there is very little appearance of hot air and present alteration. This is the more curious in connection with the condition of the Solfatara and the country adjacent. The small craters in the slopes of Vesuvius, as they contain few new fumaroles, also show but little alteration in the material of which they are composed. All the Vesuvian lavas are known to be rich in the alkaline bases, especially soda, and they differ in this respect from the Etna lavas. This does not prevent the metamorphosis being almost precisely the same in the craters where acid vapours at a high temperature are evolved; but it may have something to do with the ultimate transformations.

In concluding these remarks, I would remind the reader, that although much still remains to be worked out in the chemical investigation of volcanic phenomena, it is evident that the results already obtained are sufficiently promising to justify and encourage further and closer inquiries. It is only in this way that we can hope to understand the course of Nature in these her grandest operations, and, perhaps, although the phenomena of an actual eruption are infinitely more striking to the imagination, they are not on the whole more instructive than the continued chemical changes produced by these subsequent and much smaller movements.

THE GRAPHOTYPE.

BY THE EDITOR.

WE have heard of the Talbotype and of the ubiquitous Wöthlytype, and of the terribly unpronounceable Caoutchoucotype; but what in the name of rational orthography is the Graphotype? Such we imagine will be the exclamation of not a few of our readers. Scientific terms are in nine cases out of ten badly constructed, and the title of our article is by no means an exception. The literal signification of the word, which is to the effect that something writes and prints, conveys no approach to the real nature of the new discovery it designates. We shall therefore state generally that the graphotype is a process by which the artist is made his own engraver; for it is no exaggeration to say that the pencil is converted into the graving-tool, in the method which has recently been discovered by Mr. Hitchcock, and described so well by Mr. H. Fitzcook. Who has compared an original sketch with an engraving, and failed to see the difference between the two? In many instances, no doubt, the engraver seizes upon the spirit of the artist, and gives to the block all those finer touches which convey force and power to the drawing. But it not unfrequently happens that the engraver is but a copyist, and an unfaithful one. The more strongly marked characters of the sketch are carefully delineated upon the block; but the more subtle grades of light and shade are passed by unnoticed. It may be urged that when the artist draws upon the block, this difficulty is removed. But even in such cases we very often find that—unless the engraver is himself no mean artist—an undue prominence is given to certain lines, which materially alters the original design. No two heads can work out the same conceptions with the same results; and hence the objections to the existing methods of multiplying the results of our artists' labours. The artist's brain elaborates and develops an idea in one particular fashion, and it is extremely improbable that the engraver, if he even catches the idea, will hit upon the same means of carrying it out. In the case of scientific drawings this is forcibly illustrated. It would at first sight appear strange that an engraver could not accurately follow the copy which is set before him; but it is perfectly true that he cannot. The eye is so much the pupil of the mind. We have ourselves known instances in which first-class wood engravers, ignorant of the appearances of anatomical specimens, have so far deviated from the drawings set before them as absolutely to convey an idea of structure totally opposite to that which the artist intended to delineate. Indeed we apprehend that this is one of the reasons why there is so much discrepancy of opinion as to the arrangement of the minute particles which compose the tissues of animals and plants. The anatomist is seldom satisfied with the work of the engraver.

The difficulties which we have hinted at, and which arise from the circumstance that it is impossible for two individuals to work out one idea in exactly the same way, are obviated by the discovery of Mr. Hitchcock. The artist, be he never so clumsy in the use of the graving tool, may henceforth be his own engraver, for the simple reason that in using the pencil, he is absolutely preparing a block. The circumstance which led to the discovery of the graphotype, gives a good idea of the nature of the new method, and affords a proof of the truth of the old adage, that *necessity is the mother of invention.* In the summer of 1860, Mr. De Witt Clinton Hitchcock, one of the foremost draftsmen and engravers of New York, was engaged in making a drawing upon boxwood. In the course of his operations he found it necessary to erase a portion of his sketch and re-whiten the block. Now the white surface of blocks for wood-engraving is composed of a material similar to that of the enamel which we find on visiting-cards, and one of these latter was employed by Mr. Hitchcock in renewing the surface. The card he employed happened to be one printed from a copper-plate, and in rubbing off the enamel with the aid of a brush and water, he found to his astonishment that the printed letters remained in relief, and were not removed by the action of the brush. In point of fact he had accidentally produced a sort of block upon which stood out the letters of the original copper plate. The ink by combining with the enamel had been enabled to resist the action of both water and brush, and thus the elements of the new discovery were laid before the artist's mind. Surely, he said, "if I prepare a surface of prepared chalk, draw upon it with ink, and then brush the surface, my drawing will 'come out' in relief. All that I shall then have to do will be to harden the chalk, and I shall have a block for printing. He tried the experiment and he succeeded." He took a slab of chalk, and having reduced its surface to as smooth a condition as possible, he drew upon it with an ink composed of silicate of potash (water-glass) and indigo, and when the sketch was dry, he brushed the surface with a dry tooth-brush. "The lines of the drawing," says Mr. Fitzcook,* "being literally composed of stone, withstood the assault of the tooth-brush; but the intervening particles of exposed chalk succumbed and vanished in a cloud of snowy dust, leaving the impregnable lines standing in relief, inviting a proof of their strength by printing on paper. This could not be done until the whole mass of chalk was changed into stone by saturating it with the liquid glass, but in half an hour the chalk block was inked and printed from in the ordinary way by burnishing."

A number of experiments led to the following general method as the most perfect. Instead of a simple slab of chalk, a chalk surface upon a metallic plate is adopted. French chalk is reduced to the finest possible powder by grinding, and then, in order to separate the coarser particles from the finer ones, it is thrown into water, and the sediment which first subsides is removed and again ground. These operations are repeated several times, until a high degree of pulverization has been attained. The powder is next repeatedly sifted through a wire cloth, which contains 10,000 holes to the square inch, and is now ready to be laid upon the smooth metallic (zinc) plate. When this has been done, the layer is covered with a perfectly smooth steel plate, and is submitted to intense hydraulic pressure. The chalk surface has then only to be sized before being ready for the artist. In drawing upon the graphotype block, the outline is first traced with red chalk as in the ordinary way. The artist then employs sable-hair pencils and an ink which is composed of lamp-black and glue, which dries so rapidly that as soon as one set of lines are drawn they may be crossed by another series without any danger of blotting. As soon as the drawing has been completed, the surface is rubbed gently with brushes made of silk velvet or fitch-hair, till the portions of chalk intervening between the inked lines are disintegrated and removed to the depth of the eighth of an inch. The drawing is now in relief upon the prepared surface, and the next operation consists in hardening it. This is done by soaking the block in a solution of an alkaline silicate (water-glass): the silica combines with the lime, and thus converts the surface into one which is virtually stone.

At this point the purely graphotype operations are at an end; but the reader must not suppose that the block which has thus been prepared and petrified is used to print with. It might be so employed, but since it would not stand the mechanical "wear and tear" of the printing processes, it is not placed in the machine. A mould is taken of it, and from this

* *Journal of the Society of Arts*, December.

a type-metal cast is made—a stereotype in fact, which may be employed in producing impressions in the usual manner.

The extreme delicacy and precision of the new process are among its highest merits. The faintest lines are brought out with wonderful distinctness. "The impression of the thumb, wetted with the graphotype ink, can be made to give beautiful impressions in the ordinary printing press, whilst the finest hair-line that the artist can make will stand equally well with the bolder work." Accuracy and rapidity of production are the two great qualities of the graphotype, and by them it appeals in the strongest manner to the artist and the savant. The sketch which is made in the morning may be multiplied by thousands before evening, for the type-metal cast may be obtained within three hours after the completion of the drawing. For the illustration of the weekly newspapers, the graphotype will be especially valuable, since it combines speed with certainty. Take a supposititious case :—An illustrated paper goes to "press" on Thursday, and the telegrams on Wednesday night announce a terrific explosion, let us say at "Nine Elms." Under the present system of engraving, no representation of "the scene of the disaster" could be produced till the following week. By means of the graphotype, the sensation-loving public may be gratified on the succeeding Saturday. A special artist, provided with graphotypic plates, is sent down to the spot, he makes a sketch in a couple of hours, in three more it is converted into a block for printing, and by the time the paper goes to press, everything is ready for the production of thousands of copies of the original drawing.

There is no *à priori* argument so powerful as a demonstration, and we therefore beg to refer our readers to the plate illustrating the article on Raised Beaches, which has been executed by the graphotype, and which we think speaks volumes for the accuracy and artistic elegance of the new process. The sketches have been made by Mr. Archibald Geikie, F.R.S., and Mr. Hull, the author of the paper, and have been drawn upon the prepared chalk by Mr. S. J. Mackie, a gentleman whose excellence as an artist is only surpassed by his eminence as a geologist.* As we have said already, we think the graphotype is a most valuable invention, and one which seems not unlikely to supersede wood-engraving to a considerable extent; it is cheap, accurate, and rapidly worked, and while easier of production than the ordinary block, it possesses all its advantages.

* Mr. Mackie laboured under the difficulty of being obliged to employ a pencil of sable-hair, but the result he has produced only shows the ease with which even those artists unused to the process may prepare their own "blocks."

REVIEWS.

THE COMPARATIVE ANATOMY OF VERTEBRATE ANIMALS.*

PROFESSOR OWEN'S great and long-expected treatise has at last appeared. The present work will complete the outline of the organization of the animal kingdom which was begun nearly a quarter of a century ago ; but we hardly think it will satisfy those who are earnestly engaged in anatomical investigations. In fact, if truth must be told, the volume which Messrs. Longmans have just issued, is worthy to rank with that published in 1843, but is scarcely what we should have expected from one of the greatest comparative anatomists of the age writing in the year 1865. Still it is a fine one, well written, well illustrated—although most of the woodcuts are old ones,—and full of valuable information. What we find fault with most, is the tendency which the author shows to underrate the observations of anatomists who oppose his own peculiar views, and to strain every point to support speculations which are little better than creations of a mind addicted to the formation of false analogies. Professor Owen's archetype theory is a very beautiful one, and it is so ingeniously worked out, and appeals so vividly to the imagination, that it has great power of fascination for the enthusiastic philosopher. But a candid and careful examination of the evidence upon which it is based, must convince every unprejudiced observer that it is an over-generalization—a too-extended analogy. If the idea were simply to be regarded as a phantasy, we should not object to it ; but when Professor Owen says that his archetype is the great scheme upon which all vertebrate animals have been constructed, he affirms as a truth that which is only a speculation ; and he conveys an idea of the Almighty power which is absolutely degrading to the Creator, and which fails to satisfy the reason of the creature. Savants of the Bridgewater school, though their intentions are of the best order, have tripped in their transcendentalism in measuring the projects of the Creator from the narrow stand-point of their own minds. However they may express the train of reasoning which leads them to the construction of an archetype, it really comes pretty nearly to this : " If we, as men, had to undertake the construction of a series of organisms, of different degrees of complexity, we should lay down a general plan—simple at first, —and we should gradually improve upon it, till we reached the highest point

* " On the Anatomy of Vertebrates." Vol. I., " Fishes and Reptiles." By RICHARD OWEN, F.R.S. London : Longmans & Co. 1866.

of excellence of structure. So, likewise, it is evident that inasmuch as the several groups of vertebrates may be ranged into a series ranging from simple to complex, and possess certain common elements of structure, the Creator at first projected a scheme of organization, and gradually improved upon it." This is assuredly travelling beyond the limits of legitimate speculation. The existence of a series of common characters in all classes of vertebrates, by no means involves the fact that the Creator designed them upon any particular model. Man, owing to his finite comprehension, is compelled in his processes of construction to employ some scheme, in order, as it were, to keep him in the proper track. Were it not for this, he would be unsuccessful. But no truly reflective mind can be satisfied with a doctrine which teaches that an omniscient Creator either required or adopted a guiding plan. Notwithstanding Professor Owen's ingenious attack on the value of the study of development, by asserting that embryology shows nothing of homology, he cannot defend his theory against the charges urged against it in Mr. Huxley's Cromian lecture.

Development is, in all cases of philosophic inquiry, the true key to knowledge. If we sought to discover the nature of a language, and its relation to some other tongue, should we not endeavour to trace the history of its growth? Did we content ourselves with mere existing resemblances, we might be led —and those who do so are led—into the most extravagant conclusions. So, in the case of homology, or relationship of parts in anatomy, we must not take the structure as it is, but we must go back in its history, and observe and study the processes by which it came from what it was. Then by comparing the results of this mode of inquiry with those obtained from a similar way of investigation in the case of other structures, we may hope to arrive at valuable knowledge. Professor Owen cannot be said to appreciate the full importance of the developmental method. Indeed, the mere circumstance that he calls homology name-sakeism, sufficiently shows his views upon the subject. "Homological anatomy," he says, "seeks in the characters of an organ and part, those chiefly of relative position and connection, that guide to a conclusion manifested by applying the *same name* to such part or organ, so far as the determination of the name-sakeism or homology has been carried out in the animal kingdom."

Not the least important feature in the work before us is, that it contains a partial concurrence, on the part of the author, in the theory of *natural selection*. Professor Owen does not believe that this *guess-endeavour*, as he terms it, explains the relation between *Troglodytes* and *Homo ;* but he goes so far as to admit the action of external influences in destroying some species and preserving others. His remarks on this point deserve notice :—"The actual presence of small species of animals in countries where larger species of the same natural families formerly existed, is not the consequence of any gradual diminution in the size of such species, but is the result of circumstances which may be illustrated by the fable of the 'Oak and the Reed'— the smaller and feebler animals have bent and accommodated themselves to changes which have destroyed the larger species. They have fared better in the 'battle of life.'" Of the plan of the present volume there is not much to be said. It treats exclusively of the *Hæmatocrya*, or cold-blooded animals. The author first gives a general account of the characters of vertebrates, and then in the eleven following chapters he describes the several varieties of the osseous, muscular, nervous, digestive, absorbent, circulatory, respiratory, excretory, tegumentary, and reproductive systems of Fishes and Reptiles. He does not simply divide the Hæmatocrya into Fishes, Batrachia, and Reptiles; but forms the following sub-classes:—Dermopteri, Teleostomi, Plagiostomi, Dipnoa, and Monopnoa, which he thus defines. The members of the *first* have the body vermiform and limbless, the endo-skeleton cartilaginous and devoid of ribs, the skin scaleless, no sympathetic nerve, eyes wanting, branchial function independent of mouth, no amnios. The type of this sub-class is the Ammocætes. The *second* is known by a fish-like body, with fins supported by rays; in most the endo-skeleton is more or less ossified, the skin is covered with scales, the brain has a prominent mesencephalon, there is a sympathetic nerve, the mouth admits the respiratory currents, the branchial openings are two—one on each side,—there is no amnios or external allantois. This group includes the ordinary fishes and the ganoids (Sturgeon, Lepidosteus, Pterichthys) properly so called. Sub-class *three* is formed to embrace the Sharks and Rays. The species included in it have a cartilaginous skeleton, a mouth which in most is a wide, transverse slit, opening below the head, an intestine with a spiral valve, a pancreas and spleen, a bulbous arteriosus, with numerous valves, gills fixed, and with several branchial openings; the embryo is without allantois or amnios, and has deciduous external gills. The fourth sub-class, Dipnoa, corresponds to the ordinary Amphibia; and the fifth, Monopnoa, is the equivalent of Reptilia.

The best part of this voluminous work is that upon the dermal structures, which is enriched with illustrations from the author's splendid "Odontography." In the remaining chapters, there is little that will not be found in the works of Bojanus Stannius and other writers. Had Professor Owen consulted more fully even his own original memoirs, he would not have produced a treatise which is diffuse without being comprehensive, is as full of fancies as of facts, and is as out of accordance with recent progress as it is unworthy of his own great name.

POPULAR ZOOLOGY.*

MUCH as dry-as-dust naturalists may decry popular treatises, it is certain that works which are sufficiently devoid of technicalities to be understood by general readers are in great favour with the public. Not a week passes by but what produces some popular scientific treatise, and in fifty per

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* "Sea-side Studies in Natural History." By ELIZABETH C. AGASSIZ and ALEX. AGASSIZ. Boston: Ticknor & Fields. London: Trübner. 1865.

"The Structure of Animal Life." By LOUIS AGASSIZ. New York: Schreibner & Co. 1866.

"Our Reptiles." By M. C. COOKE. London: Hardwicke. 1865.

"British Beetles." By E. C. RYE. London: Lovell Reeve. 1866.

"A Plain and Easy Account of the Land and Fresh-water Mollusks of Great Britain." By RALPH TATE, F.G.S. London: Hardwicke. 1866.

cent. of the cases the works so published are upon general Natural History. These statements do not apply to Great Britain alone. All over the world there is the same desire on the part of those who do not call themselves scientific to be familiar with the sublime teachings of philosophy and the wonderful phenomena of Nature. In France, Germany, and America the rage for popular books is as great, if not greater, than it is in this country. Is it to be believed, then, that the result of the desire and supply is injurious to the true interests of science? Are we to suppose that, because the masses cannot follow the philosopher into the discussion of propositions which involve a consideration of abstract questions, therefore they cannot be improved by being taught the interesting facts and the grand general principles of science? We think not. The arguments of those who oppose popular teaching beg the entire question, and their tendency and motives are mischievous and selfish. It is too general an impression that, because "a little learning is" *sometimes* "a dangerous thing," it is better to have no knowledge at all than a superficial acquaintance with truth. Can it be thought, upon candid reflection, that such a theory as this is correct? We do not hold with such a creed. The terms little and much are, after all, but relative, and though the student of a popular treatise may learn but a little, his knowledge is as great in comparison with ignorance as that of the *savant* is in comparison with the knowable. Unquestionably, the little knowledge has led the tyro over and again into blunders and absurdities, and these have been detected by the philosopher. But, we would ask, does not the philosopher himself trip now and then, and is not his supposed freedom from error due to the fact that he has no one to point out his faults? However we may offend those who are devoted to *pure* science, we cannot help asserting our belief that a little knowledge is better than none at all.

If the publication of popular scientific works subserves no better purpose, it excites a taste for scientific pursuits, and leads many to the rank of the philosopher who, were it not for this, would remain in the slough of ignorance and contentment which the adoption of the pernicious proverb we have cited is calculated to produce. Again we say it: a little learning is *not* a dangerous thing. People who have confined their attention to popular treatises on science may often be heard expressing theories, and committing themselves to statements, which are unsound; but, with all the chaff of misconception which we detect in these utterances, there is the good grain of truth; and who will contend against its beneficial influence? How many of us, let us ask, are prepared to swear by the scientific doctrines to which we appear to yield so firm an allegiance? If we were to submit our pet theories to a rigorous analysis, how many of them would stand? We venture to say a very small proportion. Shall we, therefore, condemn popular scientific teaching because it is further from the truth than that which is more distinctly technical? Shall we exalt our own labours to the acme of perfection? Shall we, assuming an intellectual status which we have not justified, look down upon our humble fellows and say, "Be profound in knowledge, or perish in ignorance"? If so, we shall be unable to defend ourselves from the charge of interested intolerance; for, through a pretence as paltry as it is pitiful, we shall exclude the masses from the prosecution of Nature's grandest problems.

Impressed with the opinions to which we have given expression, it is with much pleasure that we introduce to our readers a series of interesting popular works on Natural History which have appeared during the past quarter. The first on our list is written by a lady, Mrs. L. Agassiz, and is illustrated by Mr. Alexander Agassiz. It is devoted to descriptions of the marine animals of Massachusetts Bay, U.S., and contains nearly two hundred pretty woodcuts, which, as they present a black background, very prettily depict the transparent creatures whose history is given in the text. The authoress limits her description to the animals included in the old sub-kingdom Radiata; but she describes a greater number of these than will be found in any other general essay. Her style is clear, and her statements are, in most cases, accurate. As much as possible she avoids touching upon abstract questions; and this is, perhaps, best in such a work as she has written. Of course, we should have wished to see the Hydrozoa more correctly defined, and the Echinoderms' affinities with the Annulosa alluded to; but, since zoologists, who ought to know more of these matters than Mrs. Agassiz, persist in adopting Cuvier's classification, we cannot attach special blame to the present writer. There is a great deal of information in her volume which can only be found elsewhere in such treatises as Forbes's "Naked-eyed Medusæ" and Huxley's "Oceanic Hydrozoa;" and we think, therefore, that Mrs. Agassiz has produced a book which meets a want.

The "Structure of Animal Life," though coming from one of the most eminent zoologists in the world, is really inferior to the work we have just noticed. It is a report of six lectures, delivered at Brooklyn Academy of Music in 1862. However, as it relates more to the principles of Natural History than to facts, it is, perhaps, unfair to compare it with Mrs. Agassiz's volume. It is published by the Directors of the institution referred to, who dwell in somewhat grandiloquent terms upon the old subject of design. If Professor Agassiz had given us anything new, or had supplied us with a sketch which was not to be found in every treatise upon Zoology, or had even put old matter in a new form, we should have had higher praise to award him than we can conscientiously bestow. Of the zoological merits of his book we have little to say; on most points he adopts the current theories and opinions. The feature to which we would call attention, and which, in our opinion, deserves the greatest censure, is one which is, unhappily, too common in Natural History treatises. We allude to the habit which certain naturalists display of dabbling in Divine matters. It appears to them that, unless they drag the Creator into every second paragraph, their essay will not possess the necessary religious veneering for the public taste. Now, when allusion is discriminately and respectfully made to the works of the great First Cause, no fault can be found. But we must raise our voice against the objectionable tendency of some writers to dilate upon what they suppose to be the views of the Almighty. The practice is unnecessary, and in some instances borders upon the blasphemous, whilst it occasionally conveys a degraded notion of the Omnipotent. No doubt the nature of the lectures on our table involved allusions of the kind we refer to, to a certain extent; but we think the author should have avoided the following passage:—"I trust you will allow me this evening to enter into such details as will make it perfectly evident, that when we analyze these structures, we disclose the *mental operations* of the Creator at every step." Mental operations are the necessities of an individual who does not possess Omniscience ; they are a clumsy method of acquiring truth which are quite inconsistent with a sublime conception of a Creator.

"Our Reptiles" is an excellent little work on the frogs, snakes, toads, newts, and lizards indigenous to Britain. Mr. Cooke writes in a light and pleasing style ; and, when he deals with the zoology of the creatures he has undertaken to describe, he tells us much that is both new and true. But critics are always cavillers, and so we suppose we must find a little fault with some of our author's observations. For example, although we do not object to his describing the true Reptilia and the Amphibia under the one general title of Reptiles, we cannot assent to his statement that they have a greater affinity with fishes than with birds. Indeed, by placing Amphibia and Reptilia together, it is impossible to say that the compound group has a greater affinity for birds than for fishes. The piscine early life of the frog, the metamorphoses it undergoes, and the absence of an amnios or allantois in the embryo all relate it to the fish. On the other hand, the single occipital condyle of the lizard, the presence of an amnios in the embryo, the absence of gills at all periods of its life, and the absence of metamorphoses, make it approach Aves very closely. Mr. Cooke should, therefore, have avoided the question of affinity, or he should have separated the Amphibians from the Reptiles. Again, he is not strictly correct in saying that, because the heart of the reptile has only "one ventricle, the result of this is that respiration is imperfect." Respiration is imperfect from several causes ; but pre-eminently because the air-vesicles are so large that but a small quantity of blood can be exposed by them to the air, in a given time. Neither is he accurate in saying that "respiration gives heat to the blood." He seems, too, to be unaware that true reptiles have the ventricles nearly divided into two chambers, and that in the crocodile there are two perfect ventricles, and that pure arterial blood circulates in the head and upper extremities of this animal. But these are trifling matters, when it is remembered that the pretty volume under notice is not intended to be a treatise on comparative anatomy, but upon the natural history of our British reptiles. Concerning its merits as a popular zoological book, we must speak highly of Mr. Cooke's production ; it is concise without being superficial, and is accurate without being technical. Eleven handsome coloured plates accompany the text.

"British Beetles" is a book which stands so much upon the boundary-line between pure and popular science, that we hardly know to which department it really belongs. We have assumed it to belong to the latter, although we are not quite sure that we are justified in the assumption. It is a sound treatise on our native Coleoptera, but we think it abounds too much in technicalities for most general readers. We admit that the glossary of terms is full and intelligible, but we do not think that mere beginners will like to learn off a few pages of tough dictionary work before commencing their practical pursuits. Still, Mr. Rye has done good service to the branch of entomology upon which his book treats ; and, even if the tyro fails in understanding the technical diagnosis of the text, he cannot fail to identify his beetles by the aid of the admirably coloured plates appended to the volume.

"British Mollusks" is another of Mr. Hardwicke's cheap series, and is a good book. Although we do not agree with Mr. Tate in thinking that all "the soft-bodied mollusks have their nervous masses" scattered throughout the body, we must congratulate him upon the general introduction he has written to his volume: it is what we do not often see, at once popular and philosophic. Of his descriptions of the several species of Lamellibranch and Gastropodous mollusks, we need only say that they are ample and intelligible. In some instances he has given good paragraphs upon the anatomy of the groups noticed, but we think he might have given us further details of the structure of such a common creature as the slug. The coloured plates are eleven in number, and are executed in Mr. Brookes' best style.

RECENT WORKS ON GEOLOGY.*

BY far the most important volume which the quarter has produced is that upon the Prehistoric Remains of Caithness, by Professor Huxley and Mr. Laing, and it is only to be regretted that Messrs. Williams & Norgate have not expended the care befitting such a treatise upon the plates which accompany its pages. These, instead of being, as is usual in books of this class, carefully-executed lithographs, are rude unartistic woodcuts, which have been "worked" in the printing-press. The volume is divided into two portions. Mr. Laing describes the weapons, &c., which he discovered in the kists at Keiss, and offers comments upon them and upon the observations of Professor Huxley, who describes the human remains, to which the second part is devoted. Mr. Laing's half of the book is of most interest to the general reader, while Professor Huxley's demands the fixed attention of the anatomist. The mounds at Keiss are described with the most scrupulous regard for minutiæ, and the account is accompanied by such a number of illustrations that it is easy to grasp an accurate notion of the locality and of the objects it contains. There is nothing calling for special remark in the weapons found accompanying the bones; but it is a singular circumstance that "in no instance was there a vestige of hair, integument, clothing, wooden coffin, urn, or pottery." The result of Mr. Huxley's examination of the bones goes to show the extreme resemblance between these and the bones of the present aboriginal Australian race. This resemblance is especially seen in the anomalous formation of the pelvis. On the whole, the evidence which

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* "The Prehistoric Remains of Caithness," by Samuel Laing, Esq., M.P., F.G.S.; with Notes on the Human Remains, by T. H. Huxley, Esq., F.R.S. London: Williams & Norgate. 1866.

"Geology for General Readers." By David Page, F.R.S.E. London: Blackwood. 1866.

"Reliquæ Aquitanicæ." By Edouard Lartet and Henry Christy. London: Baillière. 1865.

"Geology and Scenery of the North of Scotland." By James Nicol, F.R.S.E. London: Simpkin & Co. 1866.

"Geological Map of England and Wales." By Professor Ramsay, F.R.S. London: Stanford.

the two observers have brought to light favours the views of the advocates of "progressive development." Mr. Laing considers that the theory which best meets the facts of the case is that the human type is that of men who migrated northwards while Britain was united to a southern continent, and while the severity of the glacial epoch was abating. That this race, whose skulls are occasionally found in caves, lived on for an indefinite period, until they were exterminated or enslaved by superior races in times approaching to the historical era, "leaving, however, small fragments in remote and secluded situations, who preserved the primitive type and savage rudeness down to a period sufficiently modern to allow of their relics being occasionally discovered. The whole story would then be consistent—strangeness and extreme rudeness of weapons and implements would correspond with strangeness and extreme rudeness of human type." The Caithness skull No. 1 is a singularly degraded one, being indeed far more animal than any European cranium which has yet been discovered in the prehistoric tumuli of the Iron, Bronze, or later Stone periods. If, in a well-formed European head a line be drawn vertically over the skull from ear to ear, half the brain will be found to lie in front of it ; but in this specimen not one-fourth of the cranial cavity lies in front of such a line. "The degree of prognathism, as shown by the projection of the upper jaw and teeth, and the narrowness of the ape-like palate, is equal to that of the lowest specimens of the negro and Australian races." In the Appendix Professor Huxley offers some remarks upon one of the statements made by Dr. Davis in a memoir read before the Anthropological Society. Dr. Davis seems to imagine that synostosis explains fully the conformation of the Neanderthal skull. His views were very ably refuted by Dr. Thurnam, in an essay in the *Natural History Review* (a periodical now extinct) for April last. The arguments of Dr. Davis are critically examined by Professor Huxley, and are shown to be extremely distorted. The latter, in concluding his observations, says, "Would it not have been worth Dr. Davis's while (as he has read the paper from which he has done me the honour to quote a phrase) to have looked at No. 5,331 as well as at the gorilla skull in the College Museum, before he undertook to 'explain the Neanderthal skull anatomically' ? "

The "Reliquæ Aquitanicæ," or Contributions to the Archæology and Palæontology of Perigord and the adjoining provinces of Southern France, is Part I. of the joint work of M. Lartet and the late Mr. Henry Christy. It is published in quarto, is illustrated by a series of magnificent plates, and cannot fail, when completed, to be a most valuable addition to the literature of prehistoric palæontology. Owing to the lamented death of the English author, the whole onus of preparing the forthcoming parts of the work has fallen upon M. Lartet, who, however, will be assisted by Professor Rupert Jones in the labour of editing. Of course a good deal of the scheme of, and material for, the treatise had been sketched out by Mr. Christy previous to his death. For example, he had arranged its style and mode of publication ; very many plates, too, had been drawn and lithographed in Paris under his superintendence, and a general notice of the relationship between the stone implements found in the caves of Dordogne to the implements of existing savages and prehistoric ones, had been rearranged by him from his paper communicated to the *Ethnological Journal.* The present number contains an account, accompanied by diagrams, of the geological features of the Dordogne district, and descriptions and figures of the stone and bone implements found in the caverns.

Mr. Page is a well known and favourite geological teacher, and the highest praise we can award his present popular treatise is to say that in point of style and accuracy it is not below anything he has hitherto produced. It is just such a book as the general reader may peruse with pleasure and profit. In every instance where it has been possible, the author has avoided the technicalities of geology, while he has attempted to lay down the great problems of the science in language intelligible to any ordinarily well-educated person. There is one failing which we notice, and that is, the absence of illustrations. No scientific work should be unillustrated ; and this rule holds good in an intensified degree for geology. The recent discoveries have not been neglected by Mr. Page, who gives a general account of Eozoon, and states his objections to Professor W. King's startling hypothesis.

The geological map of England and Wales has been prepared by Professor Ramsay, and is creditable alike to him and to its enterprising publisher. It is on the scale of ten miles to the inch, and besides giving numerous explanatory sections, has all the recent railways marked out upon it. Forming a most convenient pocket volume, it should be in the possession of every working geologist.

Professor Nicol's little book is the report of two lectures, in which he shows that he deserves the credit of tracing the connexion of the metamorphic strata of the Grampians with the Silurian deposits in the south of Scotland. It has a bearing upon some questions of importance, and should be read by those who are acquainted with Professor Harkness's views.

THE ATLANTIC TELEGRAPH.*

THE beautiful volume before us is a fitting record of the great labour which last year saw begin and terminate. It is the history of the voyage, written by Dr. W. H. Russell, and while it is instructive and interesting as a narrative, it is highly ornamental as a sketch-book. Messrs. Day and Sons have reproduced Mr. Dudley's drawings in the best style of chromo-lithography, and altogether the book is one of which it would be hard to speak too favourably. Dr. Russell gives an account of the earlier efforts to unite the old and new continents, and shows us that the first submarine telegraph cable projected on the other side of the Atlantic was the scheme of an English engineer. The melancholy circumstances attending the rupture of the cable are conveyed as only Dr. Russell is capable of conveying them. Every little incident in connection with the great project is sketched with minuteness, and the reader's attention and sympathies are excited and engaged by this fascinating writer. Perhaps the most note-

* "The Atlantic Telegraph." By W. H. Russell, LL.D. Illustrated by Robert Dudley. London: Day & Son. 1865.

worthy portion of the work is that which refers to the probability of success attending the next effort to lay the cable. The cable of 1865, though capable of bearing a strain of seven tons, did not experience more than 14 cwt. in being paid out into the deepest water of the Atlantic. Owing to the improvements introduced into the manufacture of gutta-percha, it insulated a hundred times better than cables made in 1858, and still working. The improvements, too, effected since the beginning of 1851 in the conducting power of the copper wire, by selecting it, have increased the rate of signalling through long submarine cables by more than 33 per cent. Now, if a steam-engine be attached to the paying-out machinery, so as to permit of hauling in the cable immediately a fault is discovered, and a slight modification made in the construction of the external sheath, the cause of the faults which have yet presented themselves will be entirely done away with, and even should a fault occur, it can be picked up before it has reached the bottom of the Atlantic. All these things should make us hopeful of the success of the effort which is soon about to be made, and for which the *Great Eastern* is undergoing the necessary alterations. "Remembering," says Dr. Russell, "all that has occurred,—how well-grounded hopes were deceived, just expectations frustrated,—there are still grounds for confidence, absolute as far as the nature of human affairs permits them in any calculation of future events to be, that the year 1866 will witness the consummation of the greatest work of civilized man, and the grandest exposition of the development of the faculties bestowed on him to overcome material difficulties. The last word transmitted through the old telegraph from Europe to America was 'Forward,' and 'Forward' is the motto of the enterprise still!"

ALEXANDER VON HUMBOLDT.

HERO-WORSHIP is a commendable species of idolatry when the devotee is content with a moderate degreee of adoration. It is very different, however, when the particular hero is exalted into a demigod, and his worshipper becomes fanatical. This condition, for all save the enthusiast himself, is a very terrible and trying one. There is no adjective limit to the eulogium which a profound hero-worshipper passes upon his fetish. When he speaks of it, it is in terms of the superlative class, and when he writes of it, it is in a gushing style which is lovingly laudatory, but a small quantity of which goes a very great way. We are sorry to find that the author of the present biography is a hero-worshipper of the worst type. The cleverly written life of Humboldt which he gives us is eminently Boswellian, at least in some respects; still, it is a book which we have read with the greatest interest, and although it touches but lightly on some of the incidents of the German *savant's* history, and here and there betrays the author's ignorance of science, it is a pretty biographical sketch. Humboldt was a very great man,

* "Alexander von Humboldt; or, What may be Accomplished in a Life-time." By F. A. Schwarzenberg. London: Hardwicke. 1866.

a shrewd observer, an acute reasoner, and an ardent student. He used those powers to considerable advantage, in correlating a number of facts in natural and physical science, and in doing so he considerably advanced human knowledge. But he does not deserve the fulsome epithets applied to him by the writer. He was a man with a wonderful gift of intellect and an immense experience, but it is very certain that he might have achieved far more with both than he effected. We would remind Mr. Schwarzenberg that the author of the great treatise on Physio-philosophy did not spell his name "O*a*ken," and that Physiology did *not* make its "first appearance" in the early days of his much-belauded idol.

THE TREASURY OF BOTANY.*

THE two volumes which constitute this work contain a store of botanical information such as, we venture to say, is not to be found in any other treatise of the kind. There are nearly twelve hundred pages of closely printed matter relating to plants, of all sorts and all countries. It is not the species of work that one would take up for light reading, but it certainly is an admirable book of reference. Edited by Mr. Moore and the late Dr. Lindley, we have every guarantee of its general accuracy; and although it does not include all the members of the vegetable kingdom in its lucid and terse descriptions, there are few plants of importance which do not find a place in its pages. It comprises a short history of all those genera which are known to possess interest on account of their medicinal or economic uses. Those species, too, which are admired for their beauty as garden plants have not been omitted. The space devoted to each genus is necessarily limited, but the numerous plates and intercalated woodcuts clear up any difficulties in which the brevity of the descriptions might otherwise have involved the reader. The "Treasury of Botany" is essentially a library book, and we have much pleasure in recommending it to our readers.

A Year-Book of Facts in Science and Art. By JOHN TIMBS, F.S.A. (London: Lockwood, 1866).—Mr. Timbs is a wonderful compiler. In the present instance, however, he has not displayed his excellence in this direction to the best possible advantage. With the aid of "scissors and paste," he has put together a number of scientific paragraphs cut from various journals,

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* "The Treasury of Botany: a Popular Dictionary of the Vegetable Kingdom. With which is incorporated a Glossary of Botanical Terms." Edited by JOHN LINDLEY, Ph. D., F.R.S., and THOMAS MOORE, F.L.S. Two vols. London: Longmans & Co. 1866.

but he has not very carefully revised his book. His volume does not contain the matter of four numbers of our "Summary," but it does contain errors which might easily have been avoided by careful revision. M. Lestilgoudois should be M. *Lestiboudois;* Henry Christie should be Henry *Chrsty;* and Amand Grésby should be Amand *Gressly.*

The Simplicity of the Creation; or, the Astronomical Monument of the Blessed Virgin. By W. Adolph (London: Burns & Lambert).—"The Blessed Virgin, by a special act of goodness," "superseded one of the laws of nature" in Mr. Adolph's house. Mrs. Adolph had been lame for some years, but on praying to the Virgin and gazing devoutly on a picture of the Assumption, she was suddenly restored to health. In gratitude for the miracle, our author has dedicated his volume of startling theories to the Mother of God. He endeavours to demonstrate the simplicity of creation. Clearly, there is simplicity somewhere; but that it is in the universe we cannot pretend to say.

Smoky Chimneys. By F. Edwards, Jun. *Our Domestic Fireplaces.* By same author (London: Hardwicke).—These are two works upon one of the greatest plagues of domestic life, smoky chimneys. To all those who are afflicted in this particular way, we commend Mr. Edwards's treatises. They are full of sound sense and practical advice.

SCIENTIFIC SUMMARY.

AGRICULTURE.

Action of Liquid Manure on certain Soils.—Some recent researches on this point conducted by Professor Voelcker were alluded to by Dr. G. Calvert in his Canton lecture before the Society of Arts. In some respects Dr. Voelcker's conclusions differ from those of Mr. Way. They are briefly as follows:—(1) That calcareous, dry soils absorb about six times as much ammonia from the liquid manure as the sterile, sandy soil. (2) That the liquid manure in contact with the calcareous soil becomes much richer in lime, whilst during its passage through the sandy soil it becomes much poorer in this substance. (3) That the calcareous soil absorbs much more potash than the sandy soil. (4) That chloride of sodium is not absorbed to any considerable extent by either soil. (5) That both soils remove most of the phosphoric acid from the liquid. (6) That the liquid manure, in passing through the calcareous soil, becomes poor, and in passing through the sandy soil becomes richer in silica.

A phosphatic deposit, which promises to be of much service to agriculturists, has lately been discovered at Penygarnedd, in Montgomeryshire. The locality in which the deposit is found is a quarter of a mile from a proposed railway, and has ample water power, available at all seasons. A level has been driven fifty yards into the hill containing the deposit; and the latter has been found to improve with the depth.

The Value of Sewage.—This important question, which has been so ably discussed by Baron Liebig in his various works upon Agricultural Chemistry, had a paper devoted to it by Dr. Gilbert at a late meeting (February 1st) of the Chemical Society. After entering into the details of his subject, the author draws the following general conclusions:—1st. It is only by the liberal use of water that the refuse matters of large populations can be removed from their dwellings without nuisance and injury to health. 2nd. That the discharge of town sewage into rivers renders them unfit as water supplies to other towns, is destructive to fish, causes deposits which injure the channel, and emanations which are injurious to health, is a great waste of manurial matter, and should not be permitted. 3rd. That the proper mode of both purifying and utilizing sewage-water is to apply it to land. 4th. That, considering the great dilution of town sewage, its constant daily supply at all seasons, its greater amount in wet weather, when the land can least bear, or least requires more water, and the cost of distribution, it is best fitted for application to grass, which alone can receive it the year round, though it may be occasionally applied with advantage to other crops within easy reach of the line or area laid down for the continuous application to grass. 5th. That the direct result of the general application of town sewage to grass land would be an enormous increase in the production of milk (butter and cheese) and meat, whilst by the consumption of the grass a large amount of solid manure, applicable to arable land and crops generally, would be produced. 6th. That the cost or profit to a town, of arrangements for the removal and utilization of its sewage must vary greatly, according to its position and to the character of the land to be irrigated; where the sewage can be conveyed by gravitation and a sufficient tract of suitable land is available, the town may realize a profit; but, under contrary conditions, it may have to submit to a pecuniary loss to secure the necessary sanitary advantages.

ASTRONOMY.

The anniversary meeting of the Royal Astronomical Society, held on the 9th ult., claims our first attention; and first to be mentioned among the things done on that day is the award of the gold medal to Professor Adams—Neptune Adams—for his contributions to the Theory of the Moon. Mr. De la Rue's address, in which he details the many claims of the recipient, is one of the most masterly astronomical essays which we have read for a long time, and many who peruse it will probably learn for the first time how much important work has been done of late years by one of the two whose names—*teste* Sir John Herschel—"genius and destiny have joined," "to be pronounced together so long as language shall celebrate the triumphs of science in her sublimest works." The following pregnant note is given as an appendix to the address,—it is from M. Hansen, who has been quoted by some as by no means indorsing Mr. Adams's work.

"I have never disputed the theory of the secular equation of the moon's longitude, such as Mr. Adams was the first to propound. . . . . As the co-efficient which results from Mr. Adams's theory does not accord with observations, it could not be employed for the lunar tables, for in the construction of tables, either planetary or lunar, the first condition to be fulfilled is to construct them in such a manner that they represent observations as closely as possible; for without this they would be of no practical value, and therefore useless."

The Rev. C. Pritchard, who has for so long so ably fulfilled the office of secretary, in which post his high mathematical attainments have been of the greatest assistance to the Society, succeeds Mr. De la Rue as president; and, if we mistake not, his year of office promises to be a useful one. Mr. Stone takes the post of secretary, and the Council has been recruited by Captain Noble and Mr. Lockyer.

It should be a subject of congratulation to all interested in the science, that the Society is so rapidly increasing its members and becoming rich; we trust it will not be too anxious to fund its money. Surely new discoveries made by its aid will prove a more worthy inheritance for our successors than consols, be they never so much above par!

As remarked by Mr. Pritchard at the anniversary meeting, death is now busy with the eminent men to whose labours so much of the Society's success is due; the obituaries of Sir William Hamilton, Sir J. W. Lubbock, Admiral Smyth, and of Bond and Encke, appear in the annual report, while, since it was prepared, Dr. Lee and Dr. Whewell have gone from among us, the former being one of the most constant patrons the science has ever had in this country.

From the reports of the different observatories we cull the following items of information:—The Astronomer Royal of Scotland has been at work on and in the pyramids, and promises soon to let us hear the results of his observations, which were mainly directed in three departments of linear, angular, and thermal measures, with special reference to all cases of discordance amongst former observers, as well as the recovery, where possible, of ancient fiducial marks or surfaces. In connection with this it may be mentioned that the astronomical bearings of the corner sockets cut in the natural rock of the hill, marking the original size of the finished monument, were determined on two sides of the pyramid by means of a powerful altitude-azimuth circle reading by microscope micrometers. This instrument was likewise carried to the top of the pyramid, and also into the interior.

At Kew, in addition to the sun- and other work, which we have previously chronicled, a new collimator arrangement for testing sextants, devised by Mr. Cooke, is in course of construction under the superintendence of Mr. Francis Galton, F.R.S., and will shortly be erected at the Observatory, so that nautical men will then be able to have their sextants tested in an accurate manner. It is also the intention of the Kew Committee to offer to travellers and scientific observers an opportunity to make themselves acquainted at the Observatory with portable astronomical instruments of every kind, with the mode of using them properly, and the best methods of reducing observations. It is unnecessary to dwell on the great benefit which it would confer on astronomical science, if good use could be made of such an opportunity.

Mr. De la Rue is by no means discouraged by the want of success which has hitherto attended his efforts to photograph the sun on a large scale, and he is now having constructed by Messrs. Cooke and Sons, of York, a refractor for that purpose, thirteen inches in aperture and ten feet in focal length. Both object-glass and eye-piece will be specially corrected for the photographic rays, and will serve for taking lunar photographs in the principal focus, as well as sun pictures, after the rays have passed through the secondary magnifier. It is anticipated that the sun pictures procured with the new instrument will set at rest many disputed points in solar physics. This is a great deal to hope, but we do not think it is too much.

Mr. Fletcher is still proceeding with his revision of the Bedford star catalogue.

The *Séance publique* of the French Academy of Sciences has also been held since our last summary was written, and the *grand prix d'Astronomie* *de la Fondation Lalande* has this year been carried off by Mr. De la Rue for his labours in astronomical photography.

To come to our summary of astronomical progress, *proprement dit*, we find Mr. Huggins again fortunate. Not content with having taught us the real constitution of nebulæ, he has now thrown new light on the constitution of comets. Upon examining Comet I., 1866, which appeared in his telescope as an oval nebulous mass, surrounding a small and dim nucleus, the prism showed that the nucleus was self-luminous, that it consisted of matter in the state of ignited gas, and that this matter is similar in constitution to the gaseous material of some of the nebulæ. The coma was found to shine by light derived from another source. Since the extremely diffuse matter of the coma cannot be supposed to contain solid or liquid matter at the high temperature necessary for incandescence, it seems almost certain that the coma reflects the sun's light. On this supposition, the prism gives no information whether the material of the coma is solid, liquid, or gaseous. Terrestrial phenomena suggest a condition similar to fog or cloud. If the luminous gas of the nucleus suffers condensation and subsequent diffusion to form the tails of comets, it must pass through a condition in which it neither emits nor in any large degree reflects light. Dark spaces are frequently seen between the envelopes of comets.

Biela's comet, on the other hand, has escaped us altogether, and we have thus been deprived of an opportunity of observing a phenomenon unique in astronomy,—that of a twin comet. Otto Struve's and Mr. De la Rue's sweeps have been altogether unavailing, and Mr. Talmadge thinks he glimpsed it once only in Mr. Barclay's ten-inch refractor; we may imagine, therefore, that it has been playing other pranks besides the one recorded. Before we part company with comets, we may mention that Faye's comet, which, by the way, was mistaken by Father Secchi for Biela's, has been well followed by Axel Möller, who has communicated new elements of it to the *Astronomische Nachrichten*. Secchi's places given in the *Bulletino Meteorologico* are of value.

The *Comptes Rendus* have recently contained some papers by MM. Faye and Delaunay of the highest interest. Of M. Faye's paper on the sun we shall delay a detailed account until our next writing. In the interim, we may remark that the first part of it contains the following conclusions deduced from Mr. Carrington's researches:—

1. Sun-spots are depressions beneath the surface of the sun's photosphere, varying in depth from about $\frac{1}{100}$ to $\frac{1}{200}$ of the sun's radius, *i.e.*, from about 40,000 to 20,000 miles.

2. Many apparent *irregularities* in the proper motions of sun-spots hitherto supposed to be capricious, or attributable to cyclones or tornadoes, or to their own mutual actions, are now probably explicable by the continued variation in the motion proper to each successive parallel of the photosphere.

3. The astonishing *regularity* in the motions of sun-spots, the maintenance of which is thus demonstrated by M. Faye, appears to that astronomer incompatible with any hypothesis of mere superficial or local movements in the photosphere, but seems to point to some more general action arising from the internal mass of the sun.

We may also mention that Professor Spöerer, of Anclam, in a memoir presented to the Academy of Sciences of Berlin, has obtained a formula which (from four years' observations) expresses the law for the dependence of the period of the sun's rotation on the latitude

$$\xi = 16^\circ{\cdot}8475 - 3{\cdot}^\circ 3812 \sin (41^\circ\ 13' + \text{Heliographic latitude}).$$

where ξ is the angle of rotation in a day.

M. Delaunay's memoir deals with the retardation of the earth's rotation. He thinks, as others have thought before him, that the outstanding part of the moon's secular acceleration to which we have before alluded may be accounted for by a lengthening of the sidereal day. In spite of Hansen's inquiry into the subject, he considers that, on the hypothesis that the disturbing forces of the sun and moon act on the lagging protuberance of the great tidal wave, the amount of this action is sufficient to produce a progressive increase in the time of the earth's rotation, sufficient to account for the outstanding 6″ of the moon's acceleration. On this Mr. Pritchard has remarked that, should this hypothesis eventually prove to be correct, the scrupulously exact methods of astronomical investigation during the last few years will have enabled us to estimate with greater accuracy two of the prime elements of the solar system, viz., the mean distance of the sun from the earth, and the length of the terrestrial day. Mr. Stone has already discussed this paper, and although he bears testimony to its high value, he cannot accept the retardation as a demonstrated fact. We believe that, at the next meeting of the Astronomical Society, the Astronomer Royal will state his opinions on the subject.

Of planetary observations we have little to record, as none of them are well situated for observation with the exception of Saturn, whose rings are gradually opening.

We find in the *Monthly Notices* for January an interesting paper by Mr. Huggins on the variability of the stars, and on some new stars in the neighbourhood of the trapezium in the great nebula of Orion. Observations of these stars, now that we know something of the nature of nebulæ, cannot fail to lead to interesting results. In the same number Mr. Brownrig describes a very ingenious method of mounting specula and diagonal reflectors, on which the maximum of stability is obtained with a minimum loss of light.

At the meeting of the Society in March, Dr. Förster, Hermann Goldschmidt, Mr. Safford, the newly-appointed Director of the Chicago observatory, and M. Auwers were proposed as associates.

The *Astronomische Nachrichten* has recently contained a catalogue of double stars observed by Dembowski, of polar nebulæ observed by Herr Rümker (who was one of the *invités* at the last meeting of the British Association), with a special eye to their proper motion, and a description of an ingenious sun eye-piece contrived by Merz.

We learn from the *Bulletin International* (which has made its appearance in a new shape, with a supplement entirely devoted to astronomical and physical novelties) that M. Kaemtz has been appointed Director of the Central Physical Observatory of Russia, and that M. Oudemans is doing good work at Batavia, where a magnetical and meteorological observatory—we presume on the Kew model—is being erected. The registering thermometer at this observatory is a copper wire of ten metres in length, stretched horizontally, with a lever and index at the end, where there is a rotating cylinder to receive impressions, and a clock to produce them by pressing the index at stated intervals. The magnets are on Lamont's model.

The 85th Asteroid has been named Io, a designation open to the objection that it already belongs to one of the satellites of Jupiter.

Secchi, in the *Bulletino Meteorologico*, asserts that the bluish-green light which fringes the red moon in a lunar eclipse is merely an effect of contrast. The assertion is founded on observations made with a very small field of view.

ERRATA.

We regret that the printer took considerable liberties with our last Astronomical Summary. The reader is requested to make the following alterations:—

Page 91,	line 3 of text,	*for*	Lœwig	*read*	Lœwy.
„ 94,	„ 11 from top,	„	vibration	„	libration.
„ 94,	„ 18 from top,	„	Dane's	„	Dawes'.
„ 94,	„ 3 from bottom,	„	Poulhower	„	Poulkowa.
„ 95,	„ 18 from top,	„	on	„	in.
„ 95,	„ 20 from top,	*after*	elongate	*insert*	γ^2 Andromedæ.

BOTANY.

The Influence of Light on the Twining Organs of Plants.—At a meeting of the French Academy, held on Oct. 26th, a valuable paper on this subject was read by M. Duchartre. The memoir deals with the questions already discussed by Mr. Darwin, and alluded to in an article in our last number. The French botanist records his own experiments and those of other observers, and concludes that there are two groups of twining plants: 1. Such plants as *Dioscorea Batatas* and *Mandevillea suaveolens*, which have the power of attaching themselves to surrounding objects only under the influence of light. 2. Species, such as *Ipomœa purpurea* and *Phaseolus*, which exhibit this power equally well in light and darkness.

The proper Vessels of the Aroideæ.—M. Trécul continues his inquiries in this department of structural botany with much perseverance and considerable success. He describes especially the true vessels. These are canals with an oleo-resinous juice, and formed by two or three rows of small oblong cells, which are narrower than those of the surrounding parenchyma. They exist in the leaves, stems, and adventitious roots. In the blade of the leaf they are arranged parallel to the veins. The resinous matter which they contain is generally colourless in the roots; but in the stem and leaves it assumes a yellowish colour, passing to orange and red. In some Aroideæ there are, he says, two modifications of the vascular bundles, which he terms respectively *simple* and *compound.* The simple bundles have the character of the vascular bundles of the Monocotyledons; they are formed of a vascular part, properly so called, and of a liber portion. The compound bundles are aggregates of two, three, or more bundles like the preceding, placed in juxta-position, and having their liber parts confluent.

The Tendrils of the Cucurbitaceæ.—These organs have been carefully described in a paper recently laid before the Academy of Sciences, by M. Ad. Chatin. After summing up all the facts connected with the morphology of the processes in question, the author concludes :—(1) That the tendril of the Cucurbitaceæ is of axillary origin; (2) if it be undivided, its analogy with the axillary parts is invariable ; if, on the contrary, it is branched, its divisions correspond to as many appendicular organs (leaves), its main portion representing the branch; (3) there is no relation of origin between the tendrils and the ordinary roots, but there is a relationship between these organs and the adventitious roots.

Relation between Variegated Leaves and Double Flowers.—The observations of Professor E. Morren on this relation are of the highest physiological interest. This distinguished botanist contends that it is impossible for variegated leaves and double flowers to exist together upon the same plant. He explains the fact that variegated leaves (caused by the partial disappearance of chlorophyll) is a proof of weakness, whilst doubling of flowers is a proof of strength ; and as both these conditions cannot possibly occur at the same time, variegated leaves and double flowers on one and the same plant are an impossibility. Dr. Seemann, in commenting upon these opinions of Morren's, states that Bull's variegated *Camellia Japonica* is a case in point. Whilst all other *Camellia Japonicas* of our gardens have green leaves and either double or semi-double flowers, this variegated variety has flowers with the five normal petals only. An apparent exception to Professor Morren's hypothesis is presented by *Kerria Japonica.* Of this plant two varieties have recently been introduced into our gardens, but Dr. Seemann suspects that a plate on which they are depicted was made by the artist taking the varieties with variegated leaves, and sticking them on to the double flowers of the ordinary green-leaved variety.—See the *Journal of Botany*, February.

The Botanical Congress, which is to be held in May next, will be presided over by M. Alphonse de Candolle, who, since our last issue, has formally accepted the office. It is to be regretted, however, that in consequence of an important mission to Central America, Dr. Berthold Seemann has been compelled to resign the secretaryship. Dr. M. Masters has been appointed to the vacant office. We may mention, too, in passing, that during Dr. Seemann's absence, the *Journal of Botany* will be conducted by Mr. Carruthers, of the British Museum.

Local Floræ.—To those who are desirous of increasing our knowledge of local floræ, we beg to state that Mr. Hemsley, of Kew, is collecting materials for a flora of Sussex, and would be glad if local botanists would forward to him complete local lists and specimens of critical plants. Communications should be addressed to him at Kew. The same good work is being accomplished for Buckinghamshire by Mr. J. Britten, whose address is High Wycombe, Bucks. The flora of Middlesex is receiving the attention of Dr. Henry Trimen and Mr. W. Thiselton Dyer, who would feel obliged for notes of localities or any other matter (even the slightest) relating to the subject. In the case of doubtful or critical species, scraps sufficient for identification would be most acceptable. Address, "Dr. Trimen, 71, Guilford Street, Russell Square, London, W.C."

The Fibre-cells of the Anther.—The researches which have been conducted by M. Adolph Chatin enable him to conclude—(1) That the fibre-cells are generally absent in anthers opening by pores; (2) that the fibre-cells are defective in a certain number of anthers which dehisce longitudinally; (3) that in some plants, whose stamens have undergone an arrest of development, if not morphologic, at least histologic, the absence of fibre-cells coincides with the incomplete evolution of the pollen.—Vide *Comptes Rendus*, January 22.

The Spines and Thorns of Plants.—A very able essay on this subject has been published by M. Them. Lestiboudois. This distinguished botanist endeavours to show that the thorns are of two kinds: those continuous with the deeper tissues, and those which are simply superficial growths. The former he divided into *epidermic*, *epidermidic*, *parenchymatic*, and *liberian*. The second group, which especially form the subject of the present paper, may, he states, be produced in the following manner:—(1) By a single formation, commencing with the bark which bears them; (2) by a single formation, subsequent to the development of the bark which supports them; (3) by successive formations; in such cases they may remain aculiform, or may become tubercular, or even may become confounded with the bark on which they rest.

The Structure and Function of the Partitions of the Anther.—M. Chatin, who seems to be devoting himself to the investigation of the anther, has a paper in the *Comptes Rendus* (Jan. 2nd). He defines the partition to be the layer of tissue which divides each of the chambers of the anther into two distinct thecæ. It may present any of the three following conditions:—(1) It may be formed of a tissue in direct continuity with that of the "connective;" (2) it may be entirely constituted of the valve of the anther's chamber reflected upon the "connective;" (3) it may be of a mixed origin, and partake of 2 and 3. It may have three different forms of structure; thus—(*a*) It may be solely composed of fibre-cells; (*b*) it may have no fibre-cells entering into its structure; (*c*) it may be composed of fibrous tissue, properly so called.

Deceased Botanists.—We regret to announce the deaths of the following distinguished *savants*:—Dr. Joseph Maly, of Gratz, author of a "Flora von Deutschland," "Botanik für Damen," and other works; Dr. P. J. Lenné, Director-General of the Royal Gardens at Potsdam, near Berlin; and Herr George Schmittspahn, Director of the Botanic Garden at Darmstadt.

The Fecundation of Lupinus polyphyllus.—In a note contributed to the *Journal of Botany* for February, the Rev. W. A. Leighton records some very interesting observations which he made upon this subject. During last summer his attention was attracted to the operations of a small humble-bee on the flowers of *Lupinus polyphyllus* growing in his garden. The bee alighted on the blossom, and by the weight of his body drew down the alæ and the keel, and inserted his proboscis to the base of the stamens, for the purpose of extracting the nectar. In doing so, Mr. Leighton noticed that the stamens covered with pollen and the pistil were slightly extruded from the apex of the keel, and struck against the under portion of the body of the bee, which probably carried away some of the pollen with him, and alighting on other blossoms, thus probably fertilized them. This led him to examine the blossoms more closely, and the result has been a very curious discovery. Early in flowering, the standard is flattened against the other parts, but later on, it becomes reflexed. On opening some of the blossoms before the standard was reflexed, Mr. Leighton noticed that there were ten anthers, of two different sets and sizes, alternating with each other. "One of these sets consisted of five very large sagittate anthers ; whilst the other set consisted of five very small rotundo-oblong anthers, supported on stamens scarcely reaching to the base of the sagittate anthers, but both sets not half the length of the pistil. Strange to say, in this early stage of the blossom, the pollen of the sagittate anthers was all matured and falling from the open anther-cells, whilst the anthers of the other set were all closed, and the pollen in an immature state. On examining other blossoms whose standard was reflexed, I found that the large sagittate anthers were all withered, and their pollen gone, whilst the shorter and smaller stamens had become greatly elongated, so as to become equal in length to the pistil, their anther-cells expanded, and their pollen mature. In this state the elongated stamens and the pistil, with the mature pollen of the, at first, small anthers, were by the weight of the bee extruded, and, I presume, fertilization effected. I compared under the microscope the size and appearance of the pollen from the two sets of anthers, but could distinguish no appreciable difference." He now opened some of the blossoms with the unreflexed standards, and by the aid of a camel-hair pencil, removed some of the pollen from the sagittate anthers, and applied to the stigmas of other blossoms with unreflexed standards, first carefully removing the unexpanded anthers of the smaller set of stamens. After due time had elapsed, he examined them, and found that fecundation had not taken place. Thus there appears to be a state of things in *Lupinus polyphyllus* not unlike that which Mr. Darwin has pointed out in Linum and other plants.

The Parts involved in the Process of Defoliation is the title of a good essay read before the Botanical Society of Edinburgh (Jan. 11th). The author, Mr. W. R. M'Nab, believes that the only key to the nature of the process of defoliation is the study of the development of the leaf. The leaf first appears as a small mamilla or cushion, which the author called the phylloblast. This, at a certain stage, became differentiated into two parts, one near the axis—a stationary part—the other a rapidly-developing part attached to the axis, not directly, but through the lower part. The stationary lower part he called the *hypophyll ;* the other the *epiphyll.* The hypophyll developed the stipules from any part of its surface ; the epiphyll developed the parts of the leaf proper—lamina and petiole. The stipules are thus not probably appendages of the petiole, but belong to a morphologically distinct part. In the leaves of deciduous plants (those with free lateral stipules being most typical, and in which the process is best seen), the leaf falls off so as to leave the stipules and hypophyll entire, as in *Cytisus Laburnum*, *Lirriodendrum tulipifera*, &c., the cicatrix being formed by the *hypophyll.* Mr. M'Nab contends that the separation, then, occurs between one part of the leaf and another—between what he has termed the *hypophyll* and *epiphyll*—and not between the axis and the leaf, as has been generally supposed to be the case.

The Flora of the Shetland Isles.—Mr. Ralph Tate, F.G.S., who was one of the Anthropological Commission appointed to investigate the Shetland Islands, has given us a valuable and elaborate account of their flora. The facies of the flora of these islands is, he tells us, very striking; especially so on the land-slopes bordering the sea; for they are rich in plants which are more abundant in petals than in leaves. This profusion of flowers he believes to be in accordance with the operation of a law that, in proportion as the habitat of a plant becomes ungenial, and thus threatens to exterminate the species, the flowers increase in number and in size. Mr. Tate has carefully compared his own observations with those of other writers, and sums up the results of his explorations as follows:—The flora of Shetland, in its present revised form, numbers 364 indigenous species, and 14 marked indigenous varieties. With the following exceptions, all are generally distributed throughout Central Europe, and are found in Great Britain. The exceptions are *Cerastium Edmonstoni*, *Lathyrus acutifolius*, which are restricted to the island of Unst; *Arenaria Norvegica*, also confined to that island (the most northern and eastern of the Shetland group), but elsewhere only known in Scandinavia. The only boreal plants are *Cherleria sedoides*, *Arenaria Norvegica*, and *Saussurea alpina; Geranium phæum* is doubtfully native. Even alpine forms are poorly represented in these isles, and the majority of these are confined to Ronas Hill. Of the six Saxifrages, *S. stellaris*, *S. nivalis*, *S. rivularis*, *S. cæspitosa*, *S. oppositifolia*, and *S. hypnoides*, which range from Scotland to the Feroes, Iceland, and Greenland, only *S. oppositifolia* is a Shetland plant (yet occurring at the opposite extremities of the mainland).—Vide *Journal of Botany*, January.

The Fertilization of Tigridia.—Dr. Martin Duncan has contributed to the *Microscopical Journal* a most noteworthy memoir upon the structure and function of the essential parts of the flower in one of the Iridaceæ. The observations as to the structure of the parts examined deserve the attention of structural botanists. The experiments conducted upon the fertilizing organs are also of extreme interest. Several of these are minutely recorded, and in summing up their results, Dr. Duncan draws the following among other interesting conclusions:—From these experiments it is proved that the impregnation is perfected in a little more than twenty-four hours; that the pollen-grain produces a tube-cell, which grows according to the manner of cells, which passes through stigma, style, and to the remotest ovule in the ovary—a space oftentimes of five inches—in twenty-four hours; that, taking the average length of the tissue to be perforated to be four inches, the pollen-tube grows at the rate of one inch in six hours; that before the pollen-tubes are halfway down the style, if their connection with the pollen-grain be destroyed, they still grow and impregnate; that after the pollen-tube has fairly entered the style, it is independent, both as regards its subsequent growth and impregnating properties, of the pollen-grain; and that the varying conditions of the atmosphere influence the rapidity of the growth of the pollen-tube, and consequently impregnation.—Vide the *Quarterly Journal of Microscopical Science*, January, 1866.

CHEMISTRY.

The Density of Ozone has recently been considered in detail by M. J. L. Soret, who sums up our actual knowledge of the volumitive relations of this body as follows:—1st. Ordinary oxygen diminishes in volume when ozonized, that is to say, when a part of it is converted into ozone, by electricity, for example. 2nd. When oxygen charged with ozone is treated with iodide of potassium and other oxidizable bodies, the ozone dissappears without the volume of the gas changing. 3rd. Under the action of heat, oxygen charged with ozone suffers an expansion equal to the volume of the quantity of oxygen that the gas would have been capable of yielding to iodide of potassium. These facts, he says, lead to the supposition that ozone is an allotropic state of oxygen, consisting in a molecular grouping of several atoms of this body. One of the simplest hypotheses in this matter is that in which the molecule of ordinary oxygen is regarded as formed of two atoms, and the molecule of ozone as formed of three atoms.

A New Method for preparing Aniline Black.—In the *Bulletin* of the Industrial Society of Mulhouse, M. Paraf describes a new method for preparing aniline black. This method simply consists in preparing hydrofluosilicic acid of a specific gravity of 8°, and of dissolving in this, hydrochlorate of aniline. When fabrics which have been prepared with chlorate of potash are washed with this, an exquisite black is produced in the fixing. The black thus obtained may be associated with any kind of madder-colour, and in the subsequent processes may be treated exactly like a logwood black.

How to separate Cobalt from Nickel.—A method for this purpose, and also for the separation of manganese from both these metals, has been pointed out by M. Terreil in a paper read before the French Academy of Sciences, January 1st. To a solution of the two metals he adds ammonia until the oxides are redissolved. He then heats the liquor, and to the hot solution adds a solution of permanganate of potash until the mixture remains violet from an excess of permanganate. He then boils for a few minutes and redissolves the oxide of manganese with a slight excess of hydrochloric acid. The liquor is kept hot for some hours, and then set aside for twenty-four hours. At the end of this time all the cobalt is deposited in the form of a crystalline powder of a beautiful reddish-violet colour. Of this precipitate, 100 parts correspond to 22·761 of metallic cobalt or 28·929 of the protoxide. For a very accurate determination, however, a known weight of the compound may be reduced by dry hydrogen, and the pure metal weighed.

Who discovered Ozone?—M. Labord has published a note in a late number of the *Comptes Rendus* clearly with the intention of showing that some of the credit of the discovery of ozone is due to him. He says, "Some years ago I called attention to the beneficial action of electricity in purifying air which is charged with the miasmata which produce epidemics. Now, since ozone is only oxygen modified by electricity, it is seen that ozonometric observations fully confirm my views."

Chemical Rhymes.—If science cannot produce poetry, at least it is able to do something in rhyme, as the following quotation from the *Chemical News*, February 2, will prove :—

"Among the acids there were Itaconic
Oxalic, Cyanuric, and Phocenic,
With Parabanic, Gallic, and Euchronic,
Saccharic, Kakodylic, and Comenic,
Melanic, Citric, Kinic, and Myronic,
Sulphomethylic, Tannic, Sulphophenic,
Taraaric, Xanthic, Pectic, and Cerotic,
With Mucic, Malic, also Carbazotic."

—*From "Percy Villiers," a poem by John Newlands, F.C.S.*

The Purification of Coal-gas.—We have received an important essay on this subject, written by Professor A. Anderson, of Queen's College, Birmingham. It relates chiefly to the methods discovered by the author for the successful removal of bisulphide of carbon and the sulphuretted hydrocarbons, by means of the sulphides of ammonium. By washing the gas with this compound, a very large proportion (nearly 35 per cent.) of the sulphur impurities are removed, and the illuminating power of the gas, so far from being diminished, becomes actually increased. Professor Anderson records several carefully conducted experiments, all of which prove the truth of the conclusions at which he has arrived. We believe we are correct in stating that his method is now in operation at the Taunton and other local gas-works, and that it is highly spoken of by those who have given it careful consideration. His pamphlet should be in the hands of all managers of gas-works ; it is eminently a practical guide to the purification of coal-gas.

The late Mr. Brande.—It is with much regret that we have to record the death of this veteran chemist, which took place at Tunbridge Wells on the 11th of February. Professor Brande had reached the ripe old age of 81 years.

A new Test for Uric Acid has been suggested by Herr Dr. Dietrich, who has discovered that when a bromated alkaline solution of hyposulphite of soda is added to urine, it gives rise to a brilliant rose-red colour. The colour disappears after some time, and quickly on the addition of more of the bromated solution. It probably, he says, depends on the formation of alloxantin. The experiment answers well with serpents' dung, but is difficult to recognize with pigeons' dung and guano, because the substances themselves are of a dirty-brown colour. This test may, in many cases, replace the murexide test, since it is made with little trouble and in a short time.—*Zeitschrift für Analyt. Chem.*, p. 176 ; and *Chemical News*, Feb. 23.

The Decomposition of Iodide of Potassium.—M. Payen read a paper before the French Academy (February 5) proving that air has more to do with the decomposition of the iodide than is generally supposed. He showed that when a cold saturated solution of the iodide to which a very minute quantity of acetic, nitric, or oxalic acid had been added, was exposed to the air, it gradually decomposed, the iodine being at the same time liberated ; but when the same mixture was kept sheltered from the air, no decomposition took place. The author attributes the result to the influence of the oxygen tending to oxidize the potassium, and of the acid exerting its affinity for the potash. The results, he adds, have a particular interest, since they serve to explain the difference of opinion expressed by chemists, some having asserted that dilute acids decompose the iodide, while others have denied that any decomposition takes place.

The Proportion of Oxygen in certain Specimens of Air.—At a late meeting of the Manchester Literary and Philosophic Society, Dr. Angus Smith read a very interesting paper on this subject. The specimens of air contrasted were from St. John's, Antigua, and from one of our own law courts. The subjoined table shows that the latter specimen contained nearly ·5 per cent. less of oxygen than the former :—

OXYGEN PER CENT. IN SOME SPECIMENS OF AIR.

18 ft. above water. Fine day. 2·30 p.m. Lat. 43·05, W. 17·12.	St. John's, Antigua. April 11th, 1865. 9 a.m. Showery morning.
21·0100	20·9600
21·0000	20·9100
20·9700	21·0000
Mean 20·9990	Mean 20·9950
Law Court, Feb. 2, 1866.	Law Court, from the lantern, 4.30 p.m., just as the Court was closing.
20·6400	20·5000
20·6700	20·4800
Mean 20·6500	Mean 20·4900

Paraffin in the Preservation of Frescoes.—In *Dingler's Journal et Bulletin de la Société Chimique* it is stated that paraffin may be used with advantage for the above purpose. Vohl coats the picture with a saturated solution of paraffin in benzole, and when the solvent has evaporated, washes the surface with a very soft brush. Paraffin has this advantage over other greasy matters,—it does not become coloured by time.—*Vide* also *Chemical News.*

Danger in Preparing Potassium-Ethyl.—It may be well for young chemists to know that though there is no great danger to the operator in preparing the sodium compounds of ethyl or methyl, the preparation of the potassium compounds of these radicals is attended with considerable risk. It is stated by Dr. Wanklyn, of the London Institution, that when the replacement of the zinc by the alkali metal proceeds briskly, there is a considerable rise of temperature both in the case of sodium and potassium. From the low temperature at which potassium fuses, it very easily happens that the potassium fuses ; and when once this occurs, a most tremendous explosion is the immediate result.

The New Anæsthetic Chloro-carbon can be made from chloroform, by passing chlorine into it ; and it has been shown by Geuther that the process can be reversed—that chloroform may be produced from chloro-carbon, by treating it with zinc and dilute sulphuric acid, and then exposing it to the action of nascent hydrogen. The most common way hitherto adopted of forming bichloride of carbon consists in passing the vapour of bisulphide of carbon, together with chlorine, through a red-hot tube, either made of porcelain or containing within it fragments of porcelain. There result from this process chloride of sulphur and bichloride of carbon, the latter being easily separated from the former by the action of potash. The bichloride of carbon, or chlorocarbon, is a transparent colourless fluid, having an ethereal and sweetish odour, not unlike chloroform. Its specific gravity is great, being as high as 1·56; chloroform is 1·49. It boils at 170° F., the boiling-point of chloroform being 141°. The density of its vapour is 5·33, that of chloroform being 4·2.

Simple Chemical Means of Cleaning Silver or Silver-plate.—This, which was suggested by Dr. G. Calvert, F.R.S., in the recent Cantor lectures, consists in plunging for half an hour the silver article into a solution made of 1 gallon of water, 1 lb. hyposulphite of soda, 8 oz. muriate of ammonia, 4 oz. liquid ammonia, and 4 oz. cyanide of potassium; but, as the latter substance is poisonous, it can be dispensed with if necessary. The plate being taken out of the solution, is washed, and rubbed with a wash-leather.

What is Antozone?—It is, according to the opinion of M. Meisner, the fuming emanation from phosphorus. But, on the contrary, Schœnbein regards these vapours as being nitrite of ammonia, and other chemists look upon them as phosphorous acid. Experiments have recently been conducted by M. Osann, in order to clear up the whole subject. M. Osann passed these vapours into solutions of ammoniacal nitrate of silver and alkaline solutions of oxide of lead. In the first instance, a black precipitate was obtained, which contained on the average 97·28 of silver to 2·72 of oxygen; a constitution which gives it the formula of Ag_3O. M. Osann at first thought that the oxygen contained in this precipitate was ozone, which, having more powerful affinities than ordinary oxygen, had displaced the latter in the oxide of silver; but the oxidizing nature of ozone has caused him rather to attribute the formation of this body to a deoxidizing action, such as produces antozone. He afterwards passed the same vapours, first into an alkaline solution of pyrogallic acid, to retain the ozone; then partly into one of Woolf's bottles containing a little water; partly into an ammoniacal solution of nitrate of silver: in this case the same precipitate was obtained, though all the ozone must have been absorbed by the pyrogallic acid. The water in Woolf's bottle, which had remained in contact with the vapours from the phosphorus, was shaken with blued tincture of guaiacum, which immediately lost its colour. The same thing happened with nitrate of ammonia and oxygenated water, but much more slowly with the latter, though it was highly concentrated. Hence M. Osann does not hesitate to say that in his experiment the decoloration was due to nitrate of ammonia, and consequently, he attributes the vapours produced during the slow combustion of phosphorus to the formation of this body.—Vide *Journal für Pract. Chemie*, xcv. 55.

GEOLOGY AND PALÆONTOLOGY.

Remains of Pliosaurus.—Palæontologists will be pleased to learn that some very interesting remains of this extinct creature have recently been added to the collection of the British Museum, and will shortly be described in the forthcoming volume of the Palæontographical Society's memoirs by Professor Owen. The remains consist of a nearly perfect skull, with the lower jaw of the same individual, which are but slightly distorted from their normal form. The skull measures nearly five feet in length, from the end of the muzzle to the occipital condyles. The rami of the lower jaw are each upwards of five feet long, from the pivot on which they work to the front point, where they unite together. The fossils have been presented to the National Museum by Mr. J. C. Mansel, of Blandford, Dorset.

The Wollaston Gold Medal of the Geological Society has been awarded to Sir Charles Lyell, in acknowledgment of the eminent services he has rendered to the science of geology by his published works and researches.

New Irish Coal Fossils.—Through the labours of Professor Huxley, Dr. E. P. Wright, and Mr. Brownrig, some very interesting fossils from the Castlecomer coal-measures of co. Kilkenny, Ireland, have been brought under the notice of geologists. The specimens consist of fish, insects, and amphibian reptiles. Three out of the five forms of these amphibians are *undoubtedly new* to science, and, in all probability, the remaining two also. The first, and most remarkable genus, Professor Huxley has named "*Ophiderpeton*," having reference to its elongated, snake-like form, rudimentary limbs, peculiar head, and compressed tail. In outward form *Ophiderpeton* somewhat resembles *Siren lacertina* and *Amphiuma*, but the ventral surface appears covered with an armature of minute spindle-shaped plates, obliquely adjusted together, as in *Archægosaurus* and *Pholidogaster*. The second new form, which he names *Lepterpeton*, possesses an eel-like body, with slender and pointed head, and singularly constructed hourglass-shaped centra, as in *Thecodontosaurus*. The third genus, which Professor Huxley names *Ichthyerpeton*, has also ventral armour composed of delicate rod-like ossicles; the hind limbs have three short toes, and the tail was covered with small quadrate scutes, or apparently horny scales. The fourth new amphibian Labyrinthodont he appropriately names *Keraterpeton*, a singular salamandroid-looking form, but minute as compared with the other associated genera. Its highly ossified vertebral column, prolonged epiotic bones, and armour of overlapping scutes, determine its character in a remarkable manner. A paper has been read before the Royal Irish Academy upon the subject, and, in the course of the discussion which followed, Professor Haughton said he had Professor Huxley's authority for stating that the coal-pit at Castlecomer had within a few months afforded more important discoveries than all the other coal-pits of Europe.—See the *Geological Magazine*, January.

The Structure and Affinities of Eozoon.—Professor W. King deserves more credit than we were inclined to afford him at first. We do not mean for the importance of his inquiries, but for the rash zeal with which he has insisted upon bringing ridicule on Irish science. At a meeting of the Geological Society, held on the 10th of January, he and his colleague, Dr. Rowney, brought forward their geological mare's-nest once more. They will have it, despite the opinion of those who are experienced in microscopic observation, that Eozoon is the result of something which they term mineral segregation. However, they have not found any supporters, and the able paper which was read by Dr. Carpenter immediately after theirs has served to convince us more than ever that Eozoon is a foraminiferous fossil. In this paper Dr. Carpenter stated that a recent siliceous cast of *Amphistegina* from the Australian coast exhibited a perfect representation of the "asbestiform layer" which the author described in his former communication on the structure of *Eozoon*, and which led him to infer the nummuline affinities of that ancient foraminifer,—a determination which has since been confirmed by Dr. Dawson. This "asbestiform layer" was then shown to exhibit in *Eozoon* a series of remarkable variations, which can be closely paralleled by those which exist in the course of the tubuli in the shells of existing nummuline foraminifera, and to be associated with a structure exactly similar to the lacunar spaces intervening between the outside of the proper walls of the chambers and the intermediate skeleton, by which they become overgrown, formerly inferred by the author to exist in *Calcarina*. Dr. Carpenter combated the opinion advanced by Professor King and Dr. Rowney, in the preceding paper, and stated that, even if the remarkable dendritic passages hollowed out in the calcareous layers, and the arrangements of the minerals in the Eozoic limestone, could be accounted for by inorganic agencies, there still remains the nummuline structure of the chamber-walls, to which, the author asserts, no parallel can be shown in any undoubted mineral product. In conclusion, the author stated that he had recently detected *Eozoon* in a specimen of ophicalcite from Bohemia, in a specimen of gneiss from near Moldau, and in a specimen of serpentinous limestone sent to Sir Charles Lyell by Dr. Gümbel, of Bavaria.

Deceased Geologists.—We regret to learn of the death of Professor Oppul, of Munich, and of Dr. Forchhammer, of Oersted, two most distinguished geologists.

A Relic of the Mammoth.—A tusk, measuring 10 feet 2 inches in length and 22 inches in circumference at the thickest part, has been found ten feet below the surface in excavating for gravel for the Spalding and March Railway at the pits at Deeping St. James. It is in a good state of preservation.

Fossils in Volcanic Ash.—Some interesting specimens of vegetable fossils found in a bed of volcanic ash near Lagan Bay, Arran, were exhibited by Mr. Wünsch at a late meeting of the Manchester Geological Society. The stone in which the fossils were embedded appeared like an ordinary piece of whinstone, and fossils in such a stratum were novel. They appeared to be *Sigillaria*, *Lepidodendron*, *Lepidostrobus*, &c., and they had grown in a marine habitat, and had been enveloped with ash from an adjoining volcano.

Newspaper Geology.—A paragraph which originally appeared in an Australian paper, and which has gone the round of our English "Press," describes a wonderful fossil lately found in New Zealand. The paragraph states the fossil to be that of a gigantic bird, which stood twenty-five feet high. It entered into several rude osteological details (among others stating that the head was of enormous size); and these led to the following remarks, which were published in the *Times* by Professor Owen :—"Paragraphs like that on the 'Gigantic Bird' usually include elements which the naturalist sees to be fatal to the interpretation attached to the facts; yet these may be well deserving attention and inquiry. New Zealand was undoubtedly the land of huge birds, but, like their few existing congeners in other parts of the world, the head was small; that of a Dinornis, thrice the bulk of the largest living ostrich, does not exceed eight inches in length. The notice of the remains found in the province of Nelson assures me that they are those of a saurian reptile, and indicate the Jurassic age of the 'beds of limestone' in which they have been petrified. Parts of a Plesiosaurus were discovered in that province by Mr. J. H. Hood, of Cluny-house, Dunkeld, in 1861; but the present are of another kind. Should this letter appear, and meet the eyes of any colonist able to grant the request, I would ask only for a single vertebra (joint of back or tail) and one of the supposed feathers of the 'gigantic bird,' and promise to return the name of the animal."

Fossils from the Diluvium of the Tiber.—A collection of these has recently been obtained by M. De Verneuil. They consist of teeth of a large hippopotamus, of rhinosceros, horse, deer, and wild boar. At Ponte Molle the bones are most abundant, but they are better preserved at Mont Sacré in the diluvium of the Anière.—*Bulletin Soc. Géol. Fr.*, vol. xxii.

The Glacial Phenomena of Caithness have been very carefully studied by Mr. T. F. Jamieson, who has reported the results of his inquiries in a paper lately read before the Geological Society. The glacial drift of Caithness occurs in sheets, filling up the low troughs and winding hollows which form the beds of the streams, the rocks on the higher ground being either bare or hidden by a growth of peat and heather. It thins out at altitudes of from 100 to 150 feet, and its thickness, therefore, is variable, although it seldom exceeds a hundred feet. Mr. Jamieson first described the distribution of the drift-beds over the area in question, their texture and colour at the different localities in which they occur, and the nature and appearance of the stones and boulders found in them. He then noticed the broken state of the shells, the most common species being *Cyprina Islandica, Astarte borealis, A. elliptica, Tellina calcarea, T. Balthica*, and *Turritella ungulina*. The direction of the glacial markings on the rocks was shown to be pretty uniformly from N.W. to S.E. (true); so that it must have been produced by a movement of ice proceeding from an external region to the N.W., and not by glacier-action proceeding from the interior of the country, as is the case in the midland region of Scotland. The glacial drift of Caithness and the old boulder-clay of the middle of Scotland resemble one another in their physical arrangement, but differ in the prevalence of marine organisms in the former; the absence of tranquilly-deposited glacial marine beds, of moraines, and of gravel hillocks, and the deficiency of valley gravel in Caithness, are also points in which the glacial series of that area differs from that of Central Scotland; and Mr. Jamieson inferred that, of the two series, the Caithness drift was the more recent. In conclusion, the author described the deposits of the post-glacial period in Caithness, and showed that they did not differ materially from those occurring in the rest of Scotland.

The Irish Crannoges.—Mr. G. Henry Kinahan contributes a very interesting paper on these primitive lake-dwellings to the last number of the *Dublin Quarterly Journal of Science.* The essay is amply illustrated with maps and woodcuts, and is worth perusal. He has found that a number of islands in Ballin Lough, co. Galway, are really the remnants of pile-habitations. In island No. 2 a section made to the depth of five feet discovered the following materials :—

		Ft.	In.
6. Peat and clay	about	0	9
5. Peat and stones, with a few bones	„	0	9
4. Wood ashes and peat, with thousands of unbroken cherry-stones, a few broken hazel nuts, a few broken bones, teeth, and a ball of red colouring matter	„	2	6
3. Basket-floor, about one and a half inch thick			
2. Sawn oak beams, 8 by 6 inches	„	0	6
1. Peat	over	0	6
		5	0

The oak beams were evidently sawn, not cut with a chopping instrument. Through them, at about nine inches apart, there were pairs of dowels that were used to fasten the basket-flooring to them. In this flooring, at every nine inches, were poles 2·5 inches thick, through which the dowels went and fastened the flooring to the beams. These poles seemed to be of ash saplings, while the rest of the floor was made of hazel rods. The crannoge seemed to have been divided into huts or apartments, as part of a row of ash piles three inches in diameter was observed. No stone or other implements were found, a circumstance which Mr. Kinahan attributes to the incomplete character of his explorations.

The Age of Man.—A Mr. John Locke, whom we do not suppose to be a lineal descendant of the great metaphyscian, has pronounced the following verdict, in the case of positive *versus* speculative archæology:—" It is submitted that, conceding their due value and significance to the discoveries of geologists and archæologists, the phenomena adduced up to this date do not afford adequate evidence in demonstration of the universality of the (so-termed) Stone era, or that it antedated civilization upon our globe ; and both sacred and secular history accord with human experience in authenticating, first, the Mosaical limit of 6,000 years since the creation of man ; secondly, that civilization, not savagery, was his primitive condition; and, thirdly, his utter incapability of self-renovation from moral and physical deoadence, apart from extern aid and instruction."—*See a paper read before the Royal Irish Academy.*

MECHANICAL SCIENCE.

The Cigar Ship.—This remarkable vessel, named after the father of its designer, the *Ross Winans*, has been successfully launched from Mr. Hepworth's yard, in the Isle of Dogs. She has been already described in these columns, and it will therefore be unnecessary to say more than that she is 256 feet long, and 16 feet in diameter; and her engines will probably indicate 2,000 horse power. It is expected that in the trial trips, which will shortly take place, she will attain a speed of at least twenty knots an hour.

Hydraulic Lift Graving Dock.—Mr. Edwin Clark has described to the Institute of Civil Engineers the plans he has adopted at the Victoria (London) Graving Docks. The principle of these docks is to provide a single lifting pit, out of which the vessels may be raised bodily on pontoons which afterwards float them in shallow water to a convenient berth for graving purposes. The ships are raised by hydraulic presses, the idea of which appears to have been derived from the presses employed in raising the Britannia and Conway Tubular bridges, designed under Mr. Clark's superintendence. At the Victoria Docks, the depth of water in the lift-pit is 27 feet ; that over the rest of the dock area is only six feet. In raising a vessel, one of the pontoons is brought over the lift-pit, filled with water, and sunk. The vessel is then floated in over the pontoon, and the pontoon and vessel raised together by the hydraulic presses. When at a sufficient altitude, the water is drawn off from the pontoon, which then floats the vessel to its berth in the shallow water. The whole operation of lifting occupies only about half an hour, and the lifting-pit is then ready for the reception of another vessel. At the Victoria Docks there are 32 presses, with 10-inch rams, having a stroke of 25 feet. This, with a water-pressure of two tons per circular inch, gives a total lifting power of 6,400 tons, less the weight of the crossheads, rams, &c., amounting to 620 tons.

Water Supply to Towns in Lancashire and Yorkshire.—Mr. Dale has matured a magnificent project for the supply of water to towns in the North of England, from the Cumberland and Westmoreland lakes. Ulleswater is 477 feet above the sea-level, and Hawes-water 694 feet, considerably more than the elevation of some of the Yorkshire and Lancashire towns. Mr. Dale has selected a line for the pipes by Ambleside and Kendal to Keighley, and thence through Leeds (277 feet above sea-level), Wakefield (201 ft.), Dewsbury (187 ft.), Halifax (604 ft.), Rochdale (472 ft.), and Bury to Liverpool (227 ft.), a total course of 170 miles. He proposes a supply of 131 million gallons daily, to towns along this route, and estimates the cost of construction at £60,000 to £70,000 per million gallons supplied daily, or a total cost of nine or ten millions sterling.

Glasgow Ferry-boat.—A small ferry boat has been constructed for Glasgow Harbour, propelled by jets of water forced through openings in the hull by a centrifugal pump. There are four channels from the same pump-chamber, two leading towards the bows and two towards the stern. By opening the two former, the vessel goes backwards ; by opening the two latter, it goes forwards ; by opening one towards the bow and one on the other side towards the stern, it turns on its centre. If two on one side are opened, it goes broadside on. The channels are opened and closed by balanced valves, like engine throttle-valves. This little craft has been working successfully on the Clyde since November, and its constructors claim for the principle many advantages, especially for ships of war.

Petroleum as a Substitute for Coal.—Some recent experiments with petroleum oil used for heating water, gave results from which it was estimated that petroleum had more than three times the heating effect of an equal weight of coal. Mr. Richardson's experiments at Woolwich, however, gave an evaporation of 12·96 to 13·66 lb. of water, by one pound of American petroleum; 9·7 lb. of petroleum being burnt per square foot of grate per hour. With shale oil the evaporation was 10 to 10½ lb. of water per pound of fuel. The evaporative power of good coal may be taken, for comparison, at 8 to 8½ lb. per pound of fuel. Taking into account the saving of freight due to the better quality of the fuel, and the saving of labour in stoking, it is possible that at some future time mineral oil may supersede coal in some of our ocean steamers.

Frith of Forth Bridge.—Parliamentary sanction has been obtained for a bridge over the Frith of Forth, of a magnitude which gives it great scientific interest. It is to form part of a connecting-link between the North British and Edinburgh and Glasgow Railways. Its total length will be 11,755 feet, and it will be made up of the following spans, commencing from the south shore:—First, fourteen openings of 100 feet span, increasing in height from 65 to 77 ft. above high-water mark; then six openings of 150 ft. span, varying from 71 ft. to 79 ft. above high-water level; and then six openings of 175 ft. span, of which the height above high-water level varies from 76 to 83 ft. These are succeeded by fifteen openings of 200 ft. span, and height increasing from 80 ft. to 105 ft. Then come the four great openings of 500 ft. span, which are placed at a clear height of 125 ft. above high water spring tides. The height of the bridge then decreases, the large spans being followed by two openings of 200 ft., varying in height from 105 to 100 ft. above high water; then four spans of 175 ft., decreasing from 102 to 96 ft. in height; then four openings of 150 ft. span, varying in height from 95 to 91 feet; and lastly seven openings of 100 ft. span, 97 to 92 ft. in height. The piers occupy 1,005 ft. in aggregate width. The main girders are to be on the lattice principle, built on shore, floated to their position, and raised by hydraulic power. The total cost is estimated at £476,543.—*Engineering*, Jan. 5.

MEDICAL SCIENCE.

Who first discovered Trichina? is a question which has given rise to considerable controversy during the past quarter. Dr. T. Spencer Cobbold has cleared up the whole question by a very interesting and able contribution to our contemporary *The Lancet*, in which he shows that the merit of the discovery is, as often happens, not due exclusively to one individual. "Happily," says Dr. Cobbold, "the discovery of the actual flesh-worm itself will continue to be imperishably associated with the distinguished names of Owen, Paget, and Wormald ; whilst the scarcely less important discovery of the lemon-shaped and calafied capsules must permit a similar bracketing of the names of Hilton, Peacock, and Hodgkin.

The Poison of Nerium Oleander.—The researches which were conducted years ago by Orfila have been quite recently followed up by Professor Pelikan, of St. Petersburg, who, in some respects, confirms the conclusions of the French toxicologist. He believes that the yellow resinous matter is the important principle of the plant, and he is disposed to think that Nerium may be employed with advantage in cases where digitalis is now used. The experiments which he conducted upon frogs with this substance, as well as with the alcoholico-aqueous extract, have led him to the following conclusions: —1. When first administered, it produces an acceleration of the heart's action. 2. After a few minutes the beats of the heart become less frequent. 3. The pulsations in diminishing become irregular, and then cease entirely. 4. The ventricles are at this period empty and inactive, but the auricles still continue to contract. 5. Finally, the heart becomes completely paralysed.—Vide *Comptes Rendus*, January.

The Nature of Colour-Blindness.—In the *Philosophical Magazine* for February an important paper has been translated from *Poggendorff's Annalen* upon the nature of colour-blindness. The author of the essay referred to, Herr Dr. E. Rose, of Berlin, describes an instrument which he has constructed for the detection of colour-blindness, and for estimating its extent. Numerous researches have enabled him to conclude—1. That with the colour-blind it is always light of the greatest or of the least refrangibility that first becomes imperceptible. 2. That invariably, as the disease increases, the patient ceases to perceive only that light which had previously the greatest or smallest refrangibility among the rays visible to him. 3. That colour-blindness is always characterized by a shortening of the spectrum and never by an interruption. A complete and accurately defined spectrum thus forms by its extent a measure of the degree of colour-blindness. Herr Rose's instrument consists of a mirror, condensing lens, and prism, by which a well-marked solar spectrum is produced, and therefore accurately determines the extent of the affection.

Is Urea formed in the Kidneys?—Herr Dr. Zalesky, in a recently published memoir, records some experiments, which seem to prove that urea is formed in the kidneys and not in the blood. He removed the kidneys from various animals, and examined the blood subsequently for urea, but without finding larger traces than usual. In animals, however, in which (without removing the kidneys) he placed a ligature upon the ureters, he found the proportion of urea in the blood largely increased. As the consequence of several experiments upon birds, reptiles, and mammals, he concludes that the kidneys do not simply allow uric acid to filter through them, but that they form it, and that urea is equally formed in great part in the kidneys. He does not believe that uræmic accidents are due to the accumulation in the blood of either urea or ammonia, but is more disposed to attribute them to defective elimination of other extractive principles and of water.—Vide *The Lancet Record of the Progress of Medicine*, March 3.

The Cause of Cholera.—Madame de Castelnau has written to the French

Academy requesting it to direct its Commissioners to examine, with the aid of the solar microscope, the animalcules to which she attributes the production of cholera, and specimens of which she offers to place at their disposal.

The Accommodation-power of the Eye.—The manner in which the human eye alters its focus for the perception of objects at various distances has always been a difficult problem for physiologists and physicists. The literature of medical science is full of dissertations on this subject, yet very little, if anything, is positively known of the exact means by which the alteration is achieved. There appears to be now a tendency among ophthalmologists to believe that the effect required is produced by an alteration of the form of the crystalline lens of the eye, which becomes less or more convex as occasion demands. This view has just received a rather strong condemnation by the Rev. Professor Haughton, of Trinity College, Dublin, in some remarks published in the *Dublin Quarterly Journal of Science*. Speaking of the alteration of form in the lens, he says :—" Even this must take place on a far greater and more important scale than anatomists have as yet suspected. The change amounts to the addition of a double convex lens of crown glass having a radius of a third of an inch. Anatomists have not as yet discovered a mechanism for changing the shape of the lens sufficient to produce these results. The lens should almost be turned into a sphere, and I know of no ciliary muscles capable of effecting so great a change."

The Organization of the " Cell."—If we are to believe in the statements of M. Balbiani, a French naturalist of considerable repute, the function of the cell in animals is far more complex than is generally believed. M. Balbiani seems to support the cell theorists in their opinions, for he gives the cell and its nucleus peculiar vital powers. Cells, he says, have a vital individuality ; they manifest phenomena of movement and sensibility ; they are the seat of considerable nutritive activity, and the nucleus is the principal centre of this activity. The most extraordinary fact which M. Balbiani adduces is, that the phenomena exhibited by the nucleus are due to the presence of a series of canals like those of Infusoria, which serve for the distribution of liquids in the interior of the parenchyma. If this discovery be true, M. Balbiani has thrown a new light upon the subject of tissue development by establishing the existence of a circulation of fluids in the elementary parts of the organism.—*Comptes Rendus*, Dec. 26.

A Trichina Commission, consisting of M. Delpech, Professor of Medicine ; M. Raynal, Veterinarian ; and M. Alfort, has been sent by the French Minister of Agriculture to Germany, to examine and report upon the Trichina disease, prevalent in pork.

The Structure of the Blood Globules.—In the Report of the Proceedings of the Royal Academy of Sciences, St. Petersburg, we find an essay upon the structure of the minute corpuscles which give colour to the blood. M. Ofsiannikof, the author of the memoir in question, states that in all cases the blood globules possess a distinct membranous wall, which is acted on differently by different fluids, and which differs in its reaction from the nucleus and contents. The blood globules of the same animal are not alike. The contents of the corpuscle crystallize easily within the surrounding envelope. It is wrong to suppose that special fluids are required to alter the form of the blood globules, as these bodies change their outline even under the influence of the serum. All the constituents of the corpuscle—membrane, nucleus, and contents—dissolve readily in the serum, and in water, alcohol, solutions of sugar, and other fluids.

Preparations of Cod-liver Oil.—We have received a pamphlet by Mr. C. C. J. Guffroy (London: Hardwicke), in which will be found some valuable details concerning the *dragées* sold by Messrs. Barr & Co., of Fleet-street, and which have recently been so favourably received by the profession. These *dragées* are composed of the watery extract of cods' livers, coated with sugar. They contain all the valuable principles of the oil in a concentrated form, and whilst they are perfectly tasteless (save as far as the coating of sugar is concerned), they do not produce nausea. The saccharide of cod-liver oil, another and very different preparation, to which we some time since called attention, as being, according to Mr. Attfield's analysis, a mere quack imposture, is declared by the maker to contain several compounds, and among others sulphur, bromine, and hypophosphite of lime, not enumerated by the chemist to the Pharmaceutical Society.

Can the Spleen be regenerated?—M. Phillippeaux alleges that it can. In several animals from which he almost entirely removed the spleen, he found that this organ was regenerated. When the extirpation, however, had been complete, no re-development took place. The researches which have been conducted by Signor Peyrani lead to different conclusions. This physiologist asserts most positively that under no circumstances is the spleen regenerated when it has been partially removed. He records several experiments tending to corroborate his opinions. "Who shall decide?"

Glycogen in the Tissues of Entozoa.—Dr. Michael Foster publishes a valuable paper in the *Proceedings of the Royal Society*, in which he states that he has found glycogen in the substance of the tape-worm and in that of the round worm of the pig. The most remarkable fact in connection with this discovery is the circumstance that an animal which lives in a fluid whose especial quality is the conversion of starch into sugar, should, nevertheless, possess the power of amassing glycogen within its own body. There is no sugar-forming ferment in the bodies of the entozoa examined by Mr. Foster. From this fact the writer infers, that if the animal swallows the intestinal juice in which it lives, the sugar-forming ferment contained therein either does not pass through its intestinal wall into its visceral cavity, or, if it does pass, it is at once destroyed. It is evident that the formation of glycogen in the Ascaris takes place under conditions very different from those under which glycogen is deposited in the mammalian liver, since there is a powerful sugar-forming ferment in the latter.—See also *Lancet Record*, Feb. 10.

The Poisonous Effects of Alcohol.—Supporters of teetotalism will be pleased to peruse an essay on this subject by M. G. Pennetier, of Rouen. The memoir we refer to is a "Doctor's" thesis, and it treats especially of the condition known as alcoholism. The following are some of the author's conclusions:—(1) Alcoholism is a special affection, like lead-poisoning; (2) the prolonged presence of alcohol in the stomach produces inflammation of the walls of this organ and other injurious lesions; (3) the gastritis produced by alcohol may be either acute or chronic, and may be complicated by ulcer or general or partial hypertrophy, or contraction of the opening of the stomach, or purulent submucous infiltration; (4) in certain cases of alcoholic gastritis, the tubular glands of the stomach become inflamed, and pour the pus, which they secrete, into the stomach or into the cellular tissue of this organ.

Professor Würtz has been appointed Dean of the Faculty of Medicine at Paris.

Difference between Catalytic and Cell Phenomena.—Although we cannot agree with all that Dr. Beale has written upon this subject, we have much pleasure in laying his observations before our readers, as worthy of their serious attention. Dr. Beale thinks that there are very strong arguments in support of the belief in a vital force, and since many of our "Positive philosophers" contend that so-called vital actions may be explained upon the principle of catalysis, he has tried to compare vital (?) and catalytic phenomena. We ourselves do not think it fair to compare catalysis with cell-action, for as yet we do not know what catalytic *action* is, although we give it the term catalysis from the effects which we perceive. We think it is certainly impossible to explain certain of the processes of life by what we yet know of physical laws, but we contend that this does not warrant us in concluding that certain phenomena are *not* referrible to physical laws. Dr. Beale's argument appears to us to be this:—We cannot explain the phenomena associated together under the term life, by reference to what we know of physics, therefore we must refer them to the operation of a force we do *not* know—the vital. We do not think this is fair reasoning. The only justifiable conclusion appears to us to be this. Neither physicists nor vitalists can explain life by reference to the recognized laws of force; but the physicists have analogy on their side, and the vitalists have nothing. It is better to confess our ignorance of a complex phenomenon than to waste good mental power in controversy which can never be decisive, because, like Mr. Gradgrind, what we want "is facts." The following are some of Dr. Beale's observations:—"A very little consideration will show that there is little analogy between *catalysis* and the phenomena which occur in connection with *living cells.* The lifeless catalytic matter never multiplies; the living always does. The lifeless passes through no definite stages or states of being; the living invariably does so. The lifeless catalytic body does not necessarily alter in chemical composition during its action; the living one is always undergoing change in its active state. The first cannot be said to *form new material;* the last always exhibits this property. Neither the assimilation of food, nor the conversion of food into blood, nor the conversion of blood into organ or texture, can be correctly spoken of as due to catalysis or contact-action, for in these processes not only are certain elements of the pabulum taken into the very substance of the matter which is the catalytic agent, but these become a part of the agent itself. In no case does the food directly become blood, or the blood undergo direct conversion into organ or texture, but both food and blood pass through a transition stage, during which neither the compounds existing before nor those which are to be produced can be detected."—Vide *Medical Times*, March 10.

METEOROLOGY.

An Aëronautical Society, for the encouragement of balloon ascents and meteorological experiments, has been formed under the presidency of the Duke of Argyll; the Duke of Sutherland and Lord Richard Grosvenor are the vice-presidents, and Mr. James Glaisher is the Secretary. The subscription for members is to be £1. 1s. annually, and it is proposed to purchase grounds and apparatus. Subscribers will be furnished with tickets of admission to the grounds on public days. It is also proposed to issue tickets for a seat in the balloon car on certain days, and to have a balloon always inflated and ready for ascent.

The Constitution of Meteorites.—A number of interesting inquiries upon the composition of these curious bodies have been conducted by M. Daubrée. He has endeavoured to produce artificial meteorites, by combining together certain materials. His first experiments were made with ferruginous meteorites, which he divides into three classes—(1) native iron alone, (2) iron with globules of peridote, (3) iron associated with silicates, peridote, and pyroxene. All meteorites are covered with a black crystalline crust, formed by the fusion of the exterior layer in the passage of the stone through the atmosphere. All the components of stone are also of an eminently crystallizable nature. It might have been expected, therefore, that, after fusing a meteorite, a crystalline surface, would have been obtained on cooling. Nothing of the sort, however, happens. When a meteorite is fused, the mass separates into two parts very different from each other; the earthy substances and the metallic part solidify separately. The manner in which these residues crystallize is altogether different, owing probably to the rapidity of cooling. The crystals obtained by the fusion of meteorites resemble the long needles water forms on freezing slowly, while the granular semi-crystalline structure of natural meteorites resembles hoar-frost or snow, formed by the sudden passage of water from the state of vapour to the solid state. M. Daubrée proceeds to point out the analogies, chemical and mineralogical, of meteorites with terrestrial rocks, observing that as yet nothing has been found in those bodies which is not a common constituent of the surface of our globe. He remarks, however, that one essential chemical difference is the state of oxidation of the iron, stating that the protoxide, so common in our basic silicate rocks, is almost entirely wanting in meteoric stone, being apparently replaced by native iron. The masses, therefore, he believes to have been originally identical, but have been modified by different actions.—Vide *Comptes Rendus*, Jan. 29.

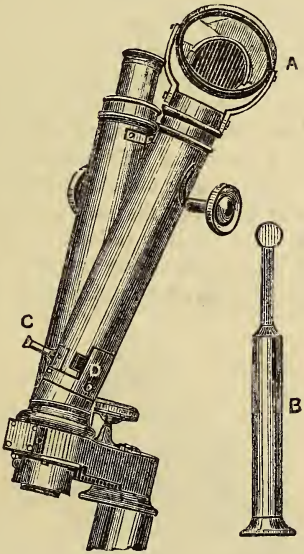
The Meteorological Character of the Month of January.—In an interesting little periodical, the *Meteorological Magazine*, we find some useful statistics concerning the above. The most general characteristics of the month were its mildness, windiness, and wetness. In so large an area as the whole of the British isles, exceptions always occur. In January the stations whose records were exceptional were the North Midland, and the East of Scotland and Ireland. The south-east of England had the greatest excess, much of which was attributable to the remarkable fall of snow on the 11th, which (as is not infrequently the case when snow falls heavily with an air temperature of 32°) was very dense, and almost sticky, from its semi-fluid, semi-frozen state: such snow, of course, adheres with especial closeness to trees wet with the rain which preceded the snow; then came frost, binding all firmly on, until even the telegraph wires were as thick as one's arm, and it is no wonder the break-down was almost universal in the district where the above conditions were fulfilled, which was generally the case in North Sussex, Kent, Surrey, Middlesex, Herts, and Oxford.

The Minimum Thermometer on Grass.—Mr. Symons, the author of "British Rainfall," states that the instructions hitherto issued on the placing of the minimum thermometer on grass, have been rather vague and require more strict definition. He thinks that probably Mr. Glaisher's paper on the "Radiation of Heat at Night from the Earth," [Phil. Trans. 1847,] affords the best basis for instruction upon the subject. As meteorology is now becoming as popular a pursuit as any we know of, we subjoin Mr. Symons's remarks for the benefit of our readers. "We may remark," he says, "that when commencing observations with a thermometer on grass, we made use of a patch of turf about 2 ft. in diamater, and on subsequently removing the instrument to a large grass plot, the recorded minima were so much lower that we rejected all the previous readings. Has any one tried the effect of *simultaneous* readings on large and small surfaces of grass? As to the effect of variations from the length and quality of grass, the results arrived at by Mr. Glaisher were that long grass gave 1°·1 lower min. than short, and that if the thermometer was even one inch *above* the grass it would be 2°·8 warmer. There are several points well worthy of consideration. For instance, would it be well to adopt some substance of high, but constant, radiating power, and not like grass varying with its daily growth; or is it better to let grass, which has been our radiation measure for some years, remain so, but try to make the conditions uniform at all stations? Again, the spirit minimum often reads 5° higher than Caselli's mercurial minimum. Is it not imperative that *all* should use one or the other; or, at any rate, that it should always be stated *which* is used? Lastly, the Scottish Meteorological Society recommend a spirit minimum whose bulb is black glass, while those used in England are mostly, if not all, transparent spirit, in clear white glass. Comparison of these instruments should be made, and the results will find ready insertion in these columns."

Weather Foreknowledge is the title of a clever little pamphlet published by Houlston & Wright, and which gives much valuable information upon the subject of Weather-wisdom. We do not think all the writer's theories are correct, but no one who has read his essay can fail to become to some extent a good weather-prophet. We commend "Weather Foreknowledge" to our readers' notice.

MICROSCOPY.

The Illumination of Opaque Objects under High Powers.—In our last number we described the ingenious invention of Mr. Smith, of Kenyon College, U.S., which has been adopted with slight modification by Messrs. Powel & Lealand. We have now to describe a method, based upon a similar principle to Mr. Smith's, which has been devised by Mr. Dancer, of Manchester. Instead of placing the mirror immediately over the opening at the back of the object-glass, a small speculum, B, one-sixth of an inch in diameter, is introduced into the front, C, of the body of the microscope, $2\frac{1}{2}$ inches above the top of the objective. A lateral opening, D, is made in the body at right angles to the speculum for the admission of light, to be reflected down through the objective to the object below it. The interposition of this small speculum



does not produce any disagreeable effect in the field of view, and in the examination of objects it is easy to use that portion of the field which is between the centre and the edge. With proper manipulation, good definition may be obtained by Mr. Dancer's method when the speculum employed is of the proper curvature. The contrivance can always remain attached to the microscope without interfering with the general appearance of the instrument, and when the use of the speculum is not required, it can be withdrawn or turned aside out of the field of view, and the aperture at the side of the body may be closed by a small shutter. The new contrivance can be adapted to both binocular and uniocular microscopes. Another method consists in placing a concave mirror, at at A, so as to reflect light down through the prism of the microscope, and upon the object. We must remark, in connection with the subject of illumination of opaqne objects under high powers, that the principle upon which both Mr. Dancer's and Mr. Smith's appliances are constructed was described *five* years ago by Mr. Hewitt.

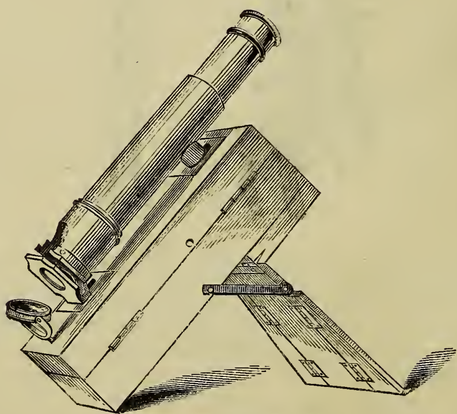
Nobert's Test-plates.—In one of the late numbers of the new and excellent Microscopical Journal edited by Herr Max Schultze, this *savant* has a paper on Nobert's test-plates. It appears that Nobert now prepares his tests in a new form. The specimens described by the writer contain nineteen groups of lines, from $\frac{1}{1000}'''$ to $\frac{1}{10000}'''$ apart, and thus arranged:—

1st set, $\frac{1}{1000}$.	3rd set, $\frac{1}{2000}$.	18th set, $\frac{1}{9500}$.
2nd ,, $\frac{1}{1500}$.	4th ,, $\frac{1}{2500}$, &c.	19th ,, $\frac{1}{10000}$.

The highest set M. Schultze has been able to define with central illumination is the 9th, which is resolved by Hartnack's immersion system No. 10, and by Merz's immersion system $\frac{1}{24}$. With oblique illumination he has not been able with any combination to get beyond the 15th. He considers the most difficult specimens of *Pleurosigma angulatum* to be about equal to the 8th or 9th set of Nobert's lines, and the larger instances to correspond with the 7th.—Vide *Quart. Journ. Microscop. Science*, January.

Specimens of Trichina.—We have received from Mr. Collins a very good specimen-slide, in which a number of Trichinæ from the flesh of pork are well shown. With a power as low as two-thirds of an inch the worms come out very nicely. In some few cases the sacs are ruptured, and the little isolated parasite may be seen separately coiled up.

A Pocket Compound Microscope, of very ingenious construction, has been devised by Mr. William Moginie, of Messrs. Baker's establishment. When



New Pocket Microscope.

packed in its case the instrument appears as a small oblong box, which may be easily placed in a great-coat pocket. When required for use, the "body," containing an attached stage, is taken out and fastened on the cover, into the lower part of which a small mirror is inserted. A leg, moving upon a hinge, is then pulled out from the bottom of the case, is fixed by means of a catch, like a house-ladder, and the apparatus is ready for use. Alteration of focus is obtained by an easy telescopic movement, and as the universal screw is employed, any objectives may be used. We have used Mr. Moginie's microscope, and can speak well of it. It is a handy instrument, and will be found useful by hospital physicians and field botanists.

The $\frac{1}{16}$th Objective used with the Binocular Microscope.—We understand that by an arrangement of prisms and parallel plates Messrs. Powel & Lealand have succeeded in obtaining perfect definition with a $\frac{1}{16}$th inch object-glass employed with a binocular microscope.

Papers relating to Microscopic Anatomy :—

BOTANY.

The Proper Vessels of the Aroideæ.
The Fibre-cells of the Anther.
The Structure of the Partitions of the Anthen.
The Parts involved in the Process of Defoliation.

GEOLOGY.

The Structure and Affinities of Eozoon.

MEDICAL SCIENCES.

Who first discovered Trichina ?
The Production of Cholera.
The Organization of the Cell.
The Structure of the Blood Globules.

ZOOLOGY.

Structure of the Investing Tunic in Gregarinidæ.
The Development of the Infusoria.
The Metamorphoses of Ostracoda.

MINING, METALLURGY, AND MINERALOGY.

Welsh Gold.—During the year 1864 we learn, from statistics only recently published, there were five gold-mines working in Merionethshire. In these 2,336 tons were crushed, from which 2,887 oz. of gold, valued at £9,991, were obtained. This is in excess of the quantity obtained in 1863, which was only 552 oz. ; but it is considerably less than the production of 1862, when 5,299 oz., having a value of £20,390, were extracted.

Improvement in Pattison's Process for Separating Lead from Silver.—An account of an improvement of this kind appears in the *Bulletin de la Société Chimique* for January. In a factory at Holtzappel they melt the lead in a pot, and then run it into a crystallizing pan, when they cover the surface with small fragments of coke, upon which a thin stream of water is directed. An agitator being set in movement, a circular motion is given to the mass of metal covered with coke, and thus the entire surface is equally moistened and cooled by the stream of water. In about an hour the lead loses its fluidity, and forms a solid crust, which envelops the small pieces of coke. The stream of water is now turned off, the agitator is stopped, and the unsolidified lead, rich in silver, is run off from the bottom. Strong iron hooks are inserted in the mass of lead and coke before complete solidification takes place, and the mass is lifted from the pan by a crane. The pan is then ready for a second operation.—See also *Chemical News*.

Crushing Masses of Cast Iron.—The ordinary methods of crushing large masses of cast iron into fragments are both cumbersome and expensive, but by the means which has lately been described in *Les Mondes*, this operation may be conducted with considerable ease. The new French method consists in drilling a hole in the mass of cast iron, for about one-third of its thickness, filling this with water, closing it with a steel plug which fits accurately, and letting the ram of a pile-driver fall on the plug. The very first blow splits up the mass.

Native Borax.—A lake about two miles in circumference, from which borax is obtained in extremely pure condition and in very large quantity, has recently been discovered in California. The borax hitherto in use has been procured by combining boracic acid, procured from Tuscany, with soda. It is used in large quantities in this country, the potteries of Staffordshire alone consuming more than 1,100 tons annually.

Obtaining Soda from Cryolite.—The Salt and Alkali Manufacturing Company of Pennsylvania are at present trying a process of obtaining soda, which consists in mixing cryolite with lime and heating it. The fluorine leaves the cryolite and combines with the calcium of the lime, forming fluoride of calcium, while the two metals remaining absorb oxygen, becoming alumina and soda—a soluble compound. This is treated with carbonic acid, which combines with the soda, forming carbonate of soda ; this remains in solution, while the alumina, being insoluble, is precipitated. Carbonate of soda once obtained is treated in the usual way.

How to protect Iron from Oxidation.—In some of our late numbers we spoke of the extreme degree of tenuity to which iron plates can now be brought. A curious property of these plates has recently been observed : they resist oxidation in an extraordinary degree. There is no doubt but that this is attributable to a fused layer of magnetic oxide, with which they are always covered ; and the fact has been applied to the protection of articles of wrought iron. The latter are embedded in a pulverized layer of native oxide of iron—hæmatite, for instance—and kept at a full red heat for several hours, after which they are allowed to cool gradually. Plates treated in this way are perfectly covered with the oxide, and are well suited for shipbuilding. A combination of the oxides of zinc and iron, formed by the use of oxide of zinc also in the process, gives rise to a black coating, which is, perhaps, even more effective.—See the *Scientific Review*, March.

English Petroleum.—It is found that mineral oil can be produced at the cost of sixpence per gallon from the shales of unctuous clay overlying the ironstone deposits of the moors in the North Riding of Yorkshire. This circumstance is of much importance, and promises to effect a good deal for the industry of the district in which the petroleum shale occurs.

Progress of the Mont Cenis Tunnel.—According to the assurances of the contractors, the international railway between France and Italy *viâ* the Alps will be open for passengers at the latest in 1871, unless some unforeseen accident should mar the progress of the present operations. The *Gazetta di*

Genova says :—" The piercing of one of the most important tunnels of the railroad of Eastern Liguria has just been completed ; we mean the Ruta, which connects Camoglia with San Margherita by a passage of 3,050 yards. The termination of this important work does away with the most serious difficulty to the opening of the branch line from Genoa to Chiavari."

The Minerals of Lake Superior.—In the *Canadian Journal* there is a note by Professor Chapman, announcing the discovery of native lead near Dog Lake. It occurs in the form of a small string in white semi-opaque quartz. The quartz contains no other substances, with the exception of a small quantity of specular iron ore ; the absence of gold is noteworthy, as in the European localities where native lead has been found it is generally accompanied with gold. He also records the occurrence of Galena, Marcasite, Molybdenite, Barytine or Heavy Spar, Fluor Spar, and Anthracite, in the vicinity of Lake Superior.

Romeine.—At a late meeting of the French Academy, M. Bertrand de Lom presented a note on the above subject. The mineral traverses vertically the mass of the manganese of Saint-Marcel. M. de Lom has found that romeine may be obtained in the form of beautiful microscopic crystals by submitting the substance containing it to sublimation.

New Source of Jasper.—Hitherto the supplies of this handsome mineral have been obtained, and then even in limited quantity, from Russia and Siberia. Now, however, it is obtained abundantly at St. Gervais, in Savoy, where the quartz from which it is derived has a surface of at least 24,000 square yards, and a depth of about 22 yards. It is a variety of quartz, which is characterized by being opaque, however thin the plates into which it may be cut, and is of various colours—red, brown, green, &c. ; that at present used for jewellery being green, with red spots. It resists for indefinite periods the action of the weather, and is an excellent material for ornamentation, whether as stands for small objects, &c., or as panels, columns, &c., to be used by the architect. Some of what is found at Saint Gervais bears close resemblance to the beautiful species termed *rouge antique ;* it is of a fine red, and without veins.—Vide the *Scientific Review*, March.

New Artesian Well in Paris.—A third artesian well is now being added to the two which Paris has already. Already the perforation has reached the depth of eighty-two metres, being twenty metres below the sea-level. Before reaching this point, considerable difficulties had to be overcome in the shape of intermediate sheets of water, which form a series of subterranean lakes. The first of these was kept in its bed by means of a strong iron tube driven perpendicularly through it ; that which followed received wooden palings, and the subsequent stratum being clay, the masonry was continued without difficulty to about five metres above sea-level. But at this point a layer of agglomerations was reached, which let a great deal of water escape. It thus became necessary to have again recourse to pumps : those employed were in the aggregate of 20 horse-power. Owing to the bad nature of this stratum, it was resolved to protect the perforation by a revetement of extraordinary thickness ; and in order that the well might preserve its diameter of two metres notwithstanding, the upper part has had to be widened in proportion, so as to give it the enormous width of four metres at the top. After this labour the work of perforation was continued through a stratum of pyrolithic limestone. At the depth corresponding to the level of the sea, they reached a layer of tubular chalk, all pierced with large holes, forming so many spouts, as thick as a man's thigh, through which water poured into the well with incredible velocity. While the pumps were at work to get rid of this water, a cylindrical revetement of bricks was built on a sort of wheel made of oak, and laid down flat at the bottom of the perforation by way of a foundation, and the intermediate space between this cylinder and the chalk stratum was filled with concrete, 47,000 kilos. of which were expended in this operation. As soon as the concrete might be considered to have set, or attained sufficient consistency, the brick cylinder was taken to pieces again, and the perforation continued to the pressure point, where a new sheet of water has been reached, requiring ingenious contrivances.—Vide the *Artizan.*

Origin of the Diamond.—Contrary to the usual opinion that the diamond has been produced by the action of intense heat on carbon, Herr Goeppert asserts that it owes its origin to aqueous agency. His argument is based upon the fact that the diamond becomes black when exposed to a very high temperature. He considers that its Neptunian origin is proved by the fact that it has often on the surface impressions of grains of sand, and sometimes of crystals, showing that it has once been soft.

PHOTOGRAPHY.

Action of Light on a Bichromate associated with Organic Substances.—The journal of the Photographic Society—to a strange article in which we reluctantly called attention in our last—has returned to the charge, and in language scarcely less intemperate and unjustifiable than that we have rebuked, says, in effect, that the writer in question did not mean that Mungo Ponton discovered the action of light on a bichromate in connection with gelatine, but that M. Becquerel did so. Now, the article to which we condescended to reply *did not contain either the name of, or the slightest reference to, M. Becquerel!* To quote this forgetful journalist's own words, he said—"If any fact in the history of photography be better known, more completely established, and less free from suspicion or doubt than another, it is that the discovery that organic substances combined with a bichromate become insoluble under the action of light was due to Mr. Mungo Ponton." Could anything be more dogmatically positive? Photographers will smile when we add that, as a matter of course, what the Society's journal stated on this point was duly echoed in the *Photographic News.* In reply, we must remind the editors of both these publications that priority of investigation and priority of application are two perfectly distinct things. Although it is true that M. Becquerel first investigated the action of light on chromic acid in conjunction with organic bodies, yet the fact gives this able and talented experimentalist no more claim to be considered the author of Fox-Talbot's special application of the principle than the old alchemists or Wedgwood have to be considered as originating photography because the former used horn-silver to make labels for their bottles, and Wedgwood used nitrate of silver to make profiles with.

Photography in Colours.—After the reading of Mr. Taylor's interesting historical *résumé* of the progress made towards photographing natural colours at the South London Photographic Society, and in the course of a discussion thereon, Mr. A. H. Wall, one of the Vice-Presidents of the Society, offered some suggestions in connection with a colour-printing process by light therein described. These were intended to advocate the using of negatives coloured by hand with transparent pigments. It has been since announced that M. Poiteven, of Paris, has produced photographs by a process which will probably bring Mr. Wall's suggestion into practical use. M. Poiteven's process is a very simple one, which, when perfected, may take a very important place in the arts by superseding some of the more costly, tedious, and uncertain processes in colour-printing now used. The paper was prepared with the sub-chloride of silver, and over it was brushed a solution composed of equal parts of a saturated solution of bichromate of potash, a saturated solution of copper, and a solution of chloride of potassium twenty grains to the ounce. Coloured engravings were used in lieu of negatives, and after the paper had been subjected to light in the printing frame, the print was first washed in water acidulated with chromic acid, then with water containing bichloride of mercury, then again with a weak solution of nitrate of lead. It was finally washed in distilled water to remove all soluble matter. Mr. G. W. Simpson has since announced as the result of some experiments, a process somewhat analogous to M. Poiteven's. About two grains of chloride of strontium and five of nitrate of silver were added to an ounce of collodio-chloride of silver. A plate of opal glass being coated with this and dried before a fire, was exposed to diffused daylight until it darkened to a slate-colour. It was then exposed to sunlight for some hours under pieces of variously-coloured glass, and under plain yellowish-white glass with parts left uncovered. It was found to have all the colours of the glasses, was yellowish-white where it had been covered with the plain glass, and black where it had been left uncovered.

New Photo-lithographic Process.—MM. Motay and Marechal, of Metz, France, have recently obtained a patent for a new photo-lithographic process. The specification states that the inventors have attained special effects by adding bichloride of mercury to the alkaline protochromates, bichromates, and trichromates employed with gelatine.

A Photographic Exhibition at Ghent will be opened under the auspices of the Belgian Government. The Commissioners undertake to provide frames for all specimens sent, and it is their intention to purchase a considerable number of the photographs exhibited, to be afterwards disposed of by lottery to the members of the Royal Society of Fine Arts. Mr. Ross, of Featherstone Buildings, Holborn, and Mr. Dallmeyer, of Bloomsbury Street, W.C., are the appointed agents. The collection will be opened in August.

New Developers.—Humphrey's Journal of Photography, published in America, gives the following formulæ for a developer the writer strongly recommends as superior to the ordinary iron one:—

Water	64 ounces,
Vinegar	12 ounces,
Sulphuric acid . . .	1 ounce,
Albumen	1 ounce,
Protosulphate of iron . .	6 ounces.

The egg is beaten up in half the water, and the other ingredients added to the remaining half. When filtered, it is ready for use. At a meeting of the North London Photographic Association, Mr. W. Hislop strove to revive a long disused developer which he strongly recommended, namely, iron with sugar. In his own practice Mr. Hislop stated that he used with a fifteen or twenty grain solution of protosulphate of iron not less than fifty grains of loaf sugar.

New Rest and Posing Apparatus.—Mr. Sarony, the well-known Scarborough photographer, has recently placed in the market a piece of apparatus intended to supply a means of supporting the body as well as the head during the process of photographing. It is intended to have greater rigidity than ordinary rests, and a variety of adjustments to suit different requirements. A somewhat similar rest, but more perfect in its mechanism, and, unlike Mr. Sarony's, not a fixture to the floor of the room, although even more rigid, and with all the appliances possessed by the above, has been invented by another clever photographer, Mr. Harman, of Peckham.

Mr. Woodbury's New Printing Process.—One of the more recent improvements in this process is that by which the necessity of mounting the prints has been done away with. A margin of white paper of any required width may now be obtained.

Perspective and Photography.—Mr. Carey Lea, the American correspondent of the *British Journal of Photography*, has commenced a series of papers of a kind which have long been needed, intended to point out the exceptional and false effects given in perspective by using lenses of too short focus—such as are most commonly used by photographers—and other lenses of too long focus. When the series are completed, we have some comments to make on this subject, which is a most important one, urgently demanding attention. As illustrating the necessity there is for some elementary information thereon, we may add that at one of the photographic meetings a member stated gravely that "painters invariably introduced several points of sight," and another said, or is reported to have said, that the photographer should have a background "painted to suit the perspective of the camera most generally in use," as if the camera itself, and not its relative positions, gave the perspective, or as if it were possible to take sitters of various heights and in different positions, with the camera a fixture.

National Portrait Galleries.—The Town Council of Manchester have taken up actively, at the earnest and long-continued solicitations of Mr. Lachlan McLachlan, the idea of forming a museum of photographic portraits of celebrities, which now promises to assume an important position. Other towns seem likely to follow this example.

To clean off old Dried Films whether Varnished or not.—A plan for doing this effectively has been suggested by Major Russell as the quickest and easiest he ever tried. "Pour common wood naphtha over the plate like collodion, and return to the bottle; then rub the surface with a rough cloth or tuft of coarse tow. If the film does not come off entirely at once, pour naphtha over the plate again. The same naphtha may be used indefinitely, following up with fresh as it wastes." We quote this hint, worth knowing, from the *Photographic Notes.*

Curious effects of the Yellow Ray.—In the course of some recent experiments, M. Claudet exposed a sensitive daguerreotype plate to light, and then printing on it from a negative covered with a yellow glass, obtained by development a positive image, by which it seems that the action of white light is capable of being destroyed by that of yellow light. If this were not the case, such an image would not have been so obtained on a plate of this kind. Printed on from a negative in the ordinary way without the preliminary exposure to light, and the after printing by yellow light, the daguerreotype plate would, as might be expected, give a negative image.

The Latent Image.—During the past quarter a considerable amount of study has been devoted to the latent image formed by light on iodide of silver. The questions associated with this inquiry were the first to which scientific attention was devoted when photography was new, and we have yet to learn anything positive in connection therewith. This invisible impression, so subtle and refined in its nature as to defy our efforts to define it, yet sufficiently strong not to be destroyed by powerful chemical action, is held by some to be merely physical, and by others to be chemical. Some controversy on this subject has appeared in the photographic journals, inaugurated in the *British Journal of Photography* by Mr. Carey Lea, who says, "Every chemist has had occasion to remark that with some slowly-formed precipitates there is a tendency to deposit on all the portions of the vessel which have been touched by a rod used in stirring. This is no rare or unusual case, but one of very common occurrence. The mere light drawing of a glass rod over a glass surface alters it in some most curious way, so that the saline precipitate seeks out every line with the most exact discrimination, and pours upon it a white thread-like deposit; and if the mixture has been much stirred previous to the formation of the precipitate, so that the edges of the rod have travelled over many parts of the glass, the most intricate and interwoven lines will be developed and rendered visible by the formation of the precipitate." Mr. Lea goes on to say, "If now we add sulphate of iron to a solution of nitrate of silver, metallic silver is thrown down, but not instantly; and in this condition of things the invisible image attracts the silver out of its old solvent, now by chemical changes no longer capable of holding it in solution, but just in the same way as the invisible lines of the rod did in the case above referred to." Mr. Hardwick, in his "Manual of Photographic Chemistry," took the same view of this question many years ago, and gave the same experiments as Mr. Lea describes, with others of a cognate description. Of course we have nothing conclusively demonstrated by these analogies. M. Poiteven, followed by Dr. Vogel, insists that the action of light upon iodide of silver is purely chemical, but their arguments seem to us no more conclusive on the other side, and there are many phenomena connected with development which their theories do not explain. How can solarization, for instance, be satisfactorily accounted for by the chemical theory? If this theory, as they explain it, be correct, it must follow that the longer the action of the light the more powerfully impressed would be the image, whereas it is well known that the reverse is the case—at least where a developer is employed.

Is Pure Iodide of Silver sensitive to Light?—This question has been commonly answered in the negative, and most of the great authorities have been opposed to the idea of its sensitiveness to light. But Mr. Carey Lea, by an exhaustive and, as it seems to us, conclusive series of experiments published in the *British Journal of Photography*, has proved that pure isolated iodide of silver is sensitive to light, and capable, by development, of giving a bold vigorous image. These experiments consisted in precipitating on a perfectly clean glass plate a thin film of pure metallic silver. This film was converted entirely into iodide of silver by long immersion in tincture of iodine. Every trace of the free iodine having been removed by continuous washing, the plate was placed beneath a negative and exposed to daylight for some few seconds. A forcible image, contrary to the generally received conclusion, was then developed, and this in the absence of any possible trace of a free soluble salt of silver. We have therefore another truth established as the basis of further experiments by the praiseworthy energy and perseverance of a very able experimentalist.

PHYSICS.

The Spectrum of Comet I, 1866, has been ably investigated by Mr. W. Huggins, F.R.S., and described in a paper read by this gentleman before the Royal Society. The appearance of the comet in the telescope was that of an oval nebulous mass, surrounding a very minute and not very bright nucleus. The length of the slit of the spectrum apparatus was greater than the diameter of the telescopic image of the comet. The appearance presented in the instrument when the centre of the comet was brought nearly upon the middle of the slit was that of a broad continuous spectrum fading away gradually at both edges. These fainter parts of the spectrum corresponded to the more diffused marginal portions of the comet. Nearly in the middle of this broad and faint spectrum, and in a position about mid-way between *b* and F of the solar spectrum, a bright point was seen. The absence of breadth of this bright point in a direction at right angles to that of the dispersion showed that this monochromatic light was emitted from an object possessing no sensible magnitude in the telescope. This observation, Mr. Huggins concludes, gives to us the information that the light of the *coma* of this comet is different from that of the minute nucleus. The nucleus is self-luminous ; and the matter of which it consists is in the state of ignited gas. As it cannot be supposed that the coma consists of incandescent solid matter, the continuous spectrum of its light probably indicates that it shines by reflected solar light. Since the spectrum of the light of the coma is unlike that of the light of the nucleus, it is evident that the nucleus is not the source of the light by which the coma is rendered visible to us. Hence, Mr. Huggins concludes that the coma of this comet reflects light received from without, and the only available source of light is the sun.—Vide *Proceedings of Royal Society*, No. 80, 1866.

The Spectrum of Tempel's Comet.—In a late number of the *Comptes Rendus*, a letter was published on this subject from Signor Secchi to M. Elie de Beaumont. The Italian physicist has found that the spectrum produced by the light of Tempel's Comet consists of only three bands. One, which corresponds to two-fifths of the distance between Frauenhöfer's lines *b* and *f*; the colour of this is green, and though it is bright, it differs from those of the nebula by its size. The other two bands were too small and feebly developed for Signor Secchi to discover their exact position; one is near the principal red band, and the other is at some distance from the violet one. From these facts Signor Secchi concludes that comets are bodies whose constitution is closely allied to that of the nebulæ, although they differ from them in their refrangibility of light.

Geometric Plans taken by Photography.—*The Journal of the Society of Arts* announces that M. Chevalier, the French optician, has devised an apparatus for the above purpose. The instrument is provided with a meridional telescope and a compass, in order to set it to any given point. A circular collodionized glass is placed at the bottom of a camera-obscura formed of copper, and moved by clockwork, so as to describe within a given time the outer circle, of which the station chosen is the centre, and the various objects as they are received in turn by the lens, and photographed on the circular plate through an exceedingly narrow slit in the side of the copper box. The operation is repeated at their stations, in order to avoid error, and the result is said to be highly satisfactory. The thin circular plates are used to lay down on paper all the points of the plan described.

Professor Wheatstone's New Telegraph surpasses everything which the Professor has hitherto accomplished. With the perfected automatic apparatus, we learn that *six hundred* distinctly legible signals may be transmitted in a minute.

Physics under Difficulties.—The Swiss philosophers who took up their residences on the pass of St. Théodule, last autumn, for the purpose of making meteorological observations during the winter, are all well, and, though posted at a height of 10,241 feet, they do not seem to have suffered much from cold.

Relation between Refractive Power and Chemical Constitution.—A very important essay on this relationship has been published by M. E. Reichert, in a recent number of *Poggendorff's Annalen.* The paper to which we refer contains the results of the author's experiments on solution of common salt of different strengths. The percentages of salt, as indiated by the optical method and by ordinary analysis, appear to agree very closely. The first column of the following table shows the percentages as obtained by analysis, and the second gives the results of the optical method:—

2·26	2·27
7·12	7·13
12·02	12·07
17·25	17·25
23·02	22·89

An equally satisfactory result was obtained with solutions of sugar; but with alcohol and acetic acid the differences in the refractive indices are only about half as great, and the indications were therefore not so satisfactory.

How to reproduce Old Lithographs.—Although this subject hardly comes within the range of Physics properly so called, it is closely related to it, and as the process is both simple and interesting, we lay it before our readers. The method, which is a new one, has been described by M. Rigaut. The lithograph to be transferred to stone is first laid face uppermost on a surface of pure water, and thus all those portions not covered with ink are allowed to absorb the liquid. It is then put between two sheets of blotting-paper, which carry off the excess of water ; after which it is laid face downwards on the stone, to which it adheres perfectly. Another sheet is laid on this, and moistened with dilute nitric acid ; the acid penetrates both sheets, and eats away the stone in accordance with the lights and shades of the original picture.

Improvements in the Barometer.—Some important improvements have recently been effected in the Aneroid barometer by Messrs. Cook & Sons, the opticians. Although the Aneroid, under ordinary circumstances, has been shown by Mr. Glaisher and others to be very much more effective and satisfactory in its results than could have been hoped, still, under conditions which bring rapid changes of pressure into play, the instrument when it returns to the normal pressure does not always indicate correctly. This results from the motion being communicated to the index axle by a chain, and this chain, from other considerations, is the weakest part of the instrument, and is the first acted upon by climatic influences, rust, &c. Mr. Cook has abolished this chain altogether, substituting for it an almost invisible driving-band of gold or platinum, and the result of this great improvement is that the Aneroid may now be looked upon as an almost perfect instrument for scientific research. Several such Aneroids, placed under the receiver of an air-pump, not only march absolutely together, but all return unfailingly to one and the same indication.—Vide *The Reader*, March.

The History of the Discovery of Spectrum-analysis.—A paper has on this subject been presented to the French Academy by Sir David Brewster, who thinks that the labours of those who were first in the field of discovery have been seriously overlooked. He considers that the labours of Mr. Fox-Talbot were prior to those of M. Tantedeschi. As early as 1826, Dr. David Brewster received from Mr. Talbot an essay on some "experiments on coloured flames," in which he says that the orange tint may be due to strontian, and that if such were the case, a glance at the prismatic spectrum might indicate that it contains substances which otherwise could only be discovered by laborious analysis. M. Volpecelli, in 1863, declared that Sir David had made "many discoveries in spectral analysis, which have been actually developed with modern spectroscopes." As a proof that this assertion was well founded, certain passages from the writings of Sir David Brewster were adduced by him. One of these, written in 1833, states that "the principal object of his researches had been the discovery of a general principle of chemical analysis, in which both simple and compound bodies would be characterized by their action on definite portions of the spectrum ;" and it was remarked, at the same time, "that those very absorbing elements which exist in nitrous acid gas are found likewise in the atmospheres of the sun and earth." In 1842, Sir David discovered that luminous and brilliant lines in certain flames correspond to the lines which are wanting in solar light ; and a series of experiments made by him on 180 different substances, which were ignited in a platinum cup, by means of a mixture of oxygen and hydrogen, showed that this is "a property which belongs to almost every flame." The places of the lines were, in these experiments, merely estimated by the eye ; but it was anticipated at the time that other experimentalists would determine their places, with reference to the bodies in which their number or position would be found remarkable.—Vide *Comptes Rendus*, January 2.

A New Method of Registering the Results of Spectrum-analysis is being successfully employed at the Kew Observatory. By its means the exact distances of the lines from each other and their relative positions are accurately delineated. Briefly the process is as follows:—The paper on which the lines of the spectrum are to be drawn is rolled round a cylinder whose circle is graduated and is provided with a vernier. By means of an apparatus for the purpose, the cylinder may be turned with exactitude to any required extent, and when it is stopped, a line may be readily traced upon the paper by means of a rule. The angular distances between the spectral lines are given by the graduated circle of the instrument.

A Substitute for Magnesium Light has been suggested by M. Sayers, and promises to be of much service in physical operations in which photography is employed. Twenty-four parts by weight of nitrate of potash, seven parts of flowers of sulphur, and six parts of red sulphide of arsenic, are thoroughly mixed. This composition, when set on fire, affords a most brilliant light, and the negatives produced with it give excellent positives. It has been found that about half a pound of the mixture will afford light for half a minute.

Ladd's Modification of Marcus' Thermo-electric Battery.—This instrument was exhibited at the Soirée of the Royal Society on the 10th of March. The principle is the same as that of other batteries of this class. A series of thermo-electric elements, consisting of bars of German silver (nickel, copper, and zinc) soldered to other bars compounded of an alloy of antimony, zinc, and bismuth (only one part in 18 of the latter), are heated at one end by a series of what are really small Bunsenburner jets, when electrical action is set up in the usual well-known manner. To a large induction-coil, and to a soft iron core the wires of the thermo-electric battery were alternately connected to show its power.—Vide *The Reader*, March 17.

Artificial Cobwebs for Telescopes.—The telescopes used in engineering operations are provided with cross-wires of delicate spider's-web; but, as these frequently become broken, and cannot be easily replaced in a short space of time, the following substitute has been suggested in the *Archiv für Seewesen*. The threads to be substituted are made of glass, and may rapidly be prepared in a case of emergency. The process is as follows:—Take a thin slip of window glass, and heat it at the centre in the flame of a lamp. When the glass is red hot, the strip may be pulled apart, and two pieces with pointed ends are formed. Each of these is to be heated in the flame until a small button has formed on the end, and whilst they are still hot the two buttons are to be brought into contact with each other. If the two be now pulled quickly apart, a thread will be produced, the fineness of which will vary according to the softness of the glass and the rapidity with which the hands are separated. A very little practice will be sufficient to enable any one to manufacture a thread of sufficient fineness for use in a telescope when it would be impossible to procure a piece of spider's-web.

ZOOLOGY AND COMPARATIVE ANATOMY.

The Zoological Position of the Dodo.—At a meeting of the Zoological Society on the 9th of January last, Professor Owen read a paper on the osteology of the Dodo, the great extinct bird of the Mauritius. Our readers will remember that this bird has given rise to a good deal of discussion from time to time as to its true affinities. When Professor Owen was Curator of the Royal College of Surgeons' Museum, he classed the Dodo along with the Raptorial birds. This arrangement led to the production of the huge volume of Messrs. Strickland and Melville, in which it was very ably demonstrated that the bird belongs to the *Columbæ* or pigeon group. It is highly creditable therefore to Professor Owen that upon a careful examination of the specimens of the dodo's bones which have lately come under his observation, he has consented to the view long ago expressed by Dr. Melville. The materials upon which Professor Owen's paper was based consisted of about one hundred different bones belonging to various parts of the skeleton, which had been recently discovered by Mr. George Clark, of Mahéberg, Mauritius, in an alluvial deposit in that island. After an exhaustive examination of these remains, which embraced nearly every part of the skeleton, Professor Owen came to the conclusion that previous authorities had been correct in referring the dodo to the Columbine order, the variations presented, though considerable, being mainly such as might be referable to the adaptation of the dodo to a terrestrial life, and different food and habits.

The Functions of the Air-cells in Birds. — Dr. Drosier lately read a paper on this subject before the Cambridge Philosophical Society. His memoir included a history of the different essays which have been written upon these structures, but was chiefly devoted to the author's own views, and to a consideration of the objections to the views generally held by anatomists of the present day. Dr. Drosier thinks that the air-chambers in birds are not employed to lessen the specific gravity of the body. The floating power of the air in the sacs and bones of the bird, when raised to the average temperature of the bird's body, he calculated to be in a pigeon less than a grain ; therefore he maintained that the bird was supported in the air solely by the muscular effort exerted in the downward stroke of the wing. Nor are the air-cells designed for aërating the blood, because the vessels in them are very fine and sparsely scattered. He considered their true functions to be that, since the thoracic cells expand when the abdominal contract, and *vice versâ*, during the expansion and contraction of the chest, a constant current of air is kept up through the lungs, and so fresh air plays constantly over the capillaries in the lungs, which are naked.

The Parasite of the Bee.—M. Duchemin has presented a paper to the French Academy, in which he showed that he has discovered the source of the parasite which is so destructive to our bees. He has proved, by a course of careful experiments (1) that the parasite is found commonly on the *Helianthus annuus*, or sunflower, and (2) that it is from this plant that the bee derives the parasite.

The Election in the French Academy.—The Academy has elected M. Robin to fill the vacancy in the section of zoology caused by the death of M. Valenciennes. The other candidates were MM. Lucaze-Duthiers, Gervais, and Dareste.

Structure of the Investing Tunic in the Gregarina.—A very able essay on the Gregarina appeared in the last number of the *Microscopical Journal*, from the pen of Mr. E. Ray Lankester. From this we learn that the author, although at first disposed to agree with Dr. Leidy in thinking that the investing tunic is double, has since altered his opinion. He has now, he says, reason to believe that the striations visible in the posterior sac of that species are produced merely by the contraction of a portion of the viscid material which fills it ; in fact, the investing membrane must merely be regarded as a dense layer of the same sarcodic material which forms the whole creature. The membrane which invests the whole Gregarina appears to be excessively thin and ill-defined, and more or less continuous with the viscid substance contained by it, which is denser nearer the exterior, and, in fact, seems to form a layer beneath the investing tunic, intermediate in density as well as position, which in one or two cases becomes considerably developed.

The Development of the Infusoria has recently received the attention of Mr. James Samuelson, who has contributed an interesting memoir upon the subject to the *Proceedings of the Royal Society.* It is known that when vegetable infusions are exposed to the action of the air, the first infusoria which appear belong to the very lowest groups, and are afterwards succeeded by higher forms. Mr. Samuelson explains this fact by a very reasonable theory : that the monadine form which first appears is the earlier or larval stage of at least one, if not more, of the ciliated infusoria, into which it becomes metamorphosed in the course of development. Mr. Samuelson has recorded several interesting experiments, and from some of them he concludes that the *Cerco-monades* are the larvæ or earlier forms of the ciliated animalcules which succeed them. He desires that other experimenters should repeat his observations, for, though he himself has perfect confidence in their accuracy, he is aware of the great liability to error in such a difficult pursuit.

The Circulation in the Lower Animals.—According to the researches of M. Lucaze-Duthiers, the characters of the circulatory apparatus in the lower forms of animal life are different from those of this system in the vertebral sub-kingdom. He has pointed out some curious facts relative to the blood-vessels of certain mollusks and zoophytes. He has found that the circulatory system of these animals is very different from that of the higher groups. The blood-vessels communicate with the atmosphere and with the stomach by direct apertures. Hence he concludes that it is unfair to extend to the higher animals generalizations which have been framed in accordance with the structure and functions of the lower ones.—Vide *Comptes Rendus*, Dec. 18.

The Works of Linnæus.—The first edition of the "Systema Naturæ" of Linnæus, published in 1735, is to be reproduced through the photo-lithographic process, by the Stockholm Academy of Science. It contains the earliest attempt to treat man zoologically.

Accessory Eyes in Vertebrates.—In a paper lately published in the *Archives des Sciences*, and which has been abstracted by one of our contemporaries, it is alleged that Professor Leuckart has discovered several supplementary eyes in a fish. The Professor states that the brilliant spots grouped with more or less regularity upon certain fish of the group *Scopelinidæ*, are really accessory eyes. The existence of more than a thousand such eyes in a vertebrate animal is quite unexpected. They are distributed over the hyoid apparatus, and on the head and belly, where they form two rows, which are parallel. Herr Leuckart bases his opinion upon the anatomical structure of the organs known as spots, these having really the form of little cylinders, the anterior part of which is occupied by a spherical body like a crystalline lens, behind which is a sort of vitreous humour.

The Muscular Fibres of the Heart of Vertebrates.—We have received from Dr. J. B. Pettigrew, the accomplished sub-curator of the Royal College of Surgeons' Museum, a copy of his excellent monograph on the above subject. The memoir is certainly the finest which has yet been produced; for it is comprehensive, clear, and accurate, and is accompanied by a great number of beautiful lithographs, which have been taken from photographs of actual dissections. The arrangement of the muscular fibres, as demonstrated by the author, shed much light upon the peculiar movements of the heart. For this reason the essay has a great physiological importance, and, from the circumstance that the anatomy of the heart in the four vertebrate classes is fully explored by Dr. Pettigrew, it is of equal import and interest to the comparative anatomist. We have also received Dr. Pettigrew's paper on the valvular apparatus of the circulatory system, and we commend it likewise to our readers' favourable notice.

The Natural History Review.—We regret to observe that the *Natural History Review* has ceased to exist. This journal, which was originally an Irish periodical, and subsequently an English one, was, without exception, the most excellent periodical of its kind. We fancy its articles were of too high a standard to secure for it a large number of subscribers, and hence its failure as a commercial undertaking.

The Ailanthus Silk-worm.—Those who think that this caterpillar cannot be successfully cultivated in this country should read the subjoined letter, which was recently addressed to the *Times*:—"Sir,—Having seen a letter in the *Times* relating to the new oak silk-worms, *Bombyx Yama-mai*, and their probable acclimatization in England, may I be allowed to say a few words? I have cultivated them for two years with the greatest care, and from my observations fear they will never stand our changeable climate. I reared them successfully, both under glass and in the open air, till the fourth change of skin, when they all died of the malady called 'pebrine,' induced by a few days of rainy and cold weather in the month of June. The Ailanthus worm, on the contrary, is perfectly hardy, fearing no rain or wind, or even a slight frost. His only enemies are in infancy the ants; in old age, the tom-tits. I rear many thousands every year without the slightest difficulty, and shall be glad to give any persons the benefit of my experience. To show they are gaining much in the public estimation, since I introduced them into England three years ago, I have sold and given away 70,000 eggs annually, besides sending cocoons to all parts of the world; and, more than that, I have a gown made from the silk.

"Dangstein, Petersfield, Feb. 24. Dorothy Nevill."

The Metamorphosis of the Ostracoda.—Dr. C. Claus has given the results of some interesting observations in a late number of *Siebold and Köllicker's Zeitschrift.* The species which has been particularly investigated is the *Cypris ovum*, upon the young forms of which he writes. His conclusions are:—(1.) That the Ostracoda pass through a sort of metamorphosis, for their shell varies in form, and they only acquire their limbs by gradual development. (2.) The youngest stages are shells bearing *Nauplius forms*, with three pairs of limbs for movement,—viz., two antennæ and the mandibular appendage. (3.) There are altogether nine stages of *C. ovum*, which are successive, and may be distinguished from each other, and of which the last represents the sexually-mature condition. (4.) These stages of development are marked by the stripping off of the skin; there are therefore eight corresponding moults. (5.) The *mandibles* arise first in the second stage, as powerful jaw-prolongations at the basal joint of the mandibular foot. (6.) Only the hinder antennæ already possess at the youngest age the complete jointing and figure of the sexually-mature animal. (7.) In the second stage the anterior maxillæ and anterior feet, except the antennæ and mandibles, are attached. (8.) The maxillæ of the second pair originate first in the third stage, consequently later than the following pair of jointed bodies, distinguished as the first foot. (9.) The maxillæ of both pairs and the hinder foot present in their first appearance a nearly corresponding form as a triangular plate running out into a little hook. (10.) The anterior feet proceed from the top to the base in their jointing. (11.) The abdomen gives rise to two long furcal joints.—Vide *The Quarterly Journal of Microscopical Science.*

Fissiparous Reproduction in Anthea cereus.—In the last number of the *Dublin Quarterly Journal of Science*, Dr. E. H. Bennet describes the process of fissiparous division in one of the above species. Although there is nothing very novel in the phenomenon witnessed by Dr. Bennet, his essay is of importance from the fact that many persons are disposed to think that true multiplication by division does not occur in the *Anthea*. Although Dr. Bennet's observations did not extend to an anatomical examination of the individuals produced by fission, they go quite far enough, however, to prove that division was completed, and that the two halves lived as independent animals for a few days. The whole time which the division took from the first observation of the opening in the base to the complete separation of the halves, was barely three hours. The exciting cause of the process seems to have been the condition of the water in the vessel, just verging on decomposition. The most important part of the observation is the mode of the division. This began by a fissure in the base, and proceeded in the manner described so well by the author in the following passage:—"It is a curious fact that the tentacles corresponding to the two parts now contracted separately; hitherto the contractions were convulsive, and set in suddenly at intervals and all together, now there was a distinct pause between the convulsion of the upper and lower divisions, the upper always preceding the lower by a few seconds. Does not this suggest that the seat of the central nervous system of Actinia occupies the base, as Spix thought he had demonstrated—although this demonstration has been rejected by every authority who has followed him? At 5.10 the walls of the stomach could be seen strained across the fissure, and they presently gave way, the rent extending right through the column to the oral disc. On one margin of the disc the rent involved the base of one of the outer row of tentacles, and extended along it. I was much interested in watching its progress along the tentacle, as it seemed doubtful whether it would tear along its whole length, or detach one or other half from its attachment to the body. The strain seemed great on the parts, and at last the lower half tore off from its base, and, immediately closing into a perfect tube, hung as a branch from its parent trunk. The wound in this, too, seemed to close at once when the strain was taken off. I have mentioned this apparently trivial detail as it may explain the occasional occurrence of the double or branched tentacle which has been observed in *Anthea cereus.* At 5.45, less than three hours from the commencement of the process, the division was complete, the upper half falling to the bottom of the vessel. At 6.5 the lower followed it, and the two new individuals lay together almost motionless."

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HYDRÆ, OR FRESH-WATER POLYPES.

BY REV. W. HOUGHTON, M.A., F.L.S.

PROBABLY no animal in the world ever excited more interest amongst naturalists than the little hydræ of our ponds and ditches. The interest has now, as is natural, considerably abated; further acquaintance has brought to light so many strange facts and anomalies in the animal kingdom since the days of Leeuwenhoek and Trembley, that we cease to wonder greatly at any new revelation of nature. Though familiarity never breeds contempt, but, on the contrary, stimulates the inquiring mind to further discoveries, the naturalist of the present century does not stand amazed, as of old, at the record of any well-ascertained fact in science, however anomalous it may appear. Fresh discoveries nowadays may perhaps lack the charm of novelty—at least of a kind equal to that of Trembley's account of the hydra,—but they may have a more important scientific bearing, inasmuch as increased knowledge and greater facilities for minute investigations have made us better able to appreciate their value in the grand scheme of nature. Still, it is almost impossible to exaggerate the importance of Trembley's discoveries as to the nature of those little jelly-like substances, so common in almost every pond and ditch. To the ancient naturalists of Greece and Rome the veritable hydra was entirely unknown. The term "polypus" was used by them to designate various species of cephalopodous molluscs. With coral they were partially acquainted, but they knew nothing of its real nature. Theophrastus considered coral to belong to the mineral kingdom; Pliny seems to have thought it was a vegetable; and we know that this substance, now ascertained to be of animal nature, was, even up to the middle of the last century, considered to belong to the vegetable kingdom. Marsigli, early in the eighteenth century, noticing the flower-shaped bodies in *Alcyonium* and *Corallium* on the shore of the Mediterranean, considered their vegetable nature placed beyond a doubt. It is to Peyssonnel, a learned physician of Marseilles—how much valuable zoological knowledge we owe to medical men!—to whom science is indebted for satisfactorily determining the animal nature of the polypifera. But the announcement was treated with ridicule by the learned of his day; for we read how, when Peyssonnel communicated with Réaumur on the subject, that celebrated naturalist thought the idea so improbable, that in a notice of it in the Memoirs of the Academy of Sciences of Paris in 1727, he thought it prudent to suppress the author's name. Now, it happened that soon after this Réaumur received a communication from another naturalist, whose name has now become immortal—namely, the renowned Trembley of Geneva,*—on the subject of the fresh-water polypes. It is true that Leeuwenhoek† had been before him as the discoverer of the hydra; but his observations on its nature were trifling compared with those of the Swiss naturalist, and they had been entirely forgotten. Discoveries, whether in nature or art, are seldom made by one individual alone. About two years after Trembley's letter to Réaumur, it happened that Bernard de Jussieu, the celebrated botanist, was engaged in examining *Flustra* and *Tubularia* on the coast of Normandy. Of course, at this time those substances were undoubted vegetable products in the opinion of all; but Jussieu liked to look at things with his own eyes, and he soon became convinced of their animal nature. Thus he was able to confirm Peyssonel's discovery,‡ and to bring Réaumur over to his side. In the last century our own countryman Ellis, Pallas

* "Trembley (Abraham) de Génève, né en 1710, mort en 1784; immortel par le découverte de la reproduction du Polype."—*Cuvier.*

† Few objects escaped the lynx-eye of this admirable observer. He noticed on a portion of water-weed certain animalculæ, "whose bodies were sometimes long and sometimes contracted;" and on one individual he observed another of the same kind, but smaller, the tail of which seemed to be fastened to the other. At first he thought it might be "a young one fastened by chance to an old one; but observing it more narrowly, he saw it was a *partus*," and that it grew bigger "in horns and body." The species observed by Leeuwenhoek appears to have been *Hydra fusca*. "That which seemed very remarkable, and even wonderful to me, was that the said *animalculæ* would sometimes extend their horns to so great a length that looking on them through the microscope, you would think they were several fathoms long." Leeuwenhoek's figure is a very rude representation of a hydra, with two young ones growing from its side (see *Philosoph. Transac.*, No. 283, Vol. XXIII.). It appears that an anonymous correspondent of the Royal Society discovered hydræ in England about the same time.

‡ Ferrande Imperato (1559), a Neapolitan, appears to have been the first to assert the animal nature of corals, madrepores, &c. Though his work went through two editions, it appears to have been little read. The members of the Academy of Sciences regarded Peyssonnel's assertion as entirely new.

and others, extended our acquaintance with these interesting polypifera, whose animal nature is, of course, now known to all naturalists. I have given this brief historical sketch, because we learn from it that Trembley's discovery of the fresh-water hydræ, whose animal nature was so apparent, was the very circumstance that turned the tide of disputation about the corallines in favour of Peyssonnel's opinion, as well as because it is instructive to watch, as it were, the gradual development of a new doctrine, its severe birth-pangs, and its final acceptance as truth.

As has been stated, Leeuwenhoek was the first discoverer of the hydra, and of the manner in which the young are produced by gemmation. He noticed the great contractility of the animal's tentacles, and he sent a letter to the Royal Society, dated December 25, 1702, which may be read in vol. xxiii. pp. 1304—1311 of the *Philosophical Transactions.* This communication attracted little notice at the time, and seems to have been forgotten when Trembley announced his startling discoveries. Leeuwenhoek's letter to the Royal Society was dated 1702, as has been already stated; Peyssonnel was born in 1700; Réaumur's notice of Peyssonnel's assertion of the animal nature of coral was made to the French Academy of Sciences in 1727; that is to say, twenty-five years after Leeuwenhoek's letter. Trembley drew the attention of the learned world to his experiments with the hydra about the year 1744. We have seen how these experiments turned the tide in favour of Peyssonnel's opinion; it is highly probable that Leeuwenhoek's communication, with the figure he has given, would have helped to settle the question as to the animal nature of corals some years before Trembley wrote, had the Dutch naturalist published his account of the hydra after the year 1727 instead of before it. However, it is satisfactory to know that Peyssonnel lived to see a change of opinion in his favour, and to find De Jussieu and Réaumur his hearty advocates. The excitement amongst naturalists that followed Trembley's discoveries of the extraordinary properties of the hydra was intense. That an animal should be chopped into several pieces, and that each part should survive and the creature increase under the operation, that a veritable animal should bud out young ones after the manner of plants, that whether its body were turned inside or outside it made no difference, that portions of one individual could be grafted into portions of another,—all these things were so contrary to established experience and to all then known physiological laws that many would not believe them. And so the sceptics—and scepticism in science is a virtue—experimentalized themselves on these animals; members of the different learned societies were to be seen poking about ditches and ponds in search of specimens and practising experiments daily. Carefully packed-up bottles were sent to distant friends, by post; and even ambassadors were full of the all-engrossing theme.

Hydræ are found only in fresh water, and generally in such as flows very slowly or is quite still. The best way to obtain specimens is to take a handful or two of weeds, such as duckweed, star-wort, water-crowfoot, &c., from any clear pond or ditch, and place them in a glass vessel of water. After waiting half an hour, it is probable that several individuals may be seen in various attitudes, some hanging loosely down, others erecting themselves in graceful curves and throwing out their pendent tentacles many times longer than their bodies, others shooting up their arms right above their heads, others contracted so as to look like a mere dab of jelly; others with anterior and posterior extremity attached to the side of the glass, others floating on the surface of the water, the posterior discs or tail-ends serving to keep them from sinking; some of a beautiful grass-green colour, others light flesh, others white, others red.

The body of the hydra is of a gelatinous nature, varying in shape according to the position it assumes: contracted, it is in some species a mere tubercle with short radiating papillæ; it becomes a narrow cylinder when extended; one end is expanded and forms an adherent disc, the other is furnished with a mouth surrounded by a number of exceedingly contractile arms or tentacles, which vary in number both according to the species and the ages of individuals. The hydra's body is composed of two membranes, technically termed *ectoderm* and *endoderm*, the former being external, the latter constituting the lining of the inside cavity. The tentacles are membranous tubes, being in fact nothing more than the tubular prolongations of the two membranes of the body. These arms, which are the animal's instruments for seizing its prey, are situated a little below the orifice of the mouth, which, when closed, is sometimes protruded like a snout above the tentacles. Both membranes present on the surface irregularly-rounded nodules, with a number of vacuoles. These nodules contain, especially in the tentacles, capsular bodies (thread-cells), in which may be seen, under a high power of the microscope, certain curious organs (see fig. 7), consisting of spines and filaments, supposed by some to have the power of stinging, each capsule containing one filament with its spinous appendages. These organs may readily be seen by crushing the hydra between two bits of glass. There are traces of the presence of muscular fibres in the tentacles; but whether this muscular apparatus is sufficient to effect the extraordinary extensibility of these organs may be doubted. Some have supposed that the water which finds its way into the cavity of the hydra's body through the mouth, may flow in extremely narrow channels into the tentacles, and thus occasion their elongation. The tentacles of *Hydra fusca* (*Polype à longs bras* of Trembley), are the most wonderful of all for their extensibility; growing gradually finer than the lightest gossamer, they become invisible except to the eye of the microscopist.

The hydræ are very voracious, and may be kept readily in confinement for some time. They feed on the small entomostraca, such as *daphnia*, *cyclops*, *cypris*, &c., and on minute larvæ of gnats and *naïd* worms. The stomach of these animals is a simple cavity, though some authors have recorded the existence of a short narrow duct leading from the stomach to the centre of the disc which they say is perforated, and that through this aperture excrementitious particles may be seen to pass. I have been quite unable to discover any signs of an intestinal canal in any of the species I have examined; further evidence is wanted before this statement can be accepted. The food is quickly assimilated by the hydra, and the indigestible portion expelled through the mouth as in the *actiniæ*. There is no doubt as to the existence of the thread-cells before alluded to, but some persons, and conspicuously Mr. G. H. Lewes, entirely deny that they have stinging properties. "That the tentacula have the power of communicating some benumbing or noxious influence to the living animals which constitute the food of the hydra," says Professor Owen, "is evident from the effect produced, for example, upon an entomostracan which may have been touched but not seized by one of these organs. The little active crustacean is arrested in the midst of its rapid darting motion, and sinks apparently lifeless for some distance; then slowly recovers itself and resumes its ordinary movement. Siebold states, that when a naïs, a daphnia, or the larva of a cheironomus have been wounded by the darts, they do not recover, but die. These and other active inhabitants of fresh water, whose powers should be equivalent to rend asunder the delicate gelatinous arms of these low-organized captors, seem paralyzed almost immediately after they have been seized, and so countenance the opinion of Corda, that the reaction of a poison enters the wound." Trembley nowhere states that animals once caught in the hydra's embrace always died, nor does he allude to any stinging or poisoning power of the hydra.

Baker says, "I have now and then seen a very strong worm seized by a small polype break off all the polype's arms by its violent struggling, and so make its escape" (p. 68). But he remarks in another place,—"I have sometimes forced a worm from a polype, the instant it has been bitten (at the expense of breaking off the polype's arms), and have always observed it to die very soon afterwards, without one single instance of recovery." He seems to have thought the hydra was possessed of teeth. "It is surprising to behold how soon a polype kills a vigorous, nimble worm; except by crushing, no way can put it to death more speedily. But there is no certainty what kind of weapons this is effected by, though probably it may be armed with sharp teeth." It is usual to attribute to the thread-cells, which characterize the whole of the sub-kingdom *Cœlenterata*, the power of stinging, which unquestionably belongs to some of the members, as to certain of the *Medusæ*. But I think that this opinion needs more decided verification than it has yet received. If it be a fact that the thread-cells (or "cnidæ" as they are technically called) are the cause of the stinging power in the tentacles of *Cyanæa capillata*, for instance, then it is fair to *surmise* that they have a kindred property, varying in degrees, in other members of the sub-kingdom. The experiments of Mr. G. H. Lewes are sufficient to throw considerable doubt upon the benumbing properties of the hydra. This observer noticed that small entomostraca dropped suddenly to the bottom of the vessel, and remained motionless there for a minute or two, after having been held by the arms of a hydra; but he found that if he touched a water-flea (*cypris*) with the point of a pin, precisely the same thing occurred. He considers that this sudden motionlessness of the water-flea is analogous to what we often observe in numerous other animals, viz., the practice of "shamming dead," in schoolboy phraseology. The larva of an *Ephemera* having been "thrice caught by three different hydræ, tore itself away without any visible hurt." A naïs that had been held by the embraces of a *Hydra viridis* for some time, struggled itself free.* Not only was it apparently unhurt by this contact, but three days afterwards it was as lively as ever. "With two other naïds the same result was observed. From experiments I have myself made with regard to this question, I am inclined to doubt altogether the paralysing power ascribed to the hydra. I have repeatedly seen small worms, gnat-larvæ, and other aquatic creatures, alive and apparently quite uninjured from the effects of the hydra's embrace, some time after they had freed themselves or been released by the point of a needle."

* "Seaside Studies," p. 137.

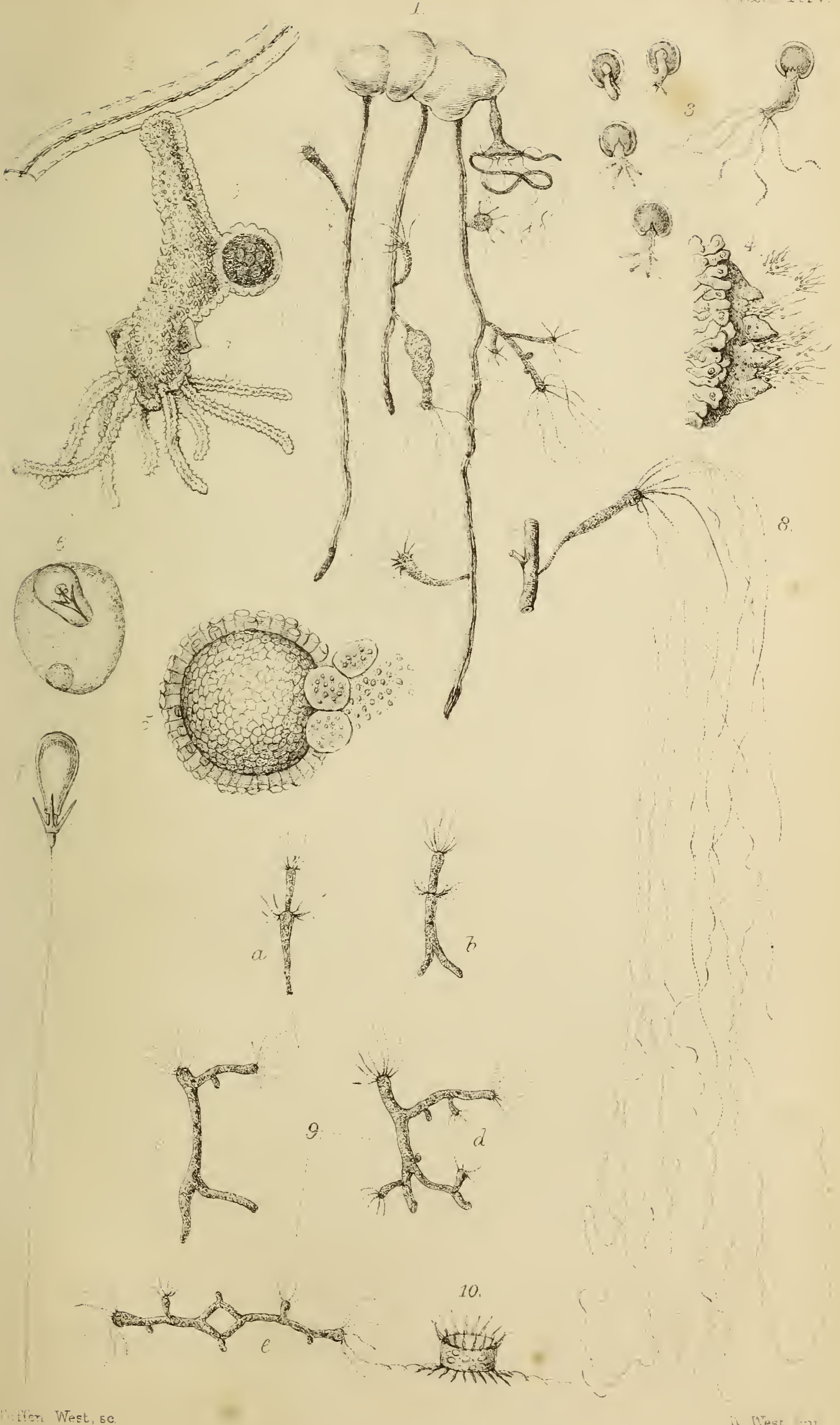
The motion of a hydra is very slow. Its ordinary mode of locomotion is like that of a leech, but changes of position may be made by a gliding motion of its disc. Sometimes this disc is protruded above the surface of the water, when it acts as a float, and the animal is borne along by any movement in the water. Hydræ may be found in the spring, summer, and autumn, towards the end of which last-named season they give birth to eggs and then die. In very mild winters I have occasionally found a few specimens of the *H. viridis*, but for the most part these polypes do not survive the winter. The mode of increase is two-fold, (1) by gemmation, and (2) by the ordinary manner of reproduction. The first takes place throughout the summer, the latter only at the end of autumn. In the case of increase by gemmation a small swelling is first observed on the hydra's body; this grows larger, and divides at its apex into several minute papillæ, which are the tentacles, but they do not appear simultaneously. The other mode of reproduction is by ova. About the end of autumn the observer will notice certain peculiar elevations on the body of the hydra; some round, and situated about the middle of the body; others of a conical shape, and close to the bases of the tentacles. Generally there are about one or two of the round bodies, and the same number of the conical ones. When there is more than one, the second is found on the opposite side of the body. These are the reproductive organs, the round elevations containing ova, the conical ones the spermatozoan bodies. The ovum, when ripe, is pushed through the body-wall, and having been impregnated, becomes attached to some water-weed, awaiting the warm weather of spring to be developed into a young hydra. Though I have frequently seen the ovigerous and spermigerous elevations, and the ovum in the body of the hydra, I have never succeeded in meeting with the detached ova. They appear to have been seen by few observers. This mode of generation in the hydra does not appear to have been observed by Trembley and Baker.

Trembley thus describes one of his attempts to turn a hydra inside out.

I begin by giving a worm to the polype on which I wish to make an experiment, and when it is swallowed I can begin operations. It is well not to wait till the worm is much digested. I put the polype, with which the stomach is well filled, in a little water in the hollow of my left hand; I then press it with a small forceps, nearer to the posterior than to the anterior extremity. In this way I push the swallowed worm against the mouth of the polype, which is thus forced to open: and by again slightly pressing the polype with my forceps, I cause the worm partly to emerge from its mouth, and thus to draw out with it an equal part of the posterior end of its stomach

The worm coming out of the mouth of the polype, forces it to enlarge itself considerably, especially if it emerges doubled up. . . . When the polype is in this state, I take it gently, without disturbing anything, out of the water, and place it on the edge of my hand, which is simply moistened, so that it may not adhere too closely. I oblige it to contract more and more, and this also enlarges the stomach and mouth. One must remember here that the worm is partly emerging from the mouth, and keeping it open. I take then with the right hand a hog's bristle, rather thick and without a point, and I hold it as one holds a lancet for bleeding. I bring its thickest end to the posterior extremity of the polype; I push this extremity, and make it enter into its stomach, which is done the more easily as it is empty in that part, and very much enlarged. I then go on advancing the end of the hog's bristle, which, as it is pushed forward, continues to invert the polype. When it reaches the worm which holds the mouth open, it either pushes the worm or passes by its side, and at last comes out by the mouth, covered with the posterior part of the polype. It is easy not to miss the mouth, because it is very open. It happens sometimes that the polype is at once completely inverted. It must be understood that it then covers the end of the hog's bristle, which is lodged inside the inverted polype; that the exterior surface of the animal is become the interior; that this surface touches that of the hog's bristle; and that the interior has become the exterior.

Trembley then goes on to say that he took steps to prevent the polypes from turning themselves back to their original condition, as they attempted to do, often with success, and found that they lived, "ate, grew, and multiplied." He turned some inside out which had little ones attached to their bodies, and these young ones, after the operation, found themselves in the interior of the polype. "If they were tolerably advanced, and the place where they joined on to the mother was considerably constricted, they became detached in a short time, about the end of a day or two; but meanwhile they extended themselves in the stomach of their inverted mother, and their heads and part of their bodies might be seen emerging from her mouth. . . . But with those less advanced, which have no arms or only very short ones, and whose posterior ends are not yet restricted, the case is different. The opening which communicates between the stomach of these little ones and that of the mother is still its full size. When the mother is turned, the little one can invert itself also. It is just the same as if, after having turned a glove, the fingers of the glove were to turn themselves inside out. By looking attentively at the body of the mother after having been turned inside out, one sees in the place of these young ones a hollow, which gradually fills, after which is to be easily distinguished the body of the young polype turning itself as it comes out. . . . In a few minutes the little polype, will be completely inverted. Then it continues to



Tuffen West, sc. W. West imp.

Hydræ or fresh-water Polyps

grow; it detaches itself from its mother, and differs not at all from any other polype. I have kept several of these polypes, and they and their young ones have multiplied in my glasses."

The following letter addressed by Baker to Mr. Martyn Folkes, President of the Royal Society in 1743, describes an attempt he made to turn a hydra inside out:—

July 6th, 1743. —Having learned, by one of Mr. Trembley's letters which you, Sir, received after the preceding experiment, and was pleased to favour me with a sight of, that his method for preparing a polype for turning inside out is by giving it a chrysalis of the *Water-Tipula*, which, when swallowed, distends the polype's stomach and body, and having some degree of hardness, enables him, by gently pressing it from the tail upwards towards the mouth, and at the same time pushing the tail behind, to return it back again through the mouth along with the tail and body, and thereby completely turned it,—I was desirous of doing the same thing; but being unable to procure any such chrysalis at London, I fancied that perhaps I might perform this operation by other means, though somewhat in the same manner. I fixed my eye, for this purpose, on a very large polype of the long-tailed sort, with only six arms, that had no young ones issuing from it, and gave thereto one of the biggest worms I could get, the whole whereof I was certain it could not possibly swallow. The polype seized the worm immediately, and in less than a quarter of an hour had gorged as much of it as its body was able to contain, leaving one-third part at least hanging from its mouth. Things succeeding thus far to my wish, I loosened the polype's tail from the side of the glass, took it out with a scoop-pen, and put it on a wetted slip of paper; for I judged it best not to remove it before it had swallowed the worm, lest it should refuse to eat afterwards. This done, I set myself to work with a great deal of care and gentleness; and fixing my paper whereon the polype lay by a pin to the writing-desk where I sat, I took hold of the worm by means of a pair of nippers which I held in my right hand, and at the same instant thrusting against the polype's tail with the head of a very small pin (the point whereof I had previously fastened into a piece of stick, which served me for a handle to guide it by), I proceeded cautiously and leisurely; and after several trials with the worm and pin, what by pulling one and thrusting with the other, the stomach, wherein part of the worm lay folded, came along with it through the mouth, and was followed by the tail, pin and all; so that the polype was really and completely turned, though the pin had made a hole quite through it, contrary to my intent, and would have injured it much more, or perhaps unturned it, had I pulled it back the same way it entered in; but, being aware of that, I unfixed the pin from the stick, took hold of it with my nippers (the polype being spitted as it were upon it), and pulled it away by the head, leaving the polype fairly inside out.

The following species have been described as belonging to the British fauna:—

Hydra viridis; of a beautiful grass-green colour, tentacles 6 to

10, shorter than the body, which is cylindrical in shape, narrowing downwards. The tentacles are frequently beset with a small infusorial animalcula (*Trichodina pediculus*), which runs up and down them with extreme vivacity. This species is pretty common, though, on account of its small size, it requires close inspection to discover it.

H. vulgaris; about the same size as *H. viridis,* of a light-brown colour usually, but sometimes red. The colour depends probably on the nature of the animal's food. Tentacles 6 to 12, about the length of the body; in still ponds or slowly running water, common.

H. fusca. This is the most beautiful of all the species; though *said* to be rare in England, I find it tolerably abundant in weedy ponds and ditches. It is this species in which an intestinal canal has been affirmed to exist; tentacles 6 to 9, capable of extraordinary extension, fifteen or twenty times the length of its body; colour, pale brown; when it has been long without food, it is almost white. I have often noticed the body of this species covered with numerous white spots, which appears to be indicative of disease.

H. attenuata. I know nothing of this species: it is described as being of a light oil-green colour, with paler tentacula, longer than itself; body larger than *H. vulgaris* and of a more graceful form. The tentacles hang like silken threads in the water, waving to and fro without assuming the regular circular position which they do in *H. viridis.*

The books of Trembley and Baker abound with various experiments practised on the bodies of hydræ; and the Memoir of the first-named observer contains many admirably executed figures. The results of these experiments may be summed up in the language of Dr. G. Johnston:—"If the body is halved in any direction, each half in a short time grows up a perfect hydra; if it is cut into four or eight, or even minced into forty pieces, each continues alive and develops a new animal, which is itself capable of being multiplied in the same extraordinary manner. If the section is made lengthways, so as to divide the body into two or more slips, connected merely by the tail, they are speedily resoldered, like some heroes of fairy tale, into one perfect whole; or if the pieces are kept asunder, each will become a polype, and thus we may have two or several polypes with only one tail between them; but if the sections be made in the contrary direction—from the tail towards the tentacula—you produce a monster with two or more bodies and one head. If the tentacula—the organs by which they take their prey, and on which their existence might seem to depend—are cut away, they are reproduced, and the lopped off parts remain not long without a new body. If only two or three tentacula are embraced in the section, the result is the same; and a single tentaculum will serve for the evolution of a complete creature. When a piece is cut out of the body, the wound speedily heals, and, as if excited by the stimulus of the knife, young polypes sprout from the wound more abundantly, and in preference to unscarred parts; when a polype is introduced by the tail into another's body, the two unite and form one individual; and when a head is lopped off, it may safely be ingrafted on the body of any other which may chance to want one. You may slit the animal up, and lay it out flat like a membrane, with impunity; nay, it may be turned inside out, so that the stomachal surface shall become the epidermous, and yet continue to live and enjoy itself. And the animal suffers very little by these apparently cruel operations—

> Scarce seems to feel, or know
> His wound—

for before the lapse of many minutes, the upper half of a cross section will expand its tentacula and catch prey as usual; and the two portions of a longitudinal division will, after an hour or two, take food and retain it. A polype cut transversely in three parts, requires four or five days in summer, and longer in cold weather, for the middle piece to produce a head and tail, and the tail part to get a body and head, which they both do in pretty much the same time." Although no one who has examined Trembley's celebrated Memoir can doubt the general truthfulness of his observations, it is very desirable that further experiments should be made, with a view to verify his statements. There is need of much patient investigation before every thing Trembley has written on the nature of the hydra can be, or ought to be, finally accepted. It is too much the habit of zoologists to take for granted the conclusions of previous observers. I fully believe, from experiments I have made upon the hydræ, that Trembley's account is wondrously accurate; but there are certain points in the physiology of these animals — as for instance, that one of their being able to assimilate their food when their bodies are turned inside out —that demand further investigation.

EXPLANATION OF PLATE.

Fig. 1. Portion of duckweed (*Lemna*) with Hydræ attached.
„ 2. Magnified specimen of *H. vulgaris*, showing spermigerous capsules at *a*, and ovigerous capsule at *b*.*
„ 3. Ova of Hydra with polypes coming out therefrom. Magnified.
„ 4. Spermigerous capsule burst under pressure, exhibiting spermatozoa. Magnified.
„ 5. Magnified representation of a ruptured ovum.
„ 6. Sarcodic globule from a hydra's tentacle, in which is imbedded one of the so-called stinging organs, the spines and filament inclosed.
„ 7. The *Cnida*, or thread-cell, with spines and filaments protruded. All highly magnified.
„ 8. A specimen of *Hydra fusca* attached to a piece of stick. Natural size.
„ 9. Represents some of the results which Trembley obtained by inserting one polype within another. The tail end of the interior animal is seen to be pushing itself out of the exterior polype at *b* ; *c* and *d*, the same animals, with young, subsequently formed, attached. *e* is a polype which, after having been turned inside out and cut with a pair of scissors, at the end of two months was of the shape represented in the figure.
„ 10. A parasite, common on *Hydra viridis*, called *Trichodina pediculus*. Magnified about 300 diam.

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* By an error the tentacles have been represented as possessing cilia.

HOW TO WORK WITH THE TELESCOPE.

PART I.

PRINCIPLES OF CONSTRUCTION — HOW TO TEST THE TELESCOPE.

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

AUTHOR OF "SATURN AND ITS SYSTEM."

Could I purchase it with travail, or procure it for gold, I would not be without a telescope.—*Crabtree.*

THE student of astronomy is often deterred from telescopic observation by the consideration that in a field in which so many have laboured, with abilities and means perhaps far surpassing those he may possess, he is little likely to reap results of any utility. He argues that, since the planets, stars, and nebulæ have been scanned by Herschel and Rosse with their gigantic mirrors, and at Pulkova and Greenwich with refractors whose construction has taxed to the utmost the ingenuity of the optician and mechanic, it must be utterly useless for an unpractised observer to direct a telescope of moderate power to the examination of those objects.

Now passing over the consideration that a small telescope may afford its possessor much pleasure of an intellectual and elevated character, even if he is never able by its means to effect original discoveries, two arguments may be urged in favour of independent telescopic observation. In the first place, the student who would rightly appreciate the facts and theories of astronomy, should familiarize himself with the nature of the instrument to which astronomers have been most largely indebted. In the second place, some of the most important discoveries in astronomy have been effected by means of telescopes of moderate power, used skilfully and systematically. One instance may suffice to show what can be done in this way. Goldschmidt (who commenced astronomical observation at the age of 48, in 1850) has added fourteen asteroids to the solar system, not to speak of important discoveries of nebulæ and variable stars, by means of a telescope only five feet in focal length, mounted on a moveable tripod stand.

Yet, undoubtedly, the feeling experienced by those who look through a telescope for the first time is commonly one of disappointment. They have been told that such and such powers will separate certain double stars, exhibit Saturn's rings, Jupiter's belts, and the continent-outlines on Mars; yet, though perhaps higher powers are applied, the inexperienced observer fails to detect these appearances, and can hardly believe that they are perfectly distinct to the practised eye. And the expectations of the beginner are especially liable to disappointment in one particular, which the following example will serve to illustrate:—Let us suppose that the observer's telescope has a power of 40, and that he proposes to apply this power to the examination of Jupiter during the last fortnight of July in the current year. He learns from the "Nautical Almanac" that the diameter of Jupiter will be 44″·8; so that, with a magnifying power of 40, his diameter will be 29′ 52″, or somewhat exceed the minimum diameter of the moon. But when the observer comes to apply such a power, he will obtain a view—interesting, indeed, and instructive—but very different from what the above calculation would lead him to expect. There will be seen a disc, apparently much smaller than the lunar disc, and not nearly so well defined in outline; in a line with the disc's centre there will be seen three or four minute dots of light, the satellites of the planet; and perhaps the observer will be able to detect faint traces of belts across the planet's disc. Yet neither the telescope nor the calculations would be in fault, as the observer might imagine, and he would find no difficulty in proving this; for during the night of July 26, Jupiter and the full moon will be close together, and if they be viewed at the same instant, the former through the telescope with a power of 40, and the latter with the naked eye, it will be found that the centres of the two discs may be made apparently to coincide, and that the moon's disc will not appreciably exceed Jupiter's. Nor should the indistinctness and incompleteness of the view be attributed to imperfection of the telescope; they are partly due to the nature of the observation and the low power employed, and partly to the inexperience of the beginner. It is to such a beginner that the following pages are specially addressed, with the hope of affording him aid and encouragement in the use of the most enchanting of scientific instruments,—an instrument that has created for astronomers a new sense, so to speak, by which, in the words of the ancient poet:

Subjecere oculis distantia sidera nostris,
Ætheraque ingenio supposuere s uo.

In the first place, it is necessary that the beginner should rightly know what is the nature of the instrument he is to use, and this the rather, because, while it is perfectly easy to obtain such knowledge without any profound acquaintance with the science of optics, yet in many popular works on this subject the really important points are omitted, and even in scientific works such points are too often left to be gathered from a formula. When the observer has learnt what it is that his instrument is actually to do for him, he will know how to estimate its performance, and how to vary the application of its powers—whether illuminating or magnifying—according to the nature of the object to be observed.

The astronomical refracting telescope, then, in its simplest form, consists of a large convex lens of long focus called the object-glass, and a small convex lens of short focus called the eye-glass. These two glasses are placed as at A B and a b in fig. 1, the distance between them being the sum of their focal

Fig. 1.

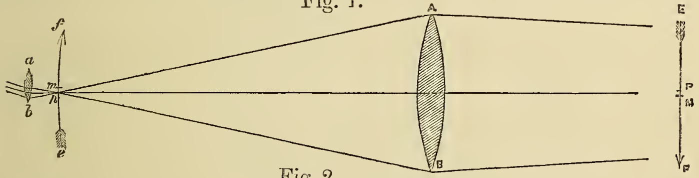


Fig. 2.

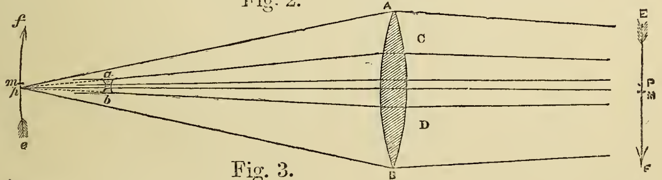
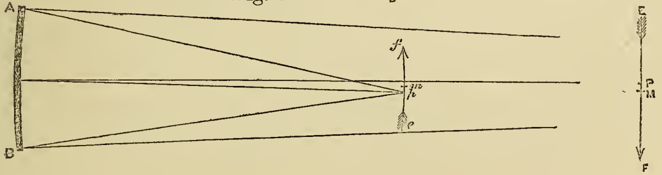


Fig. 3.



lengths. Now, let the arrow E M F be supposed to represent a distant object; * then an inverted image f m e of this object is formed at m, the focus of the object-glass, and by means of the eye-glass a b this image can be microscopically examined.

* The object is supposed to be very much larger than E M F, and so far off that the bounding rays from A and B (shown in the figure) meet at the point corresponding to the point P of the object.

Suppose, for instance, that those rays of light proceeding from the point P (slightly removed from the line of the telescope's axis), which fall upon the object-glass, converge so as to form the point *p* of the image, then after such convergence they are received as a diverging pencil upon a part of the eye-glass, and (supposing this glass properly adjusted for distinct vision) they emerge as parallel rays. It will be seen that the central ray of the pencil falls on the centre of the object-glass, but not upon the centre of the eye-glass; this is technically expressed by saying that the pencil is refracted *centrically* through the object-glass and *excentrically* through the eye-glass. It follows that *the whole of the pencil* goes to the formation of the image of the point P, so long as the whole of the pencil falls on the eye-glass; that if any part of the object-glass is covered in any way the point *p* of the image will still be visible, its illumination being, however, diminished; but that if that part of the eye-glass on which the pencil falls is covered, the point *p* will not be visible. In other words, *the astronomical refractor is an illuminating telescope, its illuminating power depends wholly on the size of the object-glass,* and the extent of the field of view depends wholly on the size of the eye-glass.*

The effect of these points will be more readily appreciated if we compare the astronomical with the Galilean refractor, exhibited at fig. 2. Surprise is sometimes expressed that this instrument, which in the hands of Galileo effected such important astronomical discoveries, should now be known as the *non-astronomical* telescope; but this will be readily understood when we compare the two arrangements. The oblique pencil from P fig. 2, which, after refraction through the lens A B, would proceed to convergence at *p*, as in the former case, is in the Galilean telescope intercepted by the concave lens *a b* (so placed that its distance from A B equals the difference of the focal lengths of the two lenses), and being formed of parallel rays after emergence affords distinct vision of the point P. Now only that part of the pencil which falls between the points C D of the object-glass is thus intercepted by the eye-glass, so that if this part of the object-glass were covered, the point P would be invisible, but a part of the eye-glass might be covered without rendering P invisible. Thus

* This seems to be contradicted by the circumstance that the higher the magnifying power of the eye-glass, the smaller is the apparent illumination of the image; it is strictly true, nevertheless,—since, whatever the power of the eye-glass, the *absolute quantity* of light received from *each point* of a luminous image remains constant.

the Galilean telescope is not an illuminating telescope, and the extent of its field of view depends on the aperture of the object-glass, not of the eye-glass.* We shall presently see that these points are highly important.

In considering the application of the telescope to practical observation, the circumstance that in the Galilean telescope no real image is formed, is yet more important, since a real image admits of measurement, linear or angular, while to a *virtual* image (such an image, for instance, as is formed by a common looking-glass), no such process can be applied. In simple observation the difference referred to is not of much importance perhaps, the only noticeable effect being that, whereas, in the astronomical telescope, a *stop* or diaphragm can be inserted in the tube so as to cut off what is called the *ragged edge* of the field of view, there is no means of remedying the corresponding defect in the case of the Galilean telescope. It would be a very annoying defect in a telescope intended for astronomical observation, since in general the edge of the field of view is not perceptible at night. The unpleasant nature of the defect may be seen by looking through an opera-glass, and noticing the gradual fading away of light round the circumference of the field of view.

The properties of reflection as well as of refraction have been enlisted into the service of the astronomical observer. The formation of an image by means of a concave mirror is exhibited at fig. 3. As the observer's head would be placed between the object and the mirror, if the image, formed as in fig. 3, were to be microscopically examined, various devices are employed in the construction of reflecting telescopes to avoid the loss of light which would result, a loss which would be important even with the largest mirrors yet constructed. Thus in Gregory's telescope a small mirror, having its concavity towards the great one, is placed in the axis of the tube, and forms an image which is viewed through an aperture in the middle of the great mirror; a like plan is adopted in Cassegrain's telescope, a small convex mirror replacing the small concave one. In Newton's telescope an inclined-plane reflector is used, which sends the pencil of light off at right angles to the axis of the tube; and in Herschel's telescope† the great mirror is inclined so that the image is formed at a

* CD is larger than the aperture of the eye, but in a ratio which is almost exactly equivalent to the magnifying power of the telescope, so that the apparent brightness of an object remains unchanged when it is viewed through a Galilean telescope.

† Sometimes called LeMaire's telescope. In reality very little credit can be claimed for the invention of new forms of the reflecting telescope. "I doubt

slight distance from the axis of the telescope. Hence in the two first cases the object is viewed in the usual way, the image being erect in Gregory's, and inverted in Cassegrain's. In the third the observer looks through the side of the telescope, seeing an inverted image of the object; and in the last the observer sees the object inverted, but not altered as respects right and left, by the *front view*, so called, I suppose (*quasi lucus a non lucendo*), because the observer's back is turned towards the object.

It appears, then, that in all astronomical telescopes, reflecting or refracting, a *real image* of an object is submitted to microscopical examination. Of this fact the possessor of a telescope may easily assure himself; for if the eye-glass be removed and a screen placed at the focus of the object-glass, there will appear upon the screen a small picture of any object towards which the tube is turned. But the image may be viewed in another way, which requires to be noticed. If the eye, placed at a distance of five or six inches from the image, be directed down the tube, the image will be seen as before: in fact, just as a single convex lens of short focus is the simplest microscope, so a single convex lens of long focus is the simplest telescope.* But a singular circumstance will immediately attract the observer's notice. A real picture, or an image formed on a screen, as in the former case, can be viewed at varying distances, but when the image is viewed directly it will be found that for distinct vision the eye must be placed exactly, or almost exactly, at a fixed distance from the image. This is more important than might be thought at first sight. In fact, it is essential that the observer who would rightly apply the powers of his telescope, or fairly test its performance, should understand how an image formed by an astronomical object-glass, or mirror, differs (as respects visibility) from a real object. The peculiarities to be noted are the *curvature*, *indistinctness*, and *false colouring* of the image.

not," says Sir Isaac Newton, "that Mr. Gregory could have described more fashions than one of these telescopes, and perhaps have run through all the possible cases of them, if he had thought it worth his pains."

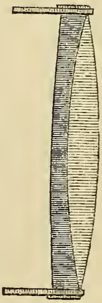
* Such a telescope is most powerful with the shortest sight. It may be noticed that the use of a telescope often reveals a difference in the sight of the two eyes. In my own case, for instance, I have found that the left eye is short-sighted, the sight of the right eye being of about the average range. Accordingly with my left eye a $5\frac{1}{2}$-foot object-glass (alone) forms an effective telescope, with which I can see Saturn's rings and Jupiter's moons quite distinctly. I find that the moon is too bright to be observed in this way without pain, except at low altitudes.

The curvature of the image is the least important of the three defects named—a fortunate circumstance, since this defect admits neither of remedy nor modification. The image of a distant object instead of lying in a plane, that is, forming what is technically called a *flat field,* forms part of a spherical surface whose centre is at the centre of the object-glass. Hence the centre of the field of view is somewhat nearer to the eye than are the outer parts of the field. The amount of curvature clearly depends on the extent of the field of view, and therefore is not great in powerful telescopes. Thus if we suppose that the angular extent of the field is about 30′ (a low-power, and therefore large field), the centre is nearer than the boundary of the field to the eye by about $\frac{1}{920}$th part only of the field's diameter.

The indistinctness of the field is partly due to the obliquity of pencils forming the image, and partly to spherical aberration. The first cause cannot be modified by the optician's skill, and is not important when the field of view is small. Spherical aberration, owing to which those parts of a direct pencil which fall near the boundary of a convex lens, converge to a nearer focus than those which fall near the centre, may be corrected by a proper selection of the forms of the two lenses which replace in all modern telescopes the single lens hitherto considered.

The false colouring of the image is due to *chromatic aberration.* The pencil of light proceeding from a point, converges, not to one point, but to a line of varying colour. Thus a series of coloured images, at different distances from the object-glass, is formed ; so that if a screen were placed to receive the mean image *in focus,* a coloured fringe, due to the other images (*out of focus, and therefore too large*), would surround the mean image.

Fig. 4.



Newton supposed that it was impossible to get rid of this defect, but the discovery that the *dispersive* power of a medium is not proportional to its *refractive* power, supplied opticians with the means of correcting the confusion of coloured images. This is effected by combining, as shown in fig. 4, a convex lens of *crown* glass with a concave lens of *flint* glass, the convex lens being nearest to the object. A little colour still remains, but not enough seriously to affect the distinctness of images.

But even if the image formed by the object-glass were perfect, yet this image, viewed through a single convex lens of short focus (placed as in fig. 1), would appear curved, indistinct, coloured, and also *distorted,* because viewed by excentrical pencils. These defects can be diminished (but not entirely removed *together*), by using an *eye-piece* consisting of two convex lenses, instead of a single eye-glass. The two forms of eye-piece most commonly used are exhibited in figs. 5 and 6. Fig. 5 is the *negative* (or Huyghens') eye-piece, so called because a real image is formed *behind* the *field-glass* (the lens which lies nearest to the object-glass). Fig. 6 represents the *positive* (or Ramsden's) eye-piece, so called because the real image formed by the object-glass lies *in front* of the field-glass. The course of a slightly oblique pencil through either piece is exhibited in the figures.

Fig. 5.

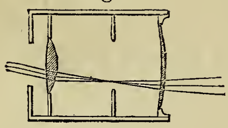
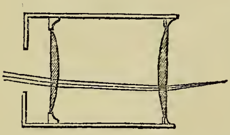


Fig. 6.



The lenses are generally plano-convex, the convexities being turned towards the object-glass in the negative eye-piece, and towards each other in the positive eye-piece; but Coddington has proved that the best forms for the lenses of the negative eye-piece are those shown in fig. 5. The negative eye-piece being achromatic, is commonly used in all observations requiring distinct vision only, but as it is clearly unfit for observations requiring micrometrical measurement, or reference to fixed lines at the focus of the object-glass, the positive eye-piece is used for these purposes.

We may now proceed to apply the facts just detailed to the determination of just methods of examining, testing, and using an astronomical telescope. The excellence of the object-glass can only be satisfactorily determined by testing the performance of the telescope in the manner presently to be noted. But it is well for the intending purchaser to examine the quality of the glass as respects transparency and uniformity of texture. Bubbles, scratches, and other such defects, are not of importance, since they do not affect the distinctness of the field, *as they would in a Galilean telescope*,—a little light is lost, and that is all. The same remark applies to dust upon the glass. The glass should be kept as free as possible from dirt, dust, or damp, but it is not advisable to remove every speck that, despite such precaution, may accidentally fall upon the object-glass. When it becomes necessary to clean the glass, it is to be noted that the substance used should be soft, perfectly dry, and free from dust, and that when a small space near the edge of the glass has been cleaned, the dust is to be *swept off* from that space as centre, *not gathered up* by pressure, as is commonly done. The two glasses should on no account be separated.

In examining an eye-piece, the quality of the glass should be noted, and care taken that both glasses (but especially the field-glass) are free from the least speck, scratch, or blemish of any kind, for these defects will be exhibited in a magnified state in the field of view. Hence the eye-pieces require to be as carefully preserved from damp and dust as the object-glass, and to be more frequently cleaned.

The tube of the telescope should be light, but strong, and free from vibration. Its quality in the last respect can be tested by lightly striking it when mounted; the sound given out should be dead or non-resonant. The inside of the tube must absorb extraneous light, and should therefore be coloured a dull black; and stops of varying radius should be placed along its length with the same object; sliding tubes, rackwork, &c., should work closely, yet easily. As respects the mounting, I shall have something to say in another paper.

But the mere examination of the glasses, tube, mounting, &c., is only the first step in the series of tests which should be applied to the instrument, since the excellence of a telescope depends, not on its size, the beauty of its mounting, or any extraneous circumstances, but on its performance.

The observer should first determine whether the chromatic aberration is corrected. To ascertain this the telescope should be directed to the moon, or (better) to Jupiter, and accurately focussed for distinct vision. If, then, on moving the eye-piece towards the object-glass, a ring of purple appears round the margin of the object, and on moving the eye-glass in the contrary direction a ring of green, the chromatic aberration is corrected, since these are the colours of the *secondary* spectrum. Sir David Brewster remarks, that if the achromatism is imperfect, "the defect may be easily removed by altering slightly the curvature of one or other of the lenses." This is not an experiment I should advise any one to attempt, however, lest the remedy prove worse than the disease.

To determine whether the spherical aberration is corrected, the telescope should be directed towards a star of the third or fourth magnitude, and focussed for distinct vision. A cap with an aperture of about one-half its diameter should then be placed over the object-glass. If no new adjustment is required for distinct vision, the spherical aberration is corrected, since the mean focal length and the focal length of the marginal rays are equal. If when the cap is on, the eye-piece has to be pulled out for distinct vision, the spherical aberration has not been fully corrected; if the eye-piece has to be pushed in, the aberration has been over-corrected.

The middle rays may, in like manner, be cut off by means of a circular piece of card covering the middle of the object-glass, and the focal length for distinct vision compared with the focal length when the cap is applied. The extent of the spherical aberration can thus be determined; but if the first experiment gives a satisfactory result, no other is required.

A star of the first magnitude should next be brought into the field of view. If an irradiation from one side is perceived, part of the object-glass has a different refractive power than the rest; and the part which is defective can be determined by applying in different positions a cap which hides half the object-glass. If the irradiation is double, it will probably be found that the object-glass has been too tightly screwed, and the defect will disappear when the glass is freed from such undue pressure. If the object-glass is not quite at right angles to the axis of the tube, or if the eye-tube is at all inclined, a like irradiation will appear when a bright star is in the field. The former defect is not easily detected or remedied; the latter may be detected by cutting out three circular cards of suitable size, with a small aperture at the centre of each, and inserting one at each end of the eye-tube and one over the object-glass; if the tube is rightly placed, the apertures will of course be in a right line, and it will be possible to see through all three at once; if not, it will be easy to determine towards what part of the object-glass the eye-tube is directed, and to correct the position of the tube accordingly.

The best tests for determining the defining power of a telescope are close double or multiple stars, the components of which are not very unequal. The illuminating power should be tested by directing the telescope towards double or multiple stars having one or more minute components. Many of the nebulæ serve as tests both for illuminating and defining power. Proper objects of this kind for testing telescopes of different sizes will be mentioned in another paper.*

From what has been said of the construction of the astronomical telescope the following practical rules may be gathered. In observing the moon, Venus, Jupiter, or Mars, with low powers, the marginal parts of the object-glass should be covered, or if in testing the object-glass any part has been found to be less perfect than the rest, that part should be covered. Enough light

* In favourable weather the following is a good general test of the performance of a telescope :—A star of the 3rd or 4th magnitude at a considerable elevation above the horizon should exhibit a small well-defined disc, surrounded by two or three fine rings of light.

will still remain, and the distinctness of the view will be increased. In like manner, when bright and close double stars are to be observed, the aperture of the object-glass should be diminished. But when the less brilliant planets —Saturn, Uranus, and Neptune—are to be observed, or when Mercury and Venus are to be observed in full twilight or by daylight, or any of the planets with high powers, the full illuminating power of the telescope may be applied. In like manner, when unequal or faint double stars are observed, the aperture must not be diminished.

Here for the present I must conclude, hoping in a future paper to point out the objects of interest which the possessor of a telescope of moderate power may profitably examine, and to show how they may be observed to the best advantage. I shall also venture to point out some paths in which the patient and systematic observer, even with low or moderate instrumental power, may hope to effect useful, if not important, discoveries,—to do "yeoman's service" in the ranks of our scientific investigators.

ON THE EXHAUSTION OF OUR COAL.

BY LEONARD LEMORAN, M.E.,

COLLIERY VIEWER.

THE impulsive way in which sometimes one, and then another, kind of question is seized upon by the public, is a very unfavourable illustration of the amount of thinking power which moves the masses. It is not, perhaps, quite right to lay this charge of impulsive action upon the large section of society generally comprehended within the term, the masses, as though they alone were guilty of those feverish manifestations of unguided energy, seeing that the educated members of our Legislature are no less liable to the disease. Of late we have had a striking example of this in the way in which "The Coal Question" has suddenly claimed the attention of the People, the Senate, and the Government. From time to time thinking men have asked themselves the question, "How long will our coal last?" and they have occasionally put the question before the public. Usually the reply which they have received has been a pitying smile, that any one should trouble his head with so absurd a problem. At length the question is put in a new form. It is consequently considered from an unusual point of view, and a certain degree of alarm is manifested, on all sides, lest, on some cold winter's morning, at no very remote period, we should awake to the fact that the coal-cellar of Great Britain was empty.

Feeling that the subject is one of great national importance, we are not surprised that there is a stir at the present time about it. We are rather disposed to examine into the causes of that manifest indifference which has prevailed so long, notwithstanding that the question has been several times very forcibly put forward, by men whose standing amongst the thinkers of their day would, we should have thought, have commanded attention. It will be instructive to select a few examples in confirmation of this. In 1789, John Williams, in his "Natural History of the Mineral Kingdom," deals very fully


SKETCH MAP
of the
BRITISH COAL FIELDS.
Stirling
Edinburgh
Berwick
Ayr
Newcastle
Carlisle
Lancaster
York
Liverpool
Manchester
Sheffield
Nottingham
Oswestry
Shrewsbury
Ashby de la Zouch
Norwich
Birmingham
Cardiff
Swansea
Bristol
LONDON
Brighton
Plymouth

W. West Eng.

and fairly—according to the amount of his knowledge—with the question of the "*Limited quantity of coal in Britain.*"

"I have no doubt that the generality of the inhabitants of Great Britain believe that our coal-mines are inexhaustible; and the general conduct of the nation, so far as relates to this subject, seems to imply that this is held as an established fact. If it was not a generally received opinion, would the rage for exporting coals be allowed to go on without limitation or remorse?* But it is full time that the public were undeceived in a matter which so nearly concerns the welfare of this flourishing island" (p. 184). Again: "When our coal-mines are exhausted, the prosperity and glory of this flourishing and fortunate island are at an end. Our cities and great towns must then become ruinous heaps for want of fuel, and our mines and manufactories must fail from the same cause, and then, consequently, our commerce must vanish. In short, the commerce, wealth, importance, glory, and happiness of Great Britain will decay and gradually dwindle away to nothing, in proportion as our coal and other mines fail; and the future inhabitants of this island must live, like its first inhabitants, by fishing and hunting" (p. 195).

These words, written eighty years since, are curious and instructive, especially when placed in juxtaposition with remarks which are the birth of yesterday. In 1863 Sir William Armstrong addresses the British Association in these words:—"The greatness of England much depends upon the superiority of her coal, in cheapness and quality, over that of other nations; but we have already drawn from our choicest mines a far larger quantity of coal than has been raised in all other parts of the world put together; and the time is not remote when we shall have to encounter the disadvantages of increased cost of working and diminished value of produce. * * * * The entire quantity of available coal existing in these islands has been calculated to amount to 80,000 millions of tons, which, at the present (1863†) rate of consumption, would be exhausted in 930 years; but with a continued yearly increase of $2\frac{3}{4}$ millions of tons would only last 212 years."

When Mr. John Williams wrote, the quantity of coal raised

* In the edition of the "Mineral Kingdom" for 1810, the editor, Dr. James Millar, of Edinburgh, says—"This ground of complaint of the waste of coal is now removed. The French, during the revolutionary war, were led to examine their own resources, which were soon found so abundant as to be equal to the increasing demand of many new, extensive, and flourishing manufactures."

† 88,292,515 tons.—*Mineral Statistics.*

annually in the United Kingdom must have been very small, as compared with our present "*output*." He has furnished us with the means of roughly estimating the relation which the production of the two periods bear to each other, especially so far as the Newcastle coal-field is concerned.

The consumption of coal in London	900,000	chaldrons.
Sent coastwise (for consumption in other towns)	700,000	„
Sent for Foreign consumption..................................	250,000	„
Consumed at Newcastle, Shields, and Sunderland	450,000	„
Total consumption of coal from the rivers Tyne and Wear	2,300,000	„

The number of tons in the above quantity, taking the chaldron at 27 cwt., is 3,100,000.

In 1864 the gross produce sold from, and used at, the collieries of Northumberland and Durham, was 23,284,367 tons, or nearly *eight times* the quantity given as the produce of those collieries when Williams wrote. But a more reliable return given by Dr. Millar in the edition of this work published in 1810, shows that Williams's estimate was in excess of the truth. From this table we learn, that in each of the four years from 1802 to 1805, both inclusive, not more than 800,000 tons were sent "coastwise, over sea," and to "plantations" (our colonies). Whereas in 1864, the Great Northern coal-field sent

Coals to Foreign countries	4,104,484	tons.
Coke (*estimated as coal*) to Foreign countries	448,362	„
Coals sent coastwise	6,188,026	„
Coke (*estimated as coal*) sent coastwise	46,032	„
	10,782,904	„
To make our comparison correctly, we must deduct the quantity brought within the London district —as the quantities sent to London are not included in the 800,000 tons	2,927,176	„
	7,855,728	„

Thus we learn that the increase has been more than *ninefold* in the exportation of coal from the Northern coal ports in sixty years, and this has been considerably exceeded in several other of our large coal-fields.

When Williams expressed his fears that the coal-fields of Great Britain were being rapidly exhausted, they were not producing more than nine millions and a half tons of coals per annum. In the year when Sir William Armstrong spoke, our collieries were yielding very nearly ninety million tons. Mr. W. Stanley Jevons says, as if he felt it necessary to offer some excuse for Williams' fears, "When no statistics had been collected, and a geological map was not thought of, accurate notions were not to be expected."*

We have both statistical returns and geological maps; are the notions now entertained in the least degree more accurate than they were then? We fear not. When we examine the statements which have been made within these last few years, we cannot come to any other conclusion than this. We find Sir William Armstrong limiting our supply of coal, at our present rate of consumption, to a duration of 212 years.† Mr. R. C. Taylor,‡ who has been ever regarded as a competent authority on all that relates to coal, extends it to 1,700 years. Mr. Edward Hull,§ who is, we should suppose, from his position, as well qualified as any man to make a just computation, says,—with an increase of one million and a half of tons per annum, our coals will only be sufficient for a little upwards of 300 years. Then we have Mr. H. Hussey Vivian, in his place in the House of Commons,|| declaring that South Wales could supply "her own consumption for 5,000 years," and "all England for 500 years." This certainly does not indicate any very *accurate notions* on the subject of the duration of our coal-fields, even amongst those men who, from their connection with them, either directly or indirectly, may have been expected to possess the requisite knowledge for making a fair approximate estimate thereof. To this wretched uncertainty we must attribute the indifference to the question shown by the public.

It is certainly a very severe reflection on this great commercial and manufacturing nation, that it should be, with the strangest want of thought, wastefully using, in enormous quantities, that natural production upon which its commerce and its manufactures depend, without having made any endeavour to ascertain, by a full and fair examination of the whole question, how long its coal-beds will bear the present drain upon them.

* "The Coal Question—an inquiry concerning the Progress of the Nation, and the Probable Exhaustion of our Coal Mines;" by W. Stanley Jevons, M.A.

† "Report of the Twenty-third Meeting of the British Association," President's Address, September, 1863.

‡ "Statistics of Coal," by Richard Cowling Taylor, F.G.S.

§ "The Coal-Fields of Great Britain—their History, Structure, Duration, &c.;" by Edward Hull, B.A., of the Geological Survey of Great Britain.

|| Speech on the Debate which arose in the House of Commons upon the Coal Clause, by H. Hussey Vivian, Esq., M.P. (Ridgway.)

Many guesses have been made; but although one may be a little more ingenious than the other, they must, every one of them, be received as *guesses* and nothing more. In considering this important problem, several questions must receive the best possible answers which can be obtained.

1. What is the area of the British coal-fields, within their known limits?

2. Can the quantities of coal which have been removed from the several fields be ascertained?

3. What is the total quantity of *workable* coal remaining in the collieries now at work?

4. What is the present rate of exhaustion?

5. What are the prospects, as it regards the annual increase of the "output" (the quantity raised from each colliery).

6. Do any of our large coal-fields probably extend far beyond their known limits, under the Permian and New Red Sandstone rocks?

7. What seams of coal exist at greater depths than those now worked?

8. What are the difficulties in the way of carrying our mining operations to a depth much greater than the deepest workings now in progress?

With the three last questions I do not propose dealing, beyond the remark, that we know our coal-fields do extend under the Permian and New Red Sandstone rocks, and that coal seams do exist at much greater depths than any now worked. The extension of workings either horizontally or vertically will only take place as an increase of price stimulates the collier to make new trials. The difficulties, likewise, in the way of deep mining are mere questions of cost. It is important to notice that the assumption of 4,000 feet as the greatest depth to which coal can be worked, on account of the increase of temperature, is purely voluntary. The increase has been calculated at a rate for which there is no authority; and while we are saying our coal-beds cannot be worked below 4,000 feet, a colliery in Belgium has nearly approached that depth, and no inconvenience is experienced by the miners.

It is not my intention, indeed, to attempt to find answers to any of the above questions. My purpose is, seriously to show that answers cannot be given to most of them, without an examination of the most searching character, which examination is beset with difficulties of no common order. I desire, however, to convey to the readers of this article a very general idea of the conditions under which our beds of coal have probably been formed, and of the disturbances to which they have been subjected after they have been formed, since this geological problem bears on the questions of working the coal, and of extending those workings both horizontally and vertically.

1. Geological investigation has shown us that coal belongs to a special group of rocks, which has been named the Carboniferous group. This formation assumes, even in different parts of those islands, several peculiar variations, which clearly prove that they do not belong to the same age; that although the same general conditions of moisture and heat necessary for coal formation have prevailed, the mechanical phenomena of the transportation and deposition of carbonaceous and earthy matter have greatly varied. For example, in Western England and South Wales we find three well-defined divisions in the Carboniferous group:—

1. COAL MEASURES	Strata of shale, sandstone, and grit, from 600 to 12,000 feet thick, with occasional seams of coal.
2. MILLSTONE GRIT	A quartzose sandstone, often a conglomerate, with beds of shale, altogether more than 600 feet thick.
3. MOUNTAIN LIMESTONE	A calcareous rock, of marine origin, sometimes 900 feet thick, devoid of coal.

In the North of England, beds of limestone are found in the Millstone Grit, and even a few seams of coal, and in some parts of the Scotch coal-field we find an intercalation of the marine limestones, with sandstones and shale, containing coal.

That coal has been formed from vegetable matter, no longer admits of any doubt. The processes by which the ancient forests, the peat-like formations of semi-tropical swamps, or the plants of marine growth have been converted into coal, cannot be said to be clearly determined. This much, however, must be admitted. That there must have been extensive tracts of undrained land upon which the vegetation found in the coal measures must have grown. That inland seas, or lakes, or waters, under some conditions compelling repose, must have existed, or the shales, the clays, and the coal, could not have been deposited. The Mountain Limestone indicates marine conditions, analogous to those which now prevail amongst the Coral Islands of the Pacific Ocean. Desiring to avoid every controversial point, I am with intention especially general; the only conditions which concern the question under consideration, being, that the coal epoch proper was from the termination of that period which we distinguish as the Old Red-Sandstone age, and the commencement of that which belongs to the New Red-Sandstone time. In other words, no coal must be expected below or in the Old Red-Sandstone rocks, nor must we imagine that *true* old coal can be found in or above those rocks which we now distinguish as Permian and New Red Sandstone proper. (With the coal of the Oolitic period, such as occurs at Brora, in Sutherlandshire, and in some parts of the Continent, or the yet newer coal and lignites of the Tertiary formations, we have not to deal. These are exceptional conditions, and, as compared with the *old* coal, of very small commercial value.)

Section across the Forest of Dean Coal-field, from W. to E.:—1, Coal Measures; 2, Millstone Grit; 3, Carboniferous Limestone; 4, Old Red Sandstone.

The coal-fields of Great Britain may be grouped, as shown upon the accompanying map, into—

1. The South Wales, Gloucestershire, and Somersetshire fields.
2. The South and North Staffordshire and Shropshire fields.
3. The Midland, including the Nottinghamshire, Leicestershire, Warwickshire, Derbyshire, and Yorkshire coal-fields.
4. The Lancashire, Cheshire, and North Wales coal-fields.
5. The Northumberland and Durham coal-field.
6. The coal-fields of Scotland.

These are unquestionably isolated deposits of fossil fuel. Within those divisions there may be, there probably are, connections. The Staffordshire and the Shropshire beds may be found to be in union, and those grouped as the Midland,—although there are now wide gaps of country unexplored,—are possibly one field. From the Lancashire coal-field, it is not improbable, but an extension of beds may be discovered, passing under Liverpool and the Mersey, uniting the Lancashire with Cheshire and Flintshire fields. Some have supposed that the coal-beds were at one time extended over the whole area of the British isles, and that they have been removed, from the now vacant portions, by denudation. Such a condition is physically impossible, seeing that immense tracts of land must have been required to produce the vast vegetable growth, and quiet waters, to accelerate the necessary chemical changes in that vegetable matter, upon which the production of coal depends. Such a condition is geologically improbable, the Carboniferous Limestone requiring insular masses, around which the marine animals, upon which its formation chiefly depended, did their vast work, slowly, in shallow waters, while the Millstone Grit, and all the shales and sandstones, indicate large tracts of country from which the matter forming those rocks had been removed. This signifies, however, but little in the present inquiry. Some few persons, indeed, may be found who believe that coal may extend under the eastern and southern counties; but such a vague hypothesis cannot be entertained. We have only to deal with the coal-fields proper which are known, and their probable extension beyond the limits at present explored by the colliery operators.

The annexed section of the Forest of Dean coal-field shows a true coal basin. The South Wales coal-field is equally a basin; but this is not so evident in some others.

The difficulty, the uncertainty, which surrounds the "Coal Question" meets us at the first step. The area occupied by coal within the Carboniferous deposits has never yet been determined with that accuracy which is necessary for computing the quantity of coal now, or at any time, existing. If we examine all that has been written on the subject, we shall find a strange want of agreement between the writers on this, the simplest element in the problem they pretend to solve. The beautiful maps of the Geological Survey give the Coal Measures with great accuracy, and in remarkable detail trace out the outcrops of the beds of coal; thus furnishing a considerable amount of exact knowledge upon which an inquiry might be based; but this has not hitherto been done. On those maps, also, we have numerous "faults" carefully laid down, showing the disturbances which have dislocated the coal-beds; removing some so far below the surface that they are never likely to be reached, and lifting others so that they have been brought within the range of water action, and thus worn down, and removed for ever.

2. In reply to the second question, it will be admitted on all hands, that we have no means of arriving at any correct knowledge of the quantities of coal which have been removed. Until a very recent period, scarcely any plans of the subterranean works were kept; and, indeed, until after the passing of the Inspection Act, there was nothing approaching to a regular system of recording the work done. Consequently, there are large tracts of country of which we know nothing, except that they have been worked by the old miners, in which coal may still exist, but which is lost to us for ever. This, however, is not so all-important.

3. What is the total quantity of workable coal remaining in the collieries now at work? is the great question of which we have to seek a solution.

This may be determined within very small limits of error; but it will require a large expenditure of time, and consequently of money. There are in the British isles 3,268 collieries. Nearly all of those must be visited, and at each the quantity of coal remaining must be determined. A very large number of the coal proprietors would offer no objection to this; they would, indeed, render every possible assistance. But there are many who would very strongly object to this inquisition. Few men, indeed, would like it to be published that they had but two or three years' supply of coal left in their mines. This, however, is a difficulty which may be overcome by judicious management. Although there would be very sufficient reasons for refusing to furnish the information from individual collieries, there could be none if the collieries were taken in groups. In most cases, the coal trade associations would undertake to furnish the required data, respecting all the collieries within their jurisdiction.

Having stated the difficulties, and expressed my opinion that there are none which could not be overcome, it only remains for me to show, that no reliance can be placed, upon any statement which has hitherto been published. Instead of making the inquiry in the way indicated, which is the only method by which we can arrive at anything approaching to correctness, we find the estimates made after this manner.

Estimate of the Mineral Resources of the South Wales Coal Basin.

1. Superficial area....................................	906 square miles.
2. Greatest thickness of Coal Measures with coal	10,000 feet.
3. Number of coal-seams from 2 feet and upwards, 25 giving a thickness of	84 feet of workable coal.
4. Total quantity of coal (corrected for denudation)	48,000 millions of tons.
5. Deduct one-half for quantity below 4,000 feet, leaving	24,000 millions of tons.
6. Deduct one-third for waste, and quantity already extracted, leaving for future supply	16,000 millions of tons.

7. Divide this by 8 millions of tons, the average annual produce, we find that the *supply will last at the present rate of consumption* 2,000 *years.*

Now, Mr. F. Foster, in his communication to the Natural History Society of Newcastle, gives an area to the South Wales coal-field of 935 square miles, but he estimates the total quantity of coal ever held within that basin as only 16,000 millions of tons; whereas, Mr. H. Hussey Vivian, in his place in the House of Commons, advanced it to 54,000 millions, and yet more recently Mr. Joshua Richardson, of Neath, and Mr. Martin, gave this coal-field an area of 1,055 square miles, with 64,000,000 tons of coals in each square mile, and they tell us that it will take 10,000 years to exhaust the coal in South Wales.

Surely this is a sad reflection upon our way of looking at a very vital question. It is quite unworthy of the science of the country, and still more is it unworthy of that exactness which distinguishes our commercial transactions.

4. The rate of exhaustion is satisfactorily determined, and we have every year returns given in the "Mineral Statistics," issued from the Mining Record Office, upon which we believe reliance may be placed. From these returns and some other sources I have compiled the following tables :—

COAL RAISED IN THE UNITED KINGDOM IN EACH YEAR SINCE 1854.

	England.	Wales.	Scotland.	Ireland.	TOTAL.
1854	47,421,651	9,643,000	7,448,000	148,750	64,661,401
1855	47,305,189	9,677,270	7,325,000	145,620	64,453,079
1856	49,043,215	9,965,600	7,500,000	136,635	66,645,450
1857	48,883,800	8,178,804	8,211,473	120,630	65,394,707
1858	47,443,861	8,517,789	8,926,249	120,750	65,008,649
1859	52,297,115	9,262,350	10,300,000	120,300	71,979,765
1860	61,071,460	8,005,313	10,900,500	119,425	80,042,698
1861	63,870,123	8,561,021	11,081,000	123,070	83,635,214
1862	62,025,383	8,409,455	11,076,000	127,500	81,638,338
1863	68,419,884	8,645,081	11,100,500	127,050	88,292,515
1864	71,327,813	8,935,060	12,400,000	125,000	92,787,873
1865	72,500,255	9,560,260	12,450,500	120,500	94,631,515

EXPORTS OF COAL FOR THE SAME PERIOD, QUANTITY RETAINED FOR HOME CONSUMPTION, AND RELATION OF THAT QUANTITY TO THE POPULATION.

	Exports.	Retained for Home Consumption.	Population of Great Britain.
1854	4,309,255	60,352,146	——
1855	4,976,902	59,477,177	21,792,872
1856	5,879,779	60,765,671	22,080,449
1857	6,737,718	58,656,989	22,369,463
1858	6,529,483	58,479,166	22,616,839
1859	7,006,949	64,971,816	22,810,069
1860	7,412,575	72,630,123	22,946,988
1861	7,934,832	75,700,382	23,181,790
1862	8,330,673	73,307,665	23,416,264
1863	8,275,212	80,017,303	23,655,482
1864	8,800,420	83,987,453	23,891,009
1865	9,170,477	85,461,038	24,127,003

It will be seen that our production of coal received a sudden acceleration in 1860, which was the year when the new French Tariff came into operation. That commercial arrangement, and the consequent development of our trade,—which was greatly assisted by the International Exhibition of 1862,—has led to a steady increase in the home consumption of coal. This it is shown is not dependent upon the increase of population: it is evidently due to the activity of all our manufacturing industries.

5. May we expect that this annual increase will continue in some such ratio as that observed during the last five years?

Let us consider for a moment what is the rate of increase at present. Mr. W. Stanley Jevons, in his excellent book on "The Coal Question," who has examined this point with great care, says, "We of course regard not the average annual arithmetical increase of coal consumption between 1854 and 1863, which is 2,403,424 tons, but the average ratio or rate per cent. of increase, which is found by logarithmic calculations to be 3·26 per cent. That is to say, the consumption of each year, one with another, exceeds that of the previous as 103·26 exceeds 100." Assuming this rate of increase, 3½ per cent. per annum, to continue, we should in the year 1900 draw from our rocks, more than 300 millions of tons, and in 1950 nearly 2,000 millions. About 300,000 miners are now employed in raising rather more than 92 millions of coals; therefore more than eight million miners would be necessary to raise the quantity estimated as the produce of 1950. One third of the present population of Great Britain would be coal-miners. "If our consumption of coal continue to multiply for 110 years at the same rate as hitherto, the total amount of coal consumed in the interval will be 100,000 millions of tons" (*Jevons*). Mr. Hull tells us that he estimates the available coal in Britain at 83,000 millions of tons, within a depth of 4,000 feet; therefore in one century from the present time we shall, according to this, exhaust all the coal in our present workings, and all the coal seams which may be found at a depth of 1,500 feet below the deepest working in the kingdom. The assumption upon which this estimate is based, is absurd from every point of view. Such a continued increase as that which has taken place during the last five years, cannot continue for the succeeding ten years.

The increase in our exportation of coal has been during that period but very trifling. The price of coal is advancing, and with higher prices we must expect our exports to fall off. Although there is an extension of our pig-iron manufacture, there does not appear to be a corresponding enlargement of the trade in merchant iron, or of such manufactures as are required by the engineer. Large pumping-engines for use in

Northumberland, are now being made in Belgium, and the same country is now supplying engineers in London with such ornamental castings as they require, because, I am informed, the designs and the castings are better, and, beyond all, they are cheaper than they can be obtained from the English founders. Locomotive engines for English railways are being made in France, and, the great iron ship-building yards of the Seine and Marseilles are seriously entering into competition with our own. During the last six years, immense quantities of railway iron have been made to supply the requirements of the world. This demand is gradually subsiding, the simple cause being that there is a lull in the railway atmosphere, the current of speculation is running less rapidly, and the extension of lines of iron road is more gradual than it was. Did space admit of it, it could be shown that on every side there are evidences of the most decided character which warrant the supposition, that the annual exhaustion of our coal-fields will not at any period much exceed the 100,000,000 tons, which it has nearly reached.

The price of coal has been, and is, steadily increasing, and it must continue to do so. Our mines are worked at a greater depth from the surface than formerly, and the workings are every day extending further from the shafts, through which the coal is raised to the surface. Many of our large collieries draw an acre of coal, several feet thick, through one shaft, to the surface, every week. The cost of obtaining the coal is therefore steadily increasing. With an increase of price, a more general economy in the use of coal will arise. A rise of two or three shillings a ton on coal in London will lessen the brilliancy of the parlour fire, and check the waste in the kitchen, of many a household. Many of our large manufactories use 500,000 tons of coal a year: increase the cost by a few shillings the ton, and the same quantity of heat will be obtained by more careful stoking, from a less quantity of coal. As an example of this, the pumping-engines of the coal districts are worked with coal costing five or six shillings the ton; the pumping-engines of Cornwall are worked with coal costing fifteen or sixteen shillings the ton. Yet the Cornish engines perform a higher duty than the colliery engines do, and at less cost, because coal is wasted in the one case and economized in the other. In the colliery districts, boilers are exposed to every wind that blows, and all the rain which falls; in Cornwall they are not only housed, but they are most carefully clothed, to prevent any loss of heat. *The increase of price which is going on, is the natural check upon any greatly increased consumption of coal.*

I think it cannot but be understood, that the writer of this article regards the present excitement on the "Coal Question" as giving an undue importance to it. At the same time he hopes that it may lead to such an examination as will, approximately, determine the questions already propounded. There is considerable uneasiness amongst the coal proprietors, lest this inquiry should be instituted by the Government, and vigorous efforts are being made to persuade the public that our coal is, virtually, inexhaustible. Trade interests of various kinds, many of them of the most short-sighted description, will interfere to check inquiry,—and to lead it astray, if persisted in. The existing uncertainty is regarded most favourably by the interested few, but the removal of that uncertainty, would greatly benefit the great mass of coal consumers, and certainly introduce a far more healthful condition amongst the coal owners, than that state of intermittent fever which, ever and anon, prevails.

Our coal-fields may be sufficient to supply all our wants for many centuries; but within one century it may be found that we are beaten in our manufactures by America, because with the Americans coal will be cheap, whereas with us it will be dear. For several years there has been a slow but steady advance in the price of coal in the very centres of production. To determine if this increase of price is legitimate, and if it must continue to increase,—to suggest, by the aid of the physical and mechanical sciences, means by which the required amount of heat may be obtained with the consumption of less coal, and to introduce engineering appliances by which the coal-seams, at great depths, may be worked without any greatly increased cost—are the true objects of any inquiry which may be instituted into the EXHAUSTION OF OUR COAL-FIELDS.

While these pages have been passing through the press, Mr. Hussey Vivian has moved, in the House of Commons, "That an humble address be presented to Her Majesty, praying that she would be graciously pleased to issue a Royal Commission to investigate the probable quantity of coal contained in the coal-fields of Great Britain; and to report on the quantity of such coal which may be reasonably expected to be available for use;—whether it was probable that coal exists at workable depths under the Permian, New Red Sandstone, and other superincumbent strata; and whether they would recommend that bore-holes should be sunk in any and what localities; to ascertain and report on the quantity of coal at present consumed in the various branches of manufacture, for steam navigation, and for domestic purposes, as well as the quantity exported; and how far, and to what extent, such consumption and export may be expected to increase. How far the increase of population may necessarily accord with the increased consumption of coal, and the relations which one is likely to bear to the other; and whether there was reason to believe that coal was wasted, either by bad working, or by carelessness or neglect of proper appliances for its economical consumption; and whether they would recommend legislation with a view to avoid such waste."

Sir George Grey, in reply, stated that "the conclusion to which the Government had come to was to accede to the motion of his honourable friend (Mr. Vivian), and to nominate upon the commission eminent members of the geological department, and in association with them, gentlemen practically acquainted with mining and manufacturing operations."

ON HYBRIDIZATION AMONG PLANTS.

BY REV. G. HENSLOW, M.A., F.L.S.

HYBRIDISM in plants has long engaged the attention of many accurate observers; and the importance of it, as assisting us to arrive at more definite knowledge of the phenomena of plant life, can scarcely be overrated. Investigations in hybridism are valuable to the systematic and physiological botanist, to the horticulturist, and those who are interested in attempting the so-called "acclimatization" of plants. To the systematic botanist the study is useful as showing him, when positive results are obtained, that either the parent forms of any hybrid must be grouped under the same (natural) genus, or that they may at least be suspected to have had a common origin. Thus the late Dean Herbert crossed Amaryllis and Crinum. Hence these, as well also as the three genera, Rhododendron, Rhodora, and Azalea, which have been found capable of blending, must (he says) form a single genus respectively. But with negative results the systematist gains but little; for he can by no means draw an opposite conclusion, and say that forms must be of separate genera because his attempts have failed to secure a hybrid. For many species, apparently distantly allied, fertilize one another with avidity; whereas others, assumed to be most intimately connected, absolutely refuse all attempts to make them blend. These *negative* results would seem therefore to impede rather than aid the systematic botanist. Yet the fact of their furnishing no fertile offspring does not *necessarily* warrant us in saying they never can or would propagate any hybrid forms. Indeed, the causes of sterility are so numerous, the process of fecundation so complicated, and the difficulties, constitutional, climatal, &c., are so great, in certain cases when cross-fertilization is attempted, that it is not to be wondered at if fertile offspring are not produced on every occasion. To show how complicated is the process, we may mention that repeated applications of pollen are believed (Gaertner) to be sometimes requisite to overcome the natural want of affinity between the pollen and stigma to which it may be applied, and that the pollen may have sufficient influence to cause the ovary to swell, but no ovules to be produced; in other cases the ovules are developed, but no embryo! So that it must be borne in mind, fertilization is not merely one distinct act, but that many conditions are combined, each of which must be satisfied in order to produce a perfectly developed and embryonated seed. To the physiologist hybridism is valuable as giving him an insight into the changes that take place in the anatomy of plant organs, *e.g.*, the differentiation and deterioration of pollen, distribution of colour, and other interesting points connected with the vitality of plants.

There would seem to be at least three features which cannot help striking the observer as apparently affording some clue to discover the relative degrees of fertility and sterility of hybrids.

The first is the diversity of form; secondly, constitutional differences; and thirdly, what might be called different idiosyncrasy between the two individuals we may wish to blend. The first is that character of plants with which the systematist is for the most part alone concerned; for by morphological differences does he build up his various groups, and the greater the difference in form, the more remote is the affinity assumed to be; and, as a general rule, the slighter is the tendency to blend. So that for the purpose of experimenting upon the fertility or sterility of hybrids, we are compelled, as a rule, to confine ourselves to the so-called species, *i.e.*, plants whose supposed affinity is very great.

Another barrier to success in intercrossing allied forms is perhaps found in their constitutional differences. By this we mean their habits, which are regulated by climatical circumstances: so that one plant affects a dry soil; another species allied to it, a humid, or even becomes aquatic. One is a herb and another a shrub. One can only live in a high temperature, and consequently is impatient of cold; another is hardy.

Here we would remark that this affords a valuable subject for experiments to those interested in the acclimatization of plants. For, though it would seem that no plants are ever strictly *acclimatized*, *i.e.*, made to endure a climate which they do not naturally experience, yet a tender tropical plant might, by being crossed with a hardy species (provided they *are* capable of uniting), produce a half-hardy hybrid, which would probably stand a colder climate, and yet retain many features of the tender parent: *e.g., Crinum capense* when crossed with tropical species produces half-hardy offspring.

The third cause of sterility is the different idiosyncrasy which often obtains in plants. By this we mean that mysterious "capriciousness" that affects certain species, which, though closely allied and exhibiting no visible appearances, either in construction of pollen or elsewhere, that would lead the observer to infer any hindrance to fertilization, yet absolutely refuse all attempts to blend. In others the pollen is effete when placed upon flowers of the same plant, but is perfectly capable of performing its duty when used for fecundating other species.

In the genus *Hippeastrum* (*Amaryllidaceæ*) "self-impregnation is all but impossible, but fertilization between any two different members is readily obtained. On the other hand, in species of the genus *Habranthus,* closely allied to *Hippeastrum,* every attempt to cross the several natural sorts has entirely failed. Again, in the genus *Zephyranthes,* closely akin to *Habranthus,* and making seed freely, crosses are obtained with much difficulty, and when obtained, are rather disposed to sterility" (Herbert).* Similarly Mr. J. Scott has shown that *Passiflora racemosa, cærulea,* and *alata,* "although grown for a number of years in the Royal Botanical Gardens of Edinburgh, and annually yielding a profusion of blossoms, have never produced a single seed."† Yet he proves by experiment that the pollen of each is perfectly capable of fertilizing the others. Other instances could be cited, but these facts seem to show something widely different from the two causes of sterility mentioned. It would appear that if we suppose such groups as Hippeastrum, Habranthus, Zephyranthes, to have descended from original stocks, the variation in form has not proceeded at the same rate as that "differentiation of idiosyncrasy" which is apparently more intimately connected with constitutional differences and the reproductive system, than it is with external shape; as is indicated by individuals of nearly the same form refusing to cross, while others, more distantly connected, breed freely. The well-known discoveries of Mr. Darwin with regard to *Primula* and *Linum* would seem to point in the same direction, though in these, as also in *Lythrum,* it is not distinct species, but in different forms of the same plant, for he has shown that pollen of the long-styled form of *Linum grandiflorum* is useless upon any stigma of that kind, though capable of producing the full complement of seed in the other form with shorter styles.

* *Journal of the Royal Horticultural Society,* Vol. II. p. 10. 1847.

† *Linn. Journ.,* Vol. VIII. p. 197.

We will now pass on to the more special object that we had in contributing this Article to the POPULAR SCIENCE REVIEW; namely, to give our readers a brief *résumé* of M. Naudin's observations on Hybridism, as specially set forth in his admirable paper,* in reply to the following questions, proposed by the Academy of Science :—

1. To study vegetable hybrids with special reference to their fecundity, the perpetuity, or sterility of their character.

2. In what cases are hybrids fertile of themselves ? Is their fruitfulness in accordance with their exterior likeness to the species from which they spring, or does it indicate a special affinity with reference to their origin, as has been remarked, for the facility of the production of these hybrids themselves ?

3. Do hybrids, sterile of themselves, always owe their sterility to the imperfection of the pollen ? Are the pistils and ovules always susceptible to being fertilized by a foreign pollen suitably chosen ? Is a state of imperfection ever appreciable in the pistils or ovules ?

4. Do hybrids, which reproduce themselves by their own fertilization, sometimes preserve invariably their characters during several generations, and can they become the type of constant races, or do they always revert, on the contrary, to the forms of one of their predecessors at the end of some generations, as recent observations seem to indicate ?

We will follow M. Naudin's arrangement, and adopt the same heads under which he arranges his reply.

1. *Sterility and Fecundity of Hybrids.*—It has been long ago established that certain hybrids are absolutely barren, others are partially sterile, and some quite fertile. In fact, Herbert says there is no decided line of absolute sterility ; and we have shown that the fertility of a hybrid depends upon varying causes, more, in fact, upon "constitution" and "idiosyncracy," than mere botanic affinity : thus, *Crinum capense* (*Amaryllis longifolia*), an aquatic and extra-tropical plant, was crossed by Herbert with *C. scabrum*, a drier and tropical species. The hybrid produced proved barren for sixteen years, but at last produced two good seeds ! Whereas *C. capense* and *C. pedunculatum* both swamp plants, though placed in different genera by some botanists, produced a fertile cross.

In order to account for the sterility of hybrids, M. Naudin remarks that we must, in all probability, go to the *ovules* to look for the cause, as the pistil often presents every sign of fertility, while the ovules, either all, or some only, remain abortive, as is the case with *Luffa acutangulo* + *cylindrica* and *Cucumis Meloni* + *trigonus*. Moreover, in these cases, he remarks, as additional proof, that far more pollen grains were deposited on the stigmas than ovules were produced.

* *Nouvelles Recherches sur l'Hybridité dans les Végétaux.* Ann. Sc. Nat. XIX. p. 180.

Max Wichura,* in his paper on hybrid Willows, admirably shows the various degrees of sterility obtaining in the fruit of such hybrids. Thus, epitomizing his remarks:—

1. Catkins wither quickly, like those unimpregnated.
2. Ovaries swell and ripen, but have no seed.
3. Ovaries are filled with silken hairs.
4. Seeds are present, small and incapable of germination.
5. Seeds apparently perfect, but do not germinate.
6. Seeds germinate by young plants are weak, and soon perish.

M. Naudin further observes, that sterility takes effect much more on the pollen than on the ovules. This, too, quite agrees with Wichura's observations, who describes very minutely the various degrees of degeneration in the pollen, and the appearance that the grains present in hybrid willows, stating that "a tolerably correct opinion may be drawn of the sterility of a willow by a mere examination of the pollen," and that certain laws seem to prevail in the gradual sterility of the pollen.

1. The anomaly of the pollen increases with the succession of generation arising from the fertilizing of hybrids with their own pollen.
2. Different individuals of the same generation resemble each other in the imperfection of their pollen.
3. Distantly related willows give a more irregular pollen.
4. Anomaly of pollen increases with the number of intermingled species.

Naudin furnishes us with the instance of *Nicotiana glauca* + *angustifolia*. In this hybrid the pollen is totally defective, while the ovary grows by the impregnation of pollen from *N. Tabacum* and *N. macrophyllum* and he adds the following important generalization:—

All the hybrids which I have examined having some grains of pollen good have been fertile, often to a high degree, by their ovaries. No example is known where a plant, being sterile by its ovary, is yet fertile by its anthers, even in the most feeble degree. That sterility should take effect first on the pollen is not surprising, as that is the most elaborated or 'animalized' of all the plant organs.

2. *The inequality that obtains in the results of attempting to cross plants.*—M. Naudin remarks that if some hybrids are sterile by their stamens and ovary, others, and perhaps a great number, are fertile. Of these last, some by their ovary alone, others by both pollen and ovary, but never so by pollen alone. Hybrids are fertile by themselves every time their anthers contain well-organized pollen.

3. *The aptitude of species to cross, and the fertility of hybrids*

* *The Journal of the Horticultural Society*, Vol. I. p. 57. 1866. (New Series.)

which are produced; are they proportionate to the apparent affinity of the two species?—"Generally, yes." But many examples can be given where closely-allied species refuse to cross, where more distant affinity proves no barrier. Dean Herbert has shown this in the cases cited above, of Hippeastrum, Zephyranthes, &c., and remarks that the production of any intermixture, whether fertile or not, gives reason to suspect that the parents were descended from one common stock, *i.e.*, referable to one (natural) genus. And he gives it as his opinion, that the facility of crossing plants depends, therefore, more upon their constitution, and we would add "idiosyncracy," than upon their so-called morphological affinity. M. Naudin concludes his remarks with the following words:—

> The aptitude of species to fecundate each other reciprocally, and the degree of fertility of the hybrids which spring from them, are truly the sign of special affinity considered with reference to their origin; and, in the majority of cases, this affinity is indicated by an exterior organization—in a word, by the physiognomy of the species.

4. *The Physiognomy of Hybrids.*—We must observe the first and second generations to gain a correct idea of the aspects presented by hybrids. There is generally admitted to be a great uniformity in the members of the first generation. They resemble each other as much as the offspring of legitimate species; and this holds good with "reciprocal"* hybrids. Though they are intermediate in character between the parent forms, yet the hybrids may approach more nearly the form of one parent than the other, or partake of both forms in different groups of their organs; thus, *Mirabilis longiflora* + *jalapa* is more like *M. longiflora* in its vegetative organs, but more resembles *M. jalapa* in its flowers.

M. Naudin denies Regel's assertion that hybrids sprung from species far apart, or, from genera, are more like the male parent; and he cites *Datura Stramonium* + *ceratocaula* as an example, which more nearly resembled the former, or female type. This predominance of one form in the hybrids he, as also Gaertner, believes due to the prepotent influence of one species over another; Wichura, however, never saw a prepotent type in willows, at least, as far as the first generation would exhibit it, for he observes that double or "reciprocal" crosses are exactly alike.

"Wichura confirms Gaertner in the assertion that where hybrid pollen is used for the impregnation of simple hybrids,

* By *reciprocal* hybrids are meant, those which are obtained by using the pollen of each of the two plants for the stigma of the other respectively.

there is a great predominance of individual varieties, while hybrid ovules impregnated by the pollen of pure species, give uniform products."* Indeed, Wichura's experiments on willows have far more generally exhibited *variety* of form in the produce, when the pollen of hybrids was used; and, on the contrary, uniformity where the pollen of pure species was employed.

Now, Naudin's observations † on "Hybridism considered as a cause of variability" agree with this, for he shows that in hybrids of the second generation, there is a frequent and powerful tendency to "sport irregularly;" so that from a single bed of a uniform type, intermediate between two parent forms, in the next year innumerable forms may appear; while specific characters have a tendency to be stable. Again: he lays it down as the first fact established that "setting out from the second generation, hybrid vegetables, when fertile, revert *very frequently* to one of the two species from which they were derived; some returning absolutely to one or the other form, sometimes suddenly, at other times slowly;" and he adds, that "whole collections of individuals may be seen inclining to one side."

They do not, however, invariably revert. He gives the astonishing instance where offspring of *Datura lævis* + *ferox* and of *Datura ferox* + *lævis* differed most remarkably from the parent forms, although these reciprocal hybrids were all alike. Of the second generation he obtained twenty-six plants from *D. lævis* + *ferox*, and nineteen from *D. ferox* + *lævis*. In these two sets a most astonishing diversity of feature succeeded the former great uniformity. One only of *D. lævis* + *ferox* reverted to *D. lævis*. A very small number resembled *D. ferox*. Although it must be noted that seed of *D. ferox* and *D. lævis*, *pure*, was sown in the same bed with the hybrids, the greater number of offspring resembled *D. Stramonium* and *D. quercifolia!*

He cites *Petunia nyctaginiflora* + *violacea*, *Linaria purpurea* + *vulgaris*, as affording instances of "irregular variation." But of the latter hybrid a good number of offspring reverted more or less to *L. vulgaris*, while a smaller number resembled *L. purpurea*. This irregular variation engenders only individual differences, and uniformity is not established between the descendants of hybrids except on the condition that they resume the normal livery of the parent species. Members of the third generation vary still more, but their variations are individual, and with no persistence. To be made permanent they must be grafted.

* *Journal of the Royal Horticultural Society* (N. S.), Vol. I. p. 73, 1866.
† *Ibid.* p. 1.

These unstable forms want the true character of species from the very fact that they cannot with any certainty reproduce themselves by seed. Those species which have a tendency to vary, do so in a very different manner to hybrids, for the variety has a tendency to perpetuate itself and increase, and not to be unstable, as in hybrids. Hence can arise garden "races," an inapplicable term to the unstable "forms" of hybrid descendants. "Races bring species which are adapting themselves to new media and new finalities."

We may here insert two reasons for the want of permanency in hybrids. One, as Wichura has shown in the case of willows, is the constantly increasing sterility in the *pollen*; and secondly, the *constitution* of the hybrid being often intermediate between those of the two parents, it cannot adapt itself to localities suited to either.

5. *Reversion to the parent forms.*—This subject, to which brief allusion has just been made, was that to which M. Naudin paid particular attention, viz., to ascertain whether reversion was a universal rule or only partially applicable, or not at all.

Our author's account of certain experiments conducted at the Museum with a view to ascertaining the truth of the above statement will be found in the *Ann. des Sc. Nat.*, 4th series, No. IX., p. 257 (1858), where he commences by observing that M. Godron has come to an opposite conclusion, for he says that "fertile hybrids do not ordinarily revert, unless fecundated afresh by one or other of the parent forms, and as a consequence it appears to him (M. Godron) very doubtful whether the law above assumed is really established."

M. Naudin makes his statement in the following words:—

> Hybrids, self-fertile or otherwise, return sooner or later to the specific types from which they were derived; and this return is effected either by the separation of the two mixed essences or by the gradual extinction of one of the two. In the latter case the hybrid posterity returns entirely and exclusively to one only of the two producing species.

The examples which he takes as instances of reversion are *Primula officinali-grandiflora*, hybrids of *Datura Stramonium*, reciprocal hybrids of *Nicotiana angustifolia*, *macrophylla*, *Petunia violacea* and *nyctaginiflora*, *Luffa acutangulo-cylindrica*, and *Linaria purpurea-vulgaris*.

We will now turn to our author's experiments and adjoin a few remarks.

First, with regard to the hybrid primula. Of the second generation, raised in 1855, there were seven plants; one alone resembled the hybrid, and was sterile; three took the characters of *P. officinalis*; three, those of *P. grandiflora* (var.

purpurea). He, however, uses the suspicious words, "*il est extrêmement peu probable*" that the hybrid parent had received pollen from either specimen of the two species.

In 1855 he had ninety-six plants of *Datura Tatula* + *Stramonium* and twenty-four of *Stramonium* + *Tatula.* They were manifestly intermediate, but slightly in favour of *D. Tatula.*

All being very fertile, a space of twenty feet was sown with their seed, which entirely reverted to the type of *D. Tatula.* Our author felt certain that the hybrids were not fertilized by pollen of the parent form, for he says, "The bed in which the hybrids were in 1855, contained a good number of *D. Stramonium,* of which the pollen *ought to have intervened* in fecundizing their flowers, a thing which manifestly did not take place." But he goes on to speak of the prepotency of *D. Tatula.* Now if he admits this, we do not quite see the grounds for such certainty; for it is not unreasonable to assume the hybrid stigmas even to have been charged with pollen of *D. Stramonium;* but yet if that of *D. Tatula* were prepotent, it might subsequently completely set aside the previous attempts at impregnation, for such is quite in accordance with other cases. For example, Dean Herbert mentions the following most remarkable instance :—

In the genus Hippeastrum he says : * "Although hybrids are capable of bearing seed by their own pollen, the admission of the pollen of another cross-bred plant of the same genus (however complicated the cross) to any one flower of the umbel is almost sure to check the fructification of the others." He describes how he fertilized three flowers of two two-flowered umbels, from a bulb of *H. Organense,* brought fresh from the Organ Mountains, with its own pollen, one flower only being dusted with pollen of *H. bulbulosum* (var. *pulverulentum*) + *reginæ* — *vittatum.* After three days the first three ovaries ceased to swell and perished altogether, while the fourth made vigorous and rapid progress to maturity, and bore good seed, which vegetated freely !

We give the above example to show that the assumption we have made with regard to *D. Tatula* is quite within the bounds of possibility, if not of probability.

Now, in these experiments, as also in the case of *Linaria purpurea-vulgaris,* in which most decided reversions appear to have taken place, the fact that they were *not* protected from insect agency, renders their value less than that which they would have had if more precaution had been taken.

Moreover, M. Naudin's experiments were conducted with garden or cultivated plants. Here, too, we think, was a great mis-

* *Journal of Royal Horticultural Society,* 1847. Vol. II. Part I. p. 19.

take. Cultivated plants are not usually in their natural conditions. Their very tendency to break out into new forms appears to be an attempt of adaptation of the species to new media and circumstances; so that the stability of character would seem less to be depended upon than if natural conditions were provided, and genuine wild forms selected for operations.

Nevertheless, we cannot but think M. Naudin's experiments to have very satisfactorily shown that reversions do take place, at least amongst cultivated plants; though it would seem to occur rarely among individuals in a wild state (Gaertner). And Wichura's observations on willows agree with this, for he found nothing of the sort with such hybrids.

6. *Are there any exceptions to the law of return of hybrids to the parent form? And do certain hybrids become fixed, and give rise to new species?*

He mentions Regel as of that opinion, although he himself thinks it more probable that true species only arise from other species by variation—"by subdividing with secondary species." Herbert remarks that "the hybridizing process is to a certain extent inimical to fertility in the offspring," and Wichura has the following:—

> The constantly-increasing sterility of hybrids, and their dying out when fertilized with their own pollen" . . . . is accounted for by the fact . . . . . that "if a hybrid is fertilized for successive generations with its own pollen, individuals come together which have the same weak point, viz., that of reproduction. The increase of weakness and sterility, and the rapid dying out of hybrids by continual impregnation with their own pollen, agrees with Darwin's views of interbreeding causing sterility in successive generations.

In conclusion, we would remark that there is yet much to learn from the investigation of hybridism; and that a careful perusal of the writings of the best observers here and abroad impress us with the great difficulty there must necessarily be in arriving at satisfactory results in many cases. In fact, they so depend upon the mysterious laws of life, and the causes of sterility are so complicated and interwoven, that we doubt whether they can be entirely solved. Nevertheless, experiments may yet clear up many points, and furnish us with considerable help towards unravelling the phenomena of hybridization.

ON THE LIGHT-EMITTING APPARATUS OF THE GLOWWORM.

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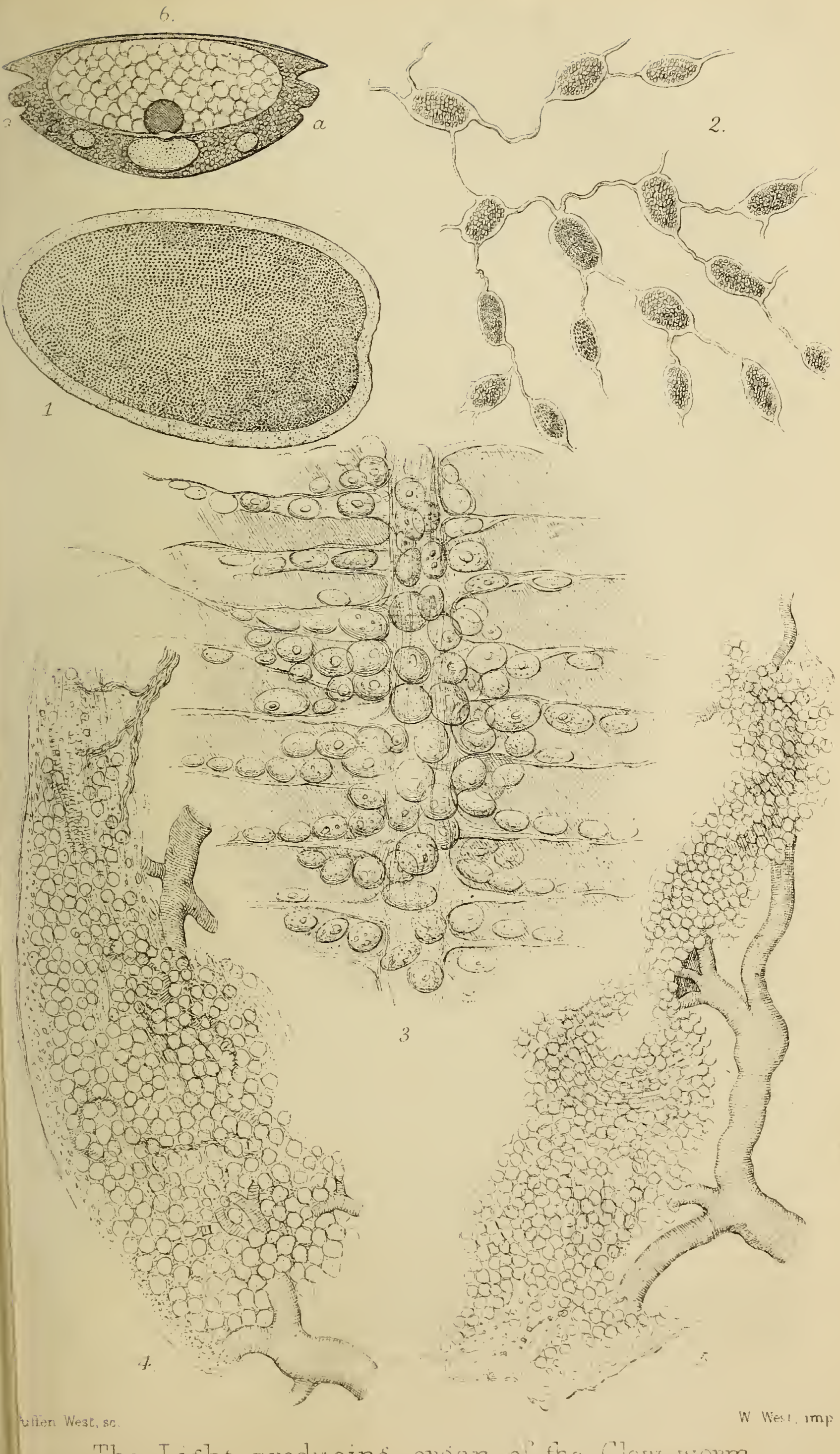
THE luminosity of animal matter must have been a familiar sight to man from the earliest ages. For then, as now, the valleys and plains which were the first dwelling-places of the human race, the great rivers which penetrated the interior of the country, and the seas which washed the coasts, teemed with animal life. The extraordinary spectacle of a luminous sea certainly could not have escaped observation, however ignorant the observers may have been at that time of its cause. Yet so long ago as the beginning of the Christian era, the great Roman naturalist Pliny was acquainted with the shining properties of the gelatinous medusæ. And nearly four centuries before, Aristotle had described the evolution of light from putrescent matter, and the light-emitting faculty of the living glowworm. In our time the number of *known* species of marine invertebrates endowed with luminous faculty exceeds one hundred, and the number of land animals known to possess this power is also considerable. The latter belong chiefly to the invertebrate kingdom, and notably to the classes of insects and myriapods. But instances of occasional luminosity are not wanting amongst the superior animals, and even in individuals of the human species. In such cases, however, the production of light appears to be dependent upon disturbance of the electric state of the tegumentary organs, and so far as it has been observed in man, upon abnormal conditions of the nervous and digestive systems.

The word "phosphorescence," commonly accepted as explanatory of this curious phenomenon, does not well accord with the revelations of modern science. As we even now speak of "*lucifer* matches," so the alchemists of old borrowed a name for the non-metallic element whose luminous property is so remarkable, from Phosphor, the morning star, and symbol of brightness. In course of time the word was applied to all phenomena of the kind, whether exhibited by minerals, plants, or animals. The study of phosphorescence,



uffen West, sc. W. West, imp.

The Light-producing organ of the Glow worm

commencing with Cascariolo's discovery (260 years ago) of luminous sulphuret of barium, and extended to the present day with the remarkable result that almost all terrestrial bodies (metals excepted) are found to shine in the dark after exposure to light, has finally culminated in the doctrine that phosphorescence is due to rapid molecular motion or vibration of matter. And the illustration which the practical endeavours of modern chemistry presents us in *the lime light*, as far eclipses the "lapis solaris" of the alchemist, as our generalizations of the multitudinous phenomena of light surpass the speculations of the gold maker.

Since the theories of oxidation and combustion have prevailed, great attention has been paid to the phosphorescence of decaying vegetable or putrescent animal matter. All such instances may be referred to chemical changes consequent on decomposition. But the investigation of the property possessed by *living* plants and animals, of emitting light in virtue of the special *organization* and self-regulating *vital* action, belongs to the physiologist. On the general subject of phosphorescence we refer our readers to the article of the celebrated French naturalist Quatrefages, published in No. 3 of our Journal, p. 275. The observations we here record have more especial reference to the light-emitting organs of insects, and, as the most typical instance in our country, those of the glowworm.

In the first place, we shall give some account of the researches of Professor Kölliker, of Wurzburg, communicated to the scientific society of that city in 1857.

The *male* Lampyris splendidula has, on the neutral side of the sixth and seventh abdominal segments, two small organs situated immediately beneath the transparent chitinous covering of the insect. The *female* has at the same places similar but larger organs, which are double under the sixth segment, and *besides* these, four or five pairs of smaller organs, disposed laterally, but not quite symmetrically, between the first and sixth segments. The light of these is best seen from the back of the insect, as they are more deeply lodged in the abdomen, and dissected out with more difficulty than the organ situated in the middle line of the ventral portion of the sixth segment.

The female Lampyris noctiluca have two large organs on the ventral side of the sixth and seventh segments, and two smaller ones beneath the tail segment. These latter are found in the male.

We may here remark that Professor Kölliker's statement disposes of any doubt as to the *male* insect possessing light-organs, and explains the discrepancy of statement as to the number of organs. Ray first noticed the light-organs of the male. Geoffry counted *four* such. Müller saw only *two* shining. It appears that Lamp. splend. has *four*, and Lamp. noct. *two*, according to Kölliker. Lampyris splend. is often found in Germany, but rare in England. The Italian Lampyris is a much more brilliant insect. In Russia a species named Corusca is found. In America an extraordinary number of species are known.

Anatomy.—All the light-organs have the same structure, being composed of an envelope (capsule), a parenchyma of cells, and a minutely ramifying system of tracheæ. Fine nerves are also found imbedded in the cellular parenchyma; the nerves are recognized with difficulty, being very pale, and without neurilemma; they enter with the tracheæ, but are soon lost in the interior of the organ; the nerve substance appears slightly enlarged at the points of bifurcation, where from two to five twigs are given off; the nerve fibrils have not been traced to their termination, nor any continuation with the cells demonstrated. The mass of the organ consists of cells which are of two kinds. In one kind the cells are pale, but contain minute granules, amidst which a distinct nucleus may be recognized. In the other kind the cell contents are granular, and appear under the microscope so stuffed with refractive granules, that no other elements can be made out. The pale clear cells lie chiefly next to the surface of the skin in Lamp. splendidula (both male and female), and in *female* noctiluca; the fatty white-looking cells fill up the deeper portion of the organ, and also the superficial portion of the small lateral organs of male Lamp. noctiluca and female splendidula. The essential illuminating substance does *not* consist of the granular matter of the white cells, but of the clear pale cells, the chemical reaction of whose contents is that of *albumen*. The granular particles of the white cells are composed of *urate of ammonia*. No phosphorus could be found, though perseveringly sought for.

Physiology.—The emission of light occurs by day as well as by night, but chiefly at night, when the insect is naturally more active. It appears to be under the insect's control, but does not depend on muscular action, which may be very active *without* emission of light; nor does exposure to light influence the activity of functions even after the insect has been kept in the dark for days together. The production of light is excited by mechanical injury, by application of the induction spark, by increased temperature, by various re-agents, *e.g.*, alkalies, mineral and vegetable acids; solutions of sugar, salt, and neutral salts; by dilute alcohol, ether, chloroform, chlorine vapour, and creosote. Without effect are water, saliva, oil, hydrocarbons, *dilute* salts and acids, and metal salts.

The faculty of producing light is very tenacious; but agents which destroy organic tissue annihilate it, *e.g.*, undiluted mineral acids and caustic alkalies, *strong* alcohol, ether, organic acids, and a powerful electric stream. *Nerve-paralyzing narcotics* distinctly weaken it, *e.g.*, coniin and prussic acid. In from three to five minutes the light disappeared from insects exposed to prussic acid vapour, and in ten minutes the function was so destroyed as to be incapable of re-animation by any stimuli.

Insects that have been dried up recover their illuminating power when moistened with water, and frozen insects revive by the warmth of the hand.

The persistent irritability of the light-organ, and its power of continuous luminosity, are astonishing. In a moist atmosphere *excised parts* may continue to give light for twenty-four to thirty-six hours: the longest observed time was forty-eight hours! The power of illumination failed in one to three hours when the insect was immersed in water.

Experiments with Du Bois Raymond's apparatus showed that the insect, when shining brightly, deflected the needle from three to seven degrees.

From the researches here recounted Kölliker concludes:—First, that the light-organ is a nerve apparatus, and finds its nearest analogy in the electric organ of fishes, since in both cases the same nerve stimuli excite, and nerve sedatives paralyze, functional activity. Secondly, that the hypothesis of oxidation of phosphorus is disproved by facts. Thirdly, that the metamorphosis of the albuminous contents of the cells is an accompaniment and material source of light function, the urate of ammonia crystals found in the white greasy cells being one of the residual products of the tissue change, and proportionate in quantity to the amount of change, which in its turn is regulated by the controlling influence of nerve force.

We may now compare the account of Professor Kölliker with those of other authors, both of earlier and more recent dates.

De Geer, Treviranus, and Carus, have noticed distinct and sometimes brilliant light both in the larva and pupa. The writer has found that the two small ovoid masses which may be dissected from the body of the pupa to be formed of a thick and tough capsule (see fig. 1), inclosing contents so opaque that nothing further could be distinguished under the microscope than a closely aggregated mass of granular particles. But on tearing up the capsule with needles these particles, under a higher power, proved to be nuclei, which showed in a few instances a cell membrane slightly raised from the nucleus. These were therefore the parenchyma cells of the adult organ seen in an early stage of their growth. The capsule was pierced at one place by a tracheal tube. The organ of the larva is, though rudimentary in size and function, essentially of similar structure to that of the adult female.

The Wurzburg Professor appears to have been the first author who laid special stress on the anatomical arrangement and nerve character of the light-organ. Macartney (in *Phil. Trans.* 1810) says, "The light proceeds from masses of a substance *not generally differing,* excepting in its yellow (?) colour, from the interstitial fatty substance of the rest of the body;" and again, "In the glowworm, besides the last-mentioned substance (which, when the season for giving light is passed, is absorbed, and replaced by the common interstitial substance), there are to be seen on the inner side of the last abdominal segment two minute oval sacs, formed of an elastic spirally-wound fibre, similar to that of tracheæ, containing a soft yellow substance of a closer texture than that which lines the adjoining parts, and affording a more permanent and brilliant light. This light Macartney found to be *less under control* of the insect than that from the adjoining substance, which it has the power of voluntarily extinguishing by some change dependant on its will. When the latter substance was extracted from living glowworms it afforded *no* light, while the two sacs in like circumstances shine uninterruptedly for several hours. Macartney conceives, however, that the interstitial substance has the property of shining (*Kirby & Spence,* vol. 2).

This account of Macartney's does not appear to be a fortunate one. The two small light-organs of the last segment are but an inconsiderable part of the whole light apparatus of the female, the larger masses of which have been confounded with the "common interstitial substance." The *cell nature* of the *parenchyma* of the light-organs has been satisfactorily demonstrated by Kölliker, as also the *albuminous* character of their contents. The common interstitial substance is, on the contrary, composed of *fatty matter,* inclosed in a membranous envelope. The essential difference in anatomical structure and chemical constitution is therefore beyond question. Moreover, the light, however produced, *emanates from the pale cells* of the light-organs. But this light, like that of the sun, is reflected and refracted in passing from one medium to another of greater or less density. The parenchyma cells, which contain granules and minute crystals of urates, act as refracting and reflecting bodies; and the fatty refractive matter of the common interstitial substance contributes further to the general illumination by its physical properties. The light emitted by the true organs from as many distinct points or surfaces as there exist organs, is thus diffused by aid of the interstitial substance, and when the light function is active, the brilliancy of the whole is nearly equal. But when the intensity of action *lessens*, the *interspaces* are less luminous, and the spots of light corresponding to the position of the light-organs continuing to shine (though with less splendour), appear distinct and isolated. Having *no* illumination of its own, the interstitial substance is the first to grow dark when the light diminishes, and thus lead to the erroneous idea of Marcartney's, that this substance is more under the influence of the insect's volition. The truth rather appears to be that the fatty interstitial substance is well adapted to multiply, by refraction and reflection, the light emitted by the proper light-organs, just as the catoptric apparatus of the lighthouse spreads the light of the lamp placed in its focus far and wide.

This physical effect of the interstitial substance is further evidenced in other luminous insects. In the glowworm, when shining brightly, the light appears at the sides and the back of the insect (particularly that coming from the deeper-seated organs), through the transparent membrane which connects the segments of the body. In the fire-fly the principal light is given out from two transparent patches situated upon the thorax, and from two similar patches concealed under the wing-cases, which are not visible except when the insect is flying. But the *whole body is full of light*, which shines out between the segments when stretched. In the lantern-fly the material which diffuses the light is contained in a snout-like projection from the head. The light of Pausus sphœrocerus shines dimly from the antennæ. In some moths, and even gnats, phosphoric light has been seen. In all insects an interstitial fatty matter is present, but in luminous insects a more or less perfect apparatus or light-organ probably exists.

The histology of this fatty matter of the glowworm has not been specially described by any writer, for which reason the following account may be worthy of record. In the adult insect a small portion of this substance, when unravelled and placed under the microscope, exhibits a series of globular-shaped bodies composed of granular and highly-refractive fatty particles inclosed in a membranous envelope, and connected together like beads on a string by one or more filaments, which are a direct continuation of the structureless membranous sheath. The ends of these filaments are attached to the inner surface of the skin, and the fatty bodies—hung, as it were, on the filaments—are suspended freely in the thoracic and abdominal cavities of the insect, chiefly along the sides of the abdomen, and form a kind of epiploon. As there is no other connective or areolar tissue, the whole structure differs greatly from ordinary adipose tissue (fig. 2). Numerous nerves are seen passing from the ventral ganglia over the fatty bodies, which are distributed to the muscle-bands of the several segments, but no nerves are supplied to the fatty bodies themselves.

In the larva the development of these fatty bodies (corps graisseux of Treviranus) may be easily followed. They first appear along the median line of the back as a mass of translucent cells containing large nuclei. The mass is separated into parallel rows by thread-like septa, upon which the cells appear sessile. As the cells gradually enlarge and fill with fatty granules, the connecting filaments appear, upon which the cells are strung in festoons. The tissue exhibits a beautifully delicate microscopic picture (fig. 3).

Our examination of the true parenchyme of the light-organs agrees with that of Professor Kölliker. In fig. 4 is seen a portion of the surface layer of pale cells next to the skin. They are nucleated, and closely packed together amidst a fine stroma of delicate fibres, seen sparsely scattered through the mass, which seemed to be nerve fibrils of the kind termed gelatinous by German histologists. M. Schultze and Dr. M. Rudneff have employed hyperosmic acid in the investigation of these nerves, on account of the property of this acid in rendering nerve fibre distinct by colouring it; but we can only refer to Schultze's *Archiv für Microscopische Anatomie* for the results obtained by them, as we have not had any opportunity of making ourselves acquainted with their labours. Our figure also represents tracheal trunks, whose branches, quickly subdividing, disappear in the substance of the organ. The tracheal distribution is exceedingly minute, and may be best seen when the parenchyma cells are removed, or when the organ is wasted and atrophied in the exhausted insect; the smallest particle of parenchyma contains one or more tracheal terminations. In fig. 5, cells and tracheæ are seen. Both figures are drawn from thin sections magnified 360 linear diameters, and the tracheal trunks are cut across in the preparation of the sections.

The existence of fine tracheal ramifications in the light-organ has been particularly emphasized by Professor Morren, who concludes from his investigation that the luminous effect is dependent upon a process of respiration (oxidation ?). The direct communication of the principal tracheæ with spiracles situated on either side of the ventral surface of each abdominal segment may be easily traced. Morren observed that when the spiracles are closed, the light is immediately extinguished, and considers that the opening and closing of the spiracle explains the nature and extent of control exercised by the insect over its light-organs. This may perhaps be true of the *living* insect, but does not account for the *intermittent* function persisting in the *excised organ*, nor for the effect of stimuli and narcotics applied to the organ itself. The same observer speaks of the capsule of the organ as being superficially mapped out by division into separate facts, the use of which he compares with refracting lenses in multiplying and intensifying the light from within. This conformation of the capsule has not been described by other writers, nor has the present writer been able to confirm it.

The obvious purpose of the tracheal distribution is admission of oxygen into the parenchyma, and the oxidation of the cell contents. It becomes important, therefore, to determine the chemical composition of the organic matter of the cells: whether it be, as Macartney, Carus, Phipson, and others believe, some form of *hydrocarbon* (i. e., *fat*) ; or, as Macaire (*Bibliothéque Universelle*), Kölliker, and others believe to have demonstrated, *albuminous*. The first assumption would support the theory of combustion, the second that of metamorphosis and evolution of force (or light as a correlation of force).

To the objection that may be raised against the *animal* character of the function, namely, that the persistence of the luminous appearance in the organic substance for so long a time after its removal from the insect's body indicates a purely physical or chemical cause of the act, it may be replied that the proofs of *functional activity of animal tissues removed from the body* are innumerable. Until the *vitality* of a tissue is *exhausted*, its proper function continues, after which general decomposition first ensues. Setting aside the unquestioned activity of the simple tissues of the lower animals under circumstances which demonstrate their possession of a *vis propria* separate from the collective vitality of the animal, we have sufficient and decisive evidence that nerve and muscle function, and even so compound an act as the secreting function of a gland, may persist so long as vitality exists in the parts. There is, therefore, no ground to deny the continuance of a light-producing function under similar conditions, than there is to deny muscular irritability or nerve excitation.

Now the theory of "combustion" and that of "metamorphosis" are both based on "oxidation," which is, in a certain sense, a physical act; but, occurring in animal tissues, cannot be separated from the vital acts by which it is regulated. The evolution of sensible heat may or may not be an accompaniment of the vital process, and the term "combustion," as applied to it, appears objectionable, as leaning too much to the chemical aspect of the phenomenon. Thus, Darwin referred it to slow combustion of phosphorus, and found a confirmation in the existence of phosphoric acid in animal secretions. Recently, M. Schnetzler (*Archives des Sciences Physiques de Genève,* 1855) attributed the light to combustion of phosphorus, on the ground that phosphates may be obtained from the destructive analysis of organic matter. This writer thought also that he had found phosphorus in the *greasy* substance of the light-organs, which was more probably urate of ammonia in a state of phosphorescence. As regards the existence of phosphates, it is well known that all albuminous matter and many organic fluids contain phosphoric acid in combination with bases.

Spallanzani regarded the luminous matter as a compound of hydrogen and carburetted gases. Thornton Herapath also believed the light to be due to a compound of hydrogen and carbon *secreted* by a particular gland organized for the purpose, and asserts that the most delicate analysis failed to show the slightest quantities of phosphates. The presence of phosphates, however (in cases where they are found), is unimportant, excepting their amount should much exceed that which tissues of a normal composition might be expected to yield to analysis, whilst the assumption of glandular apparatus for the secretion of carbo-hydrogens is entirely gratuitous, and contradicted by anatomical facts. The chemical evidence of the presence of a carburet of hydrogen is founded with more reason on the analysis of the *fatty substance,* but it has been already shown that light is not produced in the fatty bodies. The distinction between common interstitial fatty matter and the albuminous parenchyma of the true light-organs has not been sufficiently recognized, and ignorance or disregard of this fact has occasioned a confusion of experiment, the different kinds of matter not being separately and comparatively examined. The difficulty of procuring sufficient for chemical analysis also interferes with the settlement of the question. Kölliker, however, experimenting on the excised organs of as many as twenty to thirty insects at a time, positively denies the presence of any phosphorus, whilst the tests for albumen answered always affirmatively. Macaire long ago asserted the albuminous character of the light-organ, and, amongst other experimental results, notices that all agents which coagulate albumen annihilated the light-producing power.

The continued production of light under conditions which render "combustion," as ordinarily understood, next to impossible—as, for instance, in atmospheres of hydrogen and carbonic acid (Matteucci and Sir H. Davy), as well as the absence of increased illuminating effect in an atmosphere of oxygen (Beckenheim, Dr. Hulme, and Sir H. Davy)—are facts directly opposed to this hypothesis. On the other hand, all experiments tending to demonstrate the direct influence of nerve stimulation by external physical agents, as well as those which prove the paralyzing effect of narcotics on the nerves, go far to establish the theory of nerve function, or at least of nerve regulation of the metamorphosis of tissue which supports the function.

If the "slow combustion" (Matteucci and Roberts) be interpreted as oxidation of animal matter undergoing metamorphosis, the whole series of experiments apply without contradiction. The activity of function is checked by everything which interferes with oxidation, lessens nerve sensibility, or destroys the normal condition of tissue. Thus, when the light-organ is kept in vacuo, under water or oil, the illuminating effect gradually diminishes, as also when the substance is painted with a solution of gum, or the substance allowed to dry up. The latter state (pointed out by Caradori, Kölliker, and many others) has been particularly dwelt on by Carus in his communications to the Academy of Sciences in Paris. That the luminous matter loses its phosphorescent property when dried, but regains it when moistened in water, may perhaps be explained by the temporary disturbance of the naturally semi-fluid albuminous matter, and its consequent loss of capacity to undergo oxidation and metamorphosis without being actually destroyed. Carus notices that the experiment can only be performed once with the same matter, a circumstance which shows that the limit of action is connected with *organic* conditions rather than with *chemical* constitution of the luminous substance. For if the substance were independent of organic influence, the production of light might be expected to continue so long as phosphorescent matter is present.

So also in respect to the effect of heat or cold on the production or extinction of light. As the frozen insect revives by the warmth of the hand (Kölliker), the power of emitting light reappears. The effect of heat or cold is chiefly marked when change of temperature has been rapid and great within a given time, and belongs, therefore, to the known laws of action of temperature on living bodies. Heat and cold are relative stimulants or depressors of vital action.

Macartney, rejecting the theory of combustion, either chemical (as of phosphorus or carburetted hydrogen) or organic, suggests that the light is rather a quality of matter than a substance.

Brugnatelli (1797) believed that the phosphorescence of the Lampyridæ was due to a peculiar physiological act, by which these insects *separated light from their food*. In modern phraseology this opinion amounts to the hypothesis of organic assimilation, by which the nutritive act stores up certain elements of food capable of evolving, with each metamorphic change, the original forces of light and heat by which they were produced. This philosopher certainly foreshadows the doctrine of half a century later, which we have formularized in the term "correlated" force.

The remarkable analogy between this insect light and electric light has occurred to many naturalists. The anatomy of the electric organs in fishes corresponds in all essential points with that of the light-producing organs of insects. A congeries of cells, containing semi-fluid albuminous matter, with an abundant distribution of nerves and an appreciable metamorphosis of tissue, are characters common to both. In one organ the electric shock especially affects nerve and muscle of those who place themselves in contact with it. In the other, light is produced (which is not sensible *heat*). Both functions are periodical, correlative, and exhaustive.

The inconstancy of result obtained by different experimenters may be in part attributed to the healthy or unhealthy condition of the insect and its light-organ, or to the temporary exhaustion of its power. In experimenting on injured and diseased insects, the writer was struck with the diminished power of light production, and with the doubtful effects of stimuli and narcotic agents applied at different times to the same insect. The quantity of uric acid crystals found in the atrophied organs of a diseased insect is sometimes remarkable. The ventral ganglia may be seen entirely encrusted with uric acid, as well as the disorganized muscles and nerves. The light-yielding power, in such cases, fails for days or weeks before the insect's death. It may be remarked that the ventral ganglia of the female glowworm are *much larger* than those of the larva, and the nerves supplied to the light-organs both numerous and of considerable size. It is probable that the experimental section of the nerves, and the application of narcotics and stimulating agents to the ganglia, would greatly assist in determining the exact influence of nerve action on the proper function of the light-organ.

The effect of magneto-electricity has been variously reported by experimenters. Thus Alexander von Humboldt drew a vivid light from a fire-fly that was dying, by touching the ganglia of one of its anterior limbs with a piece of zinc and a piece of silver. Macaire found luminosity excited by the voltaic pile, but not by common electricity. Kölliker (vide *suprà*) excited brilliant light in Lampyris by applying the induction apparatus.

Quatrefages and Ehrenberg believe the light of Noctiluca to be an electric phenomenon: and if the evolution of animal electricity be possible in a creature of such simple organization, there can scarcely be any difficulty in recognizing the delicate nerve and cell apparatus of the glowworm as sufficient for a more complicated function.

In conclusion, we must briefly allude to that which has been called the *volitional control* of the insect over its production of light. The highest development of insect brain and nerve must necessarily be limited to *instinctive* acts and reflex function. There can be neither intellectual operation (*design*) nor perception where there is no material organ of will or mental perception. All insects perform the functions proper to their species, in the same manner, under the same circumstances, and with the same results, whether that result be the best calculated for the purpose or not—just as any given animal tissue must go through the phase of inflammation after injury, without any *intention* of cure; and the cure may or may not follow. The gradual improvement of nerve or muscle function is the consequence not of experience, but of continual development of the organism and its collective vitality. The light-producing function, so different from all others that it may justly be considered "sui generis," is obviously not performed for the individual benefit of the insect, but for the facilitation of the most important act of its life—the reproduction of the species, and fecundation of the female. But the sexual purpose effected by this means, one beyond the knowledge or experience of the insect, is an appointed phase of its existence, placed beyond its option by an instinct implanted in all brute nature by the Creator.

EXPLANATION OF PLATE.

Fig. 1. Rudimentary light-organ of Lampyris, consisting of a thick, tough capsular envelope, and densely-packed nuclear contents.

„ 2. "Fatty bodies," forming the common interstitial substance of the abdominal cavity. These bodies appear strung together upon filaments which connect them in a loose, net-like omental tissue. The connecting filaments are continuous with the transparent structureless envelope which surrounds each small mass of granular refractive greasy substance.

„ 3. Development of "fatty bodies." Along the median line of the back are attached a series of thread-like septa, which pass to the sides of the abdomen. Between these the fatty bodies first appear as large cells, filled with a clear substance, and containing large nuclei.

These cells become stuffed with fatty granules at a later period, when the nucleus is lost.

Fig. 4, 5. Parenchyma of light-organ, consisting of pale, clear cells at the surface next the skin, with tracheæ penetrating the mass; here and there a fine stroma of delicate fibres is seen.

„ 6. Diagrammatic section of insect between fourth and fifth abdominal segment. The large oval of circles represents the ovary stuffed with ova. The central dark circle marks the positions of alimentary canal and oviduct. The three smaller ovals indicate the position of the median and lateral light-emitting organs. These are imbedded in the common interstitial mass of fatty bodies, represented by the shading of small circles which fills the whole remaining space of the abdomen. Between the middle light-organ and the alimentary tube is placed the chain of ventral ganglia and their pairs of nerves. At (*a*), on either side of each abdominal segment, are the openings of the tracheæ, which penetrate between the loose strings of fatty bodies, and are distributed on the several abdominal viscera and to the light-organs.

SUN FORCE AND EARTH FORCE.

BY DR. RICHARDSON.

WHEN one of our most philosophical of poets spoke of the sun as the "soul of surrounding worlds," he made use of an expression which a modern physicist would be only too pleased to originate as a solemn truth of science. When, over the last that is mortal, the priest utters the sad "Earth to earth, ashes to ashes, dust to dust," he too makes use of an expression which a modern physicist would be only too pleased to originate as a solemn truth of science. The sun and the earth are the two great representatives, in fact, of life and of death. Did I say the representatives of life and death? I was wrong: they are the veritable life and death of the universe as it is known to us. But for our simple purpose it is at this moment sufficient that we speak of the sun and earth as each representing force; the sun active, originating, radiating, imparting; the earth passive, receiving, absorbing, retaining, re-yielding.

That which we call motion is all derived from the action of these two forces. Sun force lifts up, carries, propels; earth force draws down, resists, regulates, steadies, fixes, releases.

All our measures for producing or, rather, developing motion, are derived from one or other of these natural forces. When we move machinery by steam, we call into requisition force which the sun has at some previous time supplied to the earth, and which we now simply liberate: indirect sun force. When we take advantage of the wind to move machinery, as in the windmill, we again indirectly use sun force. When we move machinery by water power, as by the mill-stream, we use the force of the earth; we resist the force by which the earth draws the water towards itself.

The animal body, also, is made to manifest the phenomena of life or of death by the influence of these forces. Every animal, every plant, is a compound of sun and earth. The sun originally communicated its force to the plant; the plant took up the force, condensed it, and held it. The animal receiving the force from the vegetable, disengages it, and animal motion is the result. This force, however, when brought into play, were spent without effect, unless it were counterbalanced by the force exerted upon it by the earth. By this latter agency man is enchained to the planet, and he feels the influence every day he lives. When a sick man says, "I am weak, and must lie down," he announces in direct terms the action of the earth upon his organism. In scientific phraseology he is expressing that he is being subjected to the influence of gravitation; in other words, that is to say, he is not charged with so much sun force that he can resist the persistent and powerful earth force.

It is the same, physically, with a steam-engine. In the motion of the engine we observe force liberated from coal; radiating force, once in the sun, anon laid up in the plant, now set free, and producing through matter movement, or motion made indirectly visible. When the engine stops, we see again the influence of earth force; we see the earth that for a time has been conquered, reasserting its power.

It has been customary to look upon these two forces as standing to each other in the relation of activity and negativity, and the words "action" and "inertia" have been employed to distinguish between them. This hypothesis is natural, but it is not strictly correct, for both forces are, in truth, active, and both admit of being applied to make motion visible. Thus, when I wind up a clock-weight, I have truly expended so much sun force in the effort; but I leave the instrument, the clock, and straightway the weighted body I have raised, coming under the influence of the planet, descends and brings into motion the machinery by which the hands of the clock are made to move. In like manner, when I place a wheel in a descending current of water, as in the water-mill, I use actually the force of the earth, the weight of the water, to make the wheel revolve. The water which previously had been raised by sun force, descends by earth force, and gives the motion to the machine. It was the recognition, doubtless, of these facts that led the great Buffon to lay down the physical law or axiom, that all the powers of nature with which we are conversant, are reducible to two: that which causes heat, and that which causes weight. Thus both forces may be active, but there is this always to be remembered, that in every case the sun force is primarily called into play. The earth can do nothing except hold things to itself until it is resisted by the force of the sun.

No subject has been more keenly debated amongst philosophers than the natures of sun force and earth force. Newton, who first gave us clear views of the fact that there is a force resident in matter, that is in the earth, as well as in the sun—for the sun force was recognized from the earliest of days,—designates earth force as the *vis insita*, or in other terms the *vis inertiæ*. Of the character of this force of inertia he gave no explanation, but left it rather to be inferred that he was treating of an ultimate property of matter to be accepted as final and unexplainable.

In course of time, Newton himself changed his original views. He gave up the hypothesis of the vacuum of space to which at one time he fondly clung: he gave up the hypothesis of a primitive impulse, and he based, in his later days, all his explanations on the theory of a universal ether or medium through which matter was suspended, which formed as it were a solution of matter, and which, by its presence in greater or lesser quantity, if such a term be allowable, determined the structure of all bodies. This ether was capable, he thought, of contraction and of dilatation, and the particles of every substantial thing were separated from each other by it, and were set into motion through its changes or modifications.

Attempts have been made to demonstrate that sun force and earth force are the same, and that in using two terms we are only recording first impressions of natural phenomena; describing in words of a simple kind that which seems to be rather than that which is. Lord Bacon would appear to have had some such thought as this in view, when he gave utterance to the singularly beautiful sentence that "heat and cold are the two hands of nature." But the philosopher who first boldly asserted the unity of the two forces was a man much less known, though certainly not less learned than the great Lord Chancellor. I mean a man of our own time, and but recently dead, one Samuel Metcalfe. This man, tracing all motion, all force to solar fire—*Aith*, the sun; *Ur*, fire, ÆTHER—spent the whole of his life, much of it in actual want, to prove that there was no necessity to conceive two forces in nature, that two forces were impossible, and that the idea of two was founded purely on the observation of the variations of matter when the pervading force was in the active or in the negative condition.

At this moment, when the theory of mere motion as the origin of all varieties of force is again becoming the prevailing thought, it were almost heresy to re-open a debate, which for a period appears, by general consent, to be virtually closed; but I accept the risk, and shall state, therefore, what were the precise views of the immortal heretic, whose name I have whispered to the reader, respecting sun force. Starting with the argument on which nearly all physicists are agreed, that there exists in nature two agencies, matter which is ponderable, visible, and tangible, and a something which is imponderable, invisible, and appreciable only by its influence on matter, Metcalfe maintains that the imponderable and active agency, which he calls "caloric," is not a mere form of motion, not a vibration amongst the particles of ponderable matter, but itself a material substance flowing from the sun through space, filling the voids between the particles of solid bodies and conveying by sensation the property called heat. The material nature of caloric, or sun force, is contended for by him on the following grounds :—

1. That it may be added to, and abstracted from, other bodies, and measured with mathematical precision.

2. That it augments the volume of bodies which are again reduced in size by its abstraction.

3. That it modifies the forms, properties, and conditions of all other bodies.

4. That it passes by radiation through the most perfect vacuum that can be formed, in which it produces the same effects on the thermometer as in the atmosphere.

5. That it exerts mechanical and chemical forces which nothing can restrain, as in volcanos, the explosion of gunpowder and other fulminating compounds.

6. That it operates in a sensible manner on the nervous system, producing intense pain; and, when in excess, disorganization of the tissues.

As against the vibratory theory, Metcalfe further argues that, if caloric were a mere property or quality, it could not augment the volume of other bodies; for this purpose it must itself have volume, it must occupy space; and it must, therefore, be a material agent. If caloric were only the effect of vibratory motion amongst the particles of ponderable matter, it could not radiate from hot bodies without the simultaneous transition of the vibrating particles; but the fact stands out that heat can radiate from material ponderable substance without loss of weight of such substance.

"No metaphysical subtlety," he adds, "can refute the belief of mankind that whatever operates in a sensible manner upon material organs must be a material substance, for the obvious reason that there can be no virtue without substance, as maintained by Newton."

With this view as to the material nature of caloric, or sun force; with the impression firmly fixed on his mind that "everything in nature is composed of two descriptions of matter, the one essentially active and ethereal, the other passive and motionless," Metcalfe based the hypothesis that the sun force, or caloric, is a self-active principle. For its own particles, he holds, it has repulsion; for the particles of all ponderable matter it has affinity; it attracts the particles of ponderable matter with forces which vary inversely as the squares of the distance. It thus acts *through* ponderable matter. If universal space were filled with caloric, sun force, alone (without ponderable matter), caloric would also be inactive, and would constitute a boundless ocean of powerless or quiescent ether, because it would then have nothing on which to act; while ponderable matter, however inactive of itself, "has certain properties by which it modifies and controls the actions of caloric, both of which are governed by immutable laws that have their origin in the mutual relations and specific properties of each."

And he lays down a law which he believes is absolute, and which is thus expressed :—

"By the attraction of caloric for ponderable matter it unites and holds together all things; by its self-repulsive agency it separates and expands all things."

As I have already said, the tendency of modern teaching is to rest upon the hypothesis which Lord Bacon sustained, which Count Rumford sought to prove by experiment, and which through the days of Boyle and Newton, even down to the time of Sir Humphrey Davy, has been received, viz., that heat is motion, or, as it would perhaps be better stated, a specific force or form of motion.

But this hypothesis, popular as it is, is not one that ought to be accepted to the exclusion of the simpler view of the material nature of sun force and of its influence in modifying the condition of matter. We do not yet know sufficient to be dogmatic, and the very terms we now use to express differences of opinion and thought may in the ages to come be traced out as referring after all to some single principle or agency which, not being clearly definable now, admits of being seen from different sides and of seeming what it really is not. We are bound therefore to study every thought that is presented to us honestly and fully, and to consider it by its own reason and on its own merits ; not to measure it by some other hypothesis as the standard, or representation, or type. By this method of examination, then, the hypothesis of Metcalfe respecting sun force and earth force is not only very simple, but most fascinating. It is so easy that a child may read it, and thus it reads.

Here are two elements in this universe: the one is ponderable matter; it can be seen, touched, weighed, and it is made up of particles infinitely minute, so minute that according to Dr. Thompson the ultimate particle of lead, which is assumed to be large, cannot be estimated at more than the

$\frac{1}{31000000000}$th of a grain. We need not trouble ourselves with the nature of this matter, nor indulge, however pleasant the exercise, in the Newtonian idea that matter is condensed light; but we may accept the fact that here in the universe is so much substance having weight and under varying circumstances having various constitution and various form; in itself divisible, until we arrive at an ultimate particle then no longer divisible, and as we should gather from analogy existing as a sphere.

Left to itself in this state ponderable matter were inactive, *dead.* We cannot realize the condition of matter thus inert, because absolute inertia or death is what we have never seen in any particle of matter; but we may conceive inertia, all particles holding one place at rest, and this is the first element of the problem before us.

The second element is the all-pervading ether, solar fire. It is without weight, substance, form, or colour; it is matter infinitely divisible and its particles repel each other; its rarity is such that we have no word except ether by which to express it. It pervades and fills space, but alone it too is quiescent—dead. We bring together the two elements, the inert matter, the self-repulsive ether, and thereupon the dead ponderable matter is vivified: through the particles of the ponderable substance the ether penetrates, and so penetrating, it combines with the ponderable particles and holds them in mass, holds them together in one bond of union; they are dissolved in the ether.

This distribution of solid ponderable matter through ether extends, according to the theory before us, to everything that exists at this moment. The ether is all-pervading. The human body itself is charged with the ether; its minute particles are held together by it: the plant is in the same condition; the most solid earth, rock, adamant, crystal, metal, all the same.

But there are differences in the capacities of different kinds of ponderable matter to receive sun force, and upon this depends the various changing conditions of matter; the solid, the liquid, the gaseous condition. Solid bodies have attracted caloric in excess over fluid bodies and hence their firmer cohesion: when a portion of molten zinc is poured upon a plate of solid zinc, the molten zinc becomes solid, because there is a rush of caloric from the liquid to the solid, and in the equalization the particles previously loose or liquid are more closely brought together; and when water at 60° is poured on ice at a temperature below zero it becomes also ice and is added to the mass of ice, because there is a rush of caloric from the liquid to the solid, and the whole mass becomes incorporate.

Metcalfe himself, dwelling on the above-named phenomena and accounting for them by the unity of principle of action which has already been explained, sums up his argument in very clear terms, in a comment on the densities of various bodies.

"Hardness and softness, solidity and liquidity, are not essential conditions of bodies, but depend on the relative proportions of ethereal and ponderable matter of which they are composed. The most elastic gas may be reduced to the liquid form by the abstraction of caloric, and again converted into a firm solid, the particles of which would cling together with a force proportional to their augmented affinity for caloric. On the other hand, by adding a sufficient quantity of the same principle to the densest metals, their attraction for it is diminished when they are expanded into the gaseous state, and their cohesion is destroyed."

I shall not dwell at greater length on the unity of sun force and earth, which this theory implies. But I may add that out of it or out of the hypothesis of mere motion as force and of virtue without substance, we may gather as the nearest possible approach to the truth, on this, the most complex and profound of all subjects, the following inferences :—

(*a*.) Space inter-stellary, inter-planetary, inter-material, inter-organic, is not a vacuum, but is filled with a subtle fluid or gas, which for want of a better term we may call still, as the ancients did, Aith-Ur—Solar fire, ÆTHER. This fluid, unchangeable in composition, indestructible, invisible, pervades everything, and all matter; the pebble in the running brook, the tree over-hanging, the man looking on, is charged with this ether in various degree: the pebble less than the tree, the tree less than the man. All the planet in like manner is so charged! A world built up in ethereal fluid and moving through a sea of it.

(*b*) The ether, whatever its nature, is from the sun and from the suns; the suns are the generators of it, the store-houses of it, the diffusers of it.

(*c*) Without the ether there could be no motion; without it particles of ponderable matter could not glide over each other; without it there could be no impulse to excite those particles into action.

(*d*) Ether determines the constitution of bodies. Were there no ether, there could be no change of constitution of substance: water, for example, could only exist as a substance, compact and insoluble beyond any conception we could form of it. It could never even be ice, never fluid, never vapour, except for ether.

(*e*) Ether connects sun with planet, planet with planet, man with planet, man with man. Without ether there could be no communication in the universe: no light, no heat, no phenomenon of motion.

These inferences, I repeat, we may accept whatever be our theory as to the influence of ether on ponderable matter, or of such matter upon ether. We may admit, if we like, two forces, earth force and sun force; we may believe in the inherent attraction of the particles of ponderable matter for each other, and follow out motion as mere vibration or disturbance of the ethereal fluid amongst those particles; or we may look with Metcalfe on the ether itself as a self-acting principle or agency, combining with the particles of ponderable matter and repelling its own particles. We may say that light is actual matter radiating from the sun, or we may say it is a roll of ether-wave set in motion by the sun! We may urge that caloric light and electricity are all forms of motion, and that the equivalent value of each is determinable; or we may insist that caloric light and electricity are one subtle form of matter exerting differing influences on ponderable substance, and that motion is but the effect of the active principle upon ponderable matter.

We may, I repeat, accept these various readings, and if we think over them calmly, may claim for them almost an equal share of probability and value. By either we are driven back to a primary question, which is final. Suppose the particles of ponderable matter possess the force of cohesion, *i. e.*, attraction the one for the other, what is that attraction? Or, suppose an active ether possessing attraction for ponderable matter and repelling its own particles; what is this power of attraction and repulsion in the ether? Suppose the sun has force — and who shall say it has not — whence the force? Suppose we know—and we do know—that there are burning in the sun certain metals, which must, by their combustion, liberate force, whence comes the force that is being liberated by the burning metals? Whence the sun itself, were a question as difficult to interpret.

And there is one other subject, respecting which, on the acceptance of either of the two theories, we have no clear explanation afforded. I refer to the construction of ponderable matter on given types or forms. There cannot be a doubt that form results out of motion of ponderable matter, and there can scarcely less be a doubt that it is the tendency of matter to be thrown by motion into the form of a sphere: the planets have clearly resulted from motion; the blood-cell clearly results from motion; and all forms, atween these in magnitude, or greater or lesser, result equally from motion and possess the same characteristics. Whenever there is departure from the sphere, there has been invariably one of two antecedent conditions—enfeebled motion (I mean primary motion), or opposition to primary motion. Thus everything in nature is moulded out of the sphere. It would appear, in fact, as if the force that led to form in every case radiated from a centre, giving direction to the particles of ponderable matter, and, if let alone, arranging them on one fixed type.

Nature, prudent Mathematician, never endeavours to square the circle. There is no natural object whatever that has not in it the element of the sphere. At the same time, out of the element of the sphere what wonders nature develops, what art, what beauty! The alpine mountain that lifts its head "so high into the sky": and the—

> Peak that wears its cap of snow,
> In very presence of the regal sun,

together with the simplest mound that baby feet can surmount; the gigantic forester the oak, or the Wellingtonia, together with the daisy and the buttercup; the sea Leviathan and those mightier of the mighty which in past ages walked this earth, and which have waited for an Owen to reinstate them even in dead outline, together with the lowest trace of living thing that the best of microscopes can reach; the crash of Niagara, with force wasted each moment equivalent to all the engines human hands have made for motion, together with the gentlest rippling rill; the huge ocean with all the life on it and in it embracing the lands, together with the tiniest lake in mead or vale; the largest of the suns on which our earth, firmly set, would be less than "Ben Lomond" on earth itself, together with the smallest asteroid that the telescope can reveal; the things that are and are not, the forms without substance; the hollow natural cave, or the wonderful canopy of blue sky, the shadow of the mountain, or the gorgeous rainbow evanishing in the storm, together with the things that are most real and nearest to our hands, the seed we plant, the seed we crush and eat, the fruit we take from the tree or dig from the earth; our very senses, the eyes we see with, the ears we hear with, the tongue we taste with, the hands we work with, the brain we think with; the goodly framework of body that knits us together; the heart that pulsates; these, one and all, great and little, are formed on the sphere.

Man himself, who in his makings of form differs from nature, in that nature evolves or throws out, while he condenses or brings together, does still, as if by uncontrollable instinct, build or construct with the sphere as his first model. He shall span a wide river with a bridge; he shall erect a castle or cathedral; he shall raise a monument, or he shall build a ship; and wherever there is most strength and most beauty in his production, the most perfect conception, of the sphere, is simply and unobtrusively manifested. Is this strange? Not so if we remember that there is not a possible movement of the hand from the body that is not included in a sphere; that is to say, every movement, if it were written down on paper in lines, would present part of a spherical figure or design.

It remains yet for the philosopher to learn the elementary causes of typical divergences from the primitive plan. If the sun force gives the primitive impulse as to motion of matter, and to form,—and respecting this I think there need be little doubt,—there must be either virtually or actually an opposing force, which we may call earth force, to keep matter together, by which retarding influence variations of form are realized. Here for the moment we must rest content.

Sun force and earth force! When we know them better in their duality or unity, we shall have the key to nature! Then the so-called vitalist, so mysterious, so haughty, so dogmatic, so voluminous in words, and so nebulous in fact, will be here no more to exalt superstition, and to confound the wisdom of the time that is most worth possession,—the physical interpretation of the universe.

THE ERUPTION OF SANTORIN.

BY PROFESSOR D. T. ANSTED, F.R.S.

THE close of the month of January, 1865, was marked by one of the most interesting volcanic eruptions of modern times, which then commenced on the upper flanks of Etna. This eruption was sudden, rapid, and complete. It included all the recognized phenomena, such as earthquakes, wide and deep fissures reaching many miles in length, very large outbursts, both of ashes and lava; and it has been followed up by a metamorphosis of the erupted rocks, which was still going on in January last, when I visited the site on the anniversary of the disturbance. The period of intense activity was short, but the sub-active state lasted many months.

While this work was proceeding, the land, about 500 miles in a direction a little south of east, and at the southern extremity of the Morea, and in part of the island of Cerigo, was undergoing elevation (see Plate annexed), and a shoal was formed in the Mediterranean, not far off Cerigo, the existence of which was recorded by the captain of the English barque *Vigilia*, on the 19th of July, 1865. Some time afterwards, towards the close of the year, severe earthquake shocks were felt in the island of Chios, near Smyrna, on the coast of Asia Minor, distant nearly 500 miles east-north-east from Etna, and about 200 miles north-east of Cerigo. All this time Etna was smoking, but not disturbed. The relative position of these points will be seen in the sketch map annexed (see Plate).

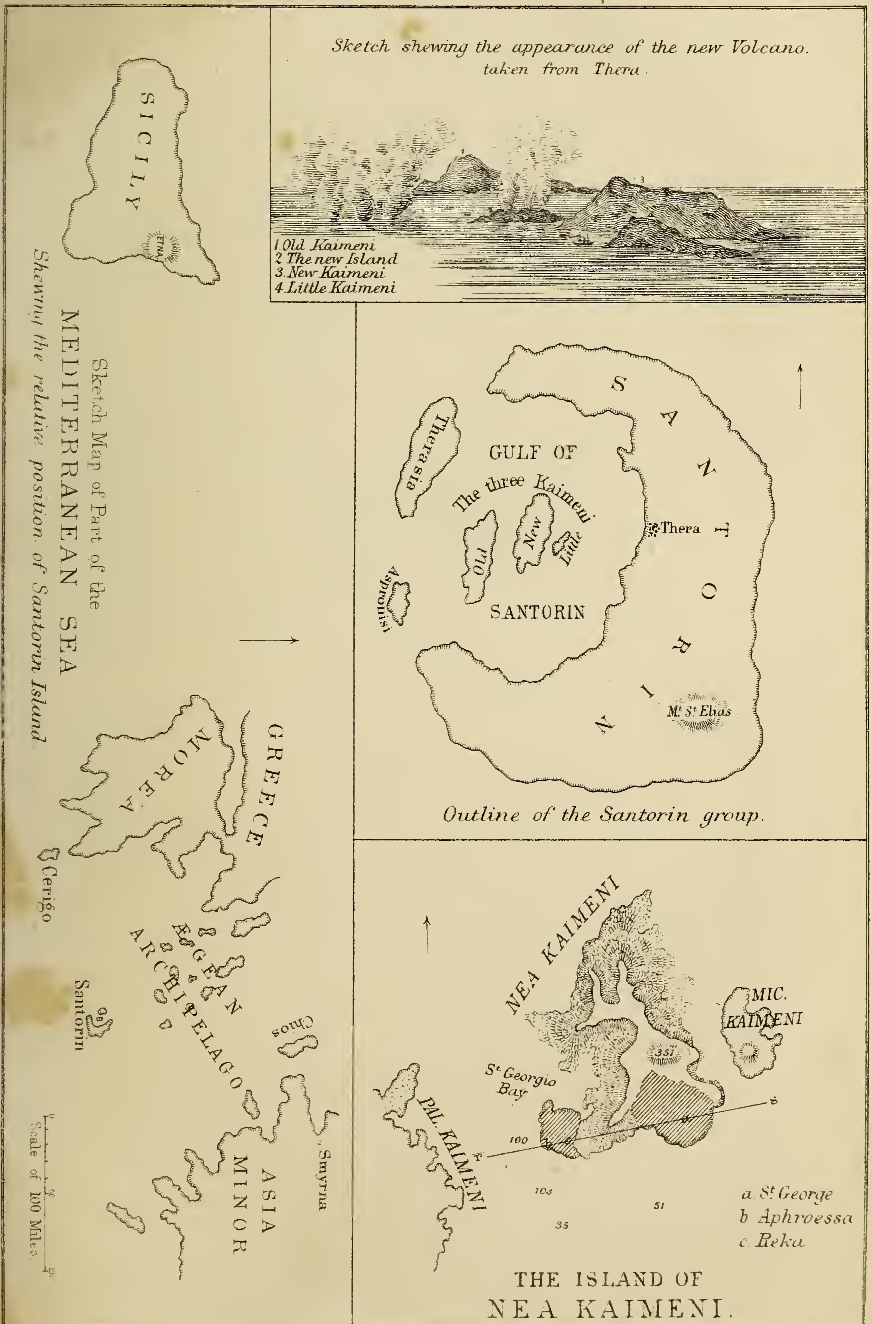
Towards the end of January of the present year, or exactly one year after the great eruption of Etna, and soon after the disturbances of Chios, small earthquake shocks were felt at Santorini, an island in the Greek Archipelago, situated about 150 miles east of Cerigo, and about the same distance to the south of Chios. Santorini, or Santorin, is one of a group of volcanic islands, sufficiently remarkable for its form (see Plate), and very interesting for its geological history. Minute descriptions of it have been published from time to time, commencing with a notice by Pliny of an eruption that occurred in the year 186 B.C. It has been rendered classical by Lyell, in his admirable work on the "Principles of Geology," and is referred to by Humboldt, Scrope, and Daubeny. What the state of the case may have been before the time of Pliny, we have no record; but it seems clear that an island arose, during a volcanic eruption, of considerable magnitude. Several small islands, three of them now known as Palaia (old), Nea (new), and Micra (little) Kaimeni, have since come into existence. The first is that of Pliny, and the last (Nea Kaimeni) rose in 1707. It is the central and largest of the three. Kaimeni means "burnt island," and the term is explained by the fact that all the islands are mere lava heaps. Important eruptions took place in 1427, 1573, and 1650; but all these were inferior to that of 1707.

The relative position of the islands will be seen in the chart in the accompanying plate. Santorin (anciently Thera) is a flattened table-land of limestone, crescent-shaped, rising to 800 or 900 feet above the sea, with a limestone hill at the south-easterly extremity about double the general height of the island. There is a gentle slope from the sea, and an abrupt face towards the bay. The crescent is filled up, and becomes a circle by the islands of Therasia and Aspronisi and shoals between them. The depth of water within the circle is very great.

The outer circle of Santorin measures nearly 30 miles in circumference (24 land and 6 water), but the gulf within is of course much smaller. Regarded as a crater, this would seem enormous, when compared even with Kilauea; but it is not a true volcanic crater. The limestone masses have been lifted up during or in anticipation of the volcanic disturbances that have formed the islands in the centre. Those are the only parts of the core of the true crater now left, and they are composed of volcanic tuff and lava. What is called the Gulf of Santorin is the whole interior of the great circle containing the real crater, fragments of which rise above the level of the sea.

On the 30th of January of the present year, after several small earthquake shocks in the central part of the Gulf of Santorin, and a small depression in Nea Kaimeni, the sea assumed a white colour, and was violently disturbed. This took place around the two islands of Old and New Kaimeni, and especially in the channel between them. Loud subterranean noises were heard, which lasted several days. On the night of the day on which these noises commenced, an appearance as of red flame was seen rising from the sea in this channel. The next morning (January 31st) the sea became red, and the waters extremely bitter. During the day a fissure was produced on a promontory of New Kaimeni, separating a portion of the island from the rest, and poisonous gases

THE RECENT ERUPTION OF SANTORIN. Pl. XVII.



(chiefly carbonic-acid gas) issued in large quantity, dispersing the birds that had assembled to feed on the dead fish floating on the surface of the water. Much black smoke accompanied the eruption of these gases.

During the night of the 31st of January the ground in the southern part of New Kaimeni began to sink, and continued to do so, but at a diminished rate, till the evening of the next day. The total sinking had then amounted to seven or eight feet and was still going on at the rate of about two inches an hour.

On the night of the 1st of February more flames were seen, followed by smoke; and on the subsequent morning, at 9 a.m., a shoal was found rising where Capt. Grave's chart (1848) marks a depth of 28 fathoms of water. At that time the shoal was within one fathom of the surface, and rising rapidly. At 4 p.m. it was above the surface, and became an island. This island was then seen rising gently, but so sensibly that the eye could follow its movement. Towards nightfall it appeared to be about 50 yards in length by 10 or 12 in width, and it had attained a considerable height above the sea. The rise continued during several succeeding days, during which other indications of the eruption ceased for the time. It was checked a little on the 7th of February, but soon recommenced with greater activity than before.

By the 9th of February this new island, at first called King George I.'s Island, but since joined to New Kaimeni, and described as the George Promontory, was 450 feet long, 200 feet wide, and about 150 feet high. It almost touched New Kaimeni. It was of conical form, composed entirely of lava and scoria, and was much fissured. Its heat was intense, and large quantities of vapour and gas issued from it. A dull roaring sound was heard on approaching the island. Judging by the odour, both carburetted and sulphuretted hydrogen gases were erupted from it. The position of this island off the extremity of New Kaimeni will be seen in the plate annexed, and is marked *a*.

On the night of the 6th of February much inflammable gas was observed to escape; but this was an exceptional phenomenon, and does not seem to have been repeated frequently or continued long. On the afternoon of the 8th, a submarine eruption of scoriæ took place between Vulcano and Diapori, in Old Kaimeni.

On the 9th of February the sinking of the land of New Kaimeni, which had been for a time checked, had recommenced, and already amounted to 18 feet. The island became traversed by a new fissure, cutting it in half. The southern half of the island was that affected by the movement of depression. It soon became cracked in every direction, vapour and gases issuing from the crevices.*

Throughout the Gulf of Santorin the milk-white colour of the waters, and in many parts their almost boiling heat, attested the energy of the action going on below. A gradual diminution of depth in the gulf was also observed by soundings taken from time to time. There were indications of small eruptions at various points.

Shortly after midnight on the 9th of February, the sea being disturbed by a violent wind and the sky clouded, the effect of the heated lava was admirably seen on the air, and was greatly increased by the noises produced and echoed by the high wall of cliff which incloses the Gulf of Santorin like an amphitheatre, and rises to a height of nearly 1,000 feet. The next morning there was a visible increase of the new island, both in area and height. Next morning (11th Feb., 9 a.m.), and again on the succeeding day, jets of flame were seen to rise, accompanied by black smoke. On the morning of the 13th there appeared above the water a second island, since called Aphroëssa. Its position is marked in the chart (see Plate) by the letter *b*.

This new island, upheaved out of a sea of boiling mud, brilliant with luminous vapours, was at first covered with marine plants and detritus. It changed its appearance several times during the first six days of its existence, but became settled by the 20th. It was then of elliptical form, about 250 yards in circumference, and 30 or 40 feet high. There was a depth of 1·7 fathoms water between the new island and New Kaimeni.

On the same day (20th February, 10 a.m.) there was a small but sharp eruption of scoriæ from the promontory George. A column of smoke, 200 yards thick at its base, is said to have risen to a height of 2,500 feet, accompanied by flame and a torrent of ashes and stones. These stones or red-hot scoriæ fell on a steamboat anchored close by, in attendance on the members of a Greek scientific commission recently arrived, and on a small trading-vessel belonging to Santorin. The captain of the latter was killed and the vessel set on fire. The crew jumped into the sea and swam to shore. Two of the crew of the steamer were injured slightly, and the vessel itself injured. The members of the commission were then on shore, and had a

* The island of New Kaimeni which has been thus exposed to disturbance and destruction during the present eruption, was originally composed of two parts—one porous and scoriaceous, the other of trachytic lava. It was formed in 1707, at the last eruption, and the movements connected with its upheaval lasted about five years. The original cone was 330 feet above the sea, and there was a crater on the summit 80 yards in diameter.

very narrow escape from the fate of Pliny. The following is a translation of part of the account given by M. Christomanos of his share of the adventure :—

"We were on the hill of the island to the north of the volcano, and noticed on the slope towards the volcano a sulphurous vapour issuing from deep fissures formed on the crater. On reaching the top we observed the island of Aphroëssa in a state much less tranquil than we had hitherto seen it.

"While we were looking at it we heard a sharp whistling sound followed by a noise like thunder. At that moment a cloud of dense black smoke enveloped our whole party, and the volcano on which we were. Turning back to avoid suffocation, we heard a frequent sound of falling bodies, and the smoke dissipating we saw a shower of stones at a white heat rising to a vast height into the air and falling around like thick hail. We rushed away as fast as possible, seeking shelter at first at a distance from the crater. But the shower was too dense, and our only chance of safety was to remain in the old crater, behind projecting fragments of rock. Even there we were not free from danger, for fine burning sand was also erupted, and this was driven into the crevices. Even if we could escape from the heavier stones, we could not avoid this sand.

"Looking round from my hiding-place I saw the old crater burning. I heard stones falling around me, and felt a burning sensation in various parts of my body. I was then suddenly struck by a stone and fell on the ground. I got up again immediately, and feeling my neck burnt I tore away from it a small fragment of scoria that was burning into my clothes. While I was endeavouring to crouch under a rock, which partly sheltered me, this rock itself was struck and turned over by an enormous stone falling upon it, and broken by the fall. In despair I then determined, in the face of the shower of stones, which still continued to fall thickly, to run across the old crater (about 150 paces). Once on the other side I succeeded in getting into a fissure between two rocks.

"Three minutes after the first appearance of the dense smoke the noise ceased and the shower was over. White vapour (steam) succeeded the smoke, and the burning vegetation on the ground, with my burnt clothes and skin, were the principal remaining indications of what had happened. I soon reached the steamboat, where I found my companions safe. They had suffered similar risks, and in their flight had lost some of our instruments."

During the 20th February the promontory continued to extend towards the south and east, but very slowly, while towards the east of the island the hot waves began to eat away the base of a conical hill on which were the houses of a summer bathing-establishment. On the 21st there was a small earthquake shock, and on the 22nd, at half-past 4 a.m., another considerable eruption from the new island of Aphroëssa. This was repeated on the 23rd, and again on the 24th. The last eruption of stones and scoriæ lasted about two minutes in full force, and nearly an hour with diminishing intensity.

A long and considerable eruption, accompanied by a slight earthquake, occurred in the evening of the 26th, and earlier in the afternoon George island (now converted into a promontory) had visibly and rapidly enlarged towards the southern extremity. The increase was estimated as amounting to twelve metres in length in a quarter of an hour. On the 28th there was an eruption, followed by the sinking in of the upper part of the promontory, and on the succeeding day the sea was greatly disturbed between Aphroëssa and New Kaimeni.

During the last days of February and the beginning of March the temperature of the sea, which had been very high (above 37°. 5 C.), was reduced to 22°. 5 C. at the extremity of the promontory. It was also observed by the captain of a vessel, who had approached in a boat, that there was no fissure on the promontory. For several days in the early part of March there was nothing special to remark upon, the phenomena continuing as before, occasional eruptions alternating with intervals of repose.

On the 8th of March M. Fouqué arrived at Santorin. This gentleman is a French geological chemist, who had been commissioned to visit the eruption of Etna in 1865, and who had lived for weeks on the mountain on that occasion with Professor Sylvestri, of Catania, studying the various phenomena. M. Fouqué found both the promontory George and the island of Aphroëssa to consist of a black, glassy, felspathic lava, identical with some of the old Etna lavas, and those which form the compact beds of Santorin. It resembles an imperfect obsidian. Crystals of glassy felspar were abundant in it. There was at that time (8th March) no true crater, and little solidified lava had been projected. The quantity of erupted scoriæ and ashes had been very small, and thus no cones of eruption of the ordinary kind had been formed.

The gaseous emanations, however, were remarkable, as they included within a very small area all those varieties generally spread over a large space in other volcanos. Near the place where the lava is incandescent the blocks were covered with a thin coating of common salt.* Not far off, stifling odours of

* I have observed common salt both in Etna and Vesuvius, on and within blocks of erupted and projected lava.

muriatic acid and sulphurous acid were recognized. At a short distance sulphuretted hydrogen was disengaged in large quantity. Much sulphur was accumulated at the base of the two volcanic monticules, but this had no doubt been derived from the mutual action of the hydrochlorate of ammonia and sulphuretted hydrogen. At a short distance inflammable gases were erupted in large quantity, apparently from out of the fluid lava. This last fact has not been observed in any other active volcano. These gases burned with a yellow flame owing to the presence of salt, and this proof of the possibility of true flame in a volcano in full eruption is very important. It is evident that flame may come even from the centre of volcanic action.

On the 10th of March a new islet was observed close to Aphroëssa, and named *Reka*. It was at first thirty or forty yards in diameter, and rose about five feet above the sea. It is marked *c* in the plan (see plate). It consisted of blocks of lava identical with those of the new promontory "George" and the island of Aphroëssa. On this day the depression of the south-east part of New Kaimeni ceased for a time. The depression was nearly twenty feet.

A line passing through the summit of the three islands formed up to this period would have a bearing of E. 20° N. mag. (declination 9°). This line marks the principal axis of the eruptive forces. (See Plate. Island of New Kaimeni, line *r s*.)

On the 13th of March Reka had joined to Aphroëssa, and on the 19th Aphroëssa had become a part of New Kaimeni, so that the result of the various movements had been to add two new headlands to the old island; one formed by George promontory on the south, the other by Aphroëssa and Reka to the west. The elevation had gone on steadily. The additions had been caused partly by upheaval and partly by lava currents issuing from the principal fissure near its extremities, George promontory and Aphroëssa being the two points of eruption. It was not difficult to distinguish the part produced by upheaval from that caused by the outpouring of lava.

In the part of New Kaimeni near Cape Phlego, several remarkable fissures were formed. They were about 150 yards long and parallel to each other, and to the line of fumaroles ranging E. 20° N. There are besides a few transverse fissures of smaller importance. They probably began with the eruption, but were first noticed on the 12th of March, and the largest was then from ten to twelve feet wide and twenty-five to thirty feet deep. They were formed in the old lava of 1707, and currents of hot salt water ran along them, through which much gas bubbled. A little sulphuretted hydrogen and carbonic acid, some carburetted hydrogen, and a little free hydrogen, were found to be the gases liberated. One of the smaller fissures crossed the old cone of New Kaimeni, but it was only six or eight feet deep and about the same width, and did not give any gases. Another wound round the base of the cone, and from it there were many fumaroles, the temperature of the gases being 30° to 40° C. The fumaroles forty yards to the north, of which the temperature had always been very high, had risen between the 12th and 20th of March from 400° C. to the melting-point of zinc. There was now much activity at this part, and the elevation of the sea bottom in the channel between the islands of New and Old Kaimeni, as well as much of the island of New Kaimeni, had become considerable, the depression amounting to sixty fathoms in the channel. On the other hand, the depression at the south-east extremity of the island, which had been checked, had recommenced, though slowly. Flames also continued to appear at night from the summit of the three centres of eruption, but not from their base. It is worthy of notice that on the 26th of March several rather sharp earthquake shocks took place in Sicily.

During the remaining days of March, and throughout the month of April, the phenomena were continued with diminishing intensity. Early in May, however, there was a slight return of activity, a new eruption having been observed in Nea Kaimeni.

On the 17th of May, we are informed, that the fissure had not increased, and that the eruption was confined to the craters at its two extremities. At that date the cone of the George promontory was regular, and measured about 100 yards in diameter. It was about 100 feet high, and was formed of rough and large blocks of lava. From the crater on the top jets of steam and thick clouds of ash occasionally rose into the air, appearing incandescent at night. Lava currents ran 300 yards into the sea from the foot of the cone. At the same date Reka was cold, Aphroëssa had a distinct cone and crater, from which were occasional small eruptions and much lava. The sea around was hot, the temperature varying from 50° to 80° C., and there was much sulphuretted hydrogen emitted. The old cone of New Kaimeni was altered and split.

Such are the principal facts concerning this remarkable and interesting eruption, as abridged from the accounts of intelligent and scientific eye-witnesses. They are especially interesting, not only in themselves, but for purposes of comparison. There can be little doubt that the eruption is now practically at an end.

REVIEWS.

WARM-BLOODED VERTEBRATES.*

A FAR shorter interval elapsed between the publication of the first and second parts of the present series of Professor Owen's work than we had been led to anticipate. In our last Number we noticed, at some length, the first volume of the "Anatomy of Vertebrates," and we now proceed to discuss the merits of the concluding division of this fine treatise. When treating of Professor Owen's transcendental speculations, we could not conscientiously award them that praise which we freely accord to his labours in the field of anatomy. There is, in all instances, a great distinction to be drawn between the facts which an author lays before his readers and the inferences which he draws from them. And although most people are careless as to this distinction, it is one of considerable importance, and of an importance which is especially illustrated in the case of the writer of the work under notice. If we separate the facts from the fancies of the present volume—and the separation is by no means difficult,—we arrive at a proper method of estimating the author's worth. Professor Owen stands forward prominently as a naturalist of the "Conceptive" school; he therefore advocates doctrines of homology and harmony which, while they are extremely fascinating and full of poetic beauty, are not the expression of honest generalization. But when we turn from his hypotheses and survey the vast accumulation of anatomical facts which the devotion of a lifetime to Natural Science has produced, we can then see how much we are indebted to Professor Owen for a comprehensive knowledge of the structure of animals. In the exploration of the animal frame our author has not been surpassed by his great predecessors, Hunter or Cuvier, though in regard to his theoretical speculations he has travelled much further, and, we may say, "fared worse" than either of them.

Our readers will remember, from our notice of vol. I., that Professor Owen divides Vertebrates into two great natural groups,—*Hœmatocrya* and *Hœmatotherma*, which correspond respectively to the popular terms cold-blooded and warm-blooded. The first volume dealt exclusively with the former section; the present one treats entirely of the latter. The classification of birds does not materially differ from that already in vogue among zoologists, except that it is proposed to embrace a division of the class into two groups, in accordance with the characters which the young present when they emerge from the shell. This binary mode of arrangement was originally suggested

* "The Anatomy of Vertebrates," vol. II. Birds and Mammals. By Richard Owen, F.R.S. London: Longmans & Co. 1866.

by the author in 1836 in his memoir in Todd's Cyclopædia. In some orders of birds the newly-hatched young are able to run about and provide for themselves the moment they leave the shell; while in others they are excluded naked, feeble, and blind, and have to depend on their parents for succour. The orders of the first series are proposed to be styled *Aves præcoces*, and those of the second, *Aves altrices*. There is not much to be said concerning the nomenclature of the several orders. The old order Insessores has been split into two sections,—the Cantores, or singing birds, and the Volitores, or those which move solely by flight: the first includes the shrike, wren, wagtail, warbler, thrush (Dentirostres); the Paradise bird, crow, starling, bunting, tit, lark, finch, grosbeak (Conirostres); the sun-bird, nuthatch, creeper (Tenuirostres), and the swallow and martin (Fissirostres). The second embraces the swift, humming-bird, nightjar, trogon, motmot, bee-eater, jacamar, roller, puff-bird, kingfisher, and hornbill. The other orders are those usually recognized, and contain the families generally allotted to them. We, however, observe one alteration, which shows a change of opinion on the part of our author; the dodo is no longer ranked by him among the raptorial birds. The views of Melville and Strickland have at last been adopted, and the strange bird of the Mauritius, which was successfully extinguished by the Dutch sailors, is now stated by Professor Owen to be "most nearly allied to the Columbaceous group of Rasores."

Passing from the consideration of our author's mode of dealing with the class in detail, we come to offer a few remarks upon his sketch of the division Aves, as a great natural group of the organic world. It is here he shows his peculiar powers. There is a broadness of thought, a vividness of description, and a keen perception of important zoological characters, in the following general survey of birds:—

"Birds form the best-characterized, most distinct, and natural class in the whole animal kingdom, perhaps even in organic nature. They present a constancy in their mode of generation, and in their tegumentary covering, which is not to be met with in any other of the vertebrate classes. No species of bird ever deviates, like the whales among mammals, the serpents among reptiles, and the eels among fishes, from the tetrapodous type characterizing the vertebrate division of animals. The anterior extremities are constructed according to that plan which best adapts them for the action of flight; and although in some instances the development of the wings proceeds not so far as to enable them to act on the surrounding atmosphere with sufficient power to overcome the counteracting force of gravity; yet in these cases they assist by analogous motions the posterior extremities; either, as in the ostrich, by beating the air, while the body is carried swiftly forward by the action of the powerful legs; or, as in the penguin, by striking the water after the manner of fins, and by the resistance of the denser medium carrying the body through the water in a manner analogous to that by which the birds of flight are borne through the air. In a few exceptions, as in the cassowary and the apteryx, the wings are outwardly represented by a few quills or a small claw. In no instances do the anterior extremities take any share in stationary support or in prehension. . . . Birds in general are associated together by characters so peculiar, definite, and unvarying, it becomes in consequence more difficult to separate them into subordinate groups, and these are naturally more arbitrary and artificial than those of the other vertebrate classes."

The plan of the present volume is similar to that of the preceding one.

The several divisions of the frame are dealt with separately, ample reference being made under each head to the modifications which the more common anatomical features undergo in particular species. Under the sections of Osseous, Muscular, Nervous, Digestive, Absorbent, Circulating, Respiratory, Secretory, Tegumentary, and Generative systems, we have an exhaustive account of the general and microscopic anatomy of birds. Finally, the chapter on development deals with the history of the bird from its commencement as a minute germ hardly bigger than a pin's point, to the period when it emerges from its calcareous prison. In the treatment of the Mammalia the same admirable method has been adopted, and in a few examples a more abundant supply of details has been given ; this is particularly true of the Quadrumana. In his classification of mammalia, Professor Owen adheres to his brain-scheme laid down in the Reade's Lecture of 1859. He divides mammalia into four sub-classes:—Archencephala, Gyrencephala, Lissencephala, and Lyencephala. In his definition of these groups the author has modified his original opinions, and has granted the accuracy of Messrs. Huxley's, Rolleston's, and Flower's observations. In his Reade's Lecture he stated that in the Archencephala, which included man only, the cerebrum extended completely over the cerebellum, so as to conceal it from view when the brain was looked on from above. He also contended that this character of the cerebrum at once served to distinguish man from all the Quadrumana. The researches, however, of Huxley and several other distinguished observers went to show that man's brain is not peculiar in the respect alleged by Professor Owen, but that in various Quadrumana the cerebrum covers in the cerebellum, so as to prevent the latter from being viewed from above. Professor Owen also, at the date we refer to, denied that in the sub-class Lyencephala there was any *corpus callosum* uniting the two hemispheres of the brain. The subject was afterwards taken up by Mr. Flower, Curator of the Museum of the College of Surgeons, who showed very clearly that a remnantory or rudimentary corpus callosum is to be found in various marsupials. Professor Owen, therefore, as we have said, slightly changes the definitions formed in 1859, and gives the following as the characters of the mammalian sub-classes. "When the hemispheres are connected by the 'round commissure' and 'hippocampal' commissure only . . . . the cerebral lobes are usually without folds, and have the cerebellum, olfactory lobes, and optic lobes exposed. The sub-class so characterized is called *Lyencephala*." The next stage is when the corpus callosum is present, but yet connects cerebral lobes which are very little superior in organization to those of the preceding sub-class ; the surface of the brain is smooth, or exhibits a few folds similar to those of the Lyencephala. "The hemispheres leave the cerebellum and part of the olfactory lobes exposed. The sub-class so characterized is called *Lissencephala*." Gyrencephala is the name given by Professor Owen to the next group in his classification. It is known by the possession of convolutions and a cerebrum, which is of large relative size, and which extends over half of the cerebrum and of the olfactory lobes. Finally, the sub-class Archencephala, which is formed for the reception of the genus Homo only, is described as having a cerebrum which not only completely covers the cerebellum and olfactory lobes, but extends "in advance of the one and further back than the other." Professor Owen's admissions that the cerebrun *does* cover the cerebellum in some

Gyrencephala, and that the hippocampal commissure is the rudiment of the corpus callosum, show, notwithstanding his bitterly and painfully personal attacks on Messrs. Huxley, Rolleston, and Flower, that he has seen the necessity of giving his definitions a greater degree of elasticity than they formerly possessed.

If we could remove the personalities of controversy, and the hypotheses of transcendentalism, in which the present work abounds, it would be all that we could wish. As it is, it is the most comprehensive and best illustrated treatise on comparative anatomy which has yet been produced in England.

STAR-MAPS.*

A GOOD series of star-maps has long been the desideratum of both amateur and professional astronomers. The publications hitherto chiefly employed have been those of the "Society for the Diffusion of Useful Knowledge," and of Mr. Johnstone's "Atlas of Astronomy." But neither of these possessed the requirements of the student, and Mr. Proctor has therefore done good service in the construction of the maps which Messrs. Longmans have issued. To those of our readers whose study of astronomy has been confined to the "celestial globe," that terror of the school-boy, it may be necessary to say a word or two in reference to the term *Gnomonic projection*, the plan on which Mr. Proctor's maps are constructed. The "celestial globe" does not convey a true idea of the relative positions of the fixed stars, from the circumstance that the observer is supposed to look at the heavens from some point billions of miles away from the surface of the earth. Now, as the position of the observer is really upon the earth, and not away in space, it is clear that for a proper representation of the heavenly bodies the observer should be placed in a huge hollow globe, upon the transparent walls of which the meridians, parallels, and stars are depicted. This is a popular way of putting the difficulty, which has been partially overcome in Mr. Proctor's maps. But since an apparatus such as we describe would be more costly than convenient, a substitute having its principal advantages has been sought for and found. If we suppose the centre of such a sphere as that we have been describing to be a brilliantly luminous point, and if we place the globe upon, let us say, an immense sheet of card-board, we shall have a series of shadows formed (Gnomonic projection) on the card, in accordance with the markings of the heavenly bodies. Of course, the shadows so produced will correspond only to one part of the sphere; but by circumscribing the sphere by a number of pieces of card-board, so as to form an even twelve-sided figure—in fact, a *dodecahedron*,—we shall perceive the shadows of all the stars; convert those shadows into fixed marks, and we have Mr. Proctor's maps before us. In all such projections there must

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* "The Stars, in Twelve Maps, on the Gnomonic projection, collected in duplicate in Four Plates." By RICHARD A. PROCTOR, B.A. Longmans & Co. 1866.

necessarily be a certain amount of distortion; but in those before us the degree of distortion is considerably less than in those formerly employed, owing to the adoption of the dodecahedron instead of the cube in the circumscription of the sphere. As the author very properly observes, a set of star-maps for popular use should fulfil the following conditions :—(1) The celestial sphere should be presented in a moderate number of maps; (2) on the Gnomonic projection; (3) with moderate distortion; (4) with moderate variation of scale; (5) with the relative positions of the constellations of each hemisphere visible at a glance. Now, in the maps at present in use it is well known that there is, as must be from their construction, excessive distortion, great variation of scale, and the equator, for the same reason, divides four of the six maps into equal parts, corresponding to the northern and southern hemispheres respectively.

Mr. Proctor has obviated the errors to which we have referred by projecting the stars upon the circumscribed dodecahedron, which, as can be shown mathematically, is the only form in which the five conditions above mentioned can be best satisfied. His maps form twelve pentagonal maps, arranged in two plates—the first containing the north polar and five northern maps, the second the south polar and five southern maps. The angles of each pentagonal map correspond to points separated by an arc of 37° 22′ 38″·5 from the principal point. The five outer maps are placed in immediate juxtaposition with the central or polar one, and the neighbouring edges of the five outer ones are not so far separated as to prevent the student identifying the divided constellations. All the stars in the Astronomical Societies' catalogue, down to those of the fifth magnitude, are included in Mr. Proctor's delineations; and the right ascension and declination of them, about 1,500 in number, have been calculated from the values and variations given in that catalogue. In order to give the student a clear conception of the nebulæ, two black maps, on which the stars and milky way, minus the constellations, have been carefully drawn, are added. Plates I. and II. are handsomely coloured, and on those also, though less distinctly, the milky way is represented. Mr. Proctor has written a most useful introduction explanatory of his maps; in this he contends, in a manner whose accuracy cannot be disputed, for the superiority of his method of projection over that of other astronomers. We have read his remarks with attention and profit, and we have much pleasure in commending his maps of the stars to all who are interested in astronomical pursuits: they are convenient, precise, and easily intelligible, and convey at a glance an idea of the relative positions of the stars, which could not be obtained in a month's study of the common celestial globe.

NOTES ON EPIDEMICS.*

THIS volume is the expanded reprint of an article which appeared in the January number of the *British Quarterly Review*, and which the

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* "Notes on Epidemics, for the use of the Public." By FRANCIS E. ANSTIE, M.D., F.R.C.P. London: Jackson, Walford, & Hodder. 1866.

publishers have shown a wise discrimination in issuing to general readers in its present form. The subjects of the causes, modes of propagation, and methods of arresting epidemics are just those with which the public should be familiar, and of which unhappily they are too frequently extremely ignorant. The popular household treatises on medicine are at the best sorry instructors, since they deal rather with the treatment of disease than with the best means of detecting its presence ; and contain very worthless information as to the prevention of infectious maladies. Dr. Anstie, therefore, has performed a duty which the profession owed to the public, in reprinting his able essay upon the subject of epidemics. No longer need it be complained that there is no accurate and yet untechnical treatise from which the general reader can learn those principles which should guide him in avoiding infection, and in detecting the early symptoms of disease. In all that relates to that wide class of affections which attack whole populations at once, and are therefore styled epidemics, sound knowledge and an acquaintance with all that recent research has taught, may be gathered from Dr. Anstie's volume. The author has laid down in the clearest manner the principles which ought to be observed by those who desire to detect the presence of epidemics ; and although he is far from advising his readers to play the part of doctor, he shows them how they may treat the common forms of fevers, &c., satisfactorily. His style, without being what is called popular, is intelligible to every educated reader ; his views are expressed with philosophic caution, and there is a careful allusion to recent discoveries, which is equally characteristic of the accomplished physician and the persevering *savant.*

The diseases to which the writer especially devotes his consideration are the following :—Relapsing fever, typhus and typhoid fevers, Asiatic cholera, epidemic diarrhœa, scarlet fever, diphtheria, measles, small-pox, and influenza. All these are treated under the separate heads of cause, mode of propagation, method of diagnosis, treatment, and general hygienic observations. Nothing can be more in accordance with the philosophy of medicine than the way in which Dr. Anstie brings together the parts of conflicting theories which appear reconcilable with fact, and thus attains to truth, where a more prejudiced analyst would fail to separate it from fallacy. This feature is particularly remarkable in the author's remarks on the various theories as to the origin of cholera, a portion of the work before us to which we especially direct the reader's attention. There can, we think, be little doubt that whatever be the primary origin of cholera, its spread is chiefly effected through the medium of drinking water which has become polluted by the drainage from some sewer that, in its turn, has conveyed the discharge of choleraic patients. At the present time the question is one of the greatest moment, and we therefore quote Dr. Anstie's account of the epidemic of Broad Street, Soho Square, in 1854 :—

"In the most crowded part of this densely-crowded parish (St. James's), there occurred, on the 31st of August, no less than 31 fatal cases, all within an extremely narrow area ; on the following day there were 131 fatal cases in the same area ; on the 2nd of September, 125 ; on the 3rd, 58 ; on the 4th, 52 ; on the 5th, 26 ; on the 6th, 28 ; on the 7th, 22 ; on the 8th, 14 fatal attacks, all in the same space, which might be marked off by a circle whose centre might be at the junction of Broad Street and Cambridge Street

(Soho), and whose radius would be of the length of 210 yards. From the last of these dates the disease rapidly diminished to a comparatively insignificant level, and may be said to have ceased by the end of October. Such a phenomenon as this was unusual in our English experience of cholera, and the very singularity of the outbreak inspired Dr. Snow with the hope that fresh light would be thrown by it on the whole question of cholera propagation. Fixing his attention steadily on the local peculiarities of the district, Dr. Snow quickly perceived that one remarkable circumstance was common to the history of the large majority of attacks of the disease—viz., that the sufferers had been in the habit of drinking the water of a well in Broad Street, which had a great reputation for sweetness and freshness. Analysis of this water soon showed that it was highly charged with organic impurities; and on the 8th of September the vestry, on the urgent persuasion of Dr. Snow, removed the handle of the pump, and so prevented the further use of the well. On subsequent examination, it was discovered that the sewage from a neighbouring house-drain had leaked into the well; and it was moreover shown that the discharges of a patient residing in the house in question, and suffering from severe diarrhœa, if not from actual cholera, must have mingled with the sewage immediately."

Among the novelties in Dr. Anstie's book we may mention the account of the thermometer in the diagnosis of febrile diseases. The thermometer may be easily (following Dr. Anstie's directions) employed by the mother or the nurse in the detection of fever, and since it gives results of the most valuable kind, the author's chapter on the subject should be attentively read. Altogether, "Notes on Epidemics" is an important work, useful alike to the public and the practitioner, accurate in its facts, clear in its descriptions, and logical in its inferences, up to the most recent advance of medical science, and highly creditable to the esteemed physician who has taken so much trouble to instruct the people.

ELEMENTARY ASTRONOMY.*

PUBLISHERS on the other side of the English Channel have so many advantages over those at home, that we are not surprised to find them issuing excellent books at about half the cost at which they could be produced in London. Labour of all kinds is so much cheaper on the Continent than here, that (we believe we are correct in stating) it would cost less to have a manuscript printed in English in Leipsic than in London. This explains why so admirably printed, well illustrated, and accurate a treatise as that we are about to notice can be issued in Paris at the low cost of three francs. The little volume before us contains over 350 pages of well-printed letterpress, and a hundred capital woodcuts, and costs only two and sixpence. To those who can read French as easily as English, we recommend M. Boillot's Astronomy. Its style is clear and its descriptions accurate; and though in some parts of the Introduction there is a little to much of the florid stamp of writing, the greater portion of the text is free from defects of diction. It is

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* "Traité Elémentaire d'Astronomie." Par A. Boillot. Paris: Furne. Jouvet, & Cie. 1866.

a well-arranged introduction to astronomy, which can be profitably read by those familiar with the elements of mathematics, and which contains reference to most of the recent discoveries. On some points M. Boillot's explanations are remarkably clear and intelligible ; this is especially true of that unpleasant stumbling-block to the beginner—the *precession* of the equinoxes. The chapter on the constitution of the sun shows that the author is a careful and efficient compiler ; containing as it does references to the investigations of Faye, Lockyer, Carrington, Thompson, Spærer, and Chacornac.

SUMMER RAMBLES.*

MR. LEO GRINDON appears to possess a most wonderful aptitude for the production of books. Here is another offshoot of his fertile mind, or rather pen, for we fear the mental power expended on "Summer Rambles" has been of that limited character which tedious summer walks appear to develop, and for which the author's previous volumes have been so eminently remarkable. The little nicely-printed and sparsely-illustrated volume, which the local publishers hope to "subscribe" extensively, is veritably a windbag of the very worst type. Honestly it must be said that everything valuable it contains might be advantageously compressed into a dozen pages. A more flagrant instance of book-making has seldom come under our notice. If our readers will be good enough to take a slice of a local Directory, a few descriptions of those country hotels in which the surrounding scenery is so graphically painted by "mine host," half a dozen pages of some very popular botany, and if he will dilute the whole with the highly elegant and unornamented (!) language of a peripatetic panorama lecturer, he will be able to ascertain to what species of work Mr. Leo Grindon's belongs. It purports to be a guide for the use of the gude folk of Manchester, who desire to indulge the pursuit of what a writer made immortal by the late Father Prout called the "botany of the boreens." It aims at a description of the pretty country places in the vicinity of the great cotton city, and of the natural objects of interest to be seen in them. But all this might have been done in a far shorter space than Mr. Grindon's ambition seems to have required, and without the painfully wishy-washy maunderings about purling brooks and murmuring streams with which the book abounds. There is hardly a grain of scientific fact in the huge desert of drivelling in which the author so inhumanly leaves his reader. There is another matter, also, on which we must take Mr. Grindon to task. He has been at too much pains to describe the advantages of certain hotels. There was no need, in a work intended for the encouragement of natural history field-studies, to devote a frontispiece to the Palace Hotel, Southport. No one would dream for a moment of accusing so respectable a gentleman as our author of puffery in a matter of this kind. Of course the very notion is ridiculous. Is it not, however, a pity to find a scientific man

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* "Summer Rambles in Cheshire, Derbyshire, Lancashire, and Yorkshire." By LEO H. GRINDON. Manchester : Palmer & Howe. 1866.

going into gushing eulogies of a particular hotel establishment, placing himself, to those who do not really know that nothing could be further from his intention, in the attitude of a clever touter seeking customers? Why did Mr. Grindon leave his wild flowers and archæology to devote himself to the following mawkish and Bradshaw-like sketch of a country hotel?—"That noble edifice, which, calling itself the Palace Hotel, will some day be a first class sanitarium. It is of this building that, by the courtesy and liberality of the proprietors, a view is prefixed as frontispiece to the present volume. No other at Southport is so truly a sea-side place, being quite away from town disturbances, yet enjoying the advantages of a railway station close at hand. The look-out in all directions is very pleasing—that over the water particularly so; and from the gallery at the summit is obtained a panoramic view so vast and varied, that Southport need never be contemned again for its features. The sand-hills immediately beyond form in their wild and everchanging aspect ample substitutes for a corn and pastoral country . . . In winter the snow beautifully flecks their northward and eastward slopes, while the southern and western ones bask in the sunshine; mosses of all shades of green and coppery gold strew the firmer parts in the little islands of sweet brightness, and the light that lies on the round pools is always purple." If Messrs. Howe & Palmer would excise the space at present devoted to the too exuberant and active fancy of the author, and would publish the really useful portions of his book in the form of a convenient pamphlet, they would benefit the public and preserve Mr. Grindon's literary reputation from the critical onslaught to which it is now so liable.

HANDBOOK OF ELECTRICITY, MAGNETISM, AND ACOUSTICS.*

LARDNER'S "Handbook" series has enjoyed a world-wide and deserved reputation, and we are pleased to see that the publishers have just commenced the issue of a new edition. For clearness of text and ampleness of illustration no works on natural philosophy have ever excelled those of the eccentric author of this series. No doubt in other points, as, for example, in scientific perfection and explanation of theories, they have been far surpassed by other writings. Indeed this has always been the fault found with Dr. Lardner's natural philosophy, and it therefore behoved Messrs. Walton & Maberly, in issuing a new edition, to take this into consideration. That the publishers have provided against the objection is evidenced by the fact that the volume just presented to the public has been revised and edited by Professor Foster. The book could not have been entrusted to any one better calculated to preserve the terse and lucid style of Lardner, while correcting his

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* "Handbook of Natural Philosophy." By DIONYSIUS LARDNER, D.C.L. "Electricity, Magnetism, and Acoustics." Revised and edited by G. Carey Foster, B.A., F.C.S., Professor in University College. London: Walton & Maberly. 1866.

errors and bringing up his work to the present state of scientific knowledge. All we can say of the editor's actual labours is, that he has added much new matter to the old text, and that he has modified some of Dr. Lardner's statements in accordance with currently accepted doctrines and recent investigations. The changes by way of substitution and alteration have not been extensive, but the additions made have been both numerous and important, and may be distinguished from the older letter-press by being included within brackets. In Book I. we find, of the editor's writing, a section on the phenomena of the residual charge of the Leyden jar, and a chapter on "Sources of Electricity other than Friction." The principal additions to the department of voltaic electricity relate to Ohm's law of the intensity of currents, the tangent galvanometer, the measurement of conducting powers, the rheostat, ozone, the polarization of electrodes, the retardation of telegraphic signals by inductive action on submarine cables, and the laws of development of heat in the voltaic currents. In this book also we observe that Chapter I., and large portions of Chapters III. IV. and XIII., have been completely re-written. In the fourth book, which relates chiefly to sound, the changes and additions have been less in number, but are not the less valuable. The work addresses itself to those who, without a profound knowledge of mathematics, desire to be familiar with experimental physics, and to such we especially recommend it. The medical student will find in its pages almost everything that is essential to a thorough knowledge of electricity and acoustics.

SCIENTIFIC SUMMARY.

ASTRONOMY.

The chances were certainly very much against the present generation witnessing a repetition of the phenomena so carefully chronicled by Tycho Brahe, and which, before his time, had induced Hipparchus to compile his star catalogue. Still, since our last Summary was written, a *stella nova* has flashed upon our retinas, and almost as rapidly has disappeared. We can, however, now look down upon Tycho, for he had no spectroscope: the tale we have learned by its aid of that strange outburst which took place perhaps some hundreds, perhaps some thousands of years ago, is bewildering to a degree. We need not here chronicle too many of the attendant circumstances; suffice it that 2765 of zone $+26°$ in Argelander's *Bonner Sternverzeichniss* is a long period variable. Its place for 1855·0 was R.A. $15^h\ 53^m\ 26{\cdot}9^s$ and $\delta + 26°\ 20{\cdot}1'$, and its tabulated magnitude 9·5.

On May 16th of the present year this star was observed to be shining like a star of the 3rd mag., a brilliancy it lost almost at the rate of a magnitude a day for some little time after. Mr. Huggins and several physicists on the continent at once attacked the stranger with their spectroscopes with a most interesting result, the ordinary stellar spectrum telling of an incandescent photosphere and an absorbing atmosphere, was here visible in company with another superposed spectrum, consisting of bright lines of various refrangibilities, two of the brightest being coincident with those of hydrogen; so that it seems certain that this sudden blaze was in some way connected with those strange lines—that is, with incandescent hydrogen and some other substances which gave rise to them.

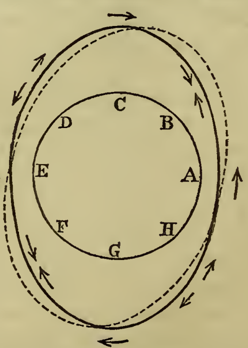
It is very difficult to imagine conditions which shall bring these agents on the scene periodically, but it really seems that this is one of the tasks which observers of variable stars must set themselves if they would attempt to account for the phenomena in a satisfactory manner. Were our sun a trifle more variable than it is, it might, perhaps, help us in this matter; but then possibly there might be drawbacks! It is, however, not too much to hope that this new fact acquired to physical science will set us working at the whole field of variable, new, temporary, and lost stars with renewed interest; the light curves of our variables will be more rigidly scrutinized than ever. From this point of view it is interesting to learn that M. Montucci has presented a paper to the Paris Academy of Sciences on an arithmetical progression which he has observed to result from certain dates contained in the list of temporary stars given by Humboldt. The progression starts from 369 A.D., and the difference is 7.75. This gives us the years 369, 393, 827, 1012, 1230, 1578, 1609, and 1670, in all of which years temporary stars were observed. If the hypothesis be correct, these temporary "stars" will be due to eight returns of a comet, which must have visited us 193 times between 369 and 1670.

This has been the salient discovery of the quarter. We must now call attention to a subject on which we remarked in our last Summary—the the action of the moon on the tides, and indirectly through them on the rotation-time of our earth. It has recently been shown, not only that M. Delauney was anticipated by Ferrel in 1853 (*Astronomical Journal*, iii. pp. 138—141), but that the connection is most probably a real one, an extension of the Astronomer Royal's mathematical investigation having lead him to support the theory. Professor Adams is of the same opinion. Professor William Thomson has pointed out that an equal retardation (10″ in a century) would result in a rise of the sea-level $\frac{4}{7}$ of an inch, or, were meteoric dust to fall at the rate of $\frac{1}{30}$th of a foot in a century. The Astronomer Royal has also given us a very beautiful geometrical proof that, contrary to generally received notion, were the tides to move without friction, there would always be *low water under the moon.*

The method of proof is as follows ; we give it in the Astronomer Royal's own words :—" To assume that the ring of water has an elliptic form, the elliptic shape (not the water) travelling round with the same angular velocity as the hour-angle velocity of the moon, and that the motion of every particle of the water is oscillatory ; to examine more precisely the laws of the oscillatory motions of the waters in different parts of the elliptic ring ; to investigate the forces which are required for maintenance of those oscillatory motions ; and to show that those forces are such as to correspond to low water under the moon, and to no other relative position of the tide and the moon.

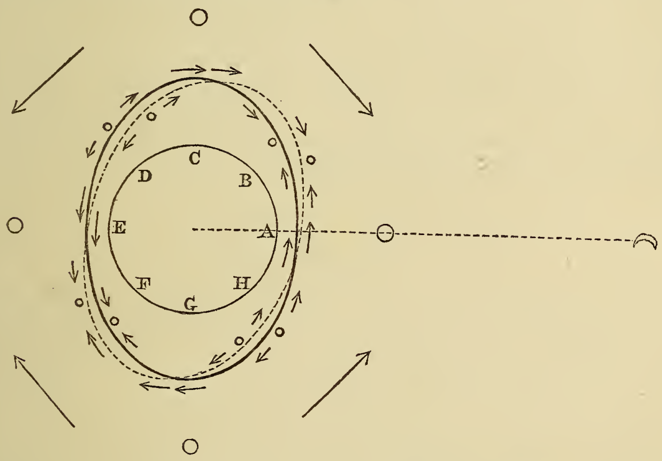
" First, it is to be carefully remarked that the rising of the water at any place does not depend on the horizontal movement of the water at that place, but on the relative values of the horizontal movement of the two sides of the place. If the water on both sides of that place is flowing towards that place, the water rises there. If the water on one side is flowing rapidly towards it, and the water on the other side is receding slowly from it, the water rises there. When the surface at any one place is stationary as to height, there may nevertheless be considerable horizontal velocity ; only it is certain that the water is flowing towards it on one side exactly as fast as it is receding from it on the other side."

In the first diagram the strong elliptic outline represents the form of the surface of the water at the present instant, and the dotted line the form which it will take in a short time ; the form of the dotted curve being the same as that of the strong-line curve, but having turned round with the same angular velocity as the moon.



" At A, C, E, and G, the height of the water has scarcely altered from the state of things with the strong outline to the state of things with the dotted outline. Therefore, the spread of the water is equal on both sides of each of these four points. And therefore it will readily be understood from the ordinary theory of maxima and minima, that at these four points the horizontal motion of the water is most rapid ; its direction at each being at present undecided. At B and F the water is rising most rapidly ; therefore the water is flowing from both sides towards B and towards F. At D and H the water is sinking most rapidly; therefore the water is receding on both sides from D and from H. Hence it follows that the directions of currents are represented by the arrows in the diagram.

"We have now obtained complete knowledge of the state of the currents in the strong-line ellipse, and from these we can infer the state of the currents in the dotted line, or subsequent ellipse, remarking that in this subsequent case the subsequent ellipse, which in the preceding case the preceding currents held to the axes of the preceding ellipse. And, by comparing these, we shall learn what are the changes made in the currents at each place, and what must be the forces which produce these changes.



"At A, C, E, G, the current is scarcely changed, or the forces are O. At B a current O is changed to ↘ and a current ↖ is changed to O, or the force is ↘. At D a current O is changed to ↓, and a current ↗ is changed to O, or the force is ↓. In like manner, at F, the force is ↖; and at H the force is ↗. These forces are such as are produced by the moon in the position shown in the diagram ☽ in the opposite position, and in no other position. Therefore it is low water under the moon."

Father Secchi has published an interesting memoir on Sun Spots, and in some well-arranged experiments has found a decided difference in the intensity, and some difference in the colour, of sun light proceeding from the centre and limb of the sun.

We have the visitation of two observatories to chronicle,—those of Greenwich and Glasgow. The former took place on June 2; the latter on March 29. Mr. Airy's address this year is of less interest than usual. In an address to the "individual members" of the Board of Visitors, Mr. Airy gives an account of the boring of the cube of the transit instrument to allow of the examination of collimator by collimator without raising the instrument. The Admiralty have consented to the purchase of two 7-inch collimators in place of the present smaller ones. Mr. Airy has observed the sun with the great equatorial, and Mr. Stone has used the same instrument for a prismatic examination of the new star. This seems all that has been done with it. The Astronomer Royal, however, saw enough with it to be convinced of the accuracy of the description, which compares (the appearance of the photosphere) with interlacing willow-leaves or rice-grains—a verdict which we can safely leave in the hands of those who come after him.

Professor Grant, in his report, deals principally with the new determination of the latitude of his observatory, and the efforts there made to distribute true time. It is possible that the Town Council of Glasgow—hear it, ye Metropolitan Boards of Works and *Un*works!—will extend the application of the method of electric control to the turret clocks of all the city churches!

Saturn, though low, has lately been a most beautiful object, and is now beginning to give way to Jupiter. Mr. Bishop has conferred a benefit upon astronomers by circulating an ephemeris of the ring system, and a table of the real dimensions of the planet, computed in English miles with Hansen's solar parallax (8″9159), and Airy's equatorial semi-diameter of the earth. This ephemeris, as also one of De Vico's comet of short period, may be obtained by application at the Twickenham Observatory.

BOTANY.

The Colouring Matter of Sea-weeds.—An instructive memoir on the physiological purposes of the red pigment in the Florideæ has been published in the *Comptes Rendus*, by M. Rosanoff, of Cherbourg. His experiments, which extended over several of the genera of this group, enabled him to form several important conclusions, a few of which we abstract as follows:—(1.) Like chlorophyll, the pigment displays protoplasmatic formations disposed upon a membranous layer of protoplasm. It is composed of granules, which may be elongated into curved spines, or may be spherical or band-like, and inflated at intervals. In the natural state they are homogeneous, but after they have been submitted to the action of water they become granular, spheroidal, and vesicular. They do not contain any appreciable quantity of starch, and are impregnated with red colouring matter. (2.) The pigment appears to be accumulated in the interior of the cells, especially when these are situated near the surface of the frond. (3.) With regard to the granules of starch and pigment particles, the latter form chains, which are broken by the former. In some cases the starch granule is surrounded by a number of pigment particles. But the starch granules are never covered by an envelope of coloured protoplasm. (4.) The Florideæ change colour on the spot on which they grow. At first they become brick-red, then they change to green, and finally they become completely discoloured. These are pathological phenomena which depend upon the action of light, of heat, and of the sea-water, which during lowtide becomes diluted by the rain. The first of these changes of colour depends upon the accumulation of the protoplasmic formations in the cellular juice; the second is produced by an alteration in the constitution of the colouring matter; and the third results from its complete destruction.

The Movements of the Diatomaceæ.—The much-debated question as to whether the diatoms are animals or plants, appears to be more difficult to decide than ever it was. A paper recently published by Herr Max Schultze, in his *Archiv für Microscopische Anatomie*, shows that the movements of their organisms take place in a manner similar to those of the Amœba. He states that in all diatoms there is a peculiar viscid substance, which he regards as protoplasm, and by which he believes the movements are determined. Concerning this he makes the following remarks :—"Analogy and the unicellular nature of the Diatomaceæ both suggest that the adhesive substance moving along the raphe is nothing but protoplasm which comes out and re-enters through these openings in the shell. As this motion of the protoplasm is capable of transporting foreign particles of considerable size, it is also sufficient to cause the creeping and various complicated movements of the diatom itself, the more so, since, as I have shown, during this movement the raphe is always directed to the surface which supports it. The protoplasm coating the raphe, and moving over it, has thus the import of a foot, on which the diatom creeps. The long-debated question concerning the movements of the Diatomaceæ I look upon, therefore, as henceforth set at rest."

The Floral Envelopes of the Lauraceæ.—At the late Botanical Congress a paper was sent in by Mr. B. Clarke on this subject, but owing to the great number of communications which the committee had to deal with, it remained unread. The views it lays down are, nevertheless, of some interest. Mr. Clarke considers that the floral envelopes in this order are composed of a trimerous calyx and corolla ; and in support of this theory he refers to the flower of *Laurus* itself, the fourth sepal of which, he says, is internal, and belongs to the petalline parts, the other two divisions of these latter being converted into stamens. He refers to the near affinity of *Hernandia* (recognized by all authors from Jussieu downwards) and of *Gyrocarpeæ* (pointed out by Robert Brown, and adopted by all subsequent writers), and to the evident relation of the last-named family to *Combretaceæ* (of which, indeed, Lindley regarded them as merely a section), and derives, from a comparison with all these plants, further arguments in support of the correctness of his notion. Evidences of near relationship are also deduced from the structure of their ovaries and the attachment of their ovules, and the author finally arrives at the conclusion that *Lauraceæ* are "*Combretaceæ*, with a superior ovary and sepaloid petals."

Insect Agency in the Fertilization of Corydalis cara.—Another memoir which was not read at the Congress was that of Herr Dr. Hildebrand, of Bonn. The author has made several interesting experiments with a view to show the necessity of insect-agency in the fertilization of *Corydalis cara*, and concludes: (1.) That the flowers of the plant when protected from insect-influence, and acted on only by their own pollen, produce no capsules. (2.) That fruit is very seldom formed when the flowers of the same raceme are crossed with each other. (3.) Perfect fertilization can alone be produced by the crossing of flowers on individual plants alone.

The Conditions of Irish Vegetation.—The inquiries of Dr. David Moore have shown that whilst Ireland is better suited than any other European country to the growth of green crops, it is unsuited to the growth of corn and fruit-trees. This is attributable to the following circumstances :—The extreme humidity of the climate, and the slight difference between the winter and summer temperatures—a difference that in Dublin amounts to only $17\frac{1}{2}$

degrees, and on the west coast is only 14 degrees. The mean temperature of Ireland is as high as though the island were 15 degrees nearer to the equator.

Euphorbia palustris in Sussex.—A new station for this plant, hitherto confined to the neighbourhood of Bath, has been recorded by Mr. W. B. Hemsley, who found this *Euphorbia* four years ago in the vicinity of Ditchling, but, until corrected by Mr. Baker, believed it to be a form of *E. amygdaloides.*

The Botanical Department of the British Museum is undergoing rapid and extensive development under the superintendence of Mr. J. J. Bennet, F.R.S. During the year 1865, we see by this gentleman's report that the following additions have been made to the collection :—1,500 species of plants, in the form of an herbarium ; 269 species of plants from the Shetland Isles ; 250 British fungi ; 5 microscopic fungi ; 80 species, illustrating a monograph of the British Cladoniæ ; 269 species of Swedish phænogamous plants ; 200 plants, forming cent. 34 and 35 of Billot's "Flora Galliæ ;" 1,000 species from the Tyrol, 100 being fasciculi 23 and 24 of the "Erbario Crittogamico Italiano ;" 400 of the rarer plants of Sicily ; 76 roses ; 273 European mosses ; 100 fungi ; 130 algæ ; 30 microscopic slides of diatomaceæ ; 1,078 species of South African plants ; 1,600 from the Zulu country ; 2,850 from Venezuela ; 2,127 phænogamous plants from Cuba ; 2,000 garden specimens from Mr. John Smith's collection ; and 100 fruits and seeds from Mexico ; making in all the enormous number of 13,027 specimens accumulated in a single year.—*Vide* Official Report.

What forms the Corona in Narcissus?—To this question a distinguished physiological botanist, Mr. W. G. Smith, replies, — the leave-stipules, and not the perianth nor the stamens. He states that since only 42 out of the 110 genera which the family Amaryllidaceæ possesses exhibit the corona, this organ must not be regarded as a typical one, but should be looked on as an appendage. The transition, he says, from leaf to sepal, from sepal to petal, and from this latter to stamen, and stamen to pistil, has been often described, but no attention has been paid to the subject of the metamorphosis of the leaf-stipule. Now, he considers that the true explanation of the corona in the small section of the order in which it appears consists in the recognition of a series of confluent petal-stipules leaving the normal six stamens and six petals as in the rest of the Amaryllidaceæ. Dr. Masters considers the corona a series of mystified stamens ; but Mr. Smith very ingeniously and fairly employs his (Dr. Masters's) arguments to support his own views. In concluding his able essay he says, "It may be objected that stipules of no sort form any character of the natural order Amaryllidaceæ ; but the answer to this is, that stipules have little or no value as a family character, as in *Hederaceæ* (or Araliaceæ) stipules are present in some genera and absent in others. This I consider exactly equivalent to the presence or absence of the corona in the genera of Amaryllidaceæ." That abnormal growths of the corona of Narcissus more nearly approach the true form of stipules is shown very distinctly by some of Mr. Smith's drawings of abnormal forms of the the corona.—Vide *The Journal of Botany*, June.

The Vacancy in the Botanical Section of the French Academy.—This has been filled by the election of M. Trécul, whose numerous researches we have had from year to year to record and abstract from. The vacancy was caused by the death of M. Montagne, and of the two competing candidates M. Trécul obtained 39 votes, and M. Chatin 14.

The Aëriferous Roots of Aquatic Species of the Genus Jussiæa.—A most valuable botanical contribution is that of M. Ch. Martins on the above subject. The genus referred to is one of the *Onagraceæ*, and includes about 80 species; some of which are terrestrial, others aërial, and others aquatic; and are natives of Asia, Africa, America, and Australia. When the plants are carefully examined, it is seen that there are four kinds of roots, which spring from the submerged branches bearing the leaves and flowers. (1.) Filiform, non-ramified roots placed at the extremity of the branches; (2) branched, or rather comb-shaped roots; (3) comb-shaped roots whose axis is thicker, whitish, and spongy. These three first varieties are either floating or buried in the mud. (4.) Roots which differ entirely from the preceding ones; these are simple, cylindrical, or conical, soft and spongy, white or red coloured, always floating, placed vertically in the water, and containing a large quantity of air. There are other aëriferous roots, or, as M. Martins calls them, the swim-bladders of the plant (*vessies natatoires de la plante*). These roots, when examined under the microscope, showed the following component parts:—(1.) A central vascular bundle, identical with that of the spongy root. (2.) A cellular tissue, formed of rows of prismatic cells placed in juxtaposition in the centre, but separated at the circumference by intercellular lacunæ filled with gas, and which become larger as one approaches the circumference. (3.) An epidermic layer, formed of several rows of elongated cells. The air contained in the bladder thus formed has been analyzed for M. Martins by M. Mortessier, who gives the subjoined as the results of 15 different analyses:—

Nitrogen	87·0
Oxygen	13·0
	100·0

—Vide *Comptes Rendus*, March 26.

The Testa of the Seeds of the Solanceæ.—Mr. Tuffen West's investigations upon the structure of the seed in Solanaceous plants have led to some important results. It is a form of barred tissue, constituting a support to the *lateral* walls of the cells; in which portion of the cells the primitive membrane is found in mature seeds to have disappeared more or less completely. The *inner* walls are greatly thickened by horny and even crustaceous deposit; in addition to their (usually) very sinuous outline, the edges of the *inner* walls are also elongated by undulation; from these edges processes arise which form a fringe having the appearance of hairs. By examination of numerous examples, this structure proves to be a form of barred tissue, which, by various intermediate conditions, passes in *S. Indicum* and *S. jasminoides* into a reticulate tissue. The author is very desirous to procure seeds for microscopic examination, the results hitherto obtained promising to possess interest and value in proportion to the extent to which they are systematically carried out.

CHEMISTRY.

Glycogen in the Tissues of Mollusks.—Signor Rizio presented a paper on this subject to a recent meeting of the French Academy. This observer not only detected an amyloid substance, which he believes to be glycogen, in the tissues of various species, such as the oyster, the mussel, the razor-shell, and the scallop; but he has shown a very curious fact in connection with the presence of this substance; viz., the rapidity with which the amyloid substance gives rise in these mollusks to lactic acid fermentation, so that in those species in which this matter is abundant the lactic acid produced is sufficient to preserve the animal from putrefaction. From this it follows that the more or less easy preservation of the body of the animal may enable us to judge of the relative quantity of amyloid substance contained in it.—*Comptes Rendus*, April 2.

Oxidizing Action of Air on Coal.—The recently published observations of Varrentrapp upon the oxidation of coal by atmospheric air have disclosed some curious results. The coal which he experimented on was gas coal from certain mines in Westphalia. The coal was dried and pounded, and the powder, which passed through a quarter of a millimetre sieve, was used for examination. The powder was next placed in a three-necked Woulffe's bottle, one neck being for the entrance, and the other for the exit of the air, while the middle one gave passage to the bulb of a thermometer, which rested upon the coal in the bottom of the vessel. The air, rendered perfectly pure by potash, &c., was measured by passing it through a gas meter; it then came in contact with the coal, and afterwards bubbled through baryta-water, the amount of carbonic being determined from the quantity of carbonate formed by a given amount of air. The coal was exposed to different temperatures by immersing the bottle in a paraffin bath; air was passed for some time through the entire apparatus before each experiment. 530 grammes of coal exposed for 30 days of 24 hours, at from 15° to 18° C., to a current of air gave off 0·109 gramme of carbon in the shape of carbonic acid. 534 grammes were moistened with boiled water, and heated to 110°; the coal only rose to 97°, and in 10 days gave off 0·529 gramme of carbon. Between 130° and 140° the first-mentioned quantity gave off 0·538 carbon in 24 hours. Up to this time the temperature of the coal has been lower than that of the bath. When, however, the latter was heated to 160°, the thermometer in the coal rose to 170°, and 1·64 grammes of carbon were oxidized in 24 hours; on heating the bath to 170° the coal showed a temperature of 180°, and in 48 hours 2·74 grammes of coal were consumed.

New Mode of preparing Oxygen.—This has been devised by Herr Fleitmann, and has recently been experimented on by Herr Reinsch. The latter rubbed up chloride of lime and water till they formed a cream, separated the lumps, and shook up the cream with water. Allowing the mixture to deposit, he then poured off the clear solution, and heated it, along with a piece of peroxide of cobalt, in a retort to the temperature of 30° or 40° Centigrade. At this temperature oxygen was freely evolved. At a greater heat the liquid passed over. Peroxide of nickel behaved like the peroxide of cobalt. With copper salts a stronger heat was required, and less oxygen was obtained. On treating a saturated solution of chloride of lime with chloride of manganese, only traces of oxygen were evolved, but the solution took a magnificent dark violet colour. Perchloride of iron gave as little oxygen. A small amount of manganese with it gave a violet colour. Chloride of lime is, therefore, a good test for detecting manganese in iron.—*Chemical News.*

The Chemical Composition of Mutton Tallow.—Heretofore this substance has been thought to have a very simple constitution; but the recently-published investigations of two French chemists show that this view is quite unfounded. MM. Maumené and Rogelet's paper on the chemical constitution of mutton suet demonstrates that this fat is of a more interesting character than chemists generally are prepared to admit. They look upon it as the most complex of all organic compounds, since they have found in it no less than twenty-nine distinct bodies, none of which have any relation to compounds with which chemists are yet familiar.—Vide *L'Institut*, April.

A Sensitive Test for the Presence of free Acids and Bases has been suggested by Schönbein. It is nothing less than cyanine blue, which is easily produced by the action of iodide of amyl on lepidine, and subsequent treatment of the product with soda. To prepare the reagent for the purpose of testing, one part of cyanine is dissolved in 100 parts of alcohol, and the resulting deep-blue solution is further diluted with twice its volume of water. The colouring powers of this liquid are so intense that the merest trace of acid can be detected by it. Well-boiled water, which has been slightly tinted with this reagent, loses its colour the moment a few bubbles of air are blown through it from the lungs, thus showing the action of so feeble an acid as carbonic in so small a proportion. All ordinary water destroys the tint of this solution by reason of the carbonic acid which it contains. Quantities of this acid, unrecognizable by baryta or lime, can be detected in this way. Water containing one-millionth of sulphuric acid destroys the colour of a quantity of cyanine solution that gives a very distinct blue tint to pure water. Schönbein likewise employs this dye for detecting the presence of small amounts of bases, by previously destroying the blue tint by the cautious addition of acid. Water containing one-millionth of caustic potash develops a quite distinct violet when mixed with this reagent. A solution of oxide of thallium, which would form no precipitate with iodide of potassium, strikes a clear blue. The solubility of oxide of lead in water is, as is well known, so feeble that many have doubted its very existence; though unrecognizable by sulphuretted hydrogen, it is shown by the cyanine. Magnesia also, when shaken with water, renders the acidulated colourless cyanine liquid distinctly blue.—Vide *The Reader.*

The Vacancy in the Chemical Section of the French Academy.—The post of honour has been virtually conferred on M. Marignac, of Geneva, who has been placed in the "first line" by M. Chevreul. The principal candidates were Kolbe, Frankland, Williamson, Strecker, Stas, Zinin, and Schrötter.

Chloride of Sodium in fixing Photographs.—A new chemical use for common salt has been discovered by an Italian chemist, Signor Roncalli, who takes his prints from the frame and places them in a solution of common salt of 5 per cent. strength, leaves them there for some time in the cold, and then gradually heats the bath up to boiling-point for about ten minutes, after which the print becomes completely "fixed."—See *Chemical News*, June 1.

Crystalline Chromic Acid.—According to the analysis of Rammelsberg, this acid is a true anhydride. The crystals examined by him contained sulphuric acid.—*Poggendorff's Annalen*, No. 3.

The Nature of Silicates.—In his lecture on Chemical Geology, recently delivered in the School of Mines, Dr. Percy entered into considerable details regarding the general and chemical characters of the silicates. He gave the following account of the physical qualities of these substances :—They are all solid and hard, and generally brittle, but varying greatly in this respect, some being exceedingly tough and others just as brittle, breaking sometimes with a stone-like fracture, sometimes with a conchoidal fracture, like a piece of glass, and possessing almost every tint of colour, according to the materials which they contain. "We have blue silicates, red silicates, yellow silicates, and all kinds of coloured silicates. Here, for example, is a blue silicate. It is a silicate of cobalt essentially with alumina and other things. It has a fine blue colour. Then there is the red colour. Take, for example, the silicate of some oxide of copper. Of this you have a specimen in this stained bottle. Here is another specimen having a red colour. This is a very curious specimen in other respects, because when viewed by transmitted light the colour is green or bluish-green. We might go on multiplying examples, but it would be useless on the present occasion. Suffice it to say we have every tint. Here, for example, is a silicate of the protoxide of copper, very easily made. Here is a silicate which is prepared artificially by double decomposition. The various coloured glasses we see owe their colour entirely to silicates of metallic oxides."

Use of Lime in extracting Sugar.—Peligot long ago demonstrated that owing to the insoluble nature of the compound formed of lime with sugar, the former substance would be a most valuable agent in the manufacture of the latter. Peligot's suggestion is now being carried out on a large scale in MM. Schrötter and Wellman's sugar-factory at Berlin. The molasses is mixed with the requisite quantity of hydrate of lime and alcohol in a large vat, and intimately stirred for more than half an hour. The lime compound of sugar which separates is then strained off, pressed, and washed with spirit. All the alcohol used in the process is afterwards recovered by distillation. The mud-like precipitate thus produced is mixed with water and decomposed with a current of carbonic acid, which is effected in somewhat less than half an hour. The carbonate of lime is removed by filtration, and the clear liquid, containing the sugar, evaporated, decolourized with animal charcoal, and crystallized in the usual manner. The sugar furnished by this method has a very clear appearance, and is perfectly crystalline. It contains, according to polarization analysis, sixty-six per cent. of sugar, twelve per cent. of water, the remainder being uncrystallizable organic matter and salts. The yield, of course, varies with the richness and degree of concentration of the raw material; on an average, 30 lbs. of sugar were obtained from 100 lbs. of molasses.

Composition of the Waters of the Red Sea, Dead Sea, and Mediterranean.—

A memoir was lately published in the *Comptes Rendus*, in which the actual chemical composition of these three seas was given by Robinet and Lefort. The following table gives the percentage composition of the residue obtained by evaporation :—

	Mediterranean.	Red Sea.	Dead Sea.
Chlorine	52·92	50·33	65.78
Bromine	1·14	1·11	1·25
Sodium	31·15	30·92	11·22
Potassium	7·00	3·33	3·71
Calcium	1·18	1·16	5·67
Magnesium	3·62	3·54	12·59
Sulphuric acid	6·42	6·35	1·05

From this we perceive that while the Mediterranean has a much larger quantity of potassium than either of the others, and both it and the Red Sea have nearly three times as much sodium as the Dead Sea, the latter has more chlorine, more calcium, more magnesium, and less sulphuric acid than either of the former.

GEOLOGY AND PALÆONTOLOGY.

Petroleum formed from Sea-weed.—This theory of the formation of rock-oil has recently been advanced by Professor Wilbur, of Hamilton, Canada West. His idea is that the petroleum has had its source in marine vegetation, just as coal has been derived from terrestrial plants. Few persons have any adequate idea of the immense growth of seaweeds in the depths of the ocean. It had been shown that seaweeds had in their composition a large amount of oily, carbonaceous matter. After their term of growth was fulfilled, they became detached, floated off, and finally sank to the bottom. Now, it was a received opinion among geologists that this portion of the North American continent had once been the bed of a salt-water ocean. The ocean-floor, as must be remembered, was not level by any means, but had throughout its whole extent deep hollows and rising ridges. It was, of course, in these deep hollows that these seaweed deposits would find their last resting-place, after long tossing about in the waves and ocean currents. In this way it would come to pass that they would not be evenly distributed over the bottom, but only in those hollows or pockets. Meanwhile the deposit of solid stratified rock, or what afterwards became such, was going on, and after untold ages these masses of seaweed became covered to various depths. He considered it no very unreasonable or unscientific supposition, that these masses of oily, carbonaceous matter should, under the circumstances, take the form of oil, of a liquid hydrocarbon. They had seen that oil existed in and was distilled from coal, which was conceded to be the remains of terrestrial vegetation. There was, therefore, nothing violent in the supposition that petroleum, so exactly like coal oil in its properties, has been formed from marine vegetation. The vegetable origin of both, he contended, was indubitable.—Vide *Mining Journal*, April.

Models of Pre-historic Pile-dwellings.—It is stated in the *Athenæum* that Professor Keller, the distinguished investigator of the ancient lake settlements, has been requested by the French Government to send a model of a pile-structure to the Paris Exhibition. Professor Keller, who only lately has received the cross of the Legion of Honour from the Emperor, in acknowledgment of his indefatigable researches, will do his utmost to furnish a faithful copy of the curious pile buildings, for which a Robenhauser structure will serve as a pattern. The building will be erected on a large water-basin outside the circle of the Exhibition, which is to supply the steam-engines and to be ready in case of fire. It is to be completely furnished, in the style and fashion of the lake settlers.

The Geology of the Bas-Boulonnais.—M. E. Rigaux's exhaustive memoir, published in the *Bulletin* of the Academic Society of Boulogne, gives numerous sections of the rocks in this district. The Palæozoic formations are (1) the Devonian, which extends from Blacourt stream, near the road between Calais and Boulogne, and disappears near Fiennes (at Caffiers it is overlain by Gault); and (2) the Carboniferous, consisting of, first, a Dolomitic bed, then a mass of Limestone, then Coal, and above that another bed of Limestone, similar to the one below. This succession M. Rigaux believes to have been due to a disturbance which has caused an inversion of the strata, so as to make the same bed of limestone appear above, as well as below the coal.

The Geological History of Malta is very interestingly sketched in an article by Captain F. W. Hutton in the *Geological Magazine* for April. The author, after giving a detailed account of the deposits in the island, proceeds to offer some theoretical remarks as to their period of formation. The Maltese beds, he thinks, were deposited at a time when probably the Alps, Apennines, and the mountains of Turkey, Greece, and North Africa, formed groups of islands in a shallow Miocene sea, which extended over the valley of the Danube, the greater part of Switzerland, and the valley of the Rhine, as far as Mayence. Central France, he supposes, in conformity with current views, to have been at that time land, with a large series of fresh-water lakes and several active volcanoes. After a long blank Etna was raised, and during its upheaval most of the faults were formed which appear in Maltese rock. Malta now was part of a continent which included most of Europe, the Mediterranean area, and the North of Africa. Then followed the Glacial period, during which the basin of what is now the Mediterranean sank—that part which now constitutes Malta to rise once more, barren and denuded of all its surface soil.

The Exhaustion of our Coal-beds.—This subject, which has attracted so much general attention since Mr. J. Stuart Mill's remarks in his speech on the malt-duty, will be found fully treated in an able article in our present number. We may mention also that in a volume recently published, an attempt is made to prove that our coal-deposits as yet unworked extend over a greater area than those now known. The author, Mr. Holdsworth, brings forward a great deal of sound evidence to show that the coal-beds dip beneath the secondary deposits of London, pass beneath the Channel and part of France, and make their reappearance in Austria and Russia. There is no reason why his theory may not be correct; but we may ask, whether it would be possible to procure coal by driving a shaft through all the secondary and tertiary deposits. Is a coal-mine workable at such a depth?

Russian Coal Resources.—Recent explorations and surveys appear to show that the Russian coal resources are much vaster even than those of the United States of America. In the Oural district coal has been found in various places, both in the east and west sides of the mountain-chain; its value being greatly enhanced by the fact that an abundance of iron is found in the vicinity. There is an immense basin in the district of which Moscow is the centre, which covers an area of 120,000 square miles, which is therefore nearly as large as the entire bituminous coal area of the United States. The coal region of the Don is more than half as large as all of our coal measures. Besides these sources, coal has lately been discovered in the Caucasus, Crimea, Simbirsk, the Kherson, and in Poland.

Fossil British Oxen have had a paper devoted to them by Mr. W. Boyd Dawkins, at the meeting of the Geological Society on the 21st of March. The author considered that the problem of the origin of our domestic races of cattle can only be solved after a careful examination of each of the three European fossil species of oxen; namely, *Bos urus* of Cæsar, *B. longifrons* of Owen, and *B. bison* of Pliny. In this paper Mr. Dawkins began the inquiry with *Bos urus*, Cæsar, and he arrived at the conclusion that between this species and *Bos taurus*, or the common ox, there is no difference of specific value, though the difference in size and some other characters of minor value render the bones of the two varieties capable of recognition. After giving the synonymy of *Bos urus* in some detail, and measurements of the different bones as represented by specimens from a number of localities, Mr. Boyd Dawkins described the range of the species in time and space.

What Atmospheric Agency can effect.—Mr. J. Beete Jukes and Mr. Scrope are still at issue on this point, the former contending that aqueous atmospheric agencies have most to do with the outline form of the earth, while the latter relies on volcanic influence as the most powerful and most general influence. In a letter, recently published, Mr. Jukes lays down two conclusions which, he says, are in our islands specially applicable to palæozoic districts, but which, *mutatis mutandis*, apply to rocks of all ages. These are as follow:—1st. The sea has removed vast masses of rock, and left undulating surfaces, the highest points of which ultimately become the summits of mountains. 2nd. When these undulating surfaces are raised high into the air, they are attacked by the atmospheric agencies, and hills, valleys, and plains gradually carved out of the rock-mass below, their particular features depending on original varieties in the nature of that mass, and variations in the action of the atmospheric agencies. The latter depend largely on the variations of temperature, by which water is made to assume the different forms of vapour, water, snow, and ice. It must be recollected that the forms of our Palæozoic grounds are of very ancient date, anterior to the period of the New Red Sandstone, and that the great denudation of the Older Palæozoic Rocks took place even before the deposition of the Old Red Sandstone. The time, then, during which the atmospheric agencies have been modelling the minor features is inconceivably great. The recent temporary depression beneath the waters of the glacial sea did little or nothing in the way of denudation, the principal effect then being the transport of blocks, or the washing about of materials already loose on the surface.—Vide *Geological Magazine*, May.

The Difference between Coal and Cannel is in all cases better marked than some geologists imagine—at least, if we are to believe the statements made in a recent communication by Mr. J. Rofe, F.G.S. Though both are undoubtedly of vegetable origin, they are clearly distinguishable by the fossils they contain. In the body of coal the fossils are nearly all, if not entirely, vegetable, whilst in the cannel, fish-remains are frequently present. Another remarkable difference is shown in the distillation of the two substances. In preparing gas from cannel it is necessary to have the pipes from the retorts much larger than when coal is employed, since they are liable to become choked by a deposit which was formerly thought to be pitch, but which is really found to consist of crystals of chloride of ammonium bound together by tar. Concerning the origin of this, Mr. Rofe asks,—"May not this large quantity of chloride of ammonium be accounted for by the cannel bed having been deposited in saltwater, the habitat of the fish found in the cannel, the seawater furnishing the chlorine for this salt? I am fully aware that the distillation of common coal gives salts of ammonium; but they are principally carbonate, sulphate, and sulphide, with very little chloride, and these are all found in what is technically called the ammoniacal liquor. The cannel also gives these salts in solution in the liquor in addition to the crystals sublimed into the pipes as above stated."

Erosion of the Surface of the Country around New York.—An instructive and useful series of diagrams illustrating the above were recently exhibited by Professor Stevens at the American Institute. The Professor considers that it is an evident truth that the irregularities in the surface of the State were caused by disintegration and denudation, the consequence of climatic influences. The first diagrams—all taken from actual surveys—showed a section of the State east and west, presenting a succession of plateaux rising at somewhat regular distances and heights, one above another; the second plateaux appearing on the horizon when standing on the first, the third when standing on the second, and so on. The section north and south presented a strikingly different appearance, viz. a succession of hills and valleys, stretching from one border of the State to the other, and terminating with the broad, elevated coal-fields of Pennsylvania. The ridges of some of these hills are so narrow that two horsemen can with difficulty ride side by side. All the summits of the ridges are somewhat on a level, and all below the level of Pennsylvania coal. His diagrams went to show that the coal-fields had in times long past covered the southern part of the State of New York as they now cover Pennsylvania, but had subsequently been washed away.

The Fossil Remains of Stylodon pusillus.—Specimens of the lower jaw and teeth of this oolitic mammal having been forwarded to Professor Owen by the Rev. P. B. Brodie, the former has given a minute account of the fossil in the *Geological Magazine* for May. The part of the lower jaw is imbedded in a small block of the matrix, with the outer surface exposed: it includes the proportion of the ascending ramus supporting the coronoid process, a film of which only remains in the depression of the matrix, mainly indicating its size and shape, and so much of the horizontal ramus as includes the alveoli of the nine posterior teeth, eight of which are *in situ.* The articular and angular processes, and the fore part of the ramus, have been broken away, and there is no indication in the matrix of the entire ramus having been imbedded therein ; so it may be inferred, therefore, that the mutilation took place prior to imbedding. Enough, however of the parts remained to enable Professor Owen to conclude that the fossil was a mammal, and to enable him to add another genus and species to the small mammalian fauna of the Mesozoic period.

MECHANICAL SCIENCE.

Balanced Rudder for Screw Steamers.—Our readers will remember that we have already described the invention of Mr. Arthur Rigg for applying fixed directing-blades behind the screws of steam-ships, by which the current of water driven off obliquely by the screw is turned into a fore-and-aft direction, in order that the increased pressure on the concave surfaces of the blades, and the diminished pressure on the convex surfaces, may produce an additional thrust for driving the vessel, and thus save power otherwise wasted. More recently, Professor Rankine and Mr. James R. Napier have proposed to modify the form of the balanced rudder abaft the screw so as to effect the same purpose, a plan which is applicable in the case of vessels which have no after-sternpost, in which fixed deflecting blades could not be used. In the rudder proposed by Professor Rankine and Mr. Napier, the forward edge, when the rudder is standing amidships, is tangential to the current from the screw, and the after-edge points directly aft. The construction for finding the form of the rudder is given in a paper by Professor Rankine, read before the Institute of Naval Architects.

On finding the most Economical Rates of Expansion in Steam-engines.—A very remarkable paper on this subject was read by Professor Rankine at the last meeting of the Institute of Naval Architects, in which a graphic construction is given for finding the most economical grade of expansion when the ratio of back pressure to absolute initial pressure, and the ratio of expense which varies with the capacity of the cylinder to the expense which varies with the quantity of steam used, are known.

The following are some of the results obtained :—

Ratio of Back Pressure to Initial Pressure.	Ratio of Cost of Engine to Cost of full Steam.				
	0·05	0·10	0·15	0·20	0·25
	Most economical cut off.				
0·05	0·16	0·22	0·27	0·30	0·33
0·10	0·20	0·25	0·30	0·33	0·37
0·15	0·24	0·29	0·33	0·37	0·40
0·20	0·28	0·33	0·37	0·40	0·44

On the Flow of Solid Bodies.—M. Tresca has communicated a remarkable paper to the French Academy of Sciences under the above title, containing the results of researches on the deformation of solid bodies under pressure, which M. Tresca seeks to explain by laws analogous to those of the flow of liquids. The experiments were made on blocks consisting of thin sheets of lead, and these were punched through by a cylindrical steel punch, distorted by compression in a direction perpendicular to the layers ; and, lastly, forced from a cylindrical chamber through an orifice. In all cases the molecules of the solid were found to change their places, flowing in the direction of least resistance in a manner analogous to fluid flow. In the case of the lead forced through an orifice, a contracted vein was formed, a very singular result. M. Tresca has subjected these experiments to mathematical analysis, with a view of finding a basis for a new theory of the resistance of materials. Some account of these experiments will be found in "*Engineering*" for March 16.

Negative Slip.—At the Institute of Naval Architects Mr. E. J. Reed read a very interesting paper on the *Negative Slip* of screw steamers, as it is called, or the phenomenon of a ship advancing in the water at a greater rate than that due to the pitch and number of revolutions of the screw. After discussing the various theories which have been proposed to account for this apparently paradoxical result, and rejecting them as insufficient, Mr. Reed stated that, in his belief, the cause of negative slip would be found in the elasticity of the fluid combined with the stream or current following in the vessel's wake.

The Non-recoil Gun.—Mr. G. P. Harding has recently proposed and experimented upon a gun on a principle so novel that, if his expectations are fulfilled, the manufacture of fire-arms will be revolutionized. His gun is, in fact, a simple cylindrical tube without any breech. The shot is placed at the centre, the charge behind it confined by a wad, and a second wad is introduced at such a distance as to leave an air-space behind the charge. Now the extraordinary fact developed by Mr. Harding's experiments is this :—That, although the gun is equally open in both directions, almost the whole force of the explosion takes effect on the shot, which attains the same velocity as if fired from an ordinary gun, and is followed by the gases generated in the gun, a very small part only escaping at the breech. Mr. Harding's theory of the action of his gun appears to be this :—That compression of the air in the air-space behind the charge occupies an appreciable time, during which the force of the explosion has been communicated to the shot ; but it is obvious that Mr. Harding's results, if confirmed, will require a new examination of the action of powder in close chambers, our present knowledge being insufficient for their adequate explanation. In the mean time Mr. Harding has made several hundred experiments, which are certainly interesting and probably important. Of course, in such a gun as Mr. Harding's there is no recoil, and hence the name he has given to it.

THE MEDICAL SCIENCES.

Microscopic Plants the Cause of Ague.—Owing to the prevalence of ague in the malarial district of Ohio and Mississippi, Dr. Salisbury undertook a series of experiments in 1862, with a view to determine the microscopic characters of the expectorations of his patients. He commenced his experiments by examining the mucous secretions of those patients who had been most submitted to the malaria, and in these he detected a large amount of low forms of life, such as Algæ, Fungi, Diatomaceæ, and Desmidiæ. At first he imagined that the presence of these organisms might be accidental, but repeated experiments convinced him that some of them were invariably associated with ague. The bodies which are constantly present in such cases, he describes as being "minute oblong cells, either single or aggregated, consisting of a distinct nucleus, surrounded with a smooth cell-wall, with a highly clear, apparently empty space between the outer cell-wall and the nucleus." From these characters Dr. Salisbury concludes that the bodies are not fungi, but belong properly to the algæ, in all probability being species of the genus *Palmella.* Whilst the Diatomaceæ and other organisms were found to be generally present, the bodies just described were not found above the level at which the ague was observed. In order to ascertain exactly their source, he suspended plates of glass over the water in a certain marsh which was regarded as unhealthy. In the water which condensed upon the under surface of these plates, he found numerous palmella-like structures, and on examining the mould of the bog, he found it full of similar organisms. From repeated researches Dr. Salisbury concludes :—(1.) Cryptogamic spores are carried aloft above the surface at night, in the damp exhalations which appear after sunset. (2.) These bodies rise from 30 to 60 feet, never above the summit of the damp night-exhalations, and ague is similarly limited. (3.) The day air of ague districts is free from these bodies.

Relative Values of Ether and Chloroform.—This question is still the subject of controversy in France. Some time since an essay appeared upon the subject in the *Comptes Rendus.* This, which was written by M. B. de Buisson, contends for the superiority of ether, and asserts that when good ether is employed by those who understand how to use it, it is more certain in its action and less dangerous in its effects than chloroform. M. Buisson alleges that "with ether of the strength of 62°, we have generally produced sleep and insensibility in from four to seven minutes ; eight to ten minutes have been rare exceptions. The sleep thus obtained is a deep one, and we have often prolonged it for more than an hour without the least inconvenience." M. Buisson enters into details to show that several ordinarily extremely painful operations were very satisfactorily performed by him on patients who were under the influence of ether ; in these cases no pain was complained of during the operation.

The Temperature of the Body.—The subject of the heat of the body—how and where it is maintained—has been very fully investigated by MM. Estor and Saint-Pierre, who have published the results of their inquiries in Robins's

Journal de l'Anatomie. The following are some of the conclusions at which these *savants* arrive :—1. That the respiratory oxidations take place exclusively in the blood, and are not limited to any particular part of its course, continuing during the whole period of the passage of the blood from the lung till it arrives at the lung again. 2. That they are very active in the arterial system. 3. That the capillaries only augment the venous character of the blood by retarding its course. 4. That the respiratory processes of oxidation are progressive : that in the arterial system they are direct or indirect causes or consequences of reduction ; whilst in the capillary and venous systems they are complete, extending to the destruction of the compounds.

Value of Nitrate of Silver in Microscopical Inquiries.—Nitrate of silver is so much used by human histologists, and so much reliance is placed on the results it gives, that it is necessary to draw the attention of students to a paper read before the Vienna Academy of Sciences on the 22nd of March last, by Dr. Federn. The author has been engaged in studying the arrangement of the parts comprising the tissues of the capillaries. The theory that capillaries are formed of flattened cells joined together is founded entirely upon the evidence derived from silver markings. The assertion that the parts mapped out by the silver markings are always each provided with a nucleus is incorrect. Some may often be observed to be without a nucleus ; while one nucleus often extends into two of these parts. The markings by silver are due to the crossings of winding threads, which, at least in many places, project near to their crossings over the outline of the vessel. With strong magnifying powers, two layers can sometimes be distinguished both in the upper and lower walls of a capillary ; and, consequently, in the whole, at least, three or even four layers of crossing threads. Further, two crossing threads of one wall of a vessel may be clearly seen to bridge one over the other at the point of crossing, which could not be done in the intercellular substance disposed cross-shaped. The author does not go further into the nature of these threads, but points out that from the silver reaction alone no definite conclusion is to be drawn, because, as we know, besides intercellular substance of the epithelium, the contractile substances of striped muscular fibres, and also protoplasm, with, perhaps, other substances, are turned brown by silver.

The Rapidity of Nerve-force.—Dr. Du Bois Reymond, the distinguished Professor of Physiology in Berlin, and who has been recently lecturing in our Royal Institution, showed some interesting experiments upon the above subject. He pointed out the analogy between nerve-force and electricity, and between nerves and telegraph wires, showing that the two latter are merely media for the transmission of their respective forces. Though the transmission of sensations is so rapid that the effect seems to be instantaneous with the exciting cause, nevertheless it is not so, and there is in reality an interval of time between the prick of a pin on the foot and the perception of the sensation—an interval so minute indeed as to be inappreciable ; for no space of time less than the tenth part of a second can be distinguished by the natural powers of man. By mechanical contrivances, however, very much smaller portions of time can be observed and noted, and by this means, with the aid of electricity, the velocity of nervous agency has been determined. Dr. Reymond exhibited several curious and complicated experiments, in which the nerves of a frog recently killed were excited by secondary voltaic currents, and the contraction of the muscles thereby produced was shown by magnifying the effects, so that in one case a small flag was raised, in another arrangement the effect was seen by releasing a trigger, and in a third case lines were stretched on a blackened glass, that were afterwards exhibited by the electric lamp. Nerve-force is not rapidly transmitted along the nerves. In a creature so long as the whale, the rate of nervous transmission becomes very perceptible when the extremities have to be moved. The fact of a harpoon having been thrust into the tail of a large whale would not be announced in the creature's brain till a second after it had entered, and it would take another second to transmit the force required to move the extremity of the tail.

Action of Carbonic Oxide on the Pulse.—The researches of Professor Traube, reported to the Vienna Academy of Sciences, show that small quantities of carbonic oxide cause a series of changes in the frequency of the pulse and the tension of the arterial system, which may be thus described:—With the pneumogastric nerves and the spinal cord uninjured, there is observed in a few seconds after the inspiration of the gas a sudden rise in the frequency of the pulse, which may even become twice as great as it was at the beginning of the experiment. Then there comes a period in which its frequency again diminishes till it is no more than the half of what it was originally. After this it rises anew, going once more beyond its original rate, though not so much as in the first rise. A little before the paralysis of the heart there occurs once more a great diminution of the frequency. The variations in the frequency of the pulse may therefore be considered in four stages: the first and third, in which it rises; the second and fourth, in which it sinks.

Mineral Waters of Vals.—We have received some of these waters for examination, and can report favourably of them. They are agreeable in flavour, possessing in part the qualities of soda and seltzer waters, but they are not effervescent. Containing as they do small quantities of the alkalies, alkaline earths, and iron, they will be found useful by dyspeptic patients. As to the pamphlet which accompanied the specimens we received, we can only characterize it as the most ridiculous piece of composition we have ever had an opportunity of reading. It is supposed to be written in English by Dr. Tourrette, of Ardèche. The subjoined short cutting will give an idea of the author's knowledge of our language:—"The last four offer a very great resemblance in their chymical composition, which by their vicinity is easily understood, and which also is seen in the other known springs. In that manner their mineralizing substances are especially: *soles carbonic acid and alkaline bicarbonates* associated to *sodium, chlorides, sulfates, silicates,* and some terreous salts (*carbonates, phosphates, etc.*); there are found a little *iron* and traces of *iodides,* lithine, *arsenic* or *arsenicates,* and a very small proportion of *organic substances.*"

Use of the Bursa Fabricii.—Dr. John Davy has printed a memoir on this subject in the *Proceedings of the Royal Society.* The curious organ which bears the name of the great anatomist Fabricius is connected with the reproductive apparatus, but its function has not yet been clearly demonstrated. Dr. Davy has examined its structure and function in at least fifty different species of birds, and he arrives at the following conclusions, which, however, he regards as in some measure conjectural :—(1) That in some birds, as in the common fowl and in the duck family, the bursa increases in size and in completeness of organization up to a certain age, beyond which it gradually diminishes equally in both sexes, and eventually disappears; (2) That in birds, such as the owl and buzzard, which take wing as soon as they are able to fly, the bursa, though large while they are nestlings, does not continue to increase, but rather diminishes in size, and disappears at a certain age. Dr. Davy does not think the bursa is used to store up the semen for the fertilization of several batches of ova, but that its uses are provisional and various, and that in some birds it may serve as a urinary bladder.

Who introduced the Sphymograph into England?—Those who are *au fait* of the progress of medical science are probably aware that to Drs. Anstie and Sanderson the credit of introducing the sphymograph into English practice is chiefly, if not wholly, due. But we must caution our readers against a paragraph which has appeared in some of our non-medical contemporaries, attributing the merit of the introduction to a Dr. Belshazzar Foster, of Birmingham. Dr. Foster, a gentleman in practice in the great provincial "town of guns and buttons," has written a clever little pamphlet on the subject of the use of the sphymograph; and as some of the passages in this which refer to the introduction of M. Marey's instrument into England were somewhat vaguely expressed, they were misinterpreted by careless readers. No doubt, no one more than Dr. Foster himself regrets this inadvertence; for his pamphlet was put forward with all the modesty characteristic of a young practitioner, and is in reality—so says the *Lancet*—"scarcely more than a collection of cuttings from the 'Physiologie de la Circulation du Sang' of M. Marey." It therefore affords us much satisfaction to be able to explain the unpleasant attitude in which Dr. Foster was placed by the unwise enthusiasm of some of his friends "on the press."

The Poisonous Principle of Mushrooms.—This, which is called amanitine, has been separated and experimented on by M. Letellier, who has quite lately presented a paper recording his investigations, to the French Academy of Medicine. He experimented with the alkaloid upon animals, and found the same results as those stated by Bernard and others to follow the action of narceine. He thinks amanitine might be used in cases where opium is indicated; and states that the best antidotes in cases of poisoning by this principle are the preparations of tannin. The general treatment in such cases consists in the administration of the oily purgatives.

M'Munn's Elixir of Opium.—We have received some of this preparation, and have very carefully tested its effects in large and small doses. In small doses it produces a pleasantly sedative effect, without giving rise to much constipating action on the intestines. Taken in drachm to drachm and a half doses, it produces sleep, as in the case of laudanum; but it does not give rise to the headache and stupor next day which follow the use of the tincture of opium. It must be remarked, however, that the patentees claim too much for it when they say it produces no intestinal unpleasantness. In doses of a drachm it gives rise to very decided constipation of the bowels.

Detection of the Alkaline Sulphides in Water.—In the *Lancet* "Record of Science" for June 9th it is stated that a new test for the presence of alkaline sulphides in water has been proposed. It is the nitro-prusside of sodium. When this is added to water containing alkaline sulphides, a deep purple coloration is produced.

Physiological Action of Narceine.—The researches of M. Linné, which have been very recently published, show that this alkaloid, while possessing all the useful qualities of opium, has none of its objectionable qualities, such as the constipating influence on the intestinal canal. The following are some of M. Linné's conclusions :—(1) Narceine is unquestionably of all the alkaloids of opium that which has the greatest narcotic power. *In the majority of cases* morphia and codeia do not produce as sound or as prolonged sleep as results from the use of narceine. (2) Narceine differs from the other alkaloids of opium in producing little perspiration, and in causing no loss of appetite or nausea. (3) So far from producing constipation of the bowels, it causes relaxation, and in large doses actually gives rise to diarrhœa. (4) It not only produces sleep, but diminishes pain. (5) It has one peculiar action —it suppresses the flow of urine.—Vide *Journal de Chimie Médicale*, May.

The Albumen of the Blood during Cholera.—Some very valuable experiments upon the nature of the albumen of the blood in choleraic patients have recently been made by M. Papillon, and have been fully detailed in the *Journal de l'Anatomie* (No. 2). M. Papillon, who has chemically tested the albumen of the blood during the progress of cholera, arrives at these five conclusions :—(1) This albumen, placed for four days in water, became neither hydrated nor swollen ; it remained just as it was when first added, although ordinary albumen is either dissolved or swells up under the same circumstances. (2) It does not dissolve in potash or soda, even at an elevated temperature, although ordinary albumen is soluble in these reagents, even at ordinary temperatures. (3) When treated with hydrochloric acid, it slowly dissolves, and the solution, instead of having the usual deep-violet colour, is only faintly tinted. (4) At the ordinary temperatures, common albumen decomposes rapidly a mixture of nitric and sulphuric acids, nitrous vapours being disengaged. Choleraic albumen does not do so at the ordinary temperatures. Ordinary albumen is very rapidly dehydrated by sulphuric acid ; the choleraic albumen is affected only after a long exposure.

Perivascular Canals in the Brain and Spinal Cord have been demonstrated by Herr His, a notice of whose observations is published in the May number of the *Archives des Sciences*. These canals may be seen as grooves, which traverse sections of the spinal cord. They are more distinct in the grey than in the white substance, and each of them incloses a blood-vessel, which either lies freely in the cavity, or is attached to its walls. In the brain they lie between the nervous matter and the pia-mater. Herr His thinks they are connected with the lymphatic system, and that they are analogous to the reservoirs which in the frog lie between the muscles and skin.

METALLURGY, MINERALOGY, AND MINING.

The Dissociation of Gases in Metallurgical Furnaces.—The *Comptes Rendus* for April contains a note by M. L. Cailletet on this subject. In this the French *savant* records some curious experiments, which show that at very high temperatures compound gases become separated into their elements, and that at such temperatures these gases have no distinct action on each other. He heated metal in a fire of coal and wood-charcoal to such a temperature that platinum was easily fusible in it. The experiment was conducted in a porcelain tube, from which the gases were afterwards collected. The analyses of these by M. Péligot gave the following results :—

Oxygen	15·24
Hydrogen	1·80
Carbonic oxide	2·10
Carbonic acid	3·0
Nitrogen	77·86
	100

These results proved that oxygen has no action upon hydrogen, carbon, or carbonic oxide, in the midst of a combustible mass which is maintained at a temperature higher than that of the fusing-point of platinum.—Vide *Comptes Rendus*, April 16.

New Sources of Indium.—The metal indium has, according to a communication of Herr Schrötter to the Vienna Academy, been found by Herr Dr. Kachler in the zinc-blende of Schonfeld, near Schlaggenwald, where this metal occurs, associated with tin ore and other metals, in a bed of steatite, in such large proportions that a few grammes of this mineral yield a very appreciable quantity of indium. The blende is roasted and then dissolved in sulphuric acid; on treating this solution with metallic zinc, the indium and some traces of other metals are precipitated, from which it is afterwards separated.

Alloclase.—A new (?) mineral, to which M. Tschermak has given this name, has been found at Oravieza, in the Banat. It is composed of sulphur, bismuth, cobalt, and arsenic, in the proportions indicated by the formula $Co^6As^5S^9$, in which it is supposed that one-fourth of arsenic may be replaced by an equal quantity of bismuth. It forms rhombohedric crystals of a copperish-grey colour, found in calcite, and accompanied with acicular arsenical pyrites. Breithaupt has confounded alloclase with glaucodote.—Vide *The Reader.*

Coal-cutting Machines.—These apparatus, on the utility of which so much doubt was entertained on their first appearance, at last begin to be employed. One has at last found its way from Leeds, and is now used in the Netherton Colliery at Northumberland, and is said to be most successful in its operation. The motive power is derived from water under pressure, natural or artificial. The mode of cutting the coal or shale is novel. It is totally different from the pick machines, and similar to the action of a slotting machine. The cutter-carrier acts direct from the machine. The fixing of the machine to its proper locality, and its adjustment to the progress of the work, is entirely self-acting. It cuts the shale which is underneath the seam, and this preserves the coal entire. It does this at the rate of 80 square feet per hour, or about 86 yards in length, by 3 feet 3 inches in depth of cutting, in 10 hours. One of these machines is nearly ready for operation at Cramlington, and another is ordered for Backworth Colliery.—Vide *The Artizan.*

Novel Application of Magnesium !—An American paper recommends that war-vessels should be built of magnesium, which, while little heavier than oak, is as strong and tenacious as steel. The abundance of magnesium is the reason of this strange suggestion. It is estimated that the ocean itself contains 160,000 cubic miles of magnesium, a quantity which would cover the entire surface of the globe, both sea and land, to a thickness of more than eight feet. In obtaining salt from sea-water, the residuum is largely magnesium.

Effect of Heat upon Yellow Diamonds.—Some very curious facts connected with the effect of heat on the colour of yellow diamonds were pointed out in May last to the French Academy by M. Frémy. This gentleman exhibited a diamond weighing about four grammes, which, under its ordinary condition, is slightly tinted yellow ; but which, when submitted to a high temperature, assumes a rose tint, which it possesses for several days, being only gradually restored to its original hue. The diamond, which, at the time of exhibition, had the rose-colour, was kept in the cabinet of the Institut until the next meeting, when its original yellowish tint was restored. Now, the price of an ordinary diamond of the weight we have mentioned would be about 60,000 francs ; but, with the delicate rose tint, it would be worth three times as much.

The Hagan Process for Desulphurizing and Disintegrating Gold and Silver Ores.—An American scientific journal gives the following explanation of this useful process. Superheated steam is introduced into fire in such a manner that in gaseous form the steam impinges upon the ignited coals or wood without mixing with atmospheric air, and thus effects the decomposition of water into oxygen and hydrogen gases. The former immediately unites with the carbon of the coals, while the liberated hydrogen passes from the fire, and burns in the presence of the oxygen in the air. The hydrogen flame and the resulting gases being brought into contact with the heated gold and silver ores, the sulphur, arsenic, antimony, &c., are dissolved, and are carried off with the products of combustion. The powerful effect of the flame of hydrogen in dissolving pyritous sulphur, arsenic, antimony, &c., and in attacking oxygen, is well known ; but the expense of producing it has hitherto prevented its application to the disintegration and desulphurization of gold and silver ores. Not until the invention of Dr. Hagan's cheap and simple method of decomposing water, and thus furnishing hydrogen gas and flame abundantly, has it been at all possible to apply it to this purpose. Furnaces are now operating by this process in California, which receive charges of sixty tons, and are eminently successful.—Vide *American Journal of Mining*, May 19.

A Rotary Rock-boring Drill. — A patent has recently been taken out at

Washngton, U.S., for a rotary rock-boring machine, which is of an ingenious kind. It consists of a drill composed of a number of scalloped cutting-wheels, which are arranged on a common head, on axles passing through said wheels at right angles, and in such a manner that by giving to the head a rapid rotary motion, the wheels will cut into the ground or rock and produce a clear hole. The dirt or dust is raised by the action of a spiral flange, secured to the outside of the drill rod, and guided by conveniently arranged friction-rollers. A stream of water is made to pass continually to the bottom of the hole through the drill rod, which is made hollow for that purpose. Much of the dirt is thus removed. The machine can be applied to ordinary rock-drilling or well-boring.

A new Oil Well in Russia has been discovered in the district of the Natuchaitz, on the shore of the Caspian Sea. After boring a depth of 120 feet in solid rock, a stream of oil made its appearance, and flowed for twenty minutes. This was followed by a deafening noise, accompanied, it is stated, by a slight earthquake, after which, a jet of clear water, very saline, burst forth, with great violence, and continued running for nearly half an hour. Since then from 1,500 to 2,000 pailfuls of oil have been drawn out.—Vide *Colliery Guardian*, April 7.

How to Prevent Explosions in Coal-mines.—We sincerely wish that the proprietors of collieries would adopt the following sensible piece of advice which Mr. G. Adcroft, of Barnsley, has published in a late number of the *Mining Journal.* In the first place, he says that in mines where there is gas, lamps should be used exclusively, and not a mixture of candles and lamps, as is often the case. The lamps used should be Stephenson's ; for the Davy is not safe. All lamps should be bought by and belong to the employers. The material of which the lamps are made should be of the best possible quality that can be obtained. They should be made in the best possible manner, with the best possible workmanship. They should be cleaned every day with flint dust by men and boys employed by the masters. The lamps should never be allowed to be taken from the pit by the men ; they should be given to them in the morning locked, and delivered up at night in the same manner. If any one in the mine happens to have his light put out, he should be compelled to come to a certain place to have it re-lighted. Neither a manager, viewer, deputy under-looker, nor any other person, should be allowed to have a key to unlock the lamps, except those stationed at proper places. "I speak particularly upon this point," he says, "because I know from experience that even deputies and managers have been imprudent at times when they have been allowed to have a key, and have unlocked lamps where there have been explosions caused through it ; whereas, if they had not had a key they could not have done it. A painted rule should be fixed at the top of the pit, where it could be seen by all the workpeople, stating that if any matches or pipes were found upon any workman's clothes he should suffer imprisonment."

METEOROLOGY.

The Meteorological Commission.—The Report of the Commission appointed to inquire into the condition of the Meteorological department of the Board of Trade has just been published, and, though a large folio blue-book, is a most interesting one. The Commissioners show that, while great credit is due to Admiral Fitzroy for being the first to organize a system of weather forewarning, the latter is at present by no means perfect or scientific. They show very fully how it may be made more accurate and reliable. In answer to the question as to how this part of the system may be improved, the Commissioners write :—"The system of Weather Telegraphy and of Foretelling Weather is not in a satisfactory state. It is not carried on by precise rules, and has not been established by a sufficient induction from facts. The Storm Warnings have, however, been to a certain degree successful, and are highly prized. We think that the Daily Forecasts ought to be discontinued, and that an endeavour should be made to improve the Storm Warnings, to define the principles on which they are issued, and to test those principles by accurate observation. Above all, we think that steps should be taken for establishing a full, constant, and accurate system of observing changes of weather in the British Isles."

The Propulsion of Balloons.—A very curious apparatus for the above purpose has been devised by Mr. Butler, one of the members of the Aëronautical Society, which has been lately established. It consists of a pair of wings, to operate from the car of the balloon, and whose downward blow is calculated to strike with a force exceeding 40 lb., a power equivalent to an ascensive force of 1,000 cubic feet of carburetted hydrogen. The action required is somewhat similar to that of rowing, and would be exactly so, if at the end of the stroke the oars sprang backwards out of the hands of the rower; but, in this case, the body is stretched forward as if towards the stern of the boat, to grasp the handle and repeat the process, during which an action equivalent to "feathering" is obtained. It is anticipated that these wings, acting from a pendulous fulcrum, will produce, in addition to the object for which they are designed, two effects, which may possibly be hereafter modified, but which will be unpleasant accompaniments to a balloon ascent; viz., the oscillation of the car and a succession of jerks upwards, first communicated to the car from below and repeated immediately by an answering jerk from the balloon.

Our Summer.—Although we have now reached midsummer, the following observations, published some time since in the *Times* by Dr. Hjaltalin, of Iceland, will be read with interest by those who remember the meteorological features of the months of May and June :—"We have had a frightful winter, the mean temperature having been about 5 deg. below the mean of our winters. The thermometer during the last few days has ranged between 12 and 14 degs. of Celsius. This state of things will, no doubt, occasion a most tremendous northern icedrift—the consequence of which you will feel in England and other northern countries. The enormous iceblocks will be drifted into the Atlantic, and, melting there, will be the cause of much rain, hail, and snow, with a considerable lowering of your mean summer temperature."

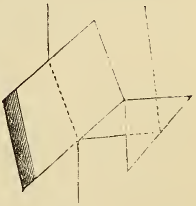
Causes and Conditions of Rain. — M. Renou, the distinguished French meteorologist, has put forward his opinions on the subject of the cause of rain, and although his views do not differ materially from those of other meteorologists, they express a useful summary of the causes which produce rain. Rain depends on the following circumstances :—(1.) Elevation of temperature. (2.) Humidity of the air. (3.) Barometric depression. (4.) Variation of temperature. (5.) General conformation of the earth's surface. But all these conditions may modify each other materially as follows :—(1.) Rain increases with the temperature, because hot air dissolves more water than cold air. (2.) The moisture of the air, which attains a maximum at the sea-shore, tends to produce a maximum of rain. This cause being constant, whilst the circumstances which tend to produce rain in the atmosphere being present to the slightest extent, rain is frequent, especially small showers, and storms are rare. (3.) In proportion as the mercury falls, there is more chance of rain being formed. Inversely, in countries with a high barometric pressure, such as those in the 30th degree of latitude possess, there is little prospect of rain. Such regions have a tendency to become deserts. (4.) Variations of temperature and irregularities of climate increase the chances of rain. (5.) Finally, the form of the soil plays an important part in the production of rain. An ascending concave soil receives a maximum of rain when it is exposed to rainy winds.—Vide *Comptes Rendus*, April 9.

Influence of Wooded Districts in the Production of Rain.—M. Becquerel and his son have laid before the French Academy the results of several observations conducted in the environment of Montargis. The general conclusion which the authors arrive at is, that wooded districts draw down a larger quantity of rain that plains do. They say it is of importance to remember the fact that when the clouds approach a mountain, or even a simple hill, they ascend, and then, meeting a colder stratum of air, become converted into rain. Hence one is led to think that lofty woods may have a similar effect, and may thus materially modify the local climate of a district. To put this view to the test, say the authors, we have, with the assistance of the Academy, established five observatories in the district of Montargis, at each of which, since July last, a daily record is kept of the temperature of the air and the earth, and of the rainfall in districts thickly planted. The result of the observations conducted up to the present time has proved that far more rain falls in the wooded than in the unwooded districts.

St. Elmo's Fire.—A good account of this curious phenomenon has been given by Captain Briggs, of the steamer *Talbot*, who observed it on the 7th of March, in the Irish Channel, at about one o'clock in the morning. He gives the subjoined description of his experiences :—" I found," he says, " that the light, which appeared large at a distance, was made up of a number of jets, each of which, expanded to the size of half-a-crown, appeared of a beautiful violet colour, and made a slight hissing noise. Placing my hand in contact with one of the jets, a sensible warmth was felt, and three jets attached themselves to as many fingers, but I could observe no smell whatever. The jets were not permanent, but sometimes went out, returning again when the snow was heaviest. This was from one to three a.m. At daylight I carefully examined the place, but no discoloration of the paint was to be seen. The stem in this part is wood, and iron plates bolted on each side, and it appears to me that the jets came out between the wood and the iron. The barometer stood at 29·1 in. The ship is an iron one, but I did not observe any alteration or other effect upon the compasses. I have seen the same phenomenon abroad, but never before in these latitudes."

MICROSCOPY.

The Binocular with high Powers.—As we stated in our last, Messrs. Powell & Lealand have devised a prism apparatus, by means of which the binocular ceases to be any longer a mere toy for exhibition at *conversazioni*. The instrument can now be easily used with the $\frac{1}{16}$ inch objective, and even with $\frac{1}{50}$ inch. Two contrivances have been already employed,—the one we have referred to, and that of Mr. Wenham. We do not think there is much material difference between the two arrangements as regards their powers of working. We have examined the circulation in Vallisneria with Messrs. Powell & Lealand's apparatus, under the $\frac{1}{16}$ and No. 1 eye-piece, and have been much pleased with the result. Although the stereoscopic effect is by no means so great as one might have expected, there is considerable "relief" shown, as may be seen by watching the movements of the green corpuscles. Besides there is, of course, the advantage of employing both eyes, which, even if there were no stereoscopic effect, affords the observer considerable ease during prolonged investigation. The action of Messrs. Powell & Lealand's device will be apparent from the accompanying diagram.



New Cells for mounting Objects.—Mr. Charles Collins, of Titchfield Street, has just shown us some very ingenious cells, which bid fair to do away with the old glass forms. They are made of pure tin, and being cut by a punch made specially for the purpose, there is no trace of bevelling on their edges. From the difficulty in cutting out thin glass rings for cells, their price is necessarily very high; the rings of tin can be sold at less than half the price of the glass ones, and may be more easily mounted. It suggested itself to us that the different expansions of glass and tin would cause cells so constructed to leak on exposure to changes of temperature; but Mr. Collins assures us that this is not the case.

The Wheels of Chirodita.—Messrs. Baker have sent us an admirable specimen of the "wheels" of this aberrant and worm-like echinoderm. They are certainly the finest specimens we have yet seen, and since Messrs. Baker have a considerable stock on hand, we invite the attention of microscopists to such specimens as we have examined.

Improvements in Objectives.—In his address to the Microscopical Society, Mr. Glaisher pointed out the recent improvement in this direction, viz., the application of the single-front lens to the highest powers, in place of the triple combination usually employed by the different makers. A simple anterior lens transmits more light, gives clearer definition, with any desired extent of aperture, and, from its simplicity and comparative freedom from errors of workmanship, is worthy of recommendation. The chromatic and spherical aberrations may be perfectly corrected in this form. Mr. Wenham informed Mr. Glaisher that there are now object-glasses existing, of various powers, having only a single-front lens, that will challenge comparison with the best of the usual form. It is suggested by Mr. Wenham, who has made practical investigations in the optical branch of Microscopy, that further improvements may be anticipated in the performance of object-glasses by discoveries connected with the quality of the glass employed.—*Vide* reprint of President's Address.

PAPERS ON HISTOLOGY.

Botany.—The Colouring-matter of Sea-weeds.
Movements of the Diatomaceæ.
The Aëriferous Roots of Jussiæa.
The Seeds of Solanaceæ.

Medicine.—The Cause of Ague.
Nitrate of Silver in Microscopy.
Perivascular Canals in the Brain.

Zoology.—Fresh-water Polyzoa.
The Fish's Eye.

PHOTOGRAPHY.

A most Important Discovery.—That photographic productions cannot be relied upon as permanent, appears a fact only too well established. The public have been convinced of it by seeing folios of choice productions and scores of treasured portraits pass gradually into "the sear and yellow leaf" of their age, and finally disappear. A few years, more or less, generally works the change. Photographers, too, have lost all faith in the absolute permanence of their productions, and have long been looking for this desirable quality in some ideal process for which their experimentalists were industriously striving and working, and for which they were most anxiously looking, rather than to any modification of the old silver process, which they have now wrought up to such a pitch of perfection. This fading has been pretty clearly shown to be, at least mainly, due to the action of the hyposulphites. The print lasts a longer or shorter time in proportion to the degrees in which the fixing agent—hyposulphite of soda—has been removed from the paper; but the slightest trace of it will assuredly bring about the destruction of the photograph. The only chance of absolute permanence appears to be in its complete elimination, although even then there are other elements of evil which may be suspiciously regarded. We have hitherto relied for this purpose upon the mechanical action of water, and some able men have run counter to the general experience by affirming that absolute permanence could be obtained by proper and sufficient washing. Mr. Carey Lea, for instance, asserted, about a year since, that he had tested properly-washed prints with a very delicate and certain test for the hyposulphites without discovering their trace, and in prints which he considered had been properly washed. This test was that of placing a few drops of an alcoholic solution of iodine in several ounces of water, and applying the same with a camel's hair brush to photographs on starch-sized paper. The presence of the starch, if freed from the hyposulphite by sufficient washing, was indicated by a violet or purple stain where the solution was applied; but in prints not thus washed the presence of the hyposulphite was indicated by the absence of such stain, which could be at once removed from the well-washed print by plunging it into a solution of alkaline hyposulphite. On the other hand, Mr. Dawson, of King's College, in a recent number of *The British Journal of Photography*, denies the power of mere washing to give permanence, "unless the prints have been soaked for some time in hot water so as to remove *all* the size—even then, supposing the paper non-albumenized,—the elimination of the whole of the hyposulphite is problematical." He adds,—"Some photographers, we are aware, do treat their prints with a final wash in hot water; but this, of course, although unquestionably conducive to the permanence of the proof, does not remove the whole of the size in which the hyposulphite is locked up; and if it did, the paper would be as little cohesive as blotting-paper, and the prints would lose much in vigour and brilliancy. In the case of prints on albumen, or albumenized paper, hot water, we may reasonably suppose, has no more powerful effect in removing hyposulphite from albumen than cold water, if, indeed, it has so much; and it can only be by acting on the texture of the paper itself, and removing the size therefrom, that it can exercise a beneficial influence at all." To demonstrate the truthfulness of his ideas on this subject, some prints which had been washed in cold running water, and with the utmost care and attention for over twenty hours,—and the final drippings from which, when subjected to the tincture of iodine test, displayed no trace of the hyposulphite,—were experimented with, and still gave up to boiling water, in which they were steeped, at least one-fortieth part of a grain of the destructive element to the half-sheet of paper, clearly showing that the cold water had not really removed it all, although it had eliminated all that it could reach or had influence over. Now whether Mr. Dawson and his supporters or Mr. Lea and his supporters be right, whether photographs fade so universally because they are rarely or never sufficiently washed after the process of fixing, or because it is impossible to remove all trace of the hyposulphites from the paper by washing, it is certain that they do fade, and few dispute the final cause of such a fading. Therefore, a discovery which destroys these mischievous agents altogether cannot but be regarded as most important, and such a discovery it is our pleasing duty to announce as having been recently published by Dr. Angus Smith, F.R.S., in the pages of *The British Journal of Photography*, from which we quote :—"Considering that the cause of the destruction of photographs, apparently by the action of time only, was in reality caused by the amount of hyposulphite remaining in the paper, D. Reissig, of Darmstadt, contrived a mode of washing it out by centrifugal force. For indicating the presence of sulphur acids, he uses a small galvanic arrangement with one cell, and decomposing the acid, had the sulphur thrown on a piece of polished silver, which became readily blackened in the solution. Dr. Theodore Reissig, my assistant, examined several faded photographs for me by his brother's method, which, however, appeared unnecessarily delicate, as it was found that the amount of sulphur was very large, and roughly, we thought, in proportion to the amount of decay. I did not determine how much was hyposulphite and how much sulphate. As I had been interesting myself in bringing into use some of the remarkable properties of peroxide of hydrogen in oxidizing metals and organic bodies in fluids, it seemed to me that we might readily use it for oxidizing the hyposulphites. I am supposing that the sulphate alone will not be injurious." Dr. Smith then shows how this powerful oxidizing agent may be used to convert the mischievous hyposulphites into the innocuous sulphate, and Mr. Dawson, in the same number of the journal, gives the following experimental illustration :—"Dissolve in a wine-glass any quantity of sulphate of soda, and add to the solution a few drops of tincture of iodine. The solution will remain permanently discoloured, showing that sulphate of soda does not dissolve iodine. In another wine-glass, half filled with plain water, drop sufficient tincture of iodine to strike a permanent dark sherry colour throughout the liquid ; then add, drop by drop, a weak solution of hyposulphite of soda till the colour is discharged, taking care to add as little excess of hyposulphite as possible. So far this experiment shows that iodine is soluble in hyposulphite of soda. Now fill up the glass with an aqueous solution of peroxide of hydrogen, and observe the effects. After a few minutes the iodine is no longer held in solution, and the liquid will resume the dark sherry colour it had before adding the hyposulphite of soda." Every chemist will readily explain this. To apply this new chemical agent to this new use, take the print, after fixing and washing, and soak it for a short time in a solution of the peroxide of hydrogen of the strength of say one ounce of a ten-volume solution in forty ounces of water.

Opaltypes.—The photographic serials often amuse us by showing upon what slight and insufficient grounds a person can sometimes dub himself "inventor," and what a trifling modification of some old process frequently constitutes what is called "a new process." Such pages chronicle the rise and fall of an extraordinary number of these photographic ephemera. Amongst the most attractive perhaps have been the modifications of what is most widely known as the opaltype, to which we called attention some time since ; but of late complaints have been rife as to the unreliable nature of all these "processes," and most of them have therefore been quietly deposited with other extinct modifications, such as the Alabastine, the Elephantinon, the Melainotype, &c., in the well-filled lumber-room of oblivion. At a recent meeting of the Philadelphia Photographic Society, the eminent photographer and able experimentalist, Mr. Wenderoth, gave the results of his practical experience with such of these processes as still linger amongst us, and his conclusions are those which our best English photographers have also arrived at. He denounces the whole class as equally mischievous, but says of the collodio-chloride modification, "It is of this style particularly that the cry of fading has been raised by those who have been practising it. When first published, I gave it a fair trial, and obtained some fair pictures, but soon found that its results could not be depended on." This experience accords with that we have met with in many other quarters, and was questioned, we believe, by none of the authorities who were present at the reading of Mr. Wenderoth's interesting paper. With wet collodion, with dry collodion, with the collodio-chloride, with gelatino-chloride, with albumen, and with salted collodion, the pretty and attractive opaltypes seem equally fugitive, their career being measured, not, as in the case of silver prints, by years, but by months.

Magic Photographs.—A playful application of photography for the production of a new kind of "parlour magic" has sprung into existence since our last summary was written. This has been termed "Magic Photography." A piece of apparently plain albumenized paper is supplied the purchaser, together with a piece of blotting-paper; by placing the latter over the former, and wetting it, an image is developed. As light has nothing to do with this process, it is regarded by the uninitiated as very wonderful, but the explanation is amusingly simple. When immersed in a saturated solution of bichloride of mercury, a fixed untoned print, which has been well washed, will gradually disappear. A piece of blotting-paper, which has been soaked in a weak solution of hyposulphite of soda and dried, will, however, when wetted and laid over the paper, restore the image very quickly, and when the image so restored is well washed, it is permanent.

The Nitrate of Silver Bath.—A contributor to *La Science pour Tous* points out the danger photographers run of being deceived as to the actual strength of the silver baths by the inconsiderate use of the ordinary argentometer. An old bath contains a considerable quantity of iodide of silver in the place of nitrate, although its density may remain but slightly changed from that it had when new; and the author accordingly recommends the dissolved iodide of silver to be precipitated by adding to the bath its own bulk of distilled water, filtering off the clear solution when it has settled, and then strengthening with fresh nitrate of silver. This suggestion is not new, but, as it has been neglected, it is worth repeating.

Perspective and "Composition Photography."—The term "Composition Photography" has been applied to one of the most unscientific and inartistic of all the many applications of photography as an art; and one which directly violates every rule of good taste and pictorial truth. It represents a species of patchwork process, by which pictures taken at different times and from different points of view are "composed," or rather incongruously combined, in the printing, for the sake of producing a photograph larger in size and more ambitious in its supposed pretensions than others. As this process, strange to say, has been very hotly and perseveringly upheld in certain of the photographic serials, we were pleased to find in one of them some articles from the pen of Mr. A. H. Wall, explaining the grounds upon which they should be discouraged and denounced. As it is impossible that objects can ever be correctly represented as they are seen by more than one person, or at more than one time, the laws of perspective show that to be in strictly accurate drawing the representation should be such as one person sees when standing in one place, and with the eye at one point of elevation. Now the various portions of these "composition" photographs almost invariably, and frequently of necessity, are taken with the camera in positions relatively different both with regard to the height of the lens, the distance of the lens from the object, and its position to the right or left thereof. Thus, nothing is more common in photographs of this description than to find half a dozen different points of sight, nearly as many horizon-lines, and three or four contradictory points of distance; and yet these productions have been awarded medals, and the process of thus spoiling a set of good pictures to make that monstrosity which violates every rule of art and science, has been upheld as the highest aim of photography.

Plate-cleaning.—Messrs. Walmsley & Co., of Milton Street, Fore Street, Cripplegate, have introduced a new spirit called "Mineral Ether," which they strongly recommend for making photographic plates chemically clean with rapidity and certainty. It differs from the ordinary preparations of benzole, its specific gravity being ·860, and its boiling-point 170 degrees, and by leaving in the evaporation, which is very rapid, no smell.

PHYSICS.

A curious Property of Magnetic Oxide of Iron has been demonstrated by Mr. Spencer, of Euston Square, in the preparation of his ingenious filters. He has shown that the magnetic carbide possesses the power of converting oxygen into ozone. Hence the oxide becomes a most valuable material for the construction of filters, since by completely burning up or oxidizing all organic matters, it renders water pure. Mr. Spencer says its purifying property is "due to its power of attracting oxygen to its surface," which then "becomes changed into ozone—or, at least, a body having its properties." He regards ozone as "oxygen polarized, and considers that oxygen when attracted by the magnetic substance becomes polarized, just as a needle is polarized when attracted by a powerful magnet. The question, however, may be raised as to whether there is such a thing as self-existent *polarized oxygen*, with little chance of a definite answer being received. That the magnetic carbide does ozonize oxygen, Mr. Spencer considers to be established by the facts that air passed through a layer of it turns tincture of guaiacum-paper blue, as would ozone; that the carbide itself turns the tincture blue; and that water filtered through the oxide into a solution of starch and iodide of potassium renders it faintly blue. May not, we suggest, the oxide,—which must not be crystalline, but in the amorphous state,—have a common principle of action with spongy platinum and charcoal, and other non-magnetic porous bodies? But whatever be the theory of its action, its effects in removing oxidizable and other organic matter from water are undoubted.—Vide *Medical Times and Gazette*, April.

The Absorption-lines of the Didymium Spectrum.—At a late meeting of the Manchester Philosophical Society, Professor Roscoe stated that he had received a letter from Professor Bunsen, announcing the discovery of a most interesting and important fact, namely, that the well-known black absorption-lines of the Didymium spectrum when examined with polarized light vary according to the direction in which the light is allowed to pass through the crystal. This shows that the position of the black absorption-lines is in some degree dependent upon the physical structure of the body through which the light passes, and is not merely determined by its chemical constitution.—Vide *Proceedings of Philosophical Society.*

An Explosive Paper, which is intended to be a substitute for gunpowder, has been invented by Mr. G. S. Melland, of Lime Street, London. The *Artizan*, which devotes an article to the subject, states that it is paper impregnated with a composition formed of chlorate of potash, 9 parts; nitrate of potash, $4\frac{1}{2}$; prussiate of potash, $3\frac{1}{4}$; powdered charcoal, $3\frac{1}{4}$; starch, $\frac{1}{12}$ part; chromate of potash, $\frac{1}{16}$ part; and water, 79 parts. These are mixed and boiled during one hour. The solution is then ready for use, and the paper passed in sheets through the solution. The saturated paper is now ready for manufacturing into the form of a cartridge, and is rolled into compact lengths of any required diameter. These rolls may also be made of required lengths, and cut up afterwards to suit the charge. After rolling, the gun-paper is dried at 212° F.; and has the appearance of a compact greyish mass. Experiments have been made with it, and it has been reported favourably of, as a perfect substitute for gunpowder, superseding gun-cotton and all other explosives. It is said to be safe alike in manufacture and in use. The paper is dried at a very low temperature. It may be freely handled without fear of explosion, which is not produced even by percussion. It is, in fact, only exploded by contact with fire, or at equivalent temperatures. In its action, it is quick and powerful, having, in this respect, a decided advantage over gunpowder. Its use is unaccompanied by the greasy residuum always observable in gun-barrels that have been fired with gunpowder. Its explosion produces less smoke than from gunpowder; it is said to give less recoil, and it is less liable to deterioration from dampness. It is readily protected from all chance of damp, by a solution of xyloidin in acetic acid. The xyloidin is prepared by acting on paper with nitric acid, one part thereof being dissolved in three parts of acetic acid of specific gravity of 1·040.

The Formation of Ice at great Depths.—An interesting instance of this phenomenon has recently been recorded by the Detroit Water Commissioners, who have for a long time (some years) met with difficulties in obtaining water from the river during winter:—The inlet pipe extends into the river for a distance of 150 feet, and on the end, which is bell-shaped and turned upwards, there is a horizontal strainer pierced with half-inch holes. When the river is covered with ice over the strainer, the ice does not collect at any degree of cold, but the greatest difficulty recurs when the thermometer ranges from 7° or 8° to 18° or 20° above zero. When the mercury rises above 20°, however suddenly, the ice disappears. The greatest collection, it has been observed, occurs at night, and when the sun is obscured by clouds; but, when the sun is unclouded, no difficulty is ever experienced. The observations do not state the effects of a cloudless night.—Vide *The Reader.*

The Electricities of Iron and Steel.—The doctrines of our British physicist, Dr. Joule, relative to the electricities of cast-iron and steel, have been quite corroborated by the researches of M. Thenard. The French chemist was not aware of Dr. Joule's investigations till he came to publish his own, but then he acknowledged their priority in a graceful manner.

New Method of producing Ice.—Signor Tonelli has constructed an ice-making machine which is intended for household purposes, in which compressed steam replaces the ammonia or sulphurous acid gas used in the ordinary machines. One of his small machines will make from 9 to 11 lbs. of ice per hour at a cost of $\frac{1}{8}$d. to $\frac{1}{4}$d. a pound. The plan adopted is briefly as follows:—In one cylinder a solution of common salt is placed, and to this another cylinder is adapted. The saline solution is then heated (not above 212°) and the steam is passed into the second cylinder. After about an hour a tap between the two cylinders is turned, and the one containing the compressed steam is placed in a vessel of cold water.

Diminution of Temperature in making Alloys.—It was stated by Dr. Phipson, at a late meeting of the Paris Chemical Society, that a very sudden fall of temperature is occasioned by mixing certain metals together. The most extraordinary descent of temperature occurs when 207 parts of lead, 118 of tin, 284 of bismuth, and 1,617 of mercury are alloyed together. The external temperature being at +170° Centigrade at the time of the mixture, the thermometer instantly falls to —10° below zero. Even when these proportions are not taken with absolute rigour, the cold produced is such that the moisture of the atmosphere is immediately condensed on the sides of the vessel in which the metallic mixture is made. The presence of lead in the alloy does not appear to be so indispensable as that of bismuth. Dr. Phipson explains this fact by assuming that the cold is produced by the liquefaction at the ordinary temperature of the air of such dense metals as bismuth, &c., in their contact with the mercury.—Vide *The Reader*, May.

The Cigar-Boat.—This vessel, which was supposed to effect such a revolution in the physics of ship-building, does not appear to have the wonderful power which was theoretically attributed to it, if we may believe the French pilot who brought the Havre boat to London. He says her average speed was 7 to 7½ knots an hour. She behaved exceedingly well at sea, rolling less than other vessels, which must be due rather to a judicious disposition of the weights aboard than to any stability derivable from the round form of her immersed transverse section.

Deviation of the Compass in Iron Ships.—Mr. Hopkins, who has for a long while been experimenting on this subject, looks upon an iron ship as a huge bar-magnet, whose polarity he proposes to neutralize by means of magnetic batteries of great power, and thus remove all deviation. Mr. Hopkins has received permission from Sir John Hay, the chairman of the Millwall Ship-building Company, to experiment upon the *Northumberland*, during the space of four months. This vessel has been built and plated in the same direction, with her head to the north, and may therefore be expected to be strongly polarized. Should Mr. Hopkins's method prove successful, he will have made a most important step in this difficult branch of science.

Vapour Densities.—A memoir has been presented to the French Academy in which the author, M. H. St. Claire Deville described an experiment giving ocular proof of the dissociation of the vapour of perchloride of phosphorus at a high temperature. The following is the mode in which the experiment was made :—The author heated in an oil bath two colourless glass tubes, one containing a mixture of equal volumes of chlorine and air, the other perchloride of phosphorus. The ends of the tubes, projecting a short distance from the bath, were flattened, so that the colour of the contents might be observed and compared, a very minute opening being made, so that the expanded gases might escape. According to all analogy, the vapour of perchloride of phosphorus should be colourless, and if at a certain moment it became yellowish-green, the natural inference would be that it contained free chlorine ; and at the temperature at which the two tubes possessed a yellow colour of equal intensity, it might be inferred that the decomposition of the perchloride was complete. Qualitatively, this experiment succeeded admirably. The colour of the chlorine was seen to be developed as the temperature rose, and no doubt of the dissociation remained ; but the author is as yet unable to obtain exact numerical results of the extent.—Vide *Comptes Rendus*, May.

An Electrical Paddle-engine has been devised by and constructed for an Italian nobleman, General the Count de Molin. It is adapted to a small boat, which is intended to ply on the large lake of the Bois de Boulogne, and has the following construction :—There are two upright hoops, about 2 feet 6 inches in diameter, placed 3 inches apart, in the periphery of each of which are encased 16 electro-magnets, placed opposite each other. Between these there is another hoop or wheel, of soft iron, of the same diameter as the others, and so articulated as to receive, when alternately attracted by the magnets at each side in succession, a sort of rolling from side to side, or "waddling" motion. To this wheel is fixed an axis about 7 feet long, which forms the prime moving shaft of the machine. When the wheel between the magnets takes its rolling motion, it causes the ends of this axis to describe circles ; one end turns the crank of a fly-wheel, while the other end is adapted to a framework, on the same principle as the pentagraph, which enlarges the motion received from the central disc, and communicates it in the form of a stroke by a connecting rod to a crank on the paddle shaft. This end of the moving bar also sets to work the distributors for alternately establishing and cutting off the electric communication between the magnets and the battery. There will be in all 16 elements of Bunsen's. The force of the machine while at work with four elements was found to be one-quarter man-power, so that with 16 cells the power will be about that of a man. The paddle-wheels are 2 feet 6 inches in diameter.

ZOOLOGY AND COMPARATIVE ANATOMY.

Preservation of the Young among Crustacea.—M. Eugène Hesse has made a singular discovery of a mode in which the young are preserved among some of the parasitic entomostraca. The larvæ are united to the mother's body by a natural cord or fibre, which passes from the parent's body to the frontal appendage of the young animal. This fibre does not play the part of an umbilical cord, but it preserves the young from danger when the parent migrates from one fish to another.

A Species of Silk-spider.—An American journal reports that a specimen of the above was found by Dr. Wilder, while in camp on Folly Island, in Charleston Harbour. From the body of one of these insects in one hour and a quarter he wound 150 yards of yellow silk. The next year another officer wound from 30 spiders 3,484 yards, or nearly two miles of silk. A single thread of this is strong enough to sustain a weight of from 54 to 107 grains. The species was shown to Professor Agassiz and other naturalists, to whom it was new. It is proposed to cultivate it.—Vide *The Boston Journal.*

The Mode of Formation of Ianthina's Float has been discovered by M. Lacaze-Duthiers, whose paper on the subject was translated in a late number of the *Annals of Natural History.* The float consists of air-bubbles, which the creature imprisons by throwing off a mucous secretion from the anterior extremity of its foot. The animal cannot swim without the float, which it thus artifically constructs.

Geneagenesis among the Cecidomyas.—The strange mode of reproduction among the Cecidomyas, which has been demonstrated by Herr Wagner, has led to some controversy among European naturalists. Indeed, the investigations referred to may be regarded as some of the most important, in respect to the results, that have been made during the present century, for they in some measure bear out the views of M. de Quatrefages on what is erroneously styled *Parthenogenesis*, and corroborate the doctrine laid down by Professor Huxley in his memoir on the reproduction of the Aphis. Of course, we allude only to the facts elicited by Herr Wagner's researches, and not to his method of viewing or explaining them. Our present motive in directing attention to them is because of a paper which has been presented to the Royal Academy of St. Petersburg by Von Baër. In this the author combats several existing theories without throwing much light upon the obscure question of *geneagenesis*, and proposes a new term, *pædogenesis*, for all those processes by which an immature creature, such as a larva, reproduces offspring.

The Anatomy of the Foot and Leg of the Phalanger has been carefully studied by M. Alix, who read a paper on the subject at a late meeting of the Philomathic Society of Paris. The paper contains an infinitude of anatomical details concerning the relations of the bones and muscles of the foot and leg, but is too technical for an abstract in these pages.—Vide *L'Institut*, May.

Forthcoming Treatise on Exotic Birds.—A splendidly-illustrated treatise upon "Exotic Ornithology" has been commenced by Dr. P. L. Sclater and Mr. Osbert Salvin. It is to be issued in parts, and is to consist of a series of coloured lithographic illustrations of new, or hitherto unfigured, birds. Thus, by forming a supplement to Temminck's *Planches coloriées*, it will be a most valuable work of reference for zoologists. To the description of each of the species figured, the authors will endeavour to add a complete list of the other known species of the genus. The first series of this work will contain 100 plates. It will be published in twelve parts, at intervals of about two months. Only 200 copies quarto will be published.

The Affinities of the Dodo. — The opinion which Professor Owen has recently adopted in regard to the affinities of the Dodo have been in great part confirmed by the observations of M. Milne Edwards, the veteran French zoologist. In a memoir which M. Edwards laid before the Academy of Sciences, he stated that so far as the evidence he was able to gather from the examination of a set of bones lately brought from the Mauritius went, it showed that the Dodo belonged not to Raptorial, but to Rasorial birds. Its affinities are most with the Columbidæ, or Pigeon family, although it must always be regarded as an extremely aberrant member of this group. This is especially shown by the formation of the sternum, or breast-bone, which is as unlike that of a pigeon as it is possible to conceive.—*Comptes Rendus*, April 23.

The Locomotion of Fishes.—The views of M. Ferd. Monoyer are not without interest. The movement of fishes through the water takes place, he says, by the action of the tail, and principally of the caudal fin. When the progression is rapid, the other fins play no part in locomotion. When the fish wishes to stop, it does so as an oarsman would by producing "backwater," which it effects through its pectoral fins. The other fins may be employed in this latter operation, but their only use is to prevent the fish turning round on its transverse axis.

Disease among Oysters.— In a report which was not long since issued by the Institute of Christiania, there is an account of an investigation of a disease among the oysters, which is said to render these mollusks highly dangerous to eat. The discovery was made in the course of an inquiry into the cause of several mysterious deaths and cases of severe indisposition, which the medical men were entirely unable to account for.

How to procure Fresh-water Polyzoa.—In a letter addressed to the editor of the *Annals of Natural History*, the Rev. W. Houghton makes some remarks of a highly practical value. He says that the most successful way of procuring these animals is to hunt for the characteristic *statoblasts* (which may, in most cases, be found in great numbers at the surface of the water in winter and spring), and to take a supply of this water, with aquatic weeds, and place all in a glass vessel exposed to subdued light, and kept in a moderately warm room. The statoblasts will soon germinate, and produce specimens for examination. In this way, he says, I have obtained young specimens of *Cristatella* and various specimens of *Plumatella*. Indeed, the naturalist will find it well worth his while to take at random a can of water and a handful of freshwater weeds at any time during the open weather in winter, and to keep a glass vessel or two of this water and weed in his sitting-room for a few weeks. He will be rewarded by discovering rare forms of minute aquatic life. On examining a vessel of water brought from the canal, I discovered, in about a fortnight's time, a rare and beautiful *Stephanoceros*, several *Melicertæ*, *Paludicella*, and young *Cristatellæ*. *Paludicella*, like *Fredericella*, is an exception to the rest of the family, being perennial.—Vide *Annals of Natural History*, No. xcix.

The New and Unfigured Birds of America will be fully described in the forthcoming work of Mr. D. G. Elliot, of New York. This work is to be issued in parts, 19 by 24 inches in size, containing each five plates coloured by hand, with a concluding part, of text; price for each part, 10 dollars. Only 200 copies will be published. Mr. Elliot is author of a monograph of the *Pittidæ*, or ant-thrushes, in one volume, imperial folio, with 31 plates; and of a monograph of the *Tetraoninæ*, or Grouse tribe, in one volume, with 25 plates. In each, the birds, with only two exceptions, are of life size.

The Physiology of the Fish's Eye.—A very elaborate paper, descriptive of the anatomy of the fish's eye, has been published by Dr. Henry Fripp. We cannot here go into the minute details of the anatomy of the eye in fishes, but we give the following conclusions as those at which the author has arrived:— 1. That the fish's vision is clear for near objects, and that the great refractive power of the lens (a prolate spheroid having great density of substance) is adequate to the production of a defined picture at short focal distance, even when rays of light pass through so dense a medium as water; objects in the air near the water being seen also, just as if they touched its surface at the point where the ray is bent. 2. That no "accommodation" such as is known to exist in the human eye, for the perfect definition of objects at a distance, occurs in fishes—or, at least, is not provided for in the same manner; the passive state of the fish's eye being that in which it is enabled to see near objects, no active or physiological change appears necessary for ordinary vision, whilst physical dispersion of light on the water renders distant objects less liable to excite attention. 3. That the iris has no power of reflex action on stimulus of light, and its immobility is in harmony with the optical deficiency of "accommodation" and the physically deficient illumination of the waters. 4. That the choroid gland is not an organ intended to assist or produce "accommodation" of focal distance of the lens, but that its vascular character, and the absence of any muscular or gland element in its composition, lead necessarily to an interpretation of functions directly relating to the static condition of the circulating fluid, and the changes of dynamic force exerted by the heart under varying pressure from without on the fish's body That, in fine, by such an arrangement (analogous examples of peculiarities in the venous circulation of mammals and other animals dwelling in the water being well known), protection to the delicate tissues of the eye is afforded in the compensation balance of pressure within and without the circulating system. 5. That there results from the globular shape of the eyeball, a secondary reflection of rays of light from the bottom of the eye against the inner pigmented surface of the choroid, which may perhaps intensify the retinal action, and probably stimulate the cells of the pigment membrane to secrete their molecular pigment from the venous flexuses of the choroid.—Vide *Proceedings of the Bristol Naturalists' Society*.

The Metamorphoses of Insects.—In the interesting and instructive lectures which Sir John Lubbock delivered in the Royal Institution, the following conclusions were specially drawn as those most important to be borne in mind. In some respects they agree very closely with the views expressed by M. Quatrefages in his excellent treatise on the "Metamorphoses of Man and the Lower Animals":—1. That the presence of metamorphoses in insects depends, in great measure at least, upon the early state in which they quit the egg. 2. That metamorphoses are of two kinds — developmental and adaptational. 3. That the apparent abruptness of the changes which they undergo arises in great measure from the hardness of their skin, which permits no gradual alteration of form, and which is itself rendered necessary in order to afford sufficient support to the muscles. 4. That the immobility of the pupa or chrysalis depends on the rapidity of the changes going on in it. 5. That although the majority of insects go through three well-marked stages after leaving the egg, still a large number arrive at maturity through a somewhat indefinite number of slight changes. 6. That the form of the larva of each species depends in great measure on the conditions in which it lives. When an animal is hatched from the egg in an immature form, the external forces acting upon it are different from those which affect the mature form, and thus changes are produced in the young, bearing reference to its present wants rather than to its ultimate form. 7. When the external organs arrive at this final form before the organs of reproduction are matured, these changes are known as metamorphoses; when, on the contrary, the organs of reproduction are functionally perfect before the external organs, or when the creature has the power of budding, then the phenomenon is known as alternation of generations. Insects present every gradation, from simple growth to alternation of generations. 8. Thus, then, it appears probable that this remarkable phenomenon may have arisen from the simple circumstance that certain animals leave the egg at a very early stage of development, and that the external forces acting on the young are different from those which affect the mature form. 9. The dimorphism thus produced differs in many important respects from the dimorphism of the mature form which we find, for instance, in the ants and bees; and it would therefore be convenient to distinguish it by a different name.

The Physiological Phenomenon known as the Voice of Fish.—In a very bombastically-written memoir on this subject, M. Dufossé observes,—"It would be a misapplication of the physiological definition of the word voice to use that word for the purpose of designating sounds so very different one from another as those of fish." He therefore proposes to sum up all the phenomena of voice in fishes under the terrible title of *ichthyopsophosy*.—See *Comptes Rendus*, April 30.

Some remarkable Muscles in Monkeys.—In a paper read before the Natural History Society of Dublin, on the 5th of April, Dr. A. Macalister recorded some interesting points in the anatomy of Quadrumana. The subjoined is a brief abstract of his paper:—The arrangement of the muscles in all animals indicates the existence of an ideal archetype, of which the various individual series are modifications, and of this type there are numerous and definite modifications in each class of animals, so as to constitute class or even generic distinctions. The Quadrumana, or monkeys, have usually in this respect some definite characteristics of muscular arrangement; such as the absence of an opponent muscle, and also of a distinct long flexor for the thumb, the prolongation of the latissimus dorsi to the olecranon, a thoracic rectus, and many others. In several species of monkey examined by me, peculiarities were observed which have not been before recorded; such as a fourfold series of pectoral muscles, the fusion of gluteus medius and pyriformis, the existence of a coraco-capsular muscle, as well as of the hitherto unnoticed muscle infra-spinatus secundus, &c. These all occurred in the Capuchin monkey (*Cebus capucicus*). The opponens pollicis was present in this cebus, and also in a cercopithecus quite separated from the other short muscles of the thumb. An extensor of the metatarsal bone of the great toe was likewise present in several species, either with or without a separate extensor hallucis. An accessory scalenus likewise occurred in cebus, as well as a double gemellus inferior. In no instance was the slip peroneus quartus present, which is of such frequent occurrence in man, but peroneus quintus existed in many species. Many of the above arrangements have been found as anomalies in the human subject.

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ON THE MOVEMENTS OF THE DIATOMACEÆ.

BY E. RAY LANKESTER.

IT is but a few years since the power of movement was thought to be confined to and characteristic of animals alone, to the exclusion of both plants and minerals, and, indeed, the prevalence of this notion has left traces which are still very evident. Whilst the power of movement has been shown to be almost universally present among the lower cryptogamic plants, it is only in those cases where the presence of "cilia" has been observed and the organ of locomotion thus detected, that all doubt has been dispelled. In the case of the minute Desmidiaceæ and Diatomaceæ, such mystery has veiled the cause of movement that the most ingenious and conflicting explanations of the phenomenon have been offered, the latter group of organisms being sometimes referred to the animal kingdom. In passing, it may be mentioned, that "movement" is no longer to be considered as belonging even to animals and plants alone. The researches of Mr. Sorby have shown that in minute cavities contained in crystalline rocks rapid oscillations are continually going on, owing to the movements of bubbles of air floating in liquid.

The characters, however, of the movements exhibited by animals, plants, and minerals differ considerably, and there can be little doubt that careful observation only is needed to distinguish them. The movement in the mineral, whether of "molecules," as described by Robert Brown,* or such as noticed by Mr. Sorby, is dependent on the simplest external causes, either physical or chemical. In the plant, movement is either continuous and recurrent, or the result of momentary irritation, whilst in the lowest Rhizopod or Gregarina the movements exhibited are ever varying, and, apparently, are dependent on the most diverse causes. The object to be attained by the movement of both plants and animals may be broadly stated as either reproduction or nutrition, contact

* Miscellaneous Botanical Works, Ray Society, 1866.

with another individual or with suitable food.* And here I think we may find some explanation of the fact that there is greater simplicity in the movements observed in those plants whose protoplasm is not imprisoned in cellulose than in the motions of the lowest animals.

The food of the plant is carbonic acid and ammonia dissolved in water; that of the animal is formed material, solid or viscous particles of proteinaceous matters. Hence, while the most rhythmic movements are sufficient to bring the plant in contact with fresh currents of water charged with its nutrition, this nutrition is ever present to act as the exciting cause of motion. Not so with the more highly organized protoplasm or sarcode of the lowest animal. Its food is not everywhere held in solution, but is suspended in the form of solid particles, or localized nutritive fluids, hence greater irritability and more varied power of locomotion are needed: contact with minute particles of varying chemical nature, and the irritation of different gases in solution, act variously on the more sensitive protoplasm of the animal as exciting causes of motion. In the animal kingdom the protoplasm becomes more and more differentiated as we ascend the scale, until we get distinct sensory and motor systems, nerves, and muscles. In the plant, as we ascend the scale, the protoplasm is more and more enclosed by its sheath of cellulose, and movements become only the rare exception, or the simple results of growth.

Before proceeding to the consideration of the movements of the Diatomaceæ, let us see what other plants exhibit movements, and of what kind. The most common movement in the higher plants is that resulting from growth, such as the underground extension of bulbilli in Orchids, and the elevation of trees from the ground by the resistance offered to the downward growth of their roots. Light acts as a great cause of movements of a certain kind, the sunflower's daily turning, and the shutting and opening of the petals and leaves of nearly all flowers, showing that the light and heat of the sun produce certain chemical and physical effects in the tissues of plants which result in movement. Similar to these movements but dependent on the more accidental irritation of contact with a foreign body, are the phenomena exhibited by the stamina of the Barbary, by the pollinia of the Orchids, and the leaves of many so-called sensitive plants. The sudden extension of the spiral flower stalk of *Valisneria* is a remarkable example of the subservience of the phenomenon of motion to reproduction, as in the case of the Orchids and others. The active gyrations

* By food is here meant *all* external agents necessary to the support of life.

and rapid movements of the spores of Algæ are another class of plant movements, the cause of which is, however, obscure. The movements of *Volvox* and its allies are due to the production of the protoplasm into ever-waving, hair-like processes, or "cilia," while the oscillating movements of the long filaments of the confervoid Oscillatoriæ, and the minute Bacteria and Vibriones are like the motions of individual cilia. The movement of the Desmidiaceæ is very slow, and somewhat similar to that of the Diatomaceæ, the cause of both perhaps being identical. In the vesicular spaces at the pointed ends of *Closterium* and other Desmids, granules in rapid movement are to be observed. This phenomenon of plant-motion may perhaps be connected with the "circulation" of chlorophyl granules in the tissues of *Chara*, *Anacharis*, and *Valisneria*, and depends, as also may the vacuolar pulsations of *Volvox*, and the circulation of granules in the protoplasm of Rhizopoda, on osmotic currents.

Nearly all the phenomena above alluded to require the most careful and painstaking inquiry, both as to their immediate and indirect causes; and until such inquiries have been made, they can be only hypothetically arranged and explained.

We now come to the movements of the Diatomaceæ, which have lately received a most minute investigation from Professor Max Schultze of Bonn, ending in a satisfactory and conclusive explanation of the method and nature of locomotion in these organisms.*

It is necessary here to remark that the Diatomaceæ are minute organisms, consisting of symmetrical siliceous shells of various shapes, apparently enclosing organic matter; the shell, or "frustule," is elongated, boat-shaped, square, or circular, and is composed of two equal and symmetrical halves, or valves, joined longitudinally in most species. The line of juncture, on either side, is called the "suture" or "raphe," and it is along this line that the diatoms frequently divide, producing new individuals. Disposed along the "raphe" in many species, in long ones more especially near the ends of the frustule, are numerous minute holes in the siliceous shell, called "puncta" or "foramina." The Diatoms may be roughly divided into three groups, viz., those which live free and apart from each other, those which live in chains or stalked groups, and those which live encased together in large numbers by a branching gelatinous envelope. It is only in those species which are free, and in some few of the fixed and chain species, that movements have been observed. Any one who gets a handful of duckweed, or conferva, from a pond, and places

* Max Schultze's "Archiv für Mikr. Anatomie," December, 1865.

some of its "droppings" under the microscope, is certain to observe some forms of *Navicula, Nitzschia,* or *Synedra,* exhibiting these movements. The motion is of a peculiar kind, a slow, regular advance in a straight line; a little hesitation; then another slow, rectilinear movement, followed perhaps by another; then a few moments' pause, and a return upon nearly the same path by similar slow, rectilinear, recurrent movement. It is particularly noticeable that an obstacle in the path does not affect the Diatom, which does not shrink from, or avoid, foreign bodies in any way. There is not the slightest evidence that the contact with a foreign body affects the nature of the movement, as it nearly invariably does in the lowest Protozoa. Either the obstacle is pushed on one side, by the motor power of the Diatom, or, should it be too large for this, the Diatom remains in apposition with it for as long a space of time as would have been occupied in its forward movement, had that been unopposed. The rate of these movements in the Diatoms is slow when compared with some of the rapid, darting evolutions of Infusoria; but, as compared with the rate of crawling movements in animals, it is exceedingly rapid. Some of the most rapid Diatoms are estimated by the Rev. W. Smith to move about four hundred times their own length in three minutes; that is to say, a Diatom $\frac{1}{400}$ of an inch in length moves more than the $\frac{1}{200}$ of an inch in a second. That this is a very rapid movement, if considered as a crawling movement, is apparent from the fact, that a snail moving at the same proportionate rate would accomplish the distance of a mile in two hours.

No organ capable of producing these movements of the siliceous frustule are apparent to the observer on his first inspection, and many varied hypotheses have been advanced as to their cause, based frequently upon the most careful observations, though more often on erroneous ones.

The various explanations offered come all under one of three heads, viz., 1st, the existence of endosmotic and exosmotic currents; 2nd, the existence of cilia on some part of the frustule; 3rd, the existence of a snail-like foot, external to the frustule.

Nägeli, in 1849, was the originator of the first of these hypotheses, and his explanation was adopted by Von Siebold and our chief English authority, the Rev. William Smith. Nägeli says:—

> The cells have no special organs for these movements. But as in consequence of their nutritive processes they both take in and give out fluid matters, the cells necessarily move when the attraction and the emission of the fluids is unequally distributed on parts of the surface, and is so active as to overcome the resistance of the water.

Von Siebold demonstrated the existence of currents on the surface of *Naviculæ* by means of indigo, and considered his researches corroborative of Nägeli's hypothesis. He remarked that indigo particles coming in contact with the Diatom remained quite motionless except along the "raphe," the line of suture: here he observed that the granules were carried from the central spot, or "umbilicus" as it is called, slowly along to the terminal points of the frustule, where they stopped a short time and were then again carried off in a reverse direction. He found the currents occasionally so strong that bodies of some size were set in motion by them. The Rev. W. Smith, in the introduction to his work on British Diatoms, states that he is constrained to accept Nägeli's hypothesis.

The fluids (he remarks) which are concerned in these actions must enter and be emitted through the minute foramina at the extremities of the siliceous valves; and it may easily be conceived that an exceedingly small quantity of water expelled through these minute apertures would be sufficient to produce movement in bodies of so little specific gravity.

He concludes, however, by observing that "the subject is one involved in much obscurity, and is probably destined to remain, for some time to come, among the mysteries of nature, which baffle while they excite inquiry."

We now come to the hypothesis of "ciliary action." Ehrenberg was the first to start this explanation with singular confidence and inconsistency, as we shall see that he had already advanced the explanation of a central foot. He gives the following minute details, which have only the most remote foundation in fact, in reference to *Surirella gemma*:—

Long delicate threads projected where the ribs or transverse markings of the shell joined the ribless lateral portions, and which the creature voluntarily drew in or extended. An animalcule, $\frac{1}{18}$ of a line long, had twenty-four for every two plates, or ninety-six in all.

These ciliary processes were stated to be actively vibratile, while the frustule was declared to be perforated with ninety-six apertures for their extrusion. The presence of hair-like processes on all parts of the frustule is not at all unfrequent, and it is not improbable that Ehrenberg was deceived by these. In plate XVIII. (fig. 4) I have given a drawing of a specimen of a living *Nitzschia sigmoides*, with numerous specimens of another Diatom—*Amphora minutissima*—adhering to it. This and similar specimens I observed at Cambridge in June, 1865. The Diatom was covered with minute, erect, immovable hair-like processes, which were also disposed over the surface of the parasitic *Amphoræ;* similar hairs were not uncommon on other species. There can be little doubt but that these hairs are foreign to the Diatom, and are in all probability fungoid growths. Independently of the correctness of Ehrenberg's views, ciliary action has been assigned as the cause of movement in Diatoms. Mr. Jabez Hogg, in the *Journal of Microscopical Science*, 1855, p. 235, tells us that he has repeatedly satisfied himself that the motive power is derived from cilia arranged around openings at either end—in some also around central openings,—which, with the terminal cilia, act as paddles or propellers. I have copied Mr. Hogg's figure in the plate as an interesting and instructive warning to microscopical observers, for Mr. Wenham (whose knowledge of and familiarity with the optical principles involved in the use of the microscope is unrivalled) has clearly shown that Mr. Hogg's "cilia" were optical illusions.

There is yet one more advocate for "cilia" to be enumerated. The writer in the last edition of Pritchard's "Infusoria" considered that, at the time when he wrote, it was not satisfactorily ascertained that minute cilia do not exist along the "raphe," causing the currents of indigo particles described by Von Siebold.

Lastly, we have to consider the hypothesis of some form of snail-like foot. It is no doubt the slow, crawling movement of the free Diatoms, together with the very considerable power exhibited by them, that first suggested this explanation, and not any observation of such an organ. Ehrenberg asserted that a snail-like foot was protruded from the central thickened portion of the frustule, known as the "umbilicus," which he believed to be a perforation. M. Focke believed in the existence of many such protusable feet, of a temporary character, while Mr. Wenham advances the following speculations on the cause of the movements, which, from their close approximation to the true state of the case as ascertained by Professor Schultze, deserve especial attention. He says (*Journal of Microscopical Science*, 1856, p. 159) :—

If caused by the action of cilia, such extremely rapid impulses would be required to propel the comparatively large body through the water, that surrounding bodies would be jerked away far and wide. A similar effect would be observed if the propulsion were caused by the reaction of a jet of water, which, according to known laws of hydrodynamics must necessarily be ejected with a rapidity sufficient to indicate the existence of the current a long distance astern. I consider there is no ground for assuming the motions of the Diatomaceæ to be due to either of these causes. They are urged forward through a mass of sediment without displacing any other particles than those they immediately come in contact with, and quietly thrust aside heavy obstacles directly in their way with a slow but decided mechanical power, apparently only to be obtained from an abutment against a solid body. In studying the motions of the Diatomaceæ, I have frequently seen one get into a position such as to become either supported or jammed endways between two obstacles. In this case particles in contact with the sides are carried up and down from the extreme ends with a jerking movement and a strange tendency to adherence, the Diatom seeming unwilling to part with the captured particle. Under these circumstances I have distinctly perceived the undulating movement of an *external membrane;* whether this envelops the whole surface of the siliceous valves I am not able to determine, nor do I know if the existence of such a membrane has yet been recognized. The movement that I refer to occupied the place *at the junction of the two valves,* and is caused by the undulation of what is known as the "connecting membrane." This will account for the progressive motion of the Diatomaceæ, which is performed in a manner analogous to that of the gasteropoda. The primary cause, however, is different, and not due to any property of animal vitality, but arises, in my opinion, from the effects of vegetable circulation. I have observed several corpuscles of uniform size travel to and fro, apparently within the membrane which is thus raised in waves by their passage.

We now come to the researches of Professor Max Schultze, of Bonn, which were published in December, 1865. After a review of the history of the subject and some remarks on the external currents in *Rhizosolenia* and *Coscinodiscus,* he proceeds to describe his very minute and careful observations on a marine naviculoid species, the *Pleurosigma angulatum,* which is not unfrequently to be met with on the sea-coast. The *P. angulatum* is to be preferred for examination to the larger *P. balticum,* because the transverse markings on its frustule do not impede to so great an extent the observation of what is going on within. When you have a specimen of *P. angulatum* under the microscope, if crawling, it always has its broad side turned to view, with one long curved "raphe" uppermost and the other in contact with the glass on which it is placed; at the central part is seen the thickened "umbilicus" (Pl. XVIII., figs. 1, 3). Within the siliceous frustule is the yellow colouring matter, or "endochrome," which fills the cavity more or less completely, and is arranged in two longitudinal masses, to the right and left of the raphe. In the broader part of the frustule these bands of endochrome describe one or two complicated windings, as seen in the figure. The breadth of these bands varies in different individuals, according to the development of the endochrome. It is only possible in those specimens in which the bands are narrow properly to trace their foldings and ascertain that only two exist, since an examination of frustules richer in endochrome has led to the impression that there are four of these bands, and, indeed, is often hardly satisfactory as to their existence. Often a long searching is required before the spots which are not occupied by the endochrome can be discovered, and then they are always found to lie under the raphe, and particularly near the umbilicus and extremities. In Fig. 3, which represents a specimen after immersion in hyperosmic acid, it is seen that the coloured bands are somewhat removed from their natural position. The next objects which strike the eye in examining a living *Pleurosigma* are highly refractive oil-globules. These are four in number; one pair near either end of the Diatom. They are not, however, all in the same plane, one globule of each pair being nearer the observer than the other; their relative position is best seen when a view of the narrow side of the frustule can be obtained, so that one raphe is to the left and the other to the right, as in fig. 2. The blue-black colour, which is assumed by these globules after the Diatom has been treated with hyperosmic acid, demonstrates that they consist of oleaginous matter. The middle of the cavity of the Diatom-frustule is occupied by a colourless finely granular mass, whose position in the body is not so clearly seen in the flat view of figs. 1 and 3 as in the side view of fig. 2. Besides the central mass, the conical cavities at either end of the siliceous shell are seen to be filled with a similar granular substance, and two linear extensions from each of the three masses are developed, closely underlying that part of the shell which is beneath the two raphæ; so that in the side view (fig. 2) they appear attached to the right and left edges of the interior of the frustule. This colourless granular substance carries in its centre, near the middle point of the Diatom, a rounded nucleus-granule, which it is not very easy to see during life; but may be easily demonstrated by the use of acid. The colourless substance is what, in other Diatoms, Professor Schultze has shown to be Protoplasm, or vegetable sarcode, and there is no doubt that it is an essential part of the organization of these minute structures. The protoplasm contains numerous small refractive particles, which hyperosmic acid colours blue-black, and proves to be fat. Professor Schultze found it exceedingly difficult to determine the exact boundaries of the protoplasm, on account of the highly refractive character of the siliceous shell, and the obstruction presented by the bands of endochrome. In the side view, given in fig. 2, the colouring matter is not represented; the protoplasm is seen to extend for some distance as a fine layer, projecting from the central mass, and passing beneath the raphe on both sides; but after a short distance it seems to disappear: it is exceedingly hard to say absolutely whether it is continued beneath the raphe, as the granules of the protoplasm, by which only it can be recognized, are very fine.

After a short distance, the protoplasm reappears, and is heaped up in a considerable mass within the conical terminations of the frustule. Professor Schultze observed in this part of the protoplasm, with very powerful objectives, a rapid molecular movement such as is well known in the Desmid *Closterium*, and further, *a current of the granules of the protoplasm along the raphe*. *Pleurosigma angulatum* crawls, as do all Diatoms possessing a raphe, along this line of suture. To crawl along, it must have a fixed support. Free swimming movements are never to be observed in this or any other Diatom. Accordingly, Schultze invariably found that the raphe is in contact with either the glass stage or the glass cover, between which the Diatom is placed, or is in apposition with some foreign body of considerable size, even when it is standing on end, as is sometimes the case. When the *Pleurosigma* crawled along the smooth surface of the glass cover, Schultze noticed that there was a slight turning of the longitudinal axis: this he connects with the fact that the raphe is inclined to opposite sides at either end of the frustule (see figures). Having thus determined that a moving protoplasmic mass was intimately connected with the raphe, and that if there were an external organ of locomotion, the raphe must prove to be its seat, Schultze's next care was to minutely examine the current of granules which he had discovered in the protoplasm underlying the raphe. If he should find that any of the current of protoplasm was flowing *externally*, the motor organ in Diatomaceæ would be discovered. It was impossible to see any such phenomenon by simple inspection. Accordingly, Schultze repeated the experiments of Siebold, and observed the same fact as he and also Wenham had done —namely, that particles of foreign matter stick to the raphe as though it were covered with some glutinous material, and are carried slowly along by the action of some current. This he observed in many Diatomaceæ, and found invariably that foreign particles adhered only to the raphe or what corresponded to it. "There is obviously," says Professor Schultze, "but one explanation; it is clear there must be a band of protoplasm lying along the raphe, which causes the particles of colouring matter to adhere, and gives rise to a gliding movement. For there is one phenomenon which can be compared with the gliding motion of foreign bodies on the Diatomaceæ, and that is, the taking up and casting off of particles by the pseudopodia of the rhizopoda, as observed, for instance, on placing a living Gromia or Miliolina in still water along with powdered carmine. The nature of the adhesion and of the motion is in both cases the same in all respects. And since with Diatoms as unicellular organisms, protoplasm forms the principal part of the cell body (in many cases too distinctly moving protoplasm), everything suggests that the external movements are referrible to the movement of this protoplasm." Unfortunately, however, as it may seem, Professor Schultze could not see this protoplasm; for although he had clearly witnessed the movement of granular protoplasm along the raphe in the *interior* of the frustule, in no Diatom could he observe it *externally*. When we reflect upon the very great difficulties offered by the minuteness of the diatom, the refraction of the siliceous shell, and the close packing of the endochrome, we cannot but admire very highly the perseverance and acumen displayed by Professor Schultze. Having satisfied himself that no external movement of *granular* protoplasm could be detected, after examining *Pleurosigma, Surirella,* and many others, our observer came to the only conclusion open to him—and that was, that the protoplasm moving on the exterior of the raphe is *hyaline,* and totally free from granules, just as are the pseudopodia of *Gromia* and *Difflugia,* described by him. The minute perforations in the shell along the raphe (alluded to above) are so very minute as to be scarcely appreciable with the microscope, and it is through these holes that the protoplasm has to flow. Accordingly, its granules, or those of any visible size, are of necessity kept back within the frustule, whilst the clear hyaline matter flows slowly over the exterior of the raphe—moving with the inner protoplasm, whose flow is more obvious from the presence of the granules suspended in it. Hence the band of protoplasm coating the raphe has the import of a foot, on which the Diatom creeps, and there can be little doubt that Professor Schultze has set the long-debated question of these movements at rest. I should wish here to point out how very near Mr. Wenham's observations and conclusions were to the truth. The undulating membrane he speaks of, is no doubt Professor Schultze's hyaline band, whilst he also observed internal currents of granules.

Professor Schultze remarks that there are three types on which the holes for the emission of the hyaline protoplasm are arranged. The first presents us with long open slits on the surface of the frustule, corresponding with the raphe, and is seen in *Navicula viridis,* and its allied forms. The second type has the raphe closed, but with fine openings at either end—this is the case in *Pleurosigma.* The third type is the most common, existing in all those flat Diatomaceæ in which the raphe runs along the narrower edges of the frustule. In these there are numerous openings placed along the elevated ridge at the sides of the frustule corresponding with the raphe. This is seen in *Nitzschia* (fig. 4), *Surirella,* &c.

The movements of the Diatomaceæ other than those of free locomotion are admirably explained by Professor Schultze's observations. The rotating movements of some of the stalked species are thus readily accounted for, while the connection of the concatenated species which live in chains of several individuals, united by their long sides or by their angles, are rendered intelligible. It is by this hyaline protoplasm that they are connected the one with the other. The movements of *Bacillaria paradoxa* and *Bacillaria cursoria,* which have so much puzzled observers, now receive a ready explanation. The *Bacillariæ* are elongated Diatoms attached to one another by their broad sides. They are frequently seen to exhibit the most strange movements. One frustule slides along its neighbour until it is only attached to it by its edge; the next one above performs the same movement, and then the whole colony follows the example, so that they become spread out like a flight of steps; after a short pause the movement is reversed (figs. 7, 8). This curious phenomenon is easily explained by the gliding movement of the hyaline protoplasm of one frustule upon that of its neighbour. It may be asked whether Professor Schultze's explanation of the movements of Diatomaceæ affects the question as to their animal or vegetable nature. He himself does not consider that it does, since motile protoplasm is as much the property of the vegetable as it is of the animal cell. Moreover, it must be remembered that the only satisfactory distinction that can be drawn between plants and animals is a chemical and functional one. There is nothing in Professor Schultze's observations to lead us to believe that the food of Diatoms is organic matter, or that they do not build up simple mineral compounds into protein and hydrocarbons.

There is every reason to hope that the observations above recorded may serve as the basis for the study of other plant-movements, such as those of the Oscillatoriæ, Desmidiaceæ, and Algæ-spores.

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EXPLANATION OF THE PLATE.

Fig. 1. *Pleurosigma angulatum* (natural size, $\frac{1}{130}$ in.)—*a*, bands of endochrome; *b*, fat globules; *c*, granular protoplasm; *d*, foreign particles adhering to the raphe.—After Schultze.

„ 2. Side view, in which the endochrome is not represented—letters as before.—After Schultze.

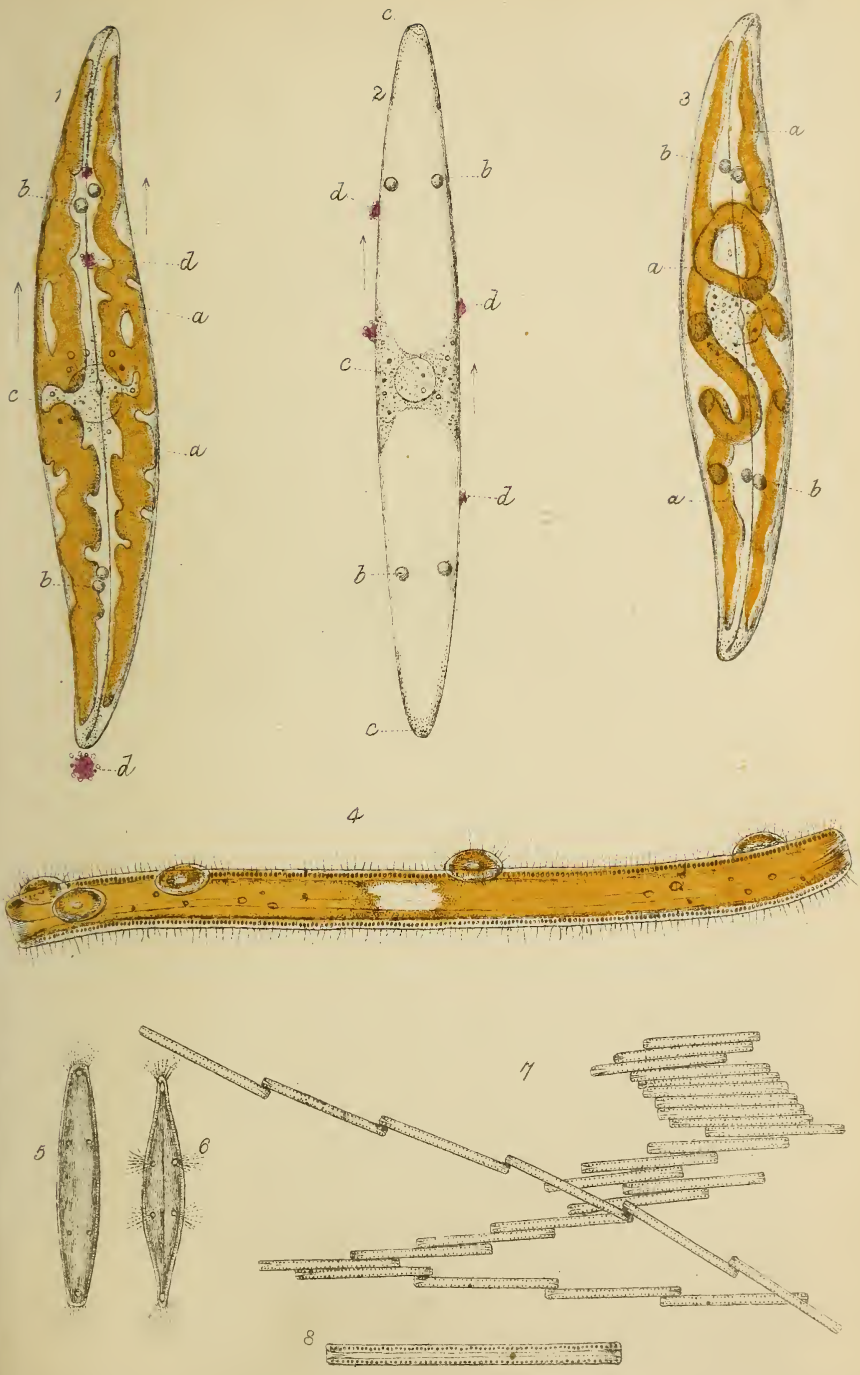
„ 3. A specimen treated with Hyperosmic Acid—letters as before.—After Schultze.

„ 4. *Nitzschia Sigmoides* (natural size, $\frac{1}{80}$ in.) with adhering *Amphora minutissima* and hair-like processes. Observed at Cambridge.

„ 5 and 6. Mr. Jabez Hogg's figures of ciliated Diatoms.

„ 7. *Bacillaria paradoxa.*—After Smith.

„ 8. A single frustule.



Tuffen West, sc

W. West imp.

Movements of Diatoms.

AEROLITES.

BY TOWNSHEND M. HALL, F.G.S.

METEORIC stones, or aërolites, as they are generally called (from two Greek words, *aer* and *lithos*, signifying "air stones"), may be defined as solid masses consisting principally of pure iron, nickel, and several other metals, sometimes containing also an admixture of augite, olivine, and hornblende, which, from time to time, at irregular intervals, have fallen upon the surface of the earth from above.

Other designations, such as "fire-balls and thunder-bolts," have been popularly applied to these celestial masses, the former denoting their usual fiery appearance, whilst the latter has reference to the extreme suddenness of their descent.

Shooting stars also, although they are not accompanied by the fall of any solid matter upon the earth, are generally placed in this same category, since they are supposed to be aërolites which pass (comparatively speaking) very near our earth, and are visible from it by night; at the same time their distance from us, varying as it does from 4 to 240 miles and upwards, is in most instances too great to allow of their being drawn down by the attractive power possessed by the earth. Like comets and eclipses, these celestial phenomena in former times were universally regarded with feelings of the greatest awe and superstition; and in Eastern countries especially, where the fall of a meteoric stone was supposed to be the immediate precursor of some important public event, or national calamity, the precise date of each descent was carefully recorded. In China, for example, such reports reach back to the year 644 before our era; and M. Biot has found in the astronomical section of some of the most ancient annals of that empire sixteen falls of aërolites, recorded as having taken place between the years 644 B.C. and 333 after Christ, whilst the Greek and Roman authors mention only four such occurrences during the same period. Even now, in this age of science and universal knowledge, aërolites can scarcely be regarded without a certain degree of dread. Indeed, four or five cases have occurred in which persons have been killed by them; in another instance, several villages in India were set on fire by the fall of a meteoric stone; and it is by no means a pleasant subject for reflection, that such a catastrophe might happen anywhere, and at any moment, especially when we remember that these stones, although not quite incandescent, are always, more or less, in a heated state; and sometimes so hot that even after the lapse of six hours they could not be touched with impunity.

The first fall of meteoric stones on record appears to have taken place about the year 654 B.C., when, according to a passage in Livy, a shower of stones fell on the Alban Hill, not far distant from Rome. The next in chronological order is mentioned by several writers, such as Diogenes of Apollonia, Plutarch, and Pliny, and described by them as a great stone, the size of two millstones, and equal in weight to a full waggon-load. It fell about the year 467 B.C., at Ægos Potamos, on the Hellespont, and even up to the days of Pliny, four centuries after its fall, it continued to be an object of curiosity and speculation. After the close of the first century we fail to obtain any account or notice of this stone; but although it has been lost sight of for upwards of eighteen hundred years, the eminent Humboldt says, in one of his works, that notwithstanding all previous failures to re-discover it, he does not wholly relinquish the hope that even after such a considerable lapse of time, this Thracian meteoric mass, which it would be so difficult to destroy, may be found again, especially since the region in which it fell has now become so easy of access to European travellers.

The next descent of any particular importance took place at Ensisheim in Alsace, where an aërolite fell on November 7th, 1492, just at the time when the Emperor Maximilian, then King of the Romans, happened to be on the point of engaging with the French army. It was preserved as a relic in the Cathedral at Ensisheim, until the beginning of the French revolution, when it was conveyed to the Public Library of Colmar, and it is still preserved there among the treasures.

In later years the shower of aërolites which fell in April, 1803, at L'Aigle, in Normandy, may well rank as the most extraordinary descent upon record. A large fire-ball had been observed a few moments previously, in the neighbourhood of Caen and Alençon, where the sky was perfectly clear and cloudless. At L'Aigle no appearance of light was visible, and the fire-ball assumed instead the form of a small black cloud, consisting of vapour, which suddenly broke up with a violent explosion, followed several times by a peculiar rattling noise. The stones at the time of their descent were hot, but not red, and smoked visibly. The number which were afterwards collected within an elliptical area measuring from six to seven miles in length, by three in breadth, has been variously estimated at from two to three thousand. They ranged in weight from 2 drachms up to 17½ lb. The French Government immediately deputed M. Biot, the celebrated naturalist and philosopher, to proceed to the spot, for the express purpose of collecting the authentic facts concerning a phenomenon which, until that time, had almost universally been treated as an instance of popular superstition and credulity. His conclusive report was the means of putting an end to all scepticism on the subject, and since that date the reality—not merely the possibility—of such occurrences has no longer been contested.

Leaving out, for the present, innumerable foreign instances which might be quoted, we must now glance rapidly at a few of the most noticeable examples of the fall of meteoric stones which have taken place in England. The earliest which appears on record descended in Devonshire, near Sir George Chudleigh's house at Stretchleigh, in the parish of Ermington, about twelve miles from Plymouth. The circumstance is thus related by Westcote, one of the quaint old Devonshire historians :—

In some part of this manor (Stretchleigh), there fell from above—I cannot say from heaven—a stone of twenty-three pounds weight, with a great and fearful noise in falling ; first it was heard like unto thunder, or rather to be thought the report of some great ordnance, cannon, or culverin ; and as it descended, so did the noise lessen, at last when it came to the earth to the height of the report of a peternel, or pistol. It was for matter like unto a stone singed, or half-burned for lime, but being larger described by a richer wit, I will forbear to enlarge on it.

The "richer wit" here alluded to, was in all probability the author of a pamphlet published at the time, which further describes this aërolite as having fallen on January 10th, 1623, in an orchard, near some men who were planting trees. It was buried in the ground three feet deep, and its dimensions were 3½ feet long, 2½ wide, and 1½ thick. The pamphlet also states that pieces broken from off it were in the possession of many of the neighbouring gentry. We may here remark that no specimen of this stone is at present known to be in existence, and that although living in the county where it fell, we have hitherto failed in tracing any of the fragments here referred to. A few years later, in August, 1628, several meteoric stones, weighing from 1 to 24 pounds, fell at Hatford, in Berkshire ; and in the month of May, 1680, several are said to have fallen in the neighbourhood of London.

The total number of aërolitic descents, which up to this present time have been observed to take place in Great

Britain and Ireland, is twenty, of which four occurred in Scotland, and four in Ireland. The largest and most noticeable of all these fell on December 13, 1795, near Wold Cottage, in the parish of Thwing, East Riding of Yorkshire. Its descent was witnessed by two persons; and when the stone was dug up, it was found to have penetrated through no less than 18 inches of soil and hard chalk. It originally weighed about 56 lb., but that portion of it preserved in the British Museum is stated in the official catalogue toweigh 47 lb. 9 oz. 53 grains—just double the weight of the Devonshire aërolite.

When we come to inquire into the various opinions which have been held in different ages respecting the origin of aërolites, and the power which causes their descent, we must go back to the times of the ancient Greeks, and we find that those of their philosophers who had directed their attention to the subject had four theories to account for this singular phenomenon. Some thought that meteoric stones had a telluric origin, and resulted from exhalations ascending from the earth becoming condensed to such a degree as to render them solid. This theory was in after-years revived by Kelper, the astronomer, who excluded fire-balls and shooting stars from the domain of astronomy; because, according to his views, they were simply "meteors arising from the exhalations of the earth, and blending with the higher ether." Others, like Aristotle, considered that they were masses of metal raised either by hurricanes, or projected by some volcano beyond the limits of the earth's attraction, so becoming inflamed and converted, for a time, into star-like bodies. Thirdly, a solar origin; this, however, was freely derided by Pliny, and several others, amongst whom we may mention Diogenes of Apollonia, already alluded to as one of the chroniclers of the aërolite of Ægos Potamos. He thus argues: "Stars that are invisible, and consequently have no name, move in space together with those that are visible. . . . . These invisible stars frequently fall to the earth and are extinguished, as the stony star which fell burning at Ægos Potamos." This last opinion, it will be seen, coincides, as far as it goes, almost exactly with the most modern views on the subject.

As some of the Greeks derived the origin of meteorites from the sun (probably from the fact of their sometimes falling during bright sunshine), so we find, at the end of the seventeenth century, it was believed by a great many that they fell from the moon. This conjecture appears to have been first hazarded by an Italian philosopher, named Paolo Maria Terzago, whose attention was specially directed to this subject on the occasion of a meteoric stone falling at Milan in 1660, and killing a Franciscan monk. Olbers, however, was the first to treat this theory in a scientific manner, and soon after the fall of an aërolite at Sienna, in the year 1794, he began to examine the question by the aid of the most abstruse mathematics, and after several years' labour he succeeded in showing that, in order to reach our earth, a stone would require to start from the moon at an initial velocity of 8,292 feet per second; then proceeding downwards with increasing speed, it would arrive on the earth with a velocity of 35,000 feet per second. But as frequent measurements have shown that the *actual* rate of aërolites averages 114,000 feet, or about 21½ miles per second, they were proved by these curious and most elaborate calculations to have come from a far greater distance than that of our satellite. It is but fair to add that the question of initial velocity, on which the whole value of this, so-called, "Ballistic problem," depends, was investigated by three other eminent geometricians, Biot, Laplace, and Poisson, who during ten or twelve years were independently engaged upon this calculation. Biot's estimate was 8,282 feet in the second; Laplace, 7,862; and Poisson, 7,585,—results all approximating very closely with those stated by Olbers.

We have already observed, at the beginning of this paper, that meteoric stones may fall at any moment, but observations, extending over many years, have sometimes been brought forward to show that, as far as locality is concerned, all countries are not equally liable to these visitations. In other words, the large number of aërolites which have been known to fall within a certain limited area, has been contrasted with the apparent rarity of such occurrences beyond these limits. If it could be proved that the earth possessed more attractive power in some places than in others, this circumstance might be satisfactorily explained, but in default of any such evidence, the advocates of this theory must rely solely upon statistics, which from their very nature require to be taken with a certain amount of reserve. Professor Shepard, in *Silliman's American Journal*, has remarked that "the fall of aërolites is confined principally to two zones; the one belonging to America is bounded by 33° and 44° north latitude, and is about 25° in length. Its direction is more or less from north-east to south-west, following the general line of the Atlantic coast. Of all known occurrences of this phenomenon during the last fifty years, 92·8 per cent. have taken place within these limits, and mostly in the neighbourhood of the sea. The zone of the eastern continent—with the exception that it extends ten degrees more to the north—lies between the same degrees of latitude, and follows a similar north-east direction, but is more than twice the length of the American zone. Of all the observed falls of aërolites, 90·9 per cent. have taken place within this area, and were also concentrated in that half of the zone which extends along the Atlantic."

On reference to a map, it will be seen that in the western continent, the so-called zone is simply confined to the United States—the most densely inhabited portion of America. In like manner the eastern zone leaves out the whole of desert Africa, Lapland, Finland, the chief part of Russia, with an average of thirty-two inhabitants to each square mile; Sweden and Norway, with only seventeen per mile, whilst it embraces all the well-peopled districts of central Europe, most of which, like England, are able to count between three and four hundred persons to every mile of their territory. In fact, Professor Shepard's statement may almost be resolved into a plain question of population, for were an aërolite to fall in the midst of a desert, or in a thinly-peopled district, it is needless to point out how few the chances are of its descent being ever noticed or recorded. That innumerable aërolites do fall without attracting any attention, is clearly proved by the number of discoveries, continually taking place, of metallic masses, which from their locality and peculiar chemical composition, could only be derived from some extra-terrestrial source. The great size also of many of these masses entirely precludes the possibility of their having been placed by human agency in the positions they have been found to occupy—sometimes on the surface of the earth, but just as frequently buried a few feet in the ground.

Thus the traveller Pallas found, in 1749, at Abakansk, in Siberia, the mass of meteoric iron, weighing 1,680 lb., now in the Imperial Museum at St. Petersburg. Another, lying on the plain of Tucuman, near Otumpa, in South America, has been estimated, by measurement, to weigh no less than 33,600 lb., or about 15 tons; and one added last year to the splendid collection of meteorites in the British Museum weighs rather more than 3½ tons. It was found at Cranbourne, near Melbourne, and was purchased by a Mr. Bruce, with a view to his presenting it to the British Museum, when, through some misunderstanding, it was discovered that one-half of it had been already promised to the Museum at Melbourne. In order, therefore, to save it from any such mutilation, the trustees of our National Museum acquired and transferred to the authorities of the Melbourne collection a smaller mass which had been sent in 1862 to the International Exhibition. It weighed about 3,000 lb., and had been found near Melbourne in the immediate vicinity of the great meteorite. The latter was then forwarded entire to London. In the British Museum may also be seen a small fragment of an aërolite, originally weighing 191 lb., which from time immemorial had been lying at Elbogen, near Carlsbad, in Bohemia, and had always borne the legendary appellation of "*Der verwünschte Burggraf*," or the enchanted Burgrave. The remainder of this mass is preserved in the Imperial collection at Vienna. In Great Britain only two meteoric masses (not seen to fall) have hitherto been discovered; one was found about forty years ago near Leadhills, in Scotland; the other in 1861, at Newstead, in Roxburghshire.

Several instances have at different times occurred in which stones like aërolites have been found, and prized accordingly, until their real nature was demonstrated by the aid of chemical analysis. One valuable specimen, found a few years ago, was shown to have derived its origin amongst the *scoriæ* of an iron foundry; another, picked up in the Isle of Wight, turned out to be a nodule of iron pyrites, similar in every respect to those which abound in the neighbouring chalk cliffs; and lastly, some aërolites of a peculiarly glassy appearance were found shortly after, of which it may, perhaps, suffice to say that the scene of this discovery was—Birmingham.

When we come to examine the composition of meteoric stones, we find in various specimens a great diversity in their chemical structure. Iron is the metal most invariably present, usually accompanied by a considerable per-centage of nickel and cobalt; also five other metals, chromium, copper, molybdenum, manganese, and tin; but of all these iron is that which largely preponderates, forming sometimes as much as 96 parts in the 100. Rare instances have, however, been recorded where the proportion of iron has sunk so low as to form only 2 per cent., and the deficiency thus caused has been made up by a larger admixture of some earthy mineral, such as augite, hornblende, or olivine. Other ingredients, like carbon, sulphur, alumina, &c., are also found to enter, in different proportions, into the composition of aërolites; the total number of chemical elements observed in them, up to this present date, being nineteen or twenty. It has been well remarked by an able writer, that no *new* substance has hitherto come to us from without; and thus we find that all these nineteen or twenty elements are precisely similar to those which are distributed throughout the rocks and minerals of our earth; the essential difference between the two classes of compounds—celestial and terrestrial—being seen most clearly in the respective methods in which the component parts are admixed.

In the outward appearance of aërolites there is one characteristic so constant that, out of the many hundred examples that have been recorded, one only (as far as we can ascertain) has been wanting in it. We refer to the black fused crust or rind with which the surface of meteoric stones is covered. It usually extends not more than a few tenths of an inch into the substance of the stone, and is supposed to result from the extreme rapidity with which they descend into the oxygen of our atmosphere, causing them to undergo a slight and partial combustion, which, however, from the short time necessarily occupied in their descent, has not sufficient time to penetrate beyond the surface. On cutting and polishing the stones, if the smooth face is treated with nitric acid, it will in many cases be found to exhibit lines and angular markings, commonly known by the name of "widmannsted figures." These are tracings of imperfect crystals, whilst the broad intermediate spaces, preserving their polish, point out those portions of the stone which contain a larger proportion of nickel than the rest of the mass. We may here add that the noise, said at times to accompany the fall of aërolites, does not appear to be a constant characteristic, nor does the cause or exact nature of it seem able to be definitely specified.

In conclusion, we cannot do better than advise those of our readers who desire further information on this subject, to take the earliest opportunity—if they have not done so already—of paying a visit to the magnificent collection of meteoric stones, contained in several glass cases at the end of the Mineral Gallery at the British Museum. The catalogue for the year 1856 gave a list of between 70 and 80 specimens; in 1863 this number had increased to 216, mainly through the energy of the Curator, Mr. Maskelyne; and since that date there have been several further additions. Chief amongst continental museums may be mentioned the Imperial collection at Vienna, as possessing a series of specimens, remarkable alike for their size and importance.

SUMMARY OF AËROLITIC DESCENTS WHICH HAVE TAKEN PLACE IN GREAT BRITAIN AND IRELAND.

England.

1623. January 10.	Ermington, near Plymouth, Devonshire.
1628. August 9.	Hatford, in Berkshire.
1642. August 4.	Woodbridge, in Suffolk.
1680. May 18.	In the neighbourhood of London.

1725. July 3.	Northamptonshire.
1780. April 1.	Beeston.
1791.	Menabilly, in Cornwall.
1795. December 13.	Wold Cottage, Thwing, Yorkshire.
1803. July 4.	East Norton, in Leicestershire.
1806. May 17.	Basingstoke, in Hampshire.
1830. February 15.	Launton, near Bicester, Oxfordshire.
1835. August 4.	Aldsworth, near Cirencester, Gloucestershire.

Scotland.

1676.	In the Orkneys.
1802. October.	In Scotland.
1804. April 5.	High Possil, near Glasgow.
1830. May 17.	Perth.

Ireland.

1779.	Pettiswood, Co. Westmeath.
1810. August.	Mooresfort, Co. Tipperary.
1813. September 10.	Adare, Co. Limerick.
1844. April 29.	Killeter, near Castle Derg, Co. Tyrone.

In addition to these, two meteoric stones have been found in Scotland, viz. :—

Found, 1820—30.	Leadhills, Lanarkshire.
„ 1861.	Newstead, Roxburghshire.

ON THE ELECTRICAL PRINCIPLES OF THE ATLANTIC TELEGRAPH.

By G. C. FOSTER, Professor of Experimental Physics in University College, London.

IT may be safely assumed that all readers of this Review have some knowledge of the peculiar properties acquired by a piece of copper wire, when it is used to form a connection between the two poles of a galvanic battery: how it makes a magnetic needle suspended in its neighbourhood tend to place itself at right angles to it; how, if coiled spirally round a piece of soft iron, it converts the iron into a magnet; how, if it is cut across and the two cut ends are dipped into water, chemical decomposition of the water ensues; how, if its dimensions are small relatively to the power of the battery, it becomes warm or hot, and may even be ignited and fused. Our readers are, doubtless, also perfectly well aware that no such properties are acquired by a glass rod, a piece of wood, or a strip of gutta-percha or india-rubber, when either of these substances is used, instead of a metallic wire, to join the poles of a battery. These familiar facts, which, with others of the same order, are summed up in the statement that copper is a *conductor* of electricity, and that glass, wood, india-rubber, &c., are *non-conductors*, form the basis of all the methods of electric telegraphy; and if we can succeed in gaining a clear conception of what this difference between conductors and non-conductors amounts to, we shall be in a position, not only to understand how submarine telegraphic communication between Ireland and Newfoundland is electrically possible, but also to appreciate a great part of the difficulties which had to be overcome before such a mode of communication could be established.

When the electrical properties of different substances are accurately examined, it is found that various so-called "conductors" differ greatly in their conducting power, and that even those which possess this property in the highest degree, such as silver and copper, are far from being absolutely perfect conductors: in other words, they oppose an appreciable *resistance* to that propagation of the electrical condition which, in

Fig 2

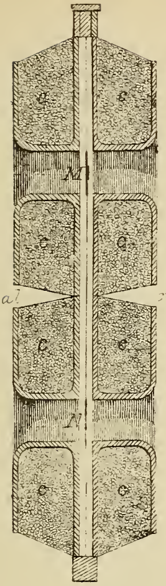


Fig 3.

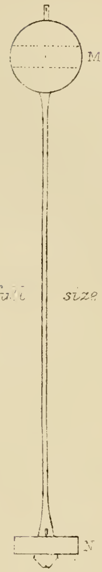


Fig. 1.

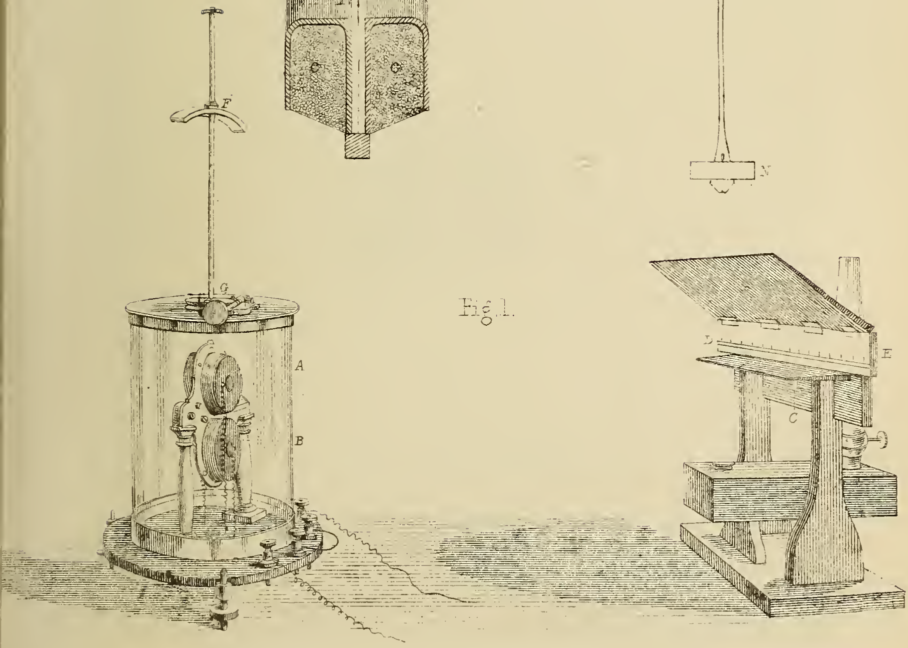
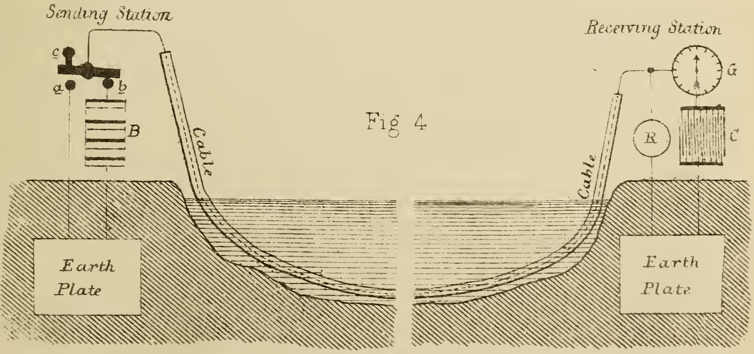


Fig 4



Prof. Thomson's Reflecting Galvanometer.

W West lith.

the language commonly used in describing these phenomena, is called the "passage of an electric current." On the other hand, it is found that the most perfect "non-conductors," or "insulators," as they are also called, do not entirely prevent the propagation of the electrical condition. Hence, instead of regarding conductors and non-conductors as bodies of essentially different properties, it is more correct to think of both as opposing resistance to the passage of electric currents, this resistance being small in the case of conductors and relatively very great in the case of non-conductors or insulators.

And it is found, further, that when any particular piece of wire of any particular material is taken as a standard of comparison, the resistance of a wire of the same material and of the same thickness, but of twice the length, is twice as great as that of the standard; while the resistance of a wire of the same length, but of twice the thickness, is only half as great as that of the standard. That is to say, the resistance of a conductor of any given material is *directly proportional to its length*, and *inversely proportional to its thickness*, or cross-section.

When we thus conceive of all bodies as resisting or opposing the passage of electric currents, it becomes at once self-evident that, when a current flows from any one point to any other, it will not necessarily follow the shortest distance between the two points, but its path will be determined by the *line of least resistance*. The two poles of a galvanic battery are two points between which there is a tendency to the interchange of electricity—in other words, to the formation of an electric current. But if the only connection between them is made (say) by a piece of gutta-percha, the only path offered for the passage of the current is one which opposes to it so much resistance, that no current of appreciable strength is produced; if, however, a thin copper wire is extended from one pole to the other, this will offer a path of much less resistance than the gutta-percha, and consequently a perceptible current will be established along it, even though it may be many times longer than the gutta-percha; and again, if a thick wire be also added, a path of still smaller resistance will be offered to the current, and the consequence will be that, although the current in the thin wire will not be arrested, the electricity will chiefly follow the easiest path, and the thick wire will carry a current just as many times stronger than that in the thin wire, as its resistance is smaller than that of the latter.

We now see what the first part of the problem was which had to be solved in order to establish an electric telegraph between Ireland and Newfoundland. This problem may be stated thus: given the two poles of a galvanic battery at Valentia, it was required to provide a path from one to the other, which, though reaching to the other side of the Atlantic and back again—a distance of some 3,500 miles, should offer less resistance to the passage of an electric current than any other possible route by which it could traverse the few feet or inches by which the two poles were separated. For this purpose it was necessary, in the first place, to diminish as much as possible the resistance which would be encountered by a current passing from one pole of the battery to Newfoundland and returning thence to the other pole; and, in the second place, to make as great as possible the resistance offered to the passage of the current from one pole to the other by any shorter path.

The first of these objects was effected by extending between Valentia and Newfoundland a copper wire,—pure copper having the smallest electrical resistance of any substance known, with the exception of silver. When the Irish end of this wire is connected with the positive pole of the battery, and the other end of the wire and the negative pole of the battery are at the same time each of them connected with a large metallic plate (called an "earth-plate"), either buried in the ground or sunk into the sea, the current starting from the positive pole passes along the wire to Newfoundland, then through the Newfoundland earth-plate into the ground or into the ocean, and so back through earth, or water, or both, to the Valentia earth-plate and the negative pole of the battery. This conductor is formed of a strand of seven wires, each of them 0·048 inch in diameter, and therefore together equivalent to a single wire of nearly 0·144 inch diameter. Its length, as laid, is about 1,858 knots, and each knot has an electrical resistance at 24° C. (or 75° Fahr.), equal to 4·272 times the unit or standard of resistance adopted by the Committee of the British Association on Electrical Standards, and known as the "British Association-Unit." Consequently, the resistance of the whole length of the conductor may be taken in round numbers as equal to 7,500 B. A.-units, allowing for a diminution of resistance caused by the low temperature of the bottom of the Atlantic. To most persons this number would certainly convey no very definite idea; but to an electrician it represents a resistance to the passage of electricity which must be *greatly* exceeded by the resistance, not only of any one other path, but of all other possible paths taken together, by which the current could pass from one pole of the battery to the other.

To appreciate what is involved in this last statement, we must remember that the superficial area of the copper conductor, according to the dimensions already given, is about 425,000 square feet, and that this large surface is surrounded by water, which, if the current could reach it, would afford a passage back to the battery, offering practically no resistance; while the area of its cross section is only 0·0163 square inch. The current may therefore be considered as having the choice of two channels, one of them 425,000 square feet in width, the other less than $\frac{1}{60}$ of a square inch, and the question is to make it take the narrower channel in preference to the wider one. It is for this purpose that the copper conducting wire of the Atlantic cable, instead of being allowed to come into direct contact with the water, is separated from it by being coated throughout its whole length by four layers of gutta-percha and "Chatterton's compound," of a total thickness of 0·16 of an inch. The electrical resistance of gutta-percha is so enormous, that the current finds a much easier passage along the copper wire, more than 2,000 English miles in length, and only about $\frac{1}{60}$ of a square inch in section, than through this coating, notwithstanding that its thickness is what we have just stated (little more than $\frac{1}{6}$ of an inch), and that the wire is in contact with it over a surface of about 425,000 square feet.

Let us try to put this comparison between the resistance of the conductor and that of its insulating coating into a more exact form. We have already estimated the former at about 7,500 B. A.-units: a statement by Mr. Latimer Clark, in the *Mechanics' Magazine* for the 10th August, enables us to estimate the latter. According to this statement, the resistance to the escape of electricity from each knot of the conductor through the gutta-percha covering into the ocean may be represented by 2,200,000,000 B.A.-units; consequently, the resistance to the escape of electricity from the whole 1,858 knots of the cable will be equal to $\frac{1}{1858}$ of 2,200,000,000, or 1,180,000 B. A.-units; or it is about 157 times more difficult for an electric current to find its way back to the battery by taking a short cut across the gutta-percha into the water, than by traversing the whole distance from one end of the cable to the other and back by the way prepared for it. The same comparison may be otherwise stated as follows: of a given current which enters the Irish end of the cable at Valentia, nearly 99·4 per cent. would arrive at Newfoundland, supposing it were there received upon an instrument of no appreciable resistance.

But difficulties of insulation and resistance are not the only difficulties of an electrical kind by which such an undertaking as the Atlantic Telegraph is attended. Difficulties scarcely less formidable are occasioned by the electrical phenomenon known as "induction"; but we shall be better able to understand the way in which these make themselves felt, if we have previously briefly considered the manner in which electrical changes at one end of the cable are made to produce intelligible signals at the other end.

We have already seen how the current of a galvanic battery at Valentia can be conveyed along the copper conductor of the cable to Newfoundland. And, of course, the current from a battery in Newfoundland can be conveyed in an exactly similar way to Valentia.

When a current is sent through the wire, no perceptible effect is produced at the arrival end, so long as that end is in direct communication with the ground; but by connecting the extremity of the wire with a suitable apparatus, through which the current is obliged to pass before it can reach the ground and so return to the other pole of the battery, evidence of the passage of the current can be obtained by the production of any of its characteristic effects, such as the deflection of a magnetic needle or the magnetisation of soft iron. By breaking the connection between the battery and the sending end of the wire, the current can be arrested at pleasure, and with it the effects produced at the distant end; while by re-establishing the connection these effects can be reproduced. This, as is well known, is the general principle of all processes of electrical signalling.

In the case of long submarine lines of telegraph, such as the Atlantic, the effect which it is practically easiest and most convenient to cause the current to produce at the distant end, is the deflection of a magnetic needle. The apparatus employed for this purpose in connection with the Atlantic cable is Professor William Thomson's "Reflecting Galvanometer," precisely the same instrument that is used in scientific investigations as affording the most delicate means that we possess of detecting and comparing very weak electric currents. These galvanometers are excellently made by Messrs. Elliott Brothers, of London, and by Mr. James White, Philosophical Instrument Maker to the University of Glasgow. A beautiful instrument by the former makers is represented in figs. 1, 2, and 3 (Plate XIX.), which will enable us to explain the principles of its construction and mode of action. At A and B (fig. 1), are seen the round fronts of two rather flat metallic bobbins, upon which many hundred turns of very fine copper wire, carefully insulated throughout its whole length, are wound. A vertical section, parallel to the axis of these bobbins, is shown in fig. 2, where C C . . . represent sections of the coils of wire by which they are filled. The scale of this section is half the real size of the object. At the centre of each of the bobbins a very small magnet, made of a piece of watch-spring about $\frac{3}{8}$ of an inch long, and less than a grain in weight, is hung by a fibre of raw silk, the two magnets being fastened together with their similar poles pointing in opposite directions by a thin strip of aluminium. Fastened to the upper magnet (the one inside the bobbin A, fig. 1) is a circular mirror of silvered glass, about $\frac{3}{8}$ of an inch in diameter, and weighing less than a grain. This mirror is ground slightly concave; so that, when the light of a paraffin lamp shines upon it through the opening C (fig. 1), an image of the opening is formed upon the scale D E at a distance of about three feet.* The position of the magnets and mirror inside the bobbin is indicated at M and N, fig. 2, and they are represented separately and of their real size in fig. 3. A curved steel magnet, F (fig. 1), about eight inches long, which can be placed at any height upon the vertical brass rod which supports it, and can be turned round this rod as an axis, either by hand or by the adjusting-screw G, serves to neutralise to any required extent the effect of the earth's directive force upon the suspended magnets, and to cause them to hang, when no current is passing through the instrument, so that the axis of the little mirror coincides with that of the upper bobbin. Under these circumstances, the image of the slit C is formed at the middle of the scale D E, and appears as a bright spot or line of light rendered more visible by the shadow cast upon the scale by the projecting screen above it. There are several other points of considerable interest in the construction of this apparatus, but we have not space to dwell upon them.

The simplest mode of using this apparatus, for the purpose of receiving telegraphic signals, is to connect one of the spirally coiled wires, seen at the lower part of the drawing, with the conductor of the cable, and to connect the other with the ground. The electric current, before it can pass from the cable into the earth, is thus obliged to traverse the whole length of wire forming the coils of the galvanometer, and in doing so it causes the little magnets (which in their natural position hang with their axes at right angles to the axes of the coils) to turn either towards the right or left, carrying with them the mirror, and thus causing the spot of light to move along the scale towards one end or the other. The stronger the current which is passing through the galvanometer, the further does the spot of light travel; and if the current continues of the same strength for any length of time, the spot of light comes to rest at a corresponding distance from the centre of the scale. Thus every variation in the strength of the

* The use of a concave mirror in these instruments is a very recent improvement. Until lately a flat mirror was employed, and a small convex lense, placed close in front of it, caused the rays which issued from the opening C to be brought to a focus upon the scale after reflection by the mirror.

current is indicated by a movement of the spot of light, and these movements constitute the signals in which the messages transmitted through the cable are spelt out.

From all that has been said hitherto in this article, it might be supposed that, if the near end of the cable were put into connection with the battery, and the connection maintained unbroken for a definite time, as, for instance, one minute, a similar current (only slightly weaker in consequence of the never quite perfect insulation of the conducting wire) would appear at the far end, either simultaneously or after a certain interval, and after continuing at a constant strength for one minute, would suddenly cease. If this were the case, the spot of light of the reflecting galvanometer would move right or left along the scale through a certain number of divisions, would remain stationary for one minute, and then come back to the middle of the scale. And this is exactly what would occur, but for the effects of *induction* that have been already alluded to.

The most familiar example of electrical induction is presented by the common Leyden jar. The charge of electricity, which the inner coating of this apparatus can take up from a given source of electricity, is, as is well known, many times greater than the charge which it would be capable of receiving from the same source if the outer coating were removed. Thus, in order to charge a Leyden jar to the highest point that is possible by means of a given electrical machine, four or five complete revolutions of the machine may be needed, whereas, if the outer coating of the jar were away, half a turn of the same machine might suffice to charge the jar to the same extent. That is to say, the quantity of electricity which the inner coating of a Leyden jar can take up, before the "tension," or tendency of the electricity to escape, rises to any given amount, is much greater than the quantity which would charge it up to the same tension if the outer coating were removed: in other words, the presence of the outer coating greatly increases the "capacity" for electricity of the inner coating.

Precisely the same kind of action takes place in the case of a telegraph cable immersed in the sea. Such a cable is exactly comparable with a Leyden jar, the surface of the conducting wire corresponding to the inner coating of the jar, and the water in contact with the outside of the insulator corresponding to the outer coating. Each of the cables which now lie between Valentia and Newfoundland accordingly represents a Leyden jar whose inner coated surface measures about 425,000 square feet. The way in which these facts affect the transmission of signals through the cables it is not easy to explain with perfect clearness, but it is hoped that the following considerations will make it at least partially intelligible.

The passage of a current through the instrument at the receiving station depends upon the existence of a *difference* of electrical tension between the earth and that end of the wire. If the electrical tension of the wire is greater than that of the earth, the direction of the current is from wire to earth; whereas, if the electrical tension of the wire is less than that of the earth, the current passes from earth to wire. The electrical tension of the wire can be increased, so as to become greater than that of the earth, by connecting the end at the sending station with the positive pole of the battery; and it can be diminished, so as to become less than that of the earth, by connecting the wire with the negative pole of the battery—it being understood in both cases that the second pole of the battery is connected with the earth. Now, if the conductor of the cable, instead of being surrounded by water, were suspended in the air, everywhere at a great distance from any conductor of electricity, in an immeasurably short space of time after one end was put in connexion with the battery its tension would be raised or lowered, throughout its whole length, to the full extent to which the particular battery employed was capable of affecting it. The consequence would be that, on connecting the Valentia end of the wire with the battery, a current of a certain definite strength would immediately show itself on the receiving instrument at Newfoundland —a current which would retain precisely the same strength as long as the connection with the battery was maintained, and would suddenly cease as soon as that connection was broken. Since, however, the conducting wire of the cable is far from being in the condition here supposed, the immersion of the cable in the sea making the conductor, as we have already said, equivalent to the inner coating of an immense Leyden jar, its electrical capacity is enormously increased beyond that of a similar wire suspended in the air; or, what comes to the same thing, the quantity of electricity which must be put into it or removed from it in order to alter its electrical tension to the same extent is enormously greater. Hence, during the first instant after one end of the cable is connected with the positive pole of the battery, there is no perceptible increase of tension at the opposite end, and consequently no perceptible current. After a certain interval, the length of which depends upon the resistance of the conductor, the nature and thickness of the insulating coating, and the length of the cable, the current makes its appearance at the farther end, and for a time rapidly increases in strength, so that, after an additional interval of *four times* the length of that which preceded its first appearance, the current has attained about fifty-three per cent. of the strength of the strongest current which the particular battery employed is capable of sending through the cable. After a further period of *five times* the same interval (or altogether *ten* intervals from the moment of first making connection with the battery), the strength of the current has risen to about 89 per cent. of its greatest possible strength; but by this time, although the current is still getting stronger and stronger, its rate of increase has begun perceptibly to diminish, so that after another period of *five times* the interval above mentioned its strength is still only about 97 or 98 per cent. of the maximum. If at this moment the sending end of the wire is disconnected from the battery and connected with the earth, the changes which occur in the strength of the current at the arrival end are precisely similar to those we have just described, though, of course, of the opposite kind. At first no diminution occurs in the strength of the current; then a diminution begins and soon becomes very rapid, but after a short time again becomes slower and slower; so that when the battery-connection has been broken for a period equal to that during which it was maintained, the current at the arrival end has diminished by exactly the same proportion of its previous highest amount, as that amount bore to the greatest current the battery could send through the cable. For instance, if the near end of the cable is kept connected with the battery until the current at the distant end has acquired 90 per cent. of the strength which it would ultimately attain if the connection were continued for an indefinite time, the diminution in the strength of the current which will occur during the same period, after disconnecting the near end of the cable from the battery and connecting it with the earth, will be to the extent of 90 per cent. of the current which was passing at the moment the battery-connection was broken. That is to say, after a battery-contact of a certain time, followed by an earth-contact of the same length, the current at the arrival end, instead of having disappeared, will still possess 9 per cent. of the strength of the greatest current the battery can send through the cable.

Hence we see that not only are sudden changes in the electrical condition of the sending end of the wire not perceived immediately at the receiving end, but when they do show themselves there, it is as more or less *gradual* changes of *smaller extent* than those produced at the sending end. It is not difficult to conceive how these facts must affect the transmission of signals through the wire. The signals all consist of changes in the strength of the current passing through the receiving instrument, and their distinctness or legibility depends on the extent of these changes and on the suddenness with which they take place. If the sending end of the cable is alternately connected with the battery and the earth at regular intervals, its electral condition is changed at each contact to an extent corresponding to the electromotive force of the battery; but if the contacts succeed each other at more than a certain rate, no alterations whatever are perceived at the other end of the wire, but a current appears there of constant strength, equal to that which would be produced by a battery of half the power if kept continuously connected with the cable.

It is evident, therefore, that, whatever may be the delicacy of the receiving instrument, there is for each cable an absolute limit to the number of legible signals which can be thus transmitted in a given time. If this limit be exceeded, no matter how great the battery-power employed at the sending end may be, and the consequent extent of the changes produced in the electrical condition of that end of the wire, no variations whatever are produced in the strength of the current at the receiving end. Within this limit, however, the effect of alternate battery- and earth-contacts at the sending end is to cause oscillations in the strength of the current at the receiving end. By making the alternate contacts more and more slowly, the extent—or, as it would be called in more scientific language, the "amplitude"—of these oscillations can be increased, until the received current varies from one of imperceptible strength to the strongest the battery is capable of sending. From this it will be seen that the number of signals transmitted cannot be increased beyond a certain point, except at the expense of their legibility; and, as we have already stated, there is another limit of speed beyond which they become altogether obliterated.

The precise conditions which determine the speed with which distinct signals can be made to follow each other through a submarine cable were pointed out, by Professor William Thomson,* eleven years ago. Professor Thomson showed that the intervals which must be allowed to elapse between successive signals, in order that they may have any given proportion of their greatest possible distinctness, is proportional to the electrical *resistance* of the conductor, to its electrical *capacity*, and to the *square of its length*. Hence, if cables of the same make were laid between Dover and Calais, and between Valentia and Newfoundland, their relative length being as 26 to 2,100, or as 1 to 80 nearly, the greatest rate at which it would be possible to signal through the latter cable would be about 6,400 times slower than the greatest rate possible with the former. Hence, also, if the length of any proposed telegraphic cable

* *Proceedings of the Royal Society*, vol. vii., 382 (May 24th, 1855).

and the electrical properties of its materials are known, it is possible to calculate beforehand what dimensions must be given to the conductor and insulator in order to obtain any given rapidity of signalling.

As to the absolute rate of signalling which is attainable with the Atlantic cable, the writer is informed, by Mr. Fleeming Jenkin, that, as the result of a calculation in accordance with the principles laid down by Professor Thomson, it appears that alternate battery- and earth-contacts at one end of the cable would produce a current at the other end, showing no perceptible variations of strength, if they followed each other at a greater rate than about twenty-five double-contacts in a second; while battery-contacts maintained for about four-tenths of a second, and alternated with earth-contacts of the same length, would produce sensibly the greatest possible amount of variation in the current at the receiving end. This shows, on the one hand, that legible signals could not be sent, in the way described, so fast as 25 per second; and, on the other hand, that the distinctness of the signals would not be increased by sending them more slowly than at the rate of one in about eight tenths of a second.

It is possible that to some readers these may appear to be matters of purely scientific interest, rather than of practical importance. Very little reflection, however, will show that, next to being able to transmit signals through a cable at all, the rate at which they can be sent is the point which most directly bears upon the commercial success of submarine telegraphy. When it is remembered that each word of a message represents, on an average, sixteen signals sent and received, it will be understood at once that a very small diminution in the time occupied by a single signal is equivalent to a considerable increase in the "speaking power" of the cable; while, if once a telegraph cable is fully charged with messages, its speaking power is only another name for its money-earning power. Hence the great practical importance of any instrument or contrivance by which the number of signals that can be sent in a given time is increased.

The most obvious method of increasing the rate of signalling is by the employment of a receiving instrument capable of exhibiting the most minute variations in the strength of the received current; for, as we have seen, small variations of the current can be made to succeed each other more rapidly than large ones. Herein is one among other important advantages resulting from the use of an instrument of such extreme delicacy as Professor Thomson's galvanometer. With this instrument nearly two words and a half per minute were obtained through the old Atlantic cable laid in 1858, whereas with the ordinary apparatus less than half that speed was the utmost that could be attained.*

There are, however, other methods by which, when all has been done that can be done by the improvement of instruments, the retardation and wearing-down of signals due to inductive action can be still further diminished. One of these, the method actually employed with the present Atlantic cables, affords such a beautiful example of the practical application of abstruse scientific principles, that we must briefly indicate its general features. The diagram (fig. 4) will facilitate the explanation. Here B represents the battery; G a reflecting galvanometer; C an electrical condenser (an arrangement equivalent to a very large Leyden jar); and R a conductor of very great resistance, forming a constant partial connection between the receiving end of the cable and the earth. The figure shows the sending end of the cable connected with the battery: under these circumstances a current enters the cable and charges both it and the condenser C, which is in permanent connection with it through the galvanometer, to an extent corresponding with its own electromotive force, and at the same time a slight current passes through R to the earth. These conditions are always maintained when no signals are being sent, but when the wire is required to be ready for their transmission. The galvanometer G, which shows a temporary deflection while the current is entering the condenser, returns to zero as soon as the condenser is fully charged. In order to send a signal, all that is necessary is to disconnect the sending end of the cable from the battery and connect it with the earth: this is done by pressing down the key *c*, the front end of which then comes in contact with a conductor, *a*, communicating with the earth, at the same instant that the other end, by rising, breaks the previously existing connection between the cable and the battery. On ceasing to press the key, the contact at *a* is broken, and that at *b* restored; but the effect of momentarily connecting the conductor of the cable with the earth is to arrest, and even for an instant reverse, the flow of electricity along it which is caused by the slight escape into the earth always taking place through R. The consequence is that the electrical tension of the receiving end of the cable falls below that of the condenser C, and therefore electricity returns from the condenser into the cable, so as to equalise the tension in each, causing a deflection of the galvanometer as it passes.

* It may be interesting to state that, according to Mr. Jenkin's calculation, the speaking power of the two cables which are now in operation is from twice to three times as great as that of the cable of 1858, and we believe that this result is confirmed by experience of their actual working.

The deflections thus produced constitute the signals. In this way from six to seven words are easily transmitted through each of the Atlantic cables in one minute.

In order to understand how this method of signalling should admit of signals being sent in more rapid succession than is possible when they are produced in the usual way, by intermittent currents, we may avail ourselves of an illustration employed twelve years ago by Faraday, who, in describing some of the earliest observations on the effects of induction on subaqueous telegraph wires, compared its action to that of the air-spring of a force-pump, whereby the intermittent action of the piston is caused to produce a nearly uniform flow of water. Just as the air-chamber of the pump effaces the effects of the separate strokes of the piston more completely the greater the volume of air which it contains: so, in a submarine cable, the effects of intermittent currents are more completely obliterated in proportion as the electrical capacity of the cable is greater. The condition of the cable when kept constantly charged, as in the method of signalling which has been last described, corresponds however to that of a force-pump into whose air-chamber so much water has been driven that the air in it is reduced to a small bulk, in which case it is evident that each stroke of the piston must produce nearly its full effect on the issuing jet of water.

Although this article has already greatly exceeded its intended limits, we are unwilling to close without adding one or two remarks of a more general character. That the political, social, and commercial consequences of the completion of the Atlantic cable will probably be very great, is obvious to all; how great they are likely to be is best known to those most conversant with political, social, and commercial matters. But apart altogether from results which may be looked for in the future, the past history of this great undertaking may teach us lessons which are of themselves of no small value. On the one hand, it proves to men of science, in perhaps a more striking way than it was ever proved before, how fruitful even of purely scientific results may be the practical application of scientific principles, and how much Science herself may often gain by listening to the claims of Practice for assistance. On the other hand, it ought to convince self-styled practical men, who regard improvements in the arts of life as the highest end of science, and who seldom look with much favour on scientific pursuits which have no obvious relation to practical applications, that investigations, in which they see nothing more than the mere indulgence of scientific curiosity, are often those whose results are eventually found to be of the greatest practical importance.

THE BONE-CAVERNS OF GIBRALTAR, MALTA, AND SICILY.

BY A. LEITH ADAMS, A.M., M.B., F.G.S., &c.

THE explorations conducted by geologists of late years at various points on the sea-board and islands of the Mediterranean, have elicited a mass of interesting data in connection with the pre-historic, or rather pre-modern, condition of that area, and the human inhabitants and lower animals that then frequented Southern Europe and Northern Africa. The information thus obtained has been chiefly educed from researches in the caves, fissures, and alluvial deposits of Southern Italy, Sicily, Malta, and the Rock of Gibraltar; but although the evidences furnished have been for the most part clear and decisive, they may be said to be little other than mere indications of what more extended researches will doubtless bring to light, not only in the above situations, but in other unexplored islands and shores of the great inland sea. The appearances presented by the rock formations and superficial soils show that the present outline of the Mediterranean basin was, at least in part, brought about by subsidences of land, which in certain instances was afterwards re-elevated. For example, the denuded surface of the Maltese islands, and traces of wave action on their limestones and that of Gibraltar, as clearly point to action of the sea during their submersion or subsequent emersion, as do the pot-holing and scooping out now going on. The Sirocco and Levanter, that send the billows dashing furiously along the coast lines, are not fashioning sea-bottoms and margins in any way different from those now high and dry on the rock of Gibraltar, heights of Malta, or the limestone slopes of the Val di Noto; whilst the faults and rents filled with red soil, and fragments of rock, and organic remains, show, by the extent of the former and the nature and modes of deposition of the latter, that subterranean movements on a grand scale had been at work in producing the one, and aqueous agencies had afterwards borne the others into their present situations. With reference to the indications of littoral action, there is scarcely an exposed portion of the limestone of Gibraltar, from the sea level up to the highest point of the rock, that does not present proofs of marine erosion; and perhaps in few localities is this more evident than on the plateau of Windmill Hill, rendered famous by the wonderful discoveries of Captain Brome. Here, on the surface, and running into the great tortuous rents which intersect the rock in every direction, may be observed innumerable caldron, trough-shaped, or circular hollows, smooth and rounded, and perfectly distinct from the withering and honeycombing, the result of atmospheric and chemical decomposition now going on. Caves are also plentiful; but the differences between a vaulted chamber formed by the sea waves, and a fissure with its roof partially or entirely covered in by calcareous infiltrations, or fragments of rock jammed between the opposing sides, and brought about by movements consequent on upheaval or depression, are so very various that in many instances what at first sight might appear to be a cave, will turn out subsequently to be a covered-in fissure. It is only when the cavity opens horizontally without the roof communicating with the surface, whereby the deposits or organic remains might have been conveyed thereinto, that we opine should the name cave or cavern be applied. Openings of this description are common on the sea face of the rock of Gibraltar. In one, situated on the scarped face of a cliff at Europa Point, Captain Brome found several flint implements and pieces of charcoal embedded in the red soil and calcareous deposits on its floor. The celebrated pithecoid human skull, discovered many years since, is said to have been found in a cave of this description on the north front of the rock. But one of the most important and valuable discoveries made by the above-named indefatigable geologist, was that of many human skeletons. Captain Brome's attention was directed to a small hole on the plateau of Windmill Hill, into which his terrier was often in the habit of entering in quest of rabbits. On opening this out, an irregular-shaped rock cavity was discovered, filled almost to the roof with calcareous incrustations and soil. It measured a few feet in height, by eight or ten in breadth. In a crevice close to the entrance lay the skeletons of several human beings, dispersed about seemingly without any order. The skulls were well formed, and did not indicate any very great antiquity. Associated with the human bones were flint hatchets and knives, well polished, besides a metal hook, charcoal querns, and edible marine shells. Slabs of a light reddish-brown sandstone formed the hand-mills just mentioned, or were polished on one or more sides, as if they had been also used for sharpening the flint tools. This rock is not known to be found *in situ* either on the Spanish or African side of the strait; but neither of the two localities has been carefully examined by geologists. The presence of abundance of limpets and other marine shells in the upper parts of nearly all the fissures opened on Windmill Hill seems to indicate that they had been most probably used as food by the human inhabitants of the rock; moreover, they are intimately associated with the exuviæ of living quadrupeds. The Genista fissure was filled with red earth and stalactite, forming successive feats, and proceeded downwards for two hundred feet below the level of the Windmill Hill plateau. Here masses of the parent rock, detached evidently during the formation of the rent, had fallen down, and were jammed between the opposing sides, which were encrusted with masses of stalactite, and dripping. Among the *débris* were found bones and teeth of two extinct species of rhinoceros, a hare, two species of hogs, the red and fallow deer; oxen, the larger sort allied if not identical with the almost extinct Aurochs; and innumerable remains of one or more species of ibex, besides the African leopard, lynx, serval, brown hyena, and a bear; also fragments of a large tortoise, &c. The remarkable features in the fauna of this extraordinary collection of organic remains are that, with the exception we shall presently notice, nearly all the bones lay detached, and were seemingly mixed up in the greatest confusion, just as might result from a number of carcases of various animals decomposing on a slope, from whence they were washed pell-mell into the gaping rents below. Many bones were sun-cracked, showing that they had been exposed to the weather for a length of time before being conveyed into the fissure. It is apparent, therefore, that south-westren Europe was at one time the abode of three species of leopards and a hyena, the latter being at present unknown on the north side of the African equator, or even further north than Natal. The discovery of the elephant of Africa in Spain in a fossil state, combined with the other evidences just mentioned, surely affords strong proof that Europe and Africa were at one time joined together, either wholly along the entire Mediterranean area or at certain points. A complete carcase of an extinct rhinoceros was discovered by Captain Brome in an enormous yawning fissure close to the Genista rent, and about twenty-five feet below the level of the plateau. At the time this individual was deposited in the above situation, the fissure must have presented all the appearances of a natural pitfall, into which an unwary animal might easily have fallen. Many recent quadrupeds were found associated with the extinct species; but in general the former predominated in the upper parts near the surface, with the exception of the rabbit remains, which were abundant at all levels; and even at present, along the drainage hollows on the rock, bones of such quadrupeds as the fox, hare, rabbit, mice, &c., are being conveyed by rain-water into fissures, and with the red soil and fragments of rock form the well-known long breccias of Gibraltar.

Several of the long bones of deer discovered in the fissures bore marked traces of sharp instruments, and from the abundance of ibex remains it may be surmised that either the ruminants were exceedingly common on the rock, or had been conveyed there by man, who lived, in all probability, in certain of the sea-board caves, such as the one already referred to; moreover, that the canine * and feline quadrupeds preyed on the ruminants and others, and possibly all, from the rhinoceros downwards, were eaten and destroyed by the savages who continued for ages to frequent the district. The decided race character of the skulls discovered by Captain Brome, and the strange, ill-shapen, and ape-like cranium alluded to above, may represent vast ages of man's sojourn on the Spanish peninsula, and whilst the former may have lived on the rock up to a comparatively modern period, the latter would represent a far earlier epoch; yet perhaps coeval with the extinct rhinoceros and *Elephas antiquus*—a tooth of the latter having been discovered several years since on Europa point. The subterranean movements which occasioned the submergence of the intervening land between Africa and Europe, and opened the Straits, must have taken place long after the exuviæ had been deposited; for how could the present bare rock have maintained such vast numbers of wild animals as are represented by the Gibraltar fissures?

The disturbances to which the Maltese Islands have been subjected during periods of upheaval and depression are likewise attested by numerous and well-defined faults and displacements. These and indications of sea action on the rock-surfaces, also fossil exuviæ of extinct and recent animals in their caves, fissures, and alluvial deposits, represent also different epochs in the history of the islands, and show at least, whatever may have been the dimensions of the land in the first instance, that the present insular group are but mere fragments of what must at one time have been an extensive area, in all probability connected with Africa or Europe, or both. Compared with Gibraltar, the same evidences of littoral action are presented on their rock-surfaces, and their fissures show a like arrangement of their contents; but the organic remains differ in some very important points. No human exuviæ have

* Coprolites of the hyena were abundant in the fissures.

hitherto been met with in connection with this fossil fauna, or in fact any traces of man; and with the exception of recent land-shells and uncertain indications of a ruminant of about the size and appearance of the domestic sheep or goat, all the fossil fauna are apparently of extinct species—such as frequent countries well watered by rivers, lakes, and covered by a rich soil and luxuriant vegetation—conditions totally different from what the faces of the islands now present. The alluvial deposits of the Maltese Islands, like those of the other islands and shores of the Mediterranean, are composed of a red soil, which, in the rock cavities and hollows, is sometimes underlaid by a light-blue clay, in which also organic remains are embedded. All the numerous fissures and rents which traverse the strata in divers directions are more or less filled with the red primeval earth and clay, presenting much the same appearances as those of Gibraltar, and by the mode of deposition of their contents testify to like agencies having conveyed them into these situations. Some years since a cave on the face of an inland ravine near the middle of the Island of Malta was accidentally intersected whilst forming a water reservoir in the sandstone rock, and its contents partially cleared out, when among the red soil and clay which covered the floor were found many teeth and bones of extinct species of elephant, apparently different from any yet discovered, besides remains of a large tortoise and birds. Professor Busk and the late Dr. Falconer, who have carefully examined these fossils, come to the conclusion that the elephantine remains belonged to two species of very small size, neither of which exceeded five feet in height; and that many of the bones indicated the presence of carnivorous animals from showing the traces of having been fiercely gnawed. However, persevering efforts made subsequently in many other fossiliferous cavities failed entirely in finding any relics of the carnivora. Not so, however, with reference to the Pachydermata, for the discovery of numerous fissures and gaps, containing abundant remains of elephants, have at least proved that whether one or more species is included among the exuviæ, it is beyond a doubt that the numbers that have come to hand could never have lived on the present islands, even allowing their botanical resources to have quadrupled those of any country on the face of the earth, irrespective of the total absence of rivers and lakes, yea, as much as a perennial stream. The same may be said of the hippopotamus, of which bones and teeth have been discovered from time to time in caverns, and always in situations indicating that they were conveyed into the openings by the agency of water, or else died in incredible numbers in the rock cavities and been subsequently buried by the introduction of blue and red clay, and the rounded and water-worn fragments of the parent rock. The fossil fauna hitherto discovered in the Maltese caves, rents, and alluvial deposits, comprise the *Hippopotamus Pentlandi*, so plentiful also in the Sicilian caves, and perhaps another species, very closely allied if not identical with an existent species found in West Africa; two, and perhaps three extinct elephants, two of which are of pigmy dimensions, the other equal to a small-sized African elephant with the molars presenting a crown pattern similar to that of *E. antiquus*, although its teeth are relatively much smaller. The dormice (*Myoxina*) are represented by an animal larger than a Guinea-pig, and found in incredible numbers associated with the elephant; also a river tortoise, which must have stood nearly two feet in height. A smaller species of the latter was found in the inland cave just referred to. Birds' bones were very numerous, and comprised several species, chiefly large raptores, and water-birds; among the latter, abundant remains of one or more species of swan, nearly one-half larger than the *Cygnus olor*, were found along with the elephantine and rodent remains. The hippopotamus exuviæ invariably occupied distinct caverns on the sides of ravines and sea cliffs, and from the mode of arrangement of the bones and teeth indicated the presence of tumultuous currents having at one time passed down the ravines and entered the caverns. The same appearances seem to pervade the river-horse remains in the Sicilian caves. It is not, therefore, easy to account for these enormous accumulations of the carcases of such huge animals in so small a space, unless we suppose that hundreds had congregated in their dens and met their death by some unnatural cause or causes. Not as might be the case with the aged individuals resorting to such places to die; but, on the contrary, almost every vestige of growth, from the new-born calf to the adult, is represented among the relics of these ancient caves. The bones and teeth are strewn about in the greatest possible disorder, but in general not so much fractured or water-worn as might have been the case had they been rudely rolled about with the hard pebbles among which they are found embedded. In the deposit of one rock cavity, about twenty feet by forty feet in breadth, we counted the straight tusks of no less than thirty individual river-horses,* and, representing, as they did, nearly every stage of growth, were surely significant so far that the animals did not all die from the usual decay of nature; and unless we suppose a scourging pestilence affecting

* This estimate is no doubt much within the truth, as the greater portion of the teeth and bones were carried off by the curious long before the author's arrival at the spot.

all the land quadrupeds more or less alike (which is extremely improbable), there is seemingly but one way of accounting for such wholesale destruction of life, and that is from a consideration of the geological changes in the outline of the area. Again, the elephantine remains and those of the rodent, birds, reptiles, and land shells, met with together, in the fissures of Malta, display the same pell-mell arrangement, only the fragments of rocks are very little water-worn. A large gap had evidently been the bed of a torrent, for whole skeletons of elephants and numbers of the dormouse were found jammed between large water-worn blocks of sandstone, arranged in layers across the ravine, and alternating with bands of pebbles and red soil, the former representing freshets or inundations, the latter periods of less turbulence. Many of the bones, both in the gaps and fissures, presented the same sun-cracked appearances as are indicated by the Gibraltar specimens, showing that they had been lying exposed and bleaching on the surface before being conveyed into the fissures and gaps. In one of the latter, the maximum length of which did not exceed 100 feet, and its greatest breadth 40 feet, were discovered, teeth of at least 150 individual elephants, representing every stage of growth from the unworn tooth-crown of the calf to that of the aged, not to speak of countless remains of the gigantic dormouse and birds. Thus the former of these rich cavities and alluvial deposits may represent widely remote epochs in the history of the ancient post-Miocene Malta, which doubtless at one time spread far and wide along the central portion of the Mediterranean basin. The hippopotamus conglomerates cave and the torrent bed deposits may have been accumulated before any very extensive submergence of the area took place; whilst the disordered and pell-mell arrangement of the contents of the fissures might indicate a far more modern epoch, when many of the great changes of level had already resulted, and the land was broken up in small islands, and severed from Africa or Europe. Supposing Malta or Sicily had been joined to either continent, or even formed one or more large islands; that the land began to sink, at first slowly, but in some parts more quickly than others, cutting off portions and forming islands, and thus contracting the range and decreasing the subsistence of numerous animals; also thereby diverting the channels of rivers and lakes, which flooded the low lands and swept the soil and carcases of myriads of living creatures, which had been either killed or died of starvation or otherwise, into gaping fissures and caverns; no doubt many of the smaller accumulations may be the results of ordinary causes continued for ages; but the extensive destruction of life represented by many of these caverns and fissures can scarcely, we opine, be accounted for on other grounds than what have just been surmised.

The discoveries of Baron Anca in the caves of Sicily have resulted in showing the presence of savage men in that island, in conjunction with the large deer, hog, and other recent animals. He has likewise established beyond a doubt the presence of the African elephant in a fossil state in that island, which, when coupled with the circumstance that the submarine plateau called Adventure Bank, stretching between Sicily and the African Continent, is only fifty fathoms under water, it may readily be supposed that there was a communication between the two lands at no very distant period. Moreover, the caverns of Palermo have furnished abundant remains of a hyena apparently identical with the spotted tiger-wolf (*Crocuta maculata*), which, like its congener of the Gibraltar fissures, has been driven back to Southern Africa. The *Elephas antiquus* has also been discovered in the cave deposits; and besides the *Hippopotamus Pentlandi*, teeth of seemingly another species, perhaps identical with the undetermined river-horse of the Maltese caves. At the same time, late researches have shown that as regards dimensions of teeth, the fossil specimens of the Nile river-horse (*H. amphibius*) have been found as large as the huge fossil *H. major* of Northern Africa and Europe; whilst the *H. Pentlandi* of the Sicilian, Maltese, and Candian caves comes nearest to the dimensions of a seemingly living species (*H. annectens*) far above the cataracts of the Nile. Another species (*H. Siberiensis*), from Western Africa, intermediate in size between the last and *H. amphibius*, might turn out the same as the undetermined species in Sicily and Malta. Thus it is not improbable, when the fossil river-horses have been more carefully compared with the living, that all the so-called extinct representatives of the genus still exist on the African continent, and, like the canine and feline mammals referred to, have been forced back.

In summing up the evidences presented by the data referred to, it may be generally stated that the two continents had a land communication at no very remote period, when many quadrupeds now repelled to Central and Southern Africa were plentiful, at least as far north as 40° latitude; and ibex, bears, oxen, deer, &c., now well nigh exterminated in Europe, roamed in vast numbers over Spain and the South. The Etruscan, but more especially the Leptorhine rhinoceros, seems also to have been then plentiful, whilst vast herds of river-horses issued from the ancient Nile, Po, and extinct rivers and lakes of the submerged lands, and spread themselves over what is now the basin and islands of the great inland sea; at least, along the central portion of this water area wandered herds of divers species of elephants, whilst the same shell-fish lived on the land and in the sea, and with many of the mammals survived all the great changes that have since taken place. Many of the animals have no doubt been driven back, and in part annihilated through man's agency; still not a few have disappeared from the face of the earth by means far beyond his most powerful energies. How, and by what manner of way, has this been accomplished? The answer must, at least for the present, remain ambiguous until we are better able to estimate the length of time represented by the evidences, and more is known of the laws which regulate the growth, decay, and final extermination of animated beings.

NOTES ON LOPHOPUS CRYSTALLINUS.

By J. JOSSELYN RANSON and T. GRAHAM PONTON.

THE subject of the following notes is one of the most beautiful of the fluviatile representatives of the Polyzoa, that remarkable group of animals which stands at the bottom of the Molluscan series. The *Lophopus* may be frequently found in sluggish streams scattered along the stems of various water-plants, such as Lemna, Sparganium, and others. It is usually attached in the axils of the leaves, and, when taken out of the water, presents a jelly-like appearance, and might then easily be mistaken for ova of one of the water snails.

On putting one of these jelly-like masses into a tube filled with clear water, however, and after the lapse of a few minutes, examining it with a lens, its true nature will at once be revealed. Delicate tubes will be slowly exserted from the mass, each tube to be crowned with a beautiful fringe of nearly transparent tentacles. These are in a double row arranged in a crescentic or horseshoe-shaped series, this peculiar arrangement being, with the exception of *Fredericella,* the tentacles of which are disposed in a circular order, a characteristic of the fresh-water Polyzoa.

The Lophopus is particularly interesting as being the first discovered of the class, having been noticed by Trembley as early as the year 1741.

It was long confounded with two other genera, *Plumatella* and *Alcyonella ;* Dumortier, however, who re-discovered it in 1834, recognized it as the type of a new genus.

The generic characters, as given by Dr. Allman in his elaborate monograph of the fresh-water Polyzoa, are as follows :—

Cœnœcium, sacciform, hyaline, with a disc which serves for attachment but not for locomotion ; ectocyst gelatinoid ; orifices scattered, statoblasts elliptical, with an annulus, but without marginal spines.

There is only one species, Lophopus Crystallinus (Pallas), consequently the specific characters are the same as that of the genus.

The above description is similar to that given by Baker and Van Beneden, except so far as that they consider the disc to be used in locomotion—an opinion which our own observations confirm ; for, having kept many specimens for a lengthened period, and having many opportunities of carefully examining them, we have come to the conclusion that the disc

Plate. XX.

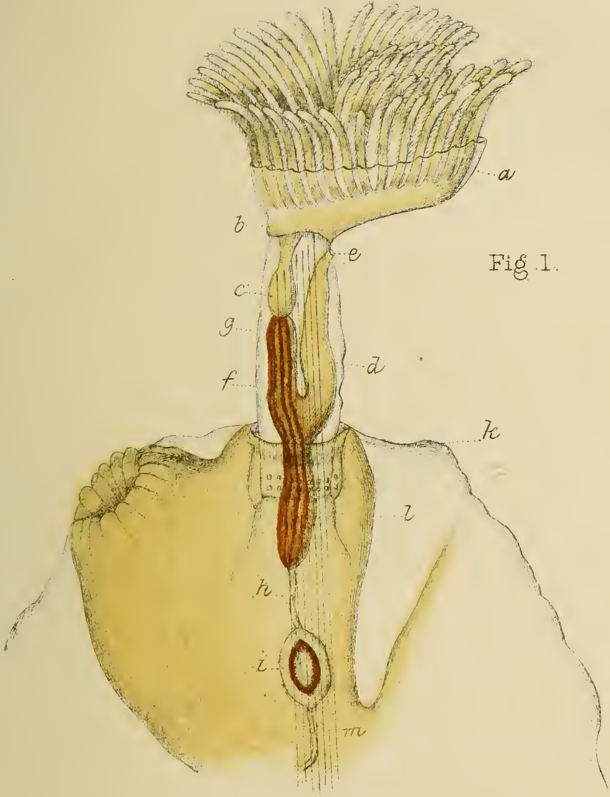


Fig. 1.

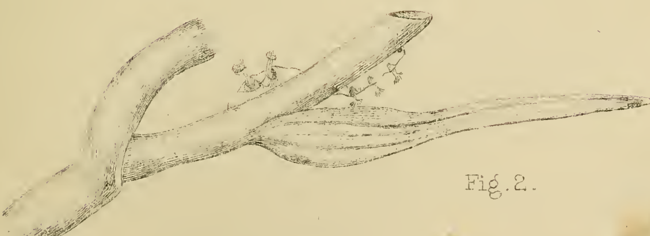


Fig. 2.

Tuffen West, Sc.

W. West imp.

Lophopus Crystallinus. *Pallas.*

is certainly employed for the purpose of locomotion, although, undoubtedly, as Dr. Allman observes, it is not capable of the active movements of *Crystatella*.

The organization of *L. Crystallinus*, like that of the Polyzoa in general, is simple. It is provided with organs of digestion, circulation, respiration, and generation. The muscular and nervous systems also are well developed.

The organs of digestion consist of a mouth, an œsophagus, a stomach, and intestine. The mouth is a simple, toothless orifice, round, or slightly crescent-shaped, placed in the centre of the lophopore or tentacular disc. Its margin is slightly raised, and continuous on the neural side, *i. e.* the part in which the nervous ganglion is situated, with a hollow valve-like organ of very peculiar formation, called the *epistome*, the true function of which is doubtful. An œsophagus of considerable length connects the mouth with the stomach; it usually decreases in diameter until it approaches the cardiac orifice of the stomach, where it again expands. In some of the marine Polyzoa there is a distinct gizzard, but in Lophopus, as, probably, in all the fresh-water genera, there is no such organ, the œsophagus opening directly into the stomach, which latter may be divided into two portions, the cardiac and pyloric cavities. The first consists of a cylindrical prolongation, into one extremity of which the œsophagus opens, while the other is continuous with the rest of the stomach, which terminates in a cul de sac. The pyloric cavity communicates with the intestine by a distinct orifice, which, from its peculiar construction, is capable of dilatation or contraction, and even of being completely closed.

At the point of junction with the stomach the intestine is very wide; it rapidly decreases in size, however, until, passing along the side of the cardiac cavity and the œsophagus, it terminates in a distinct anus, below the mouth at the concave side of the lophopore.

We will next proceed to consider the organs of respiration and circulation.

The lophopore supports a series of tentacula upon its upper margin. In *Lophopus*, and most other fresh-water genera, such as *Cristatella*, *Plumatella*, and *Alcyonella*, the neural margin of the lophopore is extended into two triangular arms, causing it to present the appearance of a deep crescent. This condition of the lophopore never exists in the marine species, where it is always orbicular. In all the genera it forms the roof of the perigastric space.

The interior of these triangular arms is clothed with vibratile cilia, the tentacula are tubular, closed at their free extremity, and open by the opposite, through the lophopore into the perigastric space.

The entire plume of the tentacula is surrounded at its base by an exceedingly delicate, transparent membrane in the form of a cup, adherent to their backs, arranged in such a manner as to present a scalloped appearance; this is peculiar to the fresh-water genera alone, it not having been sufficiently clearly demonstrated to exist in the marine species. A free communication exists between the perigastric space and the interior of the tentacula and lophopore, which are filled with a clear fluid, containing numerous spherical bodies of various sizes, that are rapidly whirled about under the influence of the currents. Their presence in the perigastric fluid, which consists mainly of water that has obtained entrance from without, is supposed to be purely parasitical. The circulation through the perigastric space is the only representative in the polyzoa of the circulation in the higher animals; for they possess neither a heart nor a vascular system. This circulation, therefore, performs the threefold function of respiration and the distribution of the blood and chyle. True sexual organs have been satisfactorily made out in some genera of the fresh-water polyzoa, and are doubtless present in all; the minute details of the anatomy of these organs, however, are so difficult and technical, that we should weary our readers were we to enter upon them here; we shall therefore content ourselves with stating the fact of their existence. The mode of reproduction in these animals is threefold—by *ova*, a true *sexual* reproduction; by *gemmæ*, proceeding at once to their full development; and by a peculiar form of buds, called *statoblasts*, in which development is for a time latent, and which have always been erroneously regarded as the *eggs* of a polyzoon, but they must on no account be confounded with the genuine *ova*; these two latter modes may be classed under the head of *non-sexual* reproduction. The first two modes of reproduction, by ova and gemmæ, having only been accurately observed in two of the genera; and as that by statoblast is the most frequently met with and the most generally noticed, and consequently likely to be of the greater interest to our readers, we have rather preferred describing it in detail to dwelling slightly on the whole of them.

The statoblasts differ in form in the various genera in Lophopus. They are elliptical, with a short acute point at each extremity of their long diameter, but usually they present the appearance of lenticular bodies, varying from an orbicular to an elongated oval figure, enclosed between two concave discs of a somewhat tough consistency, united by their margins, round which a ring, differing in structure from that of the discs, runs, thus serving to strengthen it. In two of the genera the statoblast when mature is furnished with hooked spines, but in Lophopus and the rest of the genera these spines are wanting. The disc of the statoblasts in Lophopus is of a deep brown colour, seemingly composed of a layer of hexagonal cells, a peculiarity in structure also met with in the annulus, where, however, the cells are of a somewhat larger size and of a different colour; these cells being filled with air impart a light spongy texture to the statoblasts, and thus act as a float, by means of which it is kept at the surface of the water.

It should here be noticed that these statoblasts are produced in the funiculus, along which they may be seen as buds in various stages of development, decreasing in size as they approach its discal extremity. Under conditions favourable for development, the edges of the disc separate, and a young polyzoon, in a somewhat advanced stage of growth, emerges and floats away in the surrounding water.

The tentacula alone of the young polyzoon are furnished with cilia, and its condition would seem to be passive, with the exception of the slight movements produced by their action. The little animal is furnished, in all respects, with the same apparatus as that met with in the fully developed individual; but it is of a simple and not a compound nature. Soon, however, a change takes place, gemmæ are developed, and these make it assume the compound form of the adult. At present, no orifice through which the statoblasts could escape has been discovered, although it can hardly be doubted that their liberation takes place after the destruction of the soft parts of the polyzoon, which giving way afford them free egress. In some others of the polyzoa, another kind of statoblast has been noticed, but their developmental history is exceedingly obscure, and no doubt they are abnormal.

Thus much for the structure of *Lophopus crystallinus*. The careful observer of its habits and structure will be well repaid for his trouble. There is one drawback, however, to commencing the study of the Polyzoa, for although abundant where they do occur, they nevertheless are extremely local. The habitats differ with the genera; some, as *Lophopus*, delighting in the clear water of ditches, through which a gentle current is running, avoiding exposure to sunlight, while others can only be found in stagnant waters. *Cristatella*, however, the only other polyzoon to which a true locomotion has been assigned, is to be found in clear lakes and ponds creeping along the surface of stones, and the stems of water-plants delighting in the full glare of sunlight.

Description of Plate:—Fig. 1. L. Crystallinus highly magnified. *a.* Calyx; *b.* Lophopore; *c.* Œsophagus; *d.* Intestine; *e.* Anus; *f.* Pyloric cavity of stomach; *g.* Cardiac cavity of stomach; *h.* Funiculus; *i.* Statoblast; *k.* Ectocyst; *l.* Endocyst; *m.* Retractor muscles of polypide.—Fig. 2. Lophopus crystallinus, natural size.

GENESIS, OR PARTHENOGENESIS?

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THE discovery of the "viviparous larvation" of the Aphis by Réaumur dates from the year 1738; that of the "non-sexual multiplication" of the Polype, by Trembley, from the year 1794. And now, in 1866, the most recent announcements in embryological discovery are those of M. Balbiani, who confirms the original suggestion of Réaumur that the Aphis is an androgynous insect; and of M. Leuckart, who tells us of a new form of "internal gemmation," the idea of which curious mode of reproduction was derived from Trembley's observations on *Hydra viridis*.

But let not the reader infer from these facts that the progress of embryology has during this long interval either faltered or failed. As a science embryology is, perhaps, still far from being a connected body of laws and illustrations in which the exact relation between facts and principles has been established. But many important series of facts have been supplied in an empirical way by actual observation. And, although the analysis of these facts is not complete, generalizations have nevertheless been arrived at, which indicate with sufficient accuracy the essential nature of the reproductive function and of organic development as well as the influence of external force and matter upon their course and progress.

The history of the reproductive function in the lower animals has, in fine, by constant accumulation of facts and theories, become now so voluminous that it is scarcely possible, without long and close study, to form an adequate idea of the great research and intellectual effort expended on embryological investigations. Nor is it possible to condense within the limits of a short notice, such as the present, a tithe even of the numerous and interesting discoveries made during the last twenty-five years, or to attempt anything like a general outline of the various hypotheses and controversies which have arisen out of them. For our present purpose, however, it will be sufficient to advert very briefly to a few of the leading points in the history of the genesis of animals, a history which has gradually unfolded itself to view and which now claims for its subject the state and character of a special branch of science, though it may not have attained to the authority and certainty of the better and longer known physical sciences.

From the observation of the budding Hydra has arisen, and by degrees perfected itself, a doctrine of "gemmiparous reproduction," the phenomena of which received the early attention of zoologists and have been almost exhaustively investigated. The viviparous larvation of the Aphides formed the starting-point of the new and daily extending theory of Parthenogenesis. Respecting the cause of the reproduction of the Aphis larvæ the original discoverers were divided in opinion. Bonnet, a believer in the doctrine of "pre-existing germs," held that each individual of the summer Aphides was a female which developed its own germs, and that the autumn *eggs* were nothing but imperfectly nourished "germs." Réaumur, on the contrary, held to the opinion that the Aphis might be an androgynous insect. But when, in course of time, the widely-extended occurrence of "gemmiparous" reproduction through the lower classes of animals was comprehended in its full significance, and the distinction between *external* gemmation from the surface and *internal* gemmation from a "germ-stock" within the creature's body was pronounced to be one only of local circumstance, the case of the Aphis was referred to the general law of internal gemmation; that is to say, the successive broods of summer Aphides were considered to be simple "deciduous buds." The sexual condition of the Aphis first produced from the egg remained still a vexed question. And the recently published statement of Balbiani, which, if confirmed, will remove the phenomena of Aphis larvation from those of other animals under the law of Parthenogenesis, offers a suitable occasion for a short review of the facts and opinions urged by the writers who have interested themselves in the solution of this curious problem of organic life.

Whatever be the differences noticeable in the forms of "gemmiparous reproduction," they all agree in exhibiting one striking peculiarity, namely, that the immediate product of the ovum is not itself the producer of ova, but that this function is performed by the sexual individuals which are the product of its non-sexual progeny. This non-sexual multiplication may be repeated once or through many descents, but in every case a true generative act closes the cycle of intermediate production, and in every class of animal distinct sexual organs have been found, and ova resulting from their conjugation have been traced through a regular development. Contemporaneously with or between the periods of this development another and distinct set of changes known as "metamorphosis," almost invariably occur, the phases of this metamorphosis being more or less marked. But that neither metamorphosis nor gemmiparous reproduction ensures the perpetuation of species we have the strongest evidence even in the very lowest forms of animal life—the infusorial Protozoa. Siebold first discovered that the so-called nucleus inside the body of these creatures was an egg-producing organ, a fact confirmed by Stein, who described the breaking up of the nucleus and the process of encystation of the vorticellariæ; and by Cohn, who observed similar generative phenomena and metamorphoses in a great number of other infusoria. Carpenter also early expressed the opinion that something of the nature of sexual reproduction might be discovered to take place in these animals.* But it was reserved for Balbiani, who had long studied the phenomena of infusorial generation, to place beyond doubt the actual facts, which he summed up in his published memoir, as follows:—

1. The infusoria are no exceptions to the general laws that govern the reproduction of organized beings.
2. They possess complete hermaphrodite sexual organs, but two individuals are necessary for conjugation and fecundation.
3. The conjugation is effected by simple apposition of the ventral surfaces, on which occasionally an aperture is observable.
4. This condition (conjugation) is that which is usually described as longitudinal fission. The only exceptions to this rule are the vorticellariæ.
5. The organs of reproduction are the nucleus and nucleolus, the former being the female, the latter the male organ.
6. Each of these organs appears at first under the form of a simple cell (primitive ovule), which produces by consecutive transverse fission other similar cells, which again either become ova, or develop within their interior spermatozooids.
7. The development from the primitive ovules (male and female) is perfectly analogous.

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* Müller, Lachman, and Clarapède had also observed the spermatozooids within a cell, and Lieberkühn in a nucleolus. As we commenced this article with a confession that the newest discovery was but a return to the idea of the oldest discoverers, we must, to be consistent with ourselves and just to the great historian of the Infusoria—Ehrenberg,—remind our readers that this interpretation of nucleus and nucleolus was first glanced at by him; inasmuch as he termed the nucleus a "sperm-gland," and consequently that the *proof* only, not the *idea*, is new.

8. The egg presents the same essential composition as that of all other animals. The zoosperms are filiform, motionless, and develop themselves from the granular contents of the spermatic cellule.
9. After fecundation the eggs are extruded, and undergo the usual embryonic changes.

The other division of Protozoa (sponges), which, like the infusoria, also multiply by gemmation and fission, was discovered by Lieberkuhn to possess the male and female elements characteristic of sexual distinction, and to produce ova, which were first transformed into nonciliated embryos. The metamorphoses of both divisions of Protozoa prove to be remarkably complex; but the point we are desirous of emphasizing is the undoubted occurrence of a true generative act apart from all phenomena of metamorphosis. It is also worthy of notice that the production of a *multiple* progeny from the *single* nucleus and nucleolus by endogenous division has thus become a settled fact. After such clear demonstration in this the lowest class of animals, it is unnecessary to repeat the observations which prove the same thing for all the higher animals. The formula of our illustrious Harvey—"*omne vivum ex ovo*" —is established as the widest possible generalization, including every form of animal life—

Et nunc historia quod ratio ante fuit.—*Ovid.*

We return to the phenomenon of Aphis larvation. Is it the consequence of a generative process, or an instance of internal gemmation? and is the distinction between oviparous and gemmiparous reproduction an essential one?

The former question is one of observation; the answer to the latter turns upon the definition of an egg and a germ!

According to ordinary notions, an egg is the product of a true generative process by sexually distinct organs, and this product must be endowed at least with the *capacity* of fecundation. A germ is a "living thing," and capable of development and independent existence; but neither its composition nor structure is that of the egg; nor is immediate fertilization a condition of its growth. Holding to these definitions, we must accordingly distinguish between all "living things" derived by gemmation and the *living product* of a fertilized egg. And, accepting "Parthenogenesis" as the doctrine of a special form of development from an unfertilized egg, we must distinguish between this mode of reproduction and *that which consists in the successive partition of an individual* commonly known as "alternate generation," but which is not *generation* at all. "Alternate generation" belongs to the same class of phenomena as gemmiparous reproduction.

We therefore agree with Leuckart that a true generative fecundation *must occur at certain fixed periods* in every case of alternate generation: namely, when the cycle of intermediate "zooids" has reached its climax; but that in Parthenogenesis it *may* occur *before every reproductive act.* We eliminate, therefore, from our inquiry all forms of metamorphosis and all kinds of reproduction (fission, gemmation, and alternate generation) which are not sexual. For there is no question of sex in the intermediate members of a series; they are sexless, because the whole broods or series of broods belong to one generation, and are parts of a perfect individual, of which the last member only of the series is the sexual representative.

What, then, it may be asked, is meant by Parthenogenesis in the viviparous Aphis? in which only imperfect (?) female organs have been recognized. After what has been said of the generation of Protozoa by conjugation and ova, it seems unlikely that an insect belonging to a class possessing so much higher a grade of organization should be *sexually imperfect* during the period of its most astonishing fertility, and that its mode of reproduction should fall so far back in standard as that of internal gemmation. For it is clear that the immediate progeny of the oviparous insect cannot compare *in numbers* with the ten or more broods of the summer (viviparous) insect. Nor is the Aphis a solitary exception amongst insects. The ant, bee, cochineal insect, cynips, silkworm, several lepidoptera, and probably many others, exhibit the same phenomena of nonsexual reproduction; and the same anomaly must, therefore, be assumed for all. Moreover, Parthenogenesis has been observed in the higher invertebrates (crustacea) as well as in lower animals (mollusca, and lately by Leuckart in a nematoid worm). The doctrine which was invented as an explanation of the Aphis larvation has become in fact a basis for a widely extended scheme of reproduction. To the support of this doctrine two kinds of facts have been applied: namely, facts which establish the production of progeny by creatures under circumstances in which sexual congress was impossible; and facts determined by dissection which declare for or against the assumed imperfection of female and absence of male organs. Besides these facts, a physiological question is involved; namely, within what limits can the vital energy or prolific power of an unfertilised ovum be accepted? Now the first class of facts is unimpeachable in the case of the Aphides as well as most of the other instances mentioned. The second class of facts is still "*sub judice.*" And as to the physiological inquiry, it obviously waits on the determination of the anatomical facts. The setting up of any hypothesis of the kind alluded to appears of questionable advantage, as it tends to lead away from facts to discussions without a base. In exemplification we may refer to the attempt of M. Barthèlemy ("Annales des Sciences Naturelles," 1859) to account for Parthenogenesis by assuming the existence of ova more complete (!) than the ordinary kind, uniting in themselves the male and female principle, the fecundating and fecundated germ; in one word, *hermaphrodite—eggs!*

Let us, then, examine first the anatomical basis of Parthenogenesis. The result of Owen's investigations was as follows: that the successive larva are developed from cells derived from the original germ substance of the ovum from which the first larva was produced. The proliferous germ cell of the ovum is not exhausted in the production of the first larva, and "some of the derivative germ-cells may remain unchanged and become included in that body which has been composed of their metamorphosed and diversely combined or confluent brethren. So included any derivative germ-cell, or the nucleus of such, may commence and repeat the same process of growth by imbibition and of propagation by spontaneous fission as those to which itself owed its origin, followed by metamorphoses and combinations of the germ-mass so produced, which concur to the development of another individual; and this may or may not be like that individual in which the secondary germ-cell or germ-mass was included."

We are here thrown back again on the question of difference between "egg" and "germ." If the Aphis germ-stock be the analogue of an ovary, the insect is so far sexed (being in possession of ovarian chambers, tube and ova) as to be entitled to the designation female. If the granular mass, whose derivation from the germinal vesicle of the original egg is rather assumed than proved, grows by imbibition and propagates by spontaneous fission, the process is more nearly allied to gemmation than generation, and the insect in that case is sexless. Now Owen did not hesitate to accept the granular mass found within the larval body as proliferating embryo germs the direct product of an egg, and he specially refers to the propagation of single-celled infusoriæ (*monad, gregarina*) by division of their nucleus in support of his view. The recent discoveries of Balbiani, to which we have already alluded, certainly support Owen's idea of the true ovoid character of the Aphis germ-mass, though these researches set aside his anatomical details. Owen observed the germs of the viviparous larvæ in the embryos near the digestive sac, before any organs had been formed round them, and regards them, when included as they afterwards are in tubes which correspond to oviducts, as comparable to the germ-mass in its minutest state of division and as differing from ova in *the absence of the germinal cell.* This admitted absence of germinal cell appeared to all anatomists who do not believe the Aphis germ-mass to be transformed cell elements derived from an egg so serious an objection to the doctrine of Parthenogenesis that it has always met with opposition. Thus Carus considered that the formation of an embryo from a mere granular germ-mass could not be essentially the same process as the development of an embryo from an egg by segmentation of its yolk-mass. And Quatrefages particularly emphasizes the absence of the germinal vesicle as equivalent to the absence of any real ovum. The disappearance of the germinal vesicle prior to the first changes induced by fecundation is, however, as Quatrefages expressly urges (and therein he is confirmed by all recent authorities), an established fact, and may explain why the continued presence of germ vesicles would be difficult to discover amongst the rapid movements of evolution going on in the Aphis germ-mass derived by cellulation from an original egg. As to the part which the yolk segmentation takes, it belongs essentially to the nutritive function of the ovum being *influenced, but not caused,* by fertilisation. According to Robin (Journ. de l'Anatomie, vol. v.), the embryonal blastoderm of the insect (he instances the orders Diptera, Hymenoptera, and Coleoptera) is formed at the expense of the transparent portion of the yolk substance, not by its progressive segmentation (which does not, in fact, produce *cells* proper), but by "gemmation," and this interpretation Robin applies to the Articulata generally. "There are," he says, "beings in whom the blastodermic cells appear *by gemmation,* attaining at once to the constitution and properties proper to them during their individual existence; and there are other beings in which the blastodermic cells arrive only gradually at the condition of individuality of form, size, and properties, by passing through the intermediate phases of yolk, globules, progressive segmentation, to become finally blastoderm." On the other hand, Leydig, in his account of viviparous Aphis development, draws and describes cellular elements—one larger cell in the middle of a group of smaller ones, imbedded in a fine granular substance, passing from chamber to chamber of the ovarian tube. The large cell (germ) becomes in the third chamber surrounded by a mass of fine cells, the whole then resembling the usual appearance of a developing egg. He considers the viviparous larva as much the product of cell development as if it had sprung directly from an ovum. Huxley has described the ovum of the oviparous Aphis in its embryonic state as an isolated germinal vesicle with distinct germinal spot, which, in the third chamber, is surrounded by the vitellus, the germinal spot remaining still clearly distinct. In the viviparous larva he describes the ovarian chamber as filled with a pale homogeneous substance, which encloses about a dozen cells showing opaque nuclei. Portions of this material are separated from the rest by a constriction of the walls of the ovarian chamber, which becomes more and more decided. The larva is developed from this separated portion. In the midst of it may be seen a small *vesicle,* which is transparent, but sometimes includes within it a *nucleus,* though not always, a mass of rounded corpuscles being found occasionally in its place. This transparent vesicle is *not* admitted by Huxley to be a true egg, because the essential element—the germinal spot—is wanting. It is termed by Huxley "a false egg." Lubbock describes the same occurrence in the cochineal insect; that is to say, a vesicle without germinal spot, but full of fine granules. Quatrefages denies these vesicles the name or character of egg, and terms them *veritable buds.* On the ground of the distinction thus drawn he pronounces that the larvation of the Aphis and cochineal insect is *not* an instance of *Parthenogenesis,* but of what this illustrious naturalist has named *Geneagenesis.* For the doctrine of true Parthenogenesis is that an *ovum* (a true egg) shall be the source of the embryo, and that its development shall take place in the generative organs of a female; but that the female shall be virgin and the egg fertile without fertilisation.

Anatomically, then, this vesicle of the Aphis larva is considered by Huxley a pseudovum—not a bud, not an egg,—but an intermediate link, which, says Quatrefages, establishes a peculiar relation of the bud to the egg between which there may be many links. A special objection to Owen's interpretation of Parthenogenesis, in which Carpenter and Huxley concur, is the hypothetical existence of a "prolific power" resident in the "virgin" germ-mass of the Aphis larva. This objection is, however, disposed of in a manner which antagonizes equally with the views of all three of these distinguished authorities by Balbiani's recent discovery, to which we now direct the reader's attention. The translated fecundating action of the older writers, the prolific power of Owen, the geneagenetic energy of Quatrefages, and the hermaphroditism of the egg invented by M. Barthèlemy, are certainly, in the present case, gratuitous hypotheses, and equally "*unproven.*"

For our Aphis, the subject of our long discussion, seems likely to remove itself in an altogether unexpected manner from the debated field of Parthenogenesis, and the old opinion of Réaumur, Leuwenhoek, and Cestom to prove after all the right one!

According to Balbiani's account the insect is androgynous, and he explains it thus. In the end chamber of the ovarian tube of viviparous Aphides, Balbiani saw lying in a group of cells a large central one, which he states to be *mother* of all the future ovules. The sole function of this central cell is to bud off fresh ovules. The peripheral cells are attached to the central cell by tubular pedicles, and their function is to nourish the mother-cell.

The ovules derived from this mother-cell present, as they pass from the end chamber into the tube, *a distinct germinal vesicle,* whose disappearance is quickly followed by the formation of a blastoderm (cellular) which encloses the central yolk mass. The ovule now changes its shape from spherical to an elongated oval, the yolk mass within becomes granular, and is covered with a fine membrane. Next the enveloping layer of blastoderm gives way, by separation of its hitherto closely-packed cells at a point looking towards the free end of the tube. A portion of the internal granular yolk protrudes through the gap, and the vitelline membrane may be well seen at this moment inside the blastoderm envelope, but enclosing the central vitelline mass. The protruding portion of vitelline membrane and its contents now attaches itself to the epithelial lining of the ovarian chamber, the cells of which are hypertrophied, and there becomes engrafted. The ovule being thus temporarily fixed, the vitelline vesicle in the interior divides into two secondary nucleated cells, one of which is involved in the mass adhering to the tube, whilst the other remains in the interior. These cells are to be the source of the male and female elements of the future animal. Each of them becomes surrounded by a separate group of derivative cells, the group adherent to the epithelium of the tube representing the male, and that lying free in the interior of the blastoderm envelope constituting the female element—that is to say, the generative cells of the *future ovules* surrounded by *their* nutritive cells. The latter group divides into subordinate groups, over which new ovarian sheaths are subsequently formed. The generative vesicle of the male group continues its development, increases in size, and after forming connections with the female generative apparatus, constitutes a reservoir for the fecundative corpuscles,—becoming, in fact, a true seminal vesicle.

Comparing this description with those of Leydig and Huxley, we observe, especially in the earlier part, such a similarity of observation as affords warranty for the correctness of all that follows. The pseudo-vitellus of Huxley is the female group of Balbiani, the *bonâ fide* assurance of his observation of nuclear or germinal spot being given by Balbiani.*

* It is of course possible that Balbiani was not aware of Huxley's interpretation of the anatomical facts.

Up to this period the preparation of generative organs has preceded the formation of the embryo which is to possess them. It will be remembered that this is distinctly expressed in the extract given above from Owen's account. The peculiarity, indeed, of Balbiani's discovery consists in his demonstration of the male organ, and the seminal corpuscles of its seminal reservoir, as also the communication by ducts with the ovarian tubes.

According to Balbiani, the development of the embryo commences by the proliferation of blastoderm cells from the edges of the gap formed by the rupture of the blastoderm envelope. From the margin of this gap a layer of blastoderm grows inwardly, applying itself against the inner surface of the general blastodermic envelope, then folding upon itself turns back again towards the gap. This curved lamina is the embryonic rudiment of the cephalothoracic and abdominal portion of the embryo. From the lower edge of the gap grows a mass of blastoderm, which forms the head of the embryo. The first-mentioned rudiment of the embryo (the primitive streak) becomes furrowed, and on each side the longitudinal halves quickly develope as germinal tuberosities. In proportion as the primitive streak penetrates into the interior of the ovum the sexual masses previously described follow it in its movement, and place themselves against the inner face of the upper reflected abdominal portion, though still outside the embryo, the abdominal cavity not being yet closed in. The development proceeds until the mouth and anus, with the two ends of the digestive tube, are visible. Then occurs a curious change of position, described as a backward summersault of the embryo in the interior of its capsule. The capsule here spoken of is the original blastodermic envelope, which, except at the points from which the embryonal blastoderm sprang, has ceased to grow, but is transformed into a delicate membrane, enveloping the embryo in a sort of sac, which isolates it from the ovarian chamber.

From the alteration of position the head arrives at the opposite end of the capsule, the ventral surface first curved inwards now curves outwards, the abdomen is transferred to the dorsal side and rises up towards the head. The space left between the abdominal and cephalothoracic segments is now occupied by the masses of the generative organs. By the growth of the ventral arch towards the dorsal region, and the fusion of its sides in the median line, the closure of the hinder part of the body is effected.

The female ovules, with their surrounding cells, each forming a separate small mass enclosed in its proper envelope, are now seen symmetrically placed in two groups in the posterior part of the body. The male germs, also enveloped in a fine covering, are found on each side of the digestive tube included within the ovarial sheaths which have formed over the female ovules; fine granular matter fills these tubes, which is of a vivid green colour. The male germinal vesicle, which has become a seminal reservoir, is a sac of considerable size, situated on the intestine. It is full of seminal corpuscles and coloured granules, and the vesicle terminates by a slender neck and duct leading to the ovarian tubes. The embryos of the viviparous Aphides contain, therefore, at the moment of their birth the new generations to be successively developed.

The description of so many separate minute parts is necessarily complicated, and scarcely intelligible without diagrams; but we have not ventured to construct them from the text.

Insect larvæ have hitherto always been supposed to produce but *one perfect* insect. But the Aphis "*larva*" must itself be now considered a perfect insect of hermaphrodite type if Balbiani's very careful dissections are confirmed. Every succeeding larva is therefore a creature *generated* and *developed* according to the received formula "*omne vivum ex ovo.*"

Quite recently the asexual multiplication of the larva of a fly (*Cecidomyia*) has been noticed and described by Leuckart. The first discovery of this kind was made some years before by Prof. Wagner in Kasan. The examination of the facts relating to this discovery must, however, be reserved for a future occasion.

MODERN VIEWS OF DENUDATION.

By EDWARD HULL, B.A., F.G.S., of the Geological Survey of Great Britain.

IT is curious — as illustrating the tendency of opinion to revolve upon itself—that in this year of geological science, A.G. 64, dating the epoch from the publication of Playfair's "Illustrations of the Huttonian Theory," which I take to be the true birthday of modern geology—a fierce controversy should be waging on one of the fundamental principles of the science, the origin of denudation. Yet such is the fact. As it was in the days of Hutton and Werner, so it is in the latter days of Murchison and Lyell; in both cases the geological world is divided into hostile camps—one party maintaining the atmospheric, the other the combined marine and atmospheric origin of valleys, and, by implication, of ridges and escarpments.

The controversy, which was originally confined to the question of the valleys, has gradually expanded, so as to embrace the scenery and physical features of the surface—including plains, hills, terraces, and mountain heights; which, according to one set of views, have been attributed *mainly*, though not exclusively, to the eroding and levelling action of the sea during the submergences of the land; and according to the other, have been produced by the long-continued action of rains, frosts, brooks, and rivers—all included under the category of "atmospheric agencies." These latter are the modern views, adopted with enthusiasm by several eminent naturalists, and, like most new doctrines, carried to extremes which the original propounders little dreamt of. The upholders of the older views occasionally come in for a sound rating* from the apostles of the new; while others speak of the modern views as "a revelation"; and others go so far as to assert that in all cases of denudation the *onus probandi* lies with those who maintain marine agency, in preference to atmospheric. Let us in the following pages endeavour to see what, on the one hand, are the grounds

* See the *Geological Magazine* for July, p. 293.

upon which these modern views are based, and, on the other, the objections to their wide application; and then to ascertain to what extent they may be received or rejected, following as far as we can the sure and solid path of deduction from the observed phenomena of nature, and endeavouring to shun the shadowy regions of fancy.

If from our present stand-point we glance back at the days in which modern geology was in its infancy, we cannot fail to observe that we have, on the whole, made substantial progress in our views of the agencies by which the earth's surface has been moulded into form and feature. In those early days the notion prevailed that mountains and ridges were due to upheaval, and that from an "axis of elevation" the strata invariably dipped in each direction towards the plains. Subsequent investigation, however, went to show that in many cases—even among the higher ranges, such as the Alps—the strata sometimes dip inwards towards the higher elevations, and consequently that the elevatory theory was by no means a universal, if indeed a general rule. According to the modern view—while admitting to a certain extent the influence of elevation—we regard the majority of hills and mountain chains as due to "denudation,"—a word which signifies, in this instance, the removal of masses of materials once overlying, or contiguous to, the more prominent elevations. The process may be illustrated by observing how, from the flat surface of a slab, a stone-mason will produce a figure in relief by chipping away the surrounding material. With regard to volcanic cones, *that* view may be said to be exploded, according to which they were supposed to have been blown up into "craters of elevation," as it is now found that the sides of the cone, instead of being composed of the rocks which form its basis, consist of the erupted matter of the volcanoes themselves, which are in fact cones of deposition.

On the other hand, deep valleys and narrow chasms amongst mountains were generally regarded as the result of earthquake action, rending the rocks in twain; and such views are still to be found glowingly enlarged upon by amateur "geologists" in local "guides;" but it is now considered exceedingly doubtful if the world contains, even in volcanic regions, a single instance of a chasm so formed, as it would have been filled up from below with molten matter—as a trap dyke—or from above with detritus. The chasms in mountains may therefore be in all cases referred to the action of water—to denudation.

In a word, denudation by water, or in its crystalline form, by ice, has become, in the modern period of geological science, the recognised process by which the features of the land were sculptured; and to none is our science more indebted for this advance than to the great expounder of the principles of geology, Sir C. Lyell.

The next step was the recognition of ice as a mighty agent of denudation.

The snows on the higher elevations of some mountain chains descend into the valleys in the form of glaciers, which in their course carry downwards the fragments of rock which fall on their surfaces from the heights. The glacier also scores the sides and bottom of the valley along which it moves, wearing down the rocks into mud, with which the water which issues from the glacier is always highly charged. In this manner, large quantities of matter are constantly being carried from the hills to the valleys, and deposited either in the deltas of the rivers or carried out to sea.

A further extension of the theory of glacial denudation has recently been propounded by Professor Ramsay, who maintains, with the aid of a strong array of illustrations, that the lakes which are so frequently found both amongst and around mountain chains, are due to the scooping power of glaciers, either extinct or recent. This view he grounds *chiefly* on the fact that these lakes lie in true "rock-basins," and that there is no agent in nature capable of hollowing out such basins except the ice of glaciers.

It might be supposed that the effects of such an agent as glacial ice in the process of wearing away the solid rocks must be comparatively unimportant; but it must be recollected, that in the glacial period, immediately preceding the creation of man, snow and ice had a much wider domain over the whole of the northern hemisphere than at present, and must have exerted a corresponding effect in the denudation of the surface. That remarkable deposit which covers so large an area of North America and Europe, called the Boulder Clay, or Northern Drift, is to a large extent made up of materials, derived originally from the morains, or detritus, brought down by glaciers. Accordingly, we may well believe that the amount of wear and tear to which the higher elevations must have been subjected during the Glacial period was incalculably great, and that amongst the agents of waste not the least important has been glacial ice.

When we survey the present outline of the solid strata all over the globe, and observe how, throughout thousands of feet in thickness, the strata rise to the surface and are suddenly truncated, or cut off like the leaves of the books on the shelves of a library; when, in tracing the margin of such a great formation as the chalk, we find the beds, more than a thousand feet in thickness, broken off along a steep escarpment; or when, as in Wales, the contorted beds of slate are planed away over smooth surfaces, which would be actual planes if they were not channelled by innumerable river-valleys, we feel that denudation is indeed a great reality, and that the waste of this solid matter has been prodigious.

The fact of such denudation being on all hands admitted, the only question for us to consider is, what are the agents which have brought about such marvellous results. Some maintain with much ingenuity—not to say special pleading—the greater effort of atmospheric over marine agencies; others take a medium view, regarding both as having taken a part, and each special case as requiring the application of special agents. I shall now endeavour to point out one or two principles which, if kept in view, will, perhaps, serve as guides in the determining to which of these the configuration of the surface in every instance may be referred.

Every one may for himself observe the manner in which rains, frost, and rivers work. The rain falls on the surface, it trickles down in gentle rills, then flows into deeper brooks, then into rivers, which, wearing down their beds and undermining the banks, cause them to give way, and at the next flood the materials are carried away seaward. Such erosive action is clearly of a *vertical* kind, and results in the formation of channels more or less wide and deep, depending *inter alia* on the size of the river and the steepness of the fall. The action of all other agents of the air is in the *vertical* direction—tending to form channels and furrows, either branching or lying along parallel lines, as in the case of certain mountain chains.

On the other hand, the wasting effect of sea waves has a character of its own which is strictly *horizontal*. The tendency of such wave-action along a coast line need scarcely be described. It has been fully ascertained that the destructive effort is confined to the comparatively small depth to which the waves themselves extend, and that its tendency is to reduce to an uniform level all obstructions. The waves wear down the coast cliffs and rocks, spreading out the materials over the shore, or the currents carry them to more distant parts of the ocean. In general terms, therefore, we may state that the tendency of marine denudation is to the formation of level surfaces, such as plains and terraces, while that of atmospheric denudation is to produce hollows and channels; in a word, each produces results peculiar to itself,—the one being horizontal denudation, the other vertical.

If these principles be admitted (and they can scarcely be disputed), I venture to think that many difficulties in determining the nature of the eroding agents in each special instance will disappear. Wherever we find level surfaces or terraces, we have evidence of an agent which acted along a horizontal plane, such as the waves of the sea, an estuary, or a lake. Steep-sided valleys, on the other hand, afford *primâ facie* evidence of vertical erosive action, such as that of brooks or glaciers. I think we may safely say, that rivers never form terraces jutting out upon a plain, nor terraced surfaces of any kind except when composed of the gravels or silt which they themselves bring down. On the other hand, there are instances of deep ravines which cannot be regarded as the result of river action, inasmuch as they contain no rivers or brooks; while (as I hope to be able to show) wide and shallow valleys, containing others smaller and deeper, are generally referable to marine denudation.

According to these principles, such valley-plains as those of Gloucester, between the Malvern and Cotteswold Hills (happily called by Sir R. Murchison "the Ancient Straits of Malvern"), must be regarded as the result of marine denudations. Likewise the terraces of marlstone, which jut out from the base of the Cotteswold escarpment, as well as those of the lower chalk, green sand, and other formations along the outcrop of the Chalk formation. It is impossible to conceive solid materials to have been swept away from the surface of these platforms by streams which have no existence, even with the utmost latitude as regards time. To our mind, the opinions once expressed by Mr. Jukes—which possibly he might now repudiate—are most truthful and appropriate, when he says "Isolated crags and precipices, or long lines of cliff, and steep slopes looking down upon broad plains, must have, in like manner, been formed by the sweeping power of the sea." *

I now come to speak of valleys without brooks, to which allusion has already been made. If an imaginary plain be stretched across the crests and summit-ridges of many of our mountain groups, it will be found to form a surface either gently sloping or slightly undulating. This has been shown by Professor Ramsay to be the case in regard to South Wales, and is remarkably clear in the district south of Cader Idris. Such a plain as this was doubtless once a sea-bottom, and is termed by the writer above mentioned, "a plain of marine denudation." When this surface was first lifted from beneath the sea, it began to be acted on by the agents of atmospheric denudation. The rains, seeking a passage to the sea, would follow the slight irregularities of the ground, and innumerable rills, uniting into larger streams, would form channels for themselves, which, becoming deeper and wider, in the lapse

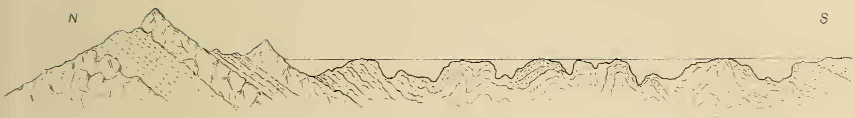
* "Student's Manual of Geology."

of time, would at length have the effect of turning a plain into a succession of hills and steep-sided valleys. (See fig. 1.) All countries present similar instances of plains, or plateaux, which have been formed into mountain chains by the channelling out of valleys. A noble example is Scandinavia; and in our own country we have the Cotteswold Hills, the Chalk Downs, Cannock Chase, and the Pennine Chain. That the valleys by which they are intersected have to a great extent been scooped out by streams, rains, &c., is undeniable; but that many of the larger ones are not due to these agents is, I think, equally certain, for several reasons, which I shall now proceed to explain. In the first place, it is evident that during the slow process of elevation the sea would have had opportunities of wearing channels in the softer strata, which it would not be slow to take advantage of, and which afterwards became the chief river valleys; in the second place, many of these valleys were formed before the Drift-period, as they are partially filled with boulder clay; and in the third place, many of them are of such extent and width as to be altogether disproportioned to the rivers or brooks which flow through them. Now I hold that all true river valleys bear some proportion to the size of their streams. Not only is this the case, but there are some well-formed valleys which have no brooks whatever for a certain distance, forasmuch as they cross the watersheds. The valley of Todmorden, on the borders of Lancashire and Yorkshire, is a remarkable example of this kind (fig. 2.) At Littleborough it contracts into a narrow, steep-sided glen, bounded by lofty cliffs several hundred feet in height, with a smooth and almost imperceptible slope. At two miles north of Todmorden the watershed is crossed, and for some distance there is no perceptible stream. Yet the valley is as well and sharply defined here as in any other part of its course. The valley of the Calder, between Todmorden and Burnley, affords another illustration; as do those of Whitworth, near Rochdale; Sabden, near Clitheroe; and that along the course of the Caledonian Railway, near Moffat. Indeed, most hilly districts afford similar examples. Nothing can be more certain than that such valleys are not due to river action, as in some parts they contain no rivers.

There are also in many of the uplands of England double valleys, or *valleys within valleys.* I have for a long time felt persuaded that in such cases we have before us examples both of marine and river denudation, the limits of the latter being clearly defined. Such instances of double valleys occur probably in every hilly district. They are to be found in the Pennine Chain and in the Cotteswold Hills, and their general form is represented in the annexed wood-cut (fig. 3). The

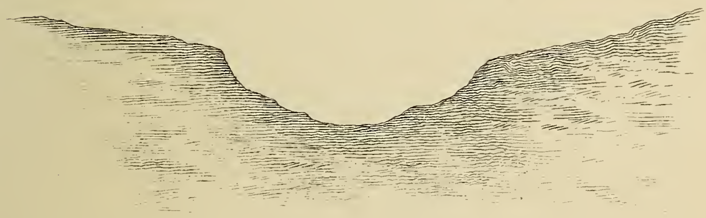
Plate XII.

Fig 1.



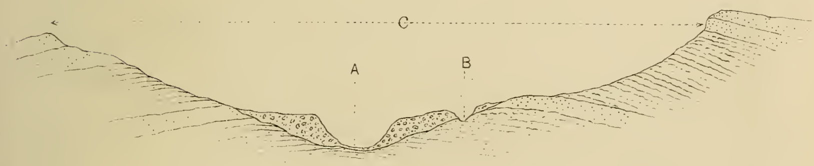
Ideal section from Cader Idris southward. The straight line shows the original plain of marine denudation in which the valleys have been scooped.

Fig. 2.



Section across Todmorden valley at the watershed.

Fig. 3.



Section near Turton, Lancashire, showing two river valleys, A, B hollowed out in boulder clay, and lying in the larger valley C supposed to be of marine origin.

Denudation.

W West lith

larger valley (sometimes filled to a certain height with marine drift) descends on both sides from ridges in a broad sweep, flattening towards the middle, at which place it is cut through by a channel of varying depth, but generally with steep banks, along which flows the stream. It seems to me unquestionable that the smaller valley *alone* is referable to river action; and, as compared with the extent of the wider valley, the amount of denudation is often inconsiderable.

The wonderful *freshness of glacial phenomena* in this country has always appeared to me to offer an obstacle to the acceptance of the views of the modern school, which has not yet been fully appreciated, much less answered. The great argument with the modern school is *time*. "Only grant unlimited time," say they, "and the work of the gentlest rills, the most ordinary frosts and rains, will effect mighty alterations in the surface of the earth." The natural reply is, that the time, though vast, is *not* unlimited, and that the vastness of the time is insufficient for the changes. On this point the evidence of glaciation is to my mind conclusive, and it may be summed up in a few words:—The vast lapse of time since the Glacial period in Europe and America has been insufficient to effect the atmospheric denudation of the boulder clay, or to materially alter the form of glaciated rocks in the valleys, or even to obliterate the delicate ice-marks on rock surfaces when protected by a few inches of turf or mould. It is undeniable that in many of the old glacial regions, such as those of North Wales, the English lakes, the Scottish uplands and highlands, the mammilated contour of the hills, allowed to be the effect of ice-action of the Glacial period, is still maintained with little alteration, and that the very valleys themselves, through which the rivers run, are often glaciated down to the water's edge. In such cases, at any rate, no one can assert that the valleys have been formed by the rivers since the glaciers disappeared from off the country; the actual extent of modern atmospheric and river action being generally clearly defined by the scarped sides of the river-banks breaking the general flow or contour of the surface.

I anticipate the answer to the above reasoning in the assertion that the lapse of time since the Glacial period, is really insignificant; but if any one seriously entertains such an opinion (which runs counter to the tendency of recent investigation), he must be prepared to produce some evidence beyond speculation. The time, at any rate, has been sufficient to allow of considerable changes in the relative position of land and sea, and other physical phenomena requiring length of time. Yet the testimony of the rocks is against any large amount of atmospheric denudation since that period.

With the absolute certainty, then, that so little has been accomplished by atmospheric denudation in some parts of our island, how are we to believe that so much has been effected in others? The reader is probably aware of the views of Professor Ramsay, Dr. Foster, and Mr. Topley regarding the atmospheric denudation of the Weald, that region of Kent and Sussex from which the Chalk and Lower Cretaceous groups have been swept away, laying bare the Wealden formation.* It is supposed, however, that this region was unsubmerged during the Drift period, and therefore that the rains and rivers have had a much more extended period of uninterrupted work than in the northern parts of the island. But this is by no means certain in itself, and the difficulty still remains of accounting for the terraced aspect of some parts of the country, which, as I have endeavoured to show, is incompatible with the view of atmospheric denudation. In the region of Auvergne, in Central France, which has been so faithfully described by Mr. Scrope, the amount of denudation by the rains and rivers has certainly been on a most extended scale; but in this case these agents have acted apparently without interruption since the latter part of the Tertiary period. In the south-west of Ireland, however, where Mr. Jukes has come to the conclusion that many of the river valleys are alone due to the rivers themselves, this has not been the case, as the country was certainly, to a large extent, submerged at the Drift period: how this fact can be reconciled with his views I am not in a position to state, but the sea having been there, it could scarcely have departed without leaving impressions on the surface.

The arguments, however, advanced by my colleagues of the Geological Survey in favour of the atmospheric denudation of the Weald are certainly very forcible, and seem to account for the fact that the rivers generally cross the chalk escarpments transversely, instead of making their way to the sea along their bases. And if it be allowed that this rain and river action has been in operation uninterruptedly since the Eocene period, it is impossible to estimate the effects which might be produced throughout so vast a lapse of time.

I hope the reader will not conclude from the above that I call in question the power of atmospheric agencies to produce considerable modifications of the earth's surface under certain

* See Professor Ramsay's "Physical Geology," 2 Edit., p. 79, &c.; Messrs. Foster and Topley, *Quarterly Journal of the Geological Society of London*, vol. xxi., p. 460.

conditions. I cannot, however, assent to the views of some of my own colleagues and other eminent geologists, at least until the objections here advanced—I trust fairly and candidly—have been fully answered. In the formation of valleys, as well as plains, terraces, and escarpments, the sea has been, as it seems to me, the great artificer. In many minor valleys, the rivers have been the agents of denudation, but every special district requires the application of special principles in order to account for its physical features.

HOW TO WORK WITH THE TELESCOPE.

PART II.

THE ALT-AZIMUTH.—THE EQUATORIAL.—PRACTICAL HINTS.—OBJECTS FOR OBSERVATION.

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

Author of "Saturn and its System."

THE best known, and, in some respects, the simplest method of mounting a telescope for general observation is that called the altitude and azimuth mounting. In this method the telescope is pointed towards an object by two motions,—one giving the tube the required *altitude* (or elevation), the other giving it the required *azimuth* (or direction as respects the compass-points).

For small alt-azimuths the ordinary pillar-and-claw stand is sufficiently steady. For larger instruments other arrangements are needed, both to give the telescope steadiness, and to supply slow movements in altitude and azimuth. The arrangement of sliding-tubes and rack-work commonly adopted is defective in many respects. The slow movement in altitude is not uniform, but varies in effect according to the elevation of the object observed: it is also limited in range; and quite a little series of operations has to be gone through when it is required to direct the telescope towards a new quarter of the sky. However expert the observer may become by practice in effecting these operations, they necessarily take up some time (performed as they must be in the dark, or by the light of a small lantern), and during this time it often happens that a favourable opportunity for observation is lost.

These disadvantages are obviated when the telescope is mounted in the manner shown in Plate XXII., fig. 1, which represents a telescope of my own construction. The slow movement in altitude is given by rotating the rod *h e*, the endless screw in which turns the small wheel at *b*, whose axle in turn bears a pinion-wheel working in the teeth of the quadrant *a*. The slow

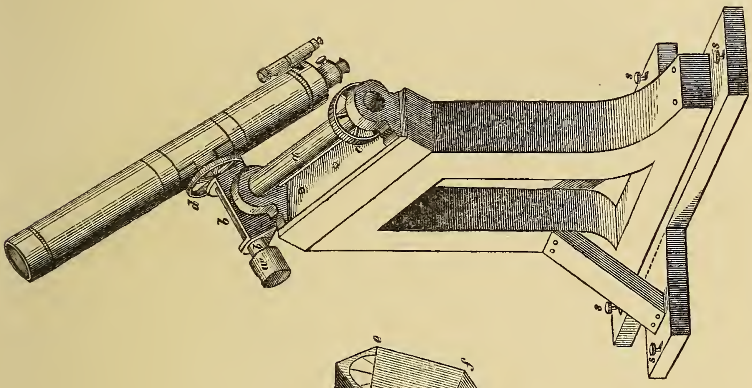


Fig. 2.

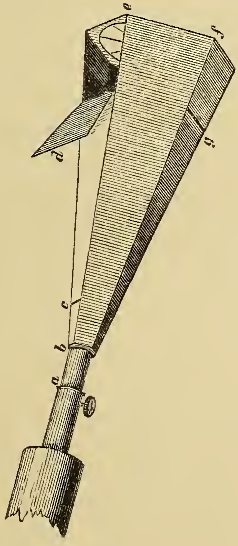


Fig. 3.

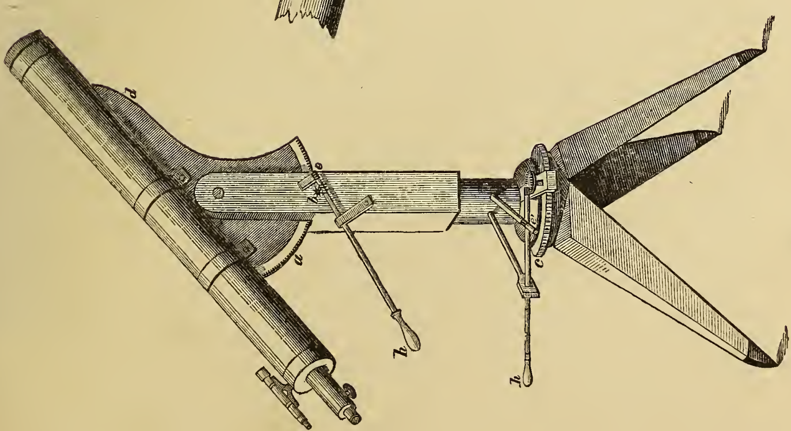


Fig. 1.

movement in azimuth is given in like manner by rotating the rod *h′ e′*, the lantern-wheel at the end of which turns a crown-wheel, on whose axle is a pinion-wheel working in the teeth of the circle *c*. The casings at *e* and *e′*, in which the rods *h e* and *h′ e′* respectively work, are so fastened by elastic cords, that an upward pressure on the handle *h*, or a downward pressure on the handle *h′*, at once releases the endless screw or the crown-wheel respectively, so that the telescope can be swept at once through any desired angle in altitude or azimuth. This method of mounting has other advantages; the handles are conveniently situated and constant in position; also, as they do not work directly on the telescope, they can be turned without setting the tube in vibration. As here shown, the mounting is too expensive for an alt-azimuth; but it is clear that, in place of the toothed-wheels *a* and *c*, a simple arrangement of belted smooth wheels could be substituted.

But, for systematic observation of the heavens, the alt-azimuth must yield place to the *equatorial*. In this mode of mounting, the main axis is directed to the pole of the heavens; the other axis, at right angles to the first, carries the telescope-tube. One of the many methods adopted for mounting equatorials is that exhibited (with the omission of some minor details) in Plate XXII., fig. 2. *a* is the polar axis, *b* is the axis (called the declination-axis) which bears the telescope; the circles *c* and *d* serve to indicate, by means of verniers revolving with the axis, the motions of the telescope in right ascension and declination respectively. The weight *w* serves to counterpoise the telescope, and the screws *s, s, s, s,* serve to adjust the instrument so that the polar axis shall be in its proper position. The advantage gained by the arrangement above indicated, is that only one motion is required to follow a star. Owing to the diurnal motion of the earth, the stars appear to move uniformly in circles parallel to the celestial equator; and it is clear that a star so moving will be kept in the field of view, if the telescope, once directed to the star, be made to revolve uniformly and at a proper rate round the polar axis.

The equatorial can be directed, by means of the circles *c* and *d*, to any celestial object whose right ascension and declination are known. On the other hand, to bring an object into the field of view of an alt-azimuth, it is necessary, either that the object itself should be visible to the naked eye, or else that the position of the object should be pretty accurately learned from star-maps, so that it may be picked up by the alt-azimuth after a little searching. A small telescope called a *finder* is usually attached to all powerful telescopes intended for general observation. The finder has a large field of view, and is adjusted so as to have its axis parallel to that of the large telescope. Thus, a star brought to the centre of the large field of the finder (indicated by the intersection of two lines placed at the focus of the eye-glass) is at, or very near, the centre of the small field of the large telescope.

In searching with an alt-azimuth for an object not visible in the finder, the best plan is to narrow the field of research by selecting as pointers stars—whether conspicuous or not is indifferent, so long as they are visible in the finder,—as near as possible to the object sought. The "straight-line pointing" of gnomonic maps and the "true-angular pointing" of stereographic maps are useful helps in finding; but if too large a part of the heavens is included in such maps, excessive scale-variation and distortion diminish their value. It is easy, in selecting maps, to determine the extent of these defects :—Examine the spaces included between successive meridians and parallels, near the edges and angles of the maps; these should not be very different either in size or shape from the *corresponding* spaces near the centre of the map.

The quality of the stand has a very important influence on the performance of a telescope. In fact, a moderately good telescope, mounted on a steady stand, working easily and conveniently, will not only enable the observer to pass his time much more pleasantly, but will absolutely exhibit more difficult objects, than a better instrument on a rickety, ill-arranged stand. A good observing-chair is also a matter of some importance, the least constraint or awkwardness of position detracting considerably from the power of distinct vision.

The object or the part of an object to be observed should be brought as nearly as possible to the centre of the field of view. Where there is no apparatus for keeping the telescope pointed upon an object, the best plan is so to direct the telescope, by means of the finder, that the object shall be just out of the field, and be brought by the earth's motion across the centre of the field. Thus the vibrations which always follow the adjustment of the tube will have subsided before the object enters the field. The object should then be intently watched during the whole interval of its passage across the field.

It will be found that even in the worst weather for observation, there are instants of distinct vision, during which the careful observer may catch sight of important details; and similarly, in the best observing weather, there are moments of unusually distinct vision well worth patient waiting for, since in such weather alone the full powers of the telescope can be applied. The telescopist should not be deterred from observation by the presence of fog or haze, since with a hazy sky definition is often singularly good.

The observer must not expect distinct vision of objects near the horizon. Objects near the eastern horizon during the time of morning twilight are especially confused by atmospheric undulations; in fact, early morning is a very unfavourable time for the observation of all objects.

A telescope should not be mounted within doors, if it can be conveniently erected on solid ground, as every movement in the house will cause the instrument to vibrate unpleasantly. Further, if the telescope be placed in a warm room, currents of cold air from without will render observed objects hazy and indistinct. In fact, Sir W. Herschel considered that a telescope should not even be erected near a house or elevation of any kind, round which currents of air are likely to be produced. If a telescope be used in a room, the temperature of the room should be made as nearly equal as possible to that of the outer air. When used out of doors a "dew-cap," that is, a tube of tin or pasteboard, some ten or twelve inches long, should be placed on the end of the instrument, so as to project beyond the object-glass. This tube should be blackened within, especially if made of metal. After use, says old Kitchener, the telescope should be kept in a warm place long enough for any moisture on the object-glass to evaporate. If damp gets between the glasses it produces a fog (which opticians call a "sweat"), or even a seaweed-like vegetation, by which a valuable glass may be completely ruined.

The observer should not leave to the precious hours of the night the study of the bearing and position of the objects he proposes to examine. This should be done by day, an arrangement which has a two-fold advantage—the time available for observation is lengthened, and the eyes are spared sudden changes from darkness to light, and *vice versâ*. Besides, the eye is ill-fitted to examine difficult objects, after searching by candle-light amongst the minute details recorded in maps or globes. Of the effect of rest to the eye we have an instance in Sir J. Herchel's rediscovery of the satellites of Uranus, which he effected after keeping the eye in darkness for a quarter of an hour. Kitchener, indeed, goes so far as to recommend (with a *crede experto*) an *interval of sleep* in the darkness of the observing-room before commencing operations.

The greatest care should be taken in focussing the telescope. When high powers are used, this is a matter of some delicacy. It would be well if the eye-pieces intended for a telescope were so constructed that when the telescope is focussed for one, this might be replaced by any other without necessitating any use of the focussing rackwork. This could be readily effected by suitably placing the shoulder which limits the insertion of the eye-piece. Theoretically, all celestial objects require the same focus. One of our most careful amateur observers remarks, however, that the moon requires a different focus than more distant objects. If there is any appreciable difference, the cause must be sought elsewhere than in the difference of distance, since it may readily be shown that the focal length for parallel rays exceeds the focal length for the moon's distance by less than one-650,000th part. Some observers have noticed that for distinct vision of spots near the sun's limb a *shorter* focus has to be used than for distinct vision of stars and planets, or of spots near the centre of the solar disc. Mr. Dawes thinks this an optical deception.

It is necessary in selecting "powers" to remember that different objects will bear different powers,—the stars will bear higher powers than the moon, Venus, and Mercury, these than Jupiter or Saturn, and these again than comets and nebulæ. In all cases it must be remembered that high powers increase the difficulty of observation, since they diminish the field of view, increase the rapidity with which (owing to the earth's motion) the image moves across the field, and magnify all defects due to instability of the stand, imperfection of the object-glass, or undulations of the atmosphere. A good object-glass of four inches aperture will, in very favourable weather, bear a power of about 400 when applied to the observation of close double, or multiple stars, but for all other observations much lower powers should be used. "He who possesses a tool of this size," says Admiral Smyth, speaking of five-foot refractors, "ought never to teaze it with the higher powers except under obvious necessity." It is, of course, useless to diminish power so much that the emergent pencils of rays are larger than the pupil of the eye. In a Galilean telescope (as may be seen in the case of an opera-glass), such low powers are employed, because in this way only a tolerably large field can be obtained;* but

* My attention has been called to the opinion expressed by Sir W. Herschel, that a concave lens would give as large and distinct a field as a convex lens of the same size and power, *if only the eye were moved about in front of the lens.* Kitchener found this to be the case, but (as might be expected) vision much less pleasant with the concave lens. The difference between the action of the two forms of eye-lens may be illustrated as follows:—Form a piece of paper into a shape resembling a speaking-trumpet; now, if the eye be placed at the smaller opening, a field of view resembling the field given by a convex eye-glass will be obtained; reversing

in an astronomical telescope (unless it is to be used for comet-seeking) no power so low as not to call into play the full light-gathering power of the telescope should be used.

That the moon may be observed to advantage with a small telescope, is clearly shown by the excellent map constructed by Beer and Mädler with a telescope (by Fräunhofer) only $4\frac{1}{2}$ feet in focal length. Much yet remains to be learnt of the moon's face. The observer who would wish to be serviceable in this way should select a small portion of the moon's surface for diligent examination. After carefully studying this part in a good map, he should scrutinize it in the original, endeavouring to detect, if possible, details not exhibited in his map. He should note the changes of appearance presented, not only with the changing lunar phases, but (especially in districts near the moon's limb) with the variations in the epochs of maximum libration. He should be prepared to attribute apparent changes of appearance to such variations of position; but any suspicion he may have, after careful scrutiny, of actual change taking place upon the lunar surface, should be noted for confirmation or disproof by other observers.

In observing the sun the eye must be protected by dark green or neutral-tint glasses having parallel surfaces, and it is convenient to have an eye-piece arranged with a rotating wheel by which darkening glasses of different power may be brought into use as the varying illumination may require. For observation of minute portions of the sun the Dawes's eye-piece should be used: in this a metallic screen placed in the focus keeps away all light but such as passes through a minute hole in the diaphragm. A very convenient way of diminishing the light is to use a glass prism, light being partially reflected from one of the exterior surfaces, and the refracted portion thrown out at another. A pleasant method of observing the sun is to project the sun's image on a screen placed (in a darkened room) at about 6 or 7 feet from the end of the telescope; a totally reflecting diagonal eye-piece being used, otherwise the telescope would have to be erected at an inconvenient height. Very beautiful and interesting views (on a smaller scale, however) may be obtained by using such a pyramidal box as is depicted in Plate XXII., fig. 3.

the instrument, it will be found that, by moving the eye over the open space at the large end of the tube (held in a fixed position), every object included in the former field can be seen *in turn*. Of this nature is the field, if field it can be called, given by a concave eye-glass, used as suggested by Sir W. Herschel.

This box, which should be made of black cloth or calico, fastened over a light framework of wire or cane, is to be placed in the sliding eye-tube as shown. The door *b c* enables the observer to "change power" without removing the box, while larger doors *d e* and *g f* enable him to examine the image,—a dark cloth, such as photographers use, being employed, if necessary, to keep out extraneous light; or the surface on which the image is received may be formed of cut-glass or oiled tissue paper, in which case the image may be examined from without.

Systematic observation of the sun, with a careful record of the number and position of the spots, of the arrangement of faculæ, and of other phenomena visible with moderate powers, cannot fail to be highly valuable. In all drawings, lines of reference should be used, which, combined with the record of the time of observation, will render it easy to mark in at leisure the position of the sun's equator and visible pole. Careful notes should be taken of all appearances, even of those about which the observer may feel doubtful. The question whether some phenomenon, seen momentarily or for a short time only, has really taken place, will be settled if the phenomenon happen to be observed simultaneously by another observer. Of such a nature, for instance, was the remarkable observation, simultaneously made by Messrs. Carrington and Hodgson, of a sudden flaming out of intense light on the solar surface. In such a case, evidence afforded by a small telescope may assume a high importance.

Observation of Mercury and Venus is rather difficult, owing to the intense light of these objects. Venus, at her brightest, is visible to the naked eye in the daytime. She can be much better observed by day or by full twilight, than on a dark background; and this not only from the fact that she is never visible on a dark background save at a low altitude, but because her great brilliancy is softened down when she is seen on a brighter background.

For the observer who possesses only an alt-azimuth, or an equatorial without circles, it may be useful to note that Venus or Jupiter (when favourably situated) by day, or Mercury when too near the sun to be easily detected by the naked eye, may readily be found in the following manner:—

Across two uprights fasten a straight rod, so that, when looked at from some fixed point of view, the rod may correspond to the sun's path near the time of observation. The rod should also be at right angles to the line of sight to its centre. Fasten another rod at right angles to the first, and also at right angles to the line of sight just named. From the point of fastening, measure off and mark on the second rod equal spaces, each subtending a degree, and therefore two inches in length if the eye is distant nine feet and a half, and proportionately less or greater, according to the distance of the eye. Suppose, now, that the observer has erected such rods to aid him in observing Mercury, on November 22 next, in the evening. Referring to Dietrichsen's Almanack, we find that on that day Mercury's R.A. and *dec.* exceed the sun's by 1h. 31m., and 5° 19′, respectively. Therefore, viewed from the fixed point, Mercury will pass the cross-rod 1h. 31m. *after* the sun, and between the fifth and sixth marks *below* the fastening. If the sun cross the rod at about 3 P.M., Mercury will pass it about half an hour after sunset, and probably be visible to the naked eye until 4h. 55m. P.M., when he sets.

With a little ingenuity a similar method may be applied to determine from the position of a known object that of any neighbouring unknown object, even at night. The first rod must be divided like the cross-rod, and the cross-rod shifted, or else two cross-rods used, when the unknown *precedes* the known object. That such methods are efficient may be gathered from an instance. On one occasion, by simply noting the hour and angle at which the sun passed the gable-end of a house at some distance, I estimated the time and place at which Mercury should emerge from behind the house, and picked him up in a 5-foot achromatic so soon after emergence that the outline of the house (out of focus, of course) was in the field of view with him.

Observation of Mars may be usefully pursued with small telescopes. A valuable series of maps of this planet was constructed by Beer and Mädler with the instrument already mentioned, in 1830, when Mars was in opposition near perihelion. Owing to the eccentricity of Mars's orbit, his distance from the earth (when he is in opposition) varies from 61,000,000 when he is in aphelion, to less than 35,000,000 when he is in perihelion. Oppositions near perihelion recur at alternate intervals of about fifteen and seventeen years. Unfortunately, when favourably situated as to distance, Mars is south of the equinoctial, and therefore not favourably situated for observation in northern latitudes, having a low altitude on the meridian. As respects altitude, Mars will be very favourably situated for observation at the opposition which will take place next January; but he will not appear nearly so large as he did in October, 1862. The vernal equinox of Mars's northern hemisphere occurs when the longitude of the planet is about $78\frac{1}{4}$°, corresponding to the position of the earth in the beginning of December. Knowing this, the student can easily determine what proportion of either hemisphere of Mars is turned towards the earth at any time;

next January, for instance, a large portion of the northern hemisphere will be visible. When Mars looks ruddiest, the spots on his surface are most clearly visible—probably because at such times the atmosphere of the planet is freer from mist or vapour.

Jupiter and Saturn are, of course, most interesting objects to the astronomical observer, though the close scrutiny to which they have been subjected by our leading observers may deter the amateur from that persistent and systematic observation which is alone likely to be rewarded with valuable results. Yet Mr. Grover, with a telescope only two inches in aperture, has detected a phenomenon in Saturn which, I believe, had escaped the notice of more powerfully armed observers,—the presence, namely, of a penumbra surrounding the shadow of the planet on the ring. For a long time Saturn will not be favourably situated for observation, owing to his low altitude when in opposition; and nearly twenty years must elapse before the planet will again exhibit his ring-system (as in 1856) fully opened and well elevated above the horizon.

Double and multiple stars supply at all times a fertile field of labour and research to the astronomical observer. They also afford a ready means of testing (1) the performance of his telescope, and (2) the state of the atmosphere on each night of observation. It is well to begin each such night with preliminary observations of a few well-known double stars, suitably placed as respects altitude, and to enter the results of such observations immediately above the notes of the evening's work. The following are among the tests given by Admiral Smyth for the performance of a telescope; but it must be remembered that they were obtained by diminishing the aperture of a 6-inch telescope having a focal length of 8½ feet, so that as far as the smaller apertures are concerned a somewhat better defining power was probably obtained than similar apertures with the usual proportionate focal lengths would give.

A 2-inch aperture, with powers of from 60 to 100, should exhibit—

α Piscium (3″.7).	δ Cassiopeiæ (9″.5), mag. (4 and 7½).
γ Leonis (2″.9).	Polaris (18″.6), mag. (2½ and 9½).

A 4-inch, powers 18 to 120—

ξ Ursæ Majoris (2″.7).	σ Cassiopeiæ (3″.1), mag. (6 and 8).
γ Ceti (2″.6).	δ Geminorum (7″.1), mag. (4 and 9).

A 6-inch, powers 240 to 300,—

λ Ophiuchi (1″4).	α Arietis (30″.0), mag. (3 and 11).
20 Draconis (0″.7).	κ Geminorum (6″.1), mag. (4 and 10).

In applying these and other tests, some allowance must be made for different powers and qualities of eye-sight, as well as for the idiosyncrasies of different instruments. Some eyes, like some telescopes, possess a remarkably acute defining power; others surpass in the power of detecting minute points of light, or small differences of shading; in the appreciation of colour, again, eyes differ greatly. The observer must also be prepared to find his eyesight vary with his health or occupations. Lastly, the eyesight will be found to improve with practice, a circumstance which must not be forgotten when a new telescope is to be tested.

Sir John Herschel has expressed the opinion, that the observation of variable stars offers the most promising field of observation to the amateur observer ambitious of effecting original discoveries. No part of the heavens can be diligently observed, even for a few weeks, without detecting signs of change. The invention of Dawes's iris-diaphragm has greatly facilitated the observation of variable stars. For observing the colours, and changes of colours of stars, I think a positive eye-piece, having a minute white disc in the focus, admitting of illumination through differently coloured glasses, carried on a rotating disc, might be employed with advantage. For such observations (as, indeed, for all delicate star observations) moonless nights must be selected, the opinion expressed by Homer of moonlit nights * being quite contrary to that held by the telescopist.

Of nebulæ and star-clusters there are many which will amply repay close study with telescopes of moderate power; though, of course, the observer will not expect to see marked traces of configurations with which Lord Rosse's gigantic mirror has made us familiar.† Indications are not wanting of processes of change in many nebulæ. Some appear to be growing gradually brighter, others fainter. It is quite within the power of the amateur telescopist to detect and estimate such variations, to seek signs of changes in position some of the nebulæ may undergo with respect to neighbouring stars, and

* *'Ως δ'ὅτ ἐν οὐρανῷ ἄστρα φαεινὴν ἀμφὶ σελήνην*
Φαίνετ' ἀριπρεπέα, &c.

The lines are beautiful, and have been beautifully rendered by Tennyson in a passage which every one has by heart; but the image is not truthful. Pope's version is gloriously incorrect.

† It may be necessary to remind some observers, that Sir J. Herschel's pictures of nebulæ, having been taken with the *front view*, must be reversed as respects right and left, before they can be compared with other pictures. This may be done by holding the picture up to a light and looking at it from the back; or by looking at its image in a mirror.

in other ways to accumulate facts to aid us in interpreting the nature of these mysterious objects. A fresh interest has been given to such researches by the revelations which the spectroscope has been made to afford under the able hands of Mr. Huggins. The same remark applies, without the change of a word, to the observation of comets.

Lastly, in the observation of eclipses, transits, occultations, and other phenomena of the like nature, the observer has pursuits which may either prove simply interesting to himself, or valuable to others, according to the method he may adopt in effecting, recording, and interpreting his observations.

REVIEWS.

PRE-HISTORIC PILE-HOUSES.*

WHO has not heard ere this of the German pfahlbauten, the Irish crannoges, and the English hut-circles? Of late years the antiquary and the geologist have joined hands in the labour of investigating primitive man, and hence a wide field of study has opened up which was undreamt of before. The researches of Dr. Keller and of Professor Desor on the Continent, of Sir John Lubbock in England, and of Sir W. Wilde and Mr. G. Henry Kinahan in Ireland, have been fertile in valuable results. Indeed, it is not too much to say that a more accurate knowledge of the habits of primitive man has been acquired during the past five years, than we ever possessed. It is now pretty well known that the hut-circles, crannoges, and lake-dwellings of Switzerland were inhabited by races whose habits of life were all but identical. Some archæologists have been induced to believe that all these pre-historic remains indicate one and the same chronological period, but there are no logical grounds for such a theory. Looking at them from a civilization stand-point, there can be little doubt but that the pile-dwellings of all nations represent the same stage of advance in intelligence of their constructors; but there is abundant evidence to show that in point of time they represent very different epochs. This is only what is to be supposed *à priori*. Even at the present day we find among the aborigines of certain countries, habits and customs which correspond closely with the early lake settlers on the one hand, and with the men of the so-called "Stone-age" on the other. Dr. Livingstone, in his book on the "Zambesi," describes some of the races he met with as grinding their corn in rude quarns of sandstone like those found in the remains of the Swiss lake-dwellings. We believe, too, that in some of the islands of the Polynesian Archipelago houses constructed of piles and cane-work are to be found in the lakes and marshes; and it has been shown that the Australian and other savages split the bones of animals in order to extract the marrow, just as the people of the Stone-age in Europe must have done in ages long gone by. All these facts, then, go against the supposition that the remnantory dwellings which the labours of so many antiquarians have brought to light, belonged to one and the same period of time.

But though we have hardly any clue to the relative ages of the several

* "The Lake Dwellings of Switzerland and other Parts of Europe." By Dr. Ferdinand Keller, President of the Antiquarian Association of Zürich. Translated by John Edward Lee, F.S.A., F.G.S. London: Longmans & Co. 1866.

specimens of lake-dwellings with which we are familiar, we see plainly enough that they all point to a very primitive and uncivilized condition of man, and hence are in the highest degree worthy of attention. To those who are really anxious to become acquainted with the habits and manners of the early European races, we commend Dr. Keller's book, as being at once the fullest, honestest, and most systematic work which has yet been published upon the subject. Mr. Lee, as translator, has discharged his duty well ; and in his editorial capacity he has furnished a number of notes, references, and tables, which are of the highest value and interest. Dr. Keller's work includes the labours of the archæologists already distinguished for their investigations in this field of inquiry. This feature is, we believe, due to the enterprise of the translator, who determined to make the work a thoroughly exhaustive one. Of the method of the book we may state that it is divided into a number of chapters, each of which is devoted to the history of a particular settlement. Although from this feature the volume has more the character of a scientific monograph than of a general treatise, it is still very readable, and is best arranged for the purposes of reference. It may be remarked that the author is very little of a theorist. He is content to lay all the facts brought to light of late years before his readers, without attempting to deduce from them any clearly laid-down laws. Hence those portions of his work devoted to a general history of the pfahlbauten are short sketches. Still there is this advantage in their terseness : a half-hour's reading gives one a capital general notion of the character of the pile-dwellings and of their variety.

The lake-habitations owe their name of pile-dwellings to the circumstance that they were constructed of stakes or piles, which were driven into the mud or sand which constitutes the bottom of fresh-water lakes. They were in many instances built in groups, thus forming a kind of settlement, and in few cases had any direct connection with the neighbouring shore. The manner in which the driven piles were arranged varied. Sometimes they were placed close together, at other times they were ranged in pairs, occasionally they were placed at considerable distances, and in some instances they seemed to be driven in without regard to plan or order. The piles were pointed before being used, and this was effected partly by burning and by the use of stone hatchets. In all cases the heads were brought to a level, and then the platform beams were laid upon them, being fastened sometimes by wooden pins, and at others by means of "mortice" work. Occasionally, says Dr. Keller, "cross-timbers were joined to the upright piles below the platform, to support and steady the structure, either forced in, as it were, between them, or fastened to them by what workmen call 'notching,' that is, portions were cut out of the vertical piles to receive the cross timbers.". Upon the platform thus produced the dwelling was constructed, but as to the exact character of the roof and sides the evidence is not so satisfactory. It would seem, however, that the walls consisted of a narrow plank, upon the upper edge of which were ranged the rude rafters upon which the hurdle-work constituting the roof rested. Remains, indeed, of such planks have been found, but there is no reason for supposing that any more elevated wall existed. Such an arrangement was sufficient to prevent the invasion of either insects or damp, and this was probably all that was needed. The floor in some instances was formed of split trunks, in others of branches, but over these was a sort of "concrete" layer composed of mud, which had been worked or "puddled" into the interstices, and upon this floor was placed a large stone slab, which, from the charred and sooty appearance of all the specimens examined, must have formed the hearth of the lake-dwellers' domestic economy. It must not be supposed from what we have said that the pfahlbauten were invariably constructed in the manner we have described. The "fascine dwellings" were made upon a very different and much simpler plan. In these the platform was not supported by stakes or piles, but rested upon a series of layers of sticks, pine branches, mud, and stones, which were built up above the surface of the water. The Irish crannoges too, a chapter on which occurs in Dr. Keller's book, were of a mixed character, possessing some of the features of the pile and some of the fascine dwellings. But in all the more perfectly constructed settlements the understructure, platform, and superstructure were as we have described them.

What were the habits of the races who built, and lived in these curious habitations? This is the question which has been so well answered by the numerous explorations of Dr. Keller and his Swiss colleagues. And how have they answered it? By giving us a thorough and carefully compiled account of the relics which their investigations of the lake-dwellings have brought to light. This account is to be found in the several chapters in which the many settlements examined are described. We find that these early Europeans presented a strange mixture of savagery and civilization. They cultivated cereals, and reared domestic animals; but their most perfect weapons and implements of household use were made of stone, wood, and bone, bronze being extremely rare; and while their utensils of pottery were of the roughest hand-made character, they were able to weave flax into a species of fabric of no ordinary quality or complexity. They must have lived upon fish, corn, and the flesh of their domestic animals; for the remains of all these have been found abundantly among the piles. Probably, too, they clothed themselves in skins, fastened round their bodies with bone pins or skewers.

It is the history of these singular people—some of the earliest inhabitants of Europe—that Dr. Keller's work opens up before us, disclosing long vistas into bygone ages, when Europe was inhabited by human beings who were of the group intermediate between the ape-like men of Darwin and the more civilized races which sprang from the Kelts. In its pages we find the results of the antiquary's exploration of Meilen, Mooseedorf, Robenhausen, Wangen, Niederwyl, Wauwyl, Allensbach, Morges, Lake of Bourget, Peschiera, Marin, and several other celebrated settlements; and elaborate accounts of the Irish and Scotch crannoges, by Sir W. Wilde and Mr. J. Stuart. Dr. Oswald Heer describes the plants of the lake-dwellings; Professor Rütimeyer does the same for the animal remains; while Professor von Fellenberg takes up the bronze implements, and discourses ably anent their origin and significance. There are nearly a hundred artistically-executed lithographic plates, which in themselves unfold the tale of the pile-dwellings to the lazy student, and thus is completed a volume such as never has been before published upon its own or any other subject. Alike interesting to the geologist, antiquary, and general reader, it must necessarily be much sought after, whilst its exhaustiveness and clearness combine to make it the standard book of reference on all that relates to the early lake-settlements.

ORGANIC HARMONIES.*

FOR those who are addicted to the Bridgewater-treatise class of scientific literature, Dr. Hartwig's work must possess the highest fascination. Written in the most thoroughly religious spirit, abounding in quotations from Holy Writ, advocating the most toothsome teleological doctrines, it appeals in the strongest manner to those who desire to see science made palatable to the most credulous. We by no means wish to inveigh against such treatises as the present. Apart from any little scientific merit they may possess, they have a mission of their own to fulfil—the superficial enlightenment of those who see only in philosophy an enemy to religion. It is, however, a pity that they are so generally prepared by writers who neglect recent discoveries, and who, ignoring all the progress made during several years, content themselves with selections and compilations from some half-dozen text-books, four or five of which at least are themselves full of errors. The book before us is, we regret to say, just one of the objectionable class to which we refer. Allusions to the Almighty are painfully plentiful, and blunders in matters-of-fact are equally abundant. Melancholy it is that those authors who profess to see so much of God's handicraft in the phenomena of nature, do not take pains to study nature to more advantage. It is one thing to spend a lifetime, as Darwin has done, in the keen investigation of nature's operations, and quite another to sit down with five or six standard treatises before you, and with the aid of scissors and paste complete a "taking" volume for one's publisher. The latter method is, we think, not entirely unknown to Dr. Hartwig, whom we would counsel to refer more to nature and less to books in preparing his next edition. Written in a style which is florid without being sublime, and ornamented without being impressive, "The Harmonies of Nature" professes to be a popular history of the earth and its inhabitants, especially with regard to the so-called co-adaptation of one to the other. The author commences with a description of the "splendour of the starry heavens," and having traced the development of the globe and of its organic life up to the creation of man, he then brings his powerful mind to bear upon the animal and vegetable world as they are; and concludes his labours by pointing out to the reader what are "the aims of human existence." When our author confines his attention to the polyps and mollusks whose forms adorn his pages, he tells us some interesting though by no means novel facts concerning them; but when he enters upon the less defined regions of speculative philosophy, he astonishes us now and then, we frankly admit. In fact, what Dr. Johnson once said of a work upon which his opinion was asked, is singularly applicable to the present book:—"It contains a great deal that is new and that is true; but the true parts are by

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* "The Harmonies of Nature; or, the Unity of Creation." By Dr. G. HARTWIG. London: Longmans & Co. 1866.

no means new, and the new ones are certainly not true." Dr. Hartwig's book is really a very popular natural history, which, like others of its kind, is in most respects behind the age, and bears evidence of being a *fricassée* of Rymer Jones's "Animal Kingdom," Gosse's sea-side books, and Wood's "Homes without Hands." It is a *réchauffée* of old books; it is light and digestible in matter, oily and creamy in style, but terribly innutritious,—a dish which looks and smells well, but which is decidedly to be avoided. Still it is a nicely "got-up" book, abounding in wood-cuts from "Milne-Edwards's" manual, and with lithographs which bear a startling resemblance to some recently issued with another work which Messrs. Longmans have published. Dr. Hartwig's treatise would form an instructive reading-book for children; but such passages as the following utterly preclude its ever attaining to any reputation as a scientific work:—

"Insect life gives us the most convincing proofs, not only of the wisdom and power of the Almighty, but also of His ineffable goodness; for these numberless species, so variously gifted, *have all been born for a far greater share of happiness than of sorrow.* The pangs of death are generally short—a fleeting moment; while their life, which, at least in the larval state, is frequently prolonged during several years, *is almost entirely devoted to agreeable occupation.* When a caterpillar is feasting on a succulent leaf, or a bee is sucking the nectar of a flower, they are surely enjoying life; and *who can doubt of the happiness of a swarm of gnats,* maintaining for hours together their dances in the air; or of the butterfly, lightly hovering through the forest glades in the warm sunshine. The hum of the beetle and the shrill tone of the cicada, the cricket's chirp, and the buz of the bee *give expression to sensations which are evidently of no gloomy nature:* and as every moderate exertion of our mental or bodily faculties calls forth agreeable feelings, we can be well assured that the rapid course of the tiger-beetle, the prodigious leap of the grasshopper, or the aërial velocity of the dragon-fly are continual sources of enjoyment for these active little creatures."

All praise to Dr. Hartwig for his conviction of the wisdom and power of God, but might he not have spared us the above maundering effusion on the æsthetic delights of insects?

MIND AND FORCE.*

IF it be not true as a general proposition that much learning is apt to turn the human mind from the channels of sane thought and argument, it is at all events unquestionable that to some mental organizations the study of metaphysics is fraught with much danger. Over and over again we have seen men of no ordinary intellectual ability run into the veriest twaddle of psychical speculation, through endeavouring to discover for themselves the why and the wherefore of the universe. There are too many of us who think that a careful inquiry into the constitution of mind will

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* On "Force and its Mental and Moral Correlates." By Charles Bray. London: Longmans, 1866.

enable us to comprehend eternity, and to grasp the idea of space. It seems so hard to have to admit that in thought we shall go "thus far and no farther." On reading the first few chapters of Mr. Bray's book, we were pleased to find an intelligible exposition of the relations of physical and mental energy. It seemed as if the author were a worthy disciple of Grove and Tyndall, from the painstaking manner in which it was shown that matter is merely force, and that vital phenomena are nothing less than the correlates of physical ones. But as we travelled through the pages of the book, we found the author wandering from the paths of legitimate reasoning, and indulging in speculations of a very visionary character. Indeed, the present work is interesting from the circumstance that it shows into what absurdities even an extremely intelligent and sceptical writer may be led by that extremely deceptive "will-o'-the-wisp," primary causation. At first Mr. Bray sets out as the champion of rationalism, and ere he concludes his book, he stumbles about, after a fashion painful to observe, in a quagmire of spiritualistic nonsense. He is up to his very waist in the mud and muck of clairvoyance, ghosts, and spirit-rapping. We almost feel inclined to ask whether Mr. Bray is not satirizing spiritualistic doctrines when he makes the following observations. Surely no one familiar with the *facts* of modern science could commit himself to such suggestions as these :—"May not the spiritualistic theory be merely casting its shadow before ? Plants prepare the food for animals, and the elaborate machine of the animal body prepares the food for mind, that is for sentiency and conscious intelligence ; and may not this result of cerebration, which has been intensifying for centuries, furnish ground for a new start—for the existence of mind in an individual form, without all the present cumbrous machinery for the correlation of force ? We have a world of spiritual food already prepared, so that there would be no necessity for the old apparatus. If it be true, as is testified by the Spiritualists, that hands and arms are now formed in such an atmosphere, who can tell what will be the ultimate effect of will-power—for I hold the whole universe to be the effect of will-power on certain prepared conditions,—as the thought of spirit atmosphere intensifies by the greatly increased action of brain now going on ?" We calmly ask is this satire, or is it the raving of one who has become metaphysically mad ?

TAPE-WORMS.*

THIS is a little volume forming an admirable introduction to the author's splendid treatise upon *Entozoa*. Here Dr. Cobbold has given very graphic accounts of the habits, sources, character, development, and influence of all those terrible tape-worms which infest the human intestines, and the numerous good wood-cuts which accompany his descriptions clear up the whole history of these parasites. The book has more than a zoological

* "Tape-worms : their Sources, Nature, and Treatment." By T. Spencer Cobbold, M.D., F.R.S., Lecturer at the Middlesex Hospital. London : Longmans, 1866.

significance; it is intended as a hand-book for the general practitioner, who will find therein a clue to the nature of the "guest" which his patient unwillingly entertains. Hitherto medical men have been too prone to divide intestinal parasites into the broad groups of tape-worms and thread-worms, without giving themselves the trouble of investigating the several species of the former. This was a serious error, and we here thank Dr. Cobbold for having pointed out to the profession the necessity for studying the several species, with a view to their identification. The matter is one of very decided importance. There are no less than eleven different kinds of these formidable entozoa, and inasmuch as the sources, consequences, and treatment of them differ with the species, a careful diagnosis is essential to the proper cure of the patient. And even when the treatment does not differ for any two tape-worms, a knowledge of the specific characters may enable the physician to relieve the anxiety of the patient, which otherwise he could not effect. Thus, Dr. Cobbold tells us that the commonest tape-worm is really not that which comes from the pig, but that of the ox. The latter differs from the former in having the head unarmed. This circumstance should be noticed, because in watching for the expulsion of the parasite one should not wait till a head armed with hooklets is expelled. It appears that very great attention must be paid to the selection of drugs in the treatment of the tape-worm, the author having known many instances of failure to result simply from the use of spurious or inactive medicaments. The creatures which Dr. Cobbold deals with in this work are the following:—The armed or pork tape-worm, the unarmed or beef tape-worm, and the pig-headed, Greenland, elliptic, margined, triple-crowned, spotted, ridged, Egyptian, and hydatid-forming tape-worms. Of these the two first and the last are those most frequently met with in these countries, and their natural history and the modes of expelling them may be learned from Dr. Cobbold's book in half an hour's reading. Of our author's knowledge of his subject it is superfluous to speak, but of his little volume we may say that we can honestly recommend it to the student, the physician, and the general reader, as the tersest and most accurate treatise on the subject of tape-worms.

POPULAR ASTRONOMY.*

ASTRONOMY is fast becoming a very popular pursuit. Of late years opticians have given an impetus to the study of the heavenly bodies, by the manufacture of excellent telescopes at moderate prices: the telescope is now as favourite an instrument as the microscope, and amateurs begin to be as familiar with the features of Mars and Saturn, and with the characteristics of the double stars, as they are with the revolving spheres of

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* "Popular Astronomy." A series of lectures by George B. Airy, Astronomer Royal. London: Macmillan & Co. 1866. "A Treatise on Astronomy," for the use of Colleges and Schools. By Hugh Godfray, M.A. Macmillan & Co. 1866. "The Handbook of the Stars." By Richard A. Proctor, B.A., F.R.A.S. London: Longmans & Co. 1866.

Volvox globator, or the delicate striæ of *Pleurosigma angulatum*. This is as it should be. The phenomena of the star-world are as accessible for observation as those of the flora and fauna of our globe, and they certainly afford a wider scope for sublime thought and philosophic generalization and analysis. As Mr. Proctor and others have pointed out, a huge, complex, and expensive equatorial telescope is not essential to astronomical discovery. Keen and patient observation, with an apparatus of very moderate power, will do wonders in the way of revealing appearances before unobserved. Just as the pursuit of astronomy becomes more general, so does, *pari passu*, the publication of treatises on the subject become more frequent. The three works whose titles we give beneath, are all excellent of their kind; two of them are general handbooks, and the third is a special essay upon the stars. Professor Airy's book merits the highest praise for its fulness and simplicity. It deals with all the more important principles of theoretical astronomy, and, what is more, it treats of the instruments employed in practical study, and how, through their use, the facts upon which the laws of the science are founded have been recorded. This is the sort of book which the amateur will highly prize. It is completely devoid of technicality, so that the most ordinary reader may understand it; while it is written by one of our best authorities, and in a most fascinating style. Professor Airy assumes that his reader is utterly ignorant of scientific terms, and explains away every difficulty as he goes on. His illustration of parallax is one of the happiest bits of popular and yet accurate explanation that we have ever seen. The book embraces six lectures, on the following subjects:—Apparent rotation of the heavens; the equatorial; refraction; the transit instrument; the mural circle; mode of observing; proof that the earth revolves; apparent motion of the sun; phenomena of an axis of rotation; apparent motion of planets; measure of distance by parallax; different methods of finding parallax; precession of the equinoxes; lunar nutation; aberration of light; measure of the distances of stars; velocity of light; gravitation; pendulum experiments; proper motion of stars; motion of solar system in space, and weight of the planets. This little manual is certainly the most accurate and lucid which has been published.

Mr. Godfray's treatise, though professing to be intended for schools, is, we fear, of too high a mathematical standard for most "academies," and it certainly is not the sort of book which a general reader or amateur could take up with profit. As a work for students who are proceeding to their B.A. degree, it is unexcelled, and the number of "examples and problems" to be worked out, which are appended, must render it an invaluable companion for those who are "going up" for examination in mixed mathematics.

Mr. Proctor's handbook will be found very useful by those engaged in stellar observations. It contains three very carefully prepared maps, of Orion, Cassiopeia, and of Jupiter's path across part of Sagittarius and Capricornus. Much of the volume is devoted to observations on the different methods of constructing star maps; and here we may remark that the author considers the "equidistant projection" to be best adapted for maps of complete hemispheres, whilst the "gnomonic projection" is more suited to the preparation of popular sets of star maps. Appended are six tables; one of the constellation seasons, one a catalogue of

1,500 stars, and four others which are respectively devoted to the names of the stars, the mode of determining the precessional motions of the stars, the construction of maps on the conical projection, the mode of determining the position of the ecliptic, and the position of the constellations at successive hours all the year round.

RAIN AND RIVERS.*

COLONEL GREENWOOD gives us a new edition of his work on denudation. The author is a desperate iconoclast, and the unhappy victim of his violence is poor Sir Charles Lyell. With some sense and a deal of nonsense, occasional clear reasoning, and frequent blunders of logic, with much expression of narrow-minded prejudice, and a great deal of objectionable personality, Colonel Greenwood's book has some merit, but can hardly be looked upon as a philosophical exposition of one of the most important doctrines of geology. The Colonel is a fierce antagonist, who has a far greater aptitude for ridicule than for argument, and whose onslaught on the most eminent of living geologists is in as bad taste as it is devoid of foundation in fact. We cannot here analyse the author's opinions, nor indeed, if we had space, should we have the inclination to dissect them thoroughly, since they are not laid down with that calmness and impartiality which command the respect of the critic. We may mention, however, that he is a warm advocate of atmospheric denudation as the agent in the production of river valleys. In this we think he has a good deal of geological evidence to support him. For though there can be little doubt that other agencies besides atmospheric erosion operate in producing river valleys, still it seems to us that it is a very constant and important means. However, the whole hypothesis is still *sub judice*, and we therefore think Colonel Greenwood's assertions are, to say the least, premature. Of the author's other views we can only say that he believes that there were no successive developments or creations of animals. "All were formed together; there is no truth in the arguments of geologists as regards *Eozoon Canadense*, and other early fossils. Man lived during the Silurian period. The whole affair is the result of the most childish confusion between space and time, between place and period." Colonel Greenwood mistakes coarse jocularity for humour, and thinks that in order to put his opinions before the public, he must "go in" for geology made funny, and for clumsily-constructed sentences, which even Artemus Ward would not have called "goaks."

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* "Rain and Rivers; or, Hutton and Playfair against Lyell and all Comers." By Colonel George Greenwood. Second Edition. London: Longmans. 1866.

ROCKS CLASSIFIED.*

A VERY different book from the foregoing is that now before us. It is the translation of a treatise on systematic lithology, and is a book at once worthy of its great author, creditable to science, and invaluable to the practical geologist. It is especially to be regarded as a book of reference, since it describes in methodical order the several varieties of rock,—igneous, aqueous, and organic,—which make up the crust of the earth. It is certainly the finest work on lithology which has as yet been presented to British readers, and since both author and translator co-operated in the preparation of this edition, we have ample guarantee for its accuracy and accordance with the progress of geological science. The classification of rocks adopted is somewhat artificial, but will, we think, be found useful. It is as follows: (1) *Igneous*, divided into basic and acidic, the basic being again sub-divided into volcanic and plutonic, and the acidic undergoing a similar grouping. (2) *Metamorphic crystalline schists*, including the felspar, quartz, chlorite, and crystalline groups. (3) *Sedimentary and fragmental rocks*, including the argillaceous, marl, limestone, gypsum, fragmental, and conglomerate groups. (4) *Rocks of special character or bedding*, comprising the serpentine, garnet, schorl, carbonaceous, and ironstone groups. The minerals are also systematically arranged, and their chemical, physical, and crystallographic characters are fully given.

MANUAL OF ELECTRICITY.†

OF the many works in Chambers's *Educational* course there are but two or three which we consider really accurate and clearly written. One of them is the admirable treatise on chemistry by the late Dr. Wilson, one of the most excellent introductions to the science ever published. The present volume is intended as a sort of companion to Wilson's book, and we think it is worthy in the highest degree of the place it seeks. It is well written, up to the most recent advance of the branch of physics on which it treats, and is, moreover, amply illustrated and comprehensive. The author is a thoroughly modern philosopher, and his book bears the impress of its author's mind. Mr. Ferguson ignores the theory that electricity is what some of the books call a "subtle fluid." This view he thinks is likely to lead to the impression that is not warranted by experience. He looks upon electricity, therefore, as "a peculiar action which the molecules of matter

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* "Rocks Classified and Described." By Bernard Von Cotta. An English edition by Philip Henry Laurence, with English, German, and French Synonyms. Revised by author. London: Longmans & Co., 1866.

† "Electricity." By Robert M. Ferguson, Ph. D. W. & R. Chambers, London and Edinburgh, 1866.

under certain conditions exert on each other." The phenomena of induction are explained upon a theory which is in accordance with that of Faraday. In the section devoted to galvanism we observe that the British Association B.A. unit of resistance has been adopted. The chapter on electric telegraphs is very instructive, and contains a full and illustrated description of the mechanism of Morse's instrument. There is a paragraph, too, on the chronology of the telegraph, which will be read with much interest. The appendix contains an account of Wilde's magnetic-electro machine, and an excellent chapter on the construction of induction coils.

POPULAR PHYSIOLOGY.*

THE little volume lying on our table is one of Buckmaster's series, and is written by Mr. Angell, of Manchester. It is by no means a bad introduction to physiology, and may be read with profit by those who are entirely ignorant of the science of life. Its chief feature, and the one which we apprehend forms its principal recommendation, is that it is systematically put together, the sections being short and well arranged. It is to be regretted that the author has dealt so much with facts and assertions, and so little with the grand principles of physiology. The illustrations are not effective, though in nearly all instances they are copies of those in Milne-Edwards's and other manuals. We should like to know why it is that Mr. Buckmaster's name is printed upon the title-page as though he were virtually the author. How surprised we should be to see "Longman's Comparative Anatomy of the Vertebrates, by Mr. Owen," or "Churchill's Principles of Physiology, by Dr. Carpenter!"

SIGHT AND HEARING.†

MR. WHARTON JONES has here given us a popular account of the eye and ear, and of their pathology and treatment. The earlier chapters are devoted to the physiology of vision, and are clear, though by no means so full as they might have been. We question the correctness of some of the optical diagrams, but in their construction Mr. Jones has only followed the too prevalent custom of confounding the axial and lateral rays in illustrating the formation of images by refracting media.

* "Buckmaster's Elements of Animal Physiology." By John Angell, Government Science Teacher. London: Longman & Co., 1866.

† "Defects of Sight and Hearing." By T. Wharton Jones, F.R.S., F.R.C.S. 2nd edition. London: Churchill, 1866.

THE NATURAL HISTORY AND EFFECTS OF LIGHTNING.*

WE have before us that rare phenomenon, a book which, professing to treat of a scientific and yet popular subject, accomplishes its task in a way which must command the deep respect of scientific men, while it also provides a mine of interesting matter for the mere intelligent dilettante. We all know how easy it would be to write a showy, useless book upon the fascinating topic of lightning and its occasional disastrous effects. The work of Dr. Sestier, however, is quite another affair. It is a solid, comprehensive, and most interesting treatise; the labour of love in which a most able physician employed every hour that he could spare from private practice for more than ten years; and it may almost be said to exhaust the subject. Unhappily the esteemed author met with a sudden death, and a short but earnestly written preface from the pen of the great French savant, Professor Louis, explains the manner in which the responsible task of editing the work has been committed to the able hands of Dr. Méhu, and bespeaks the attention of scientific Europe to what the Professor evidently judges to be a master-piece. We regret that it is impossible, owing to the great demands on our space, to give a lengthened analysis of this valuable work, and we decline to spoil the subject by a necessarily imperfect attempt at reviewing. We strongly recommend every one to read the book for himself.

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* "De la Foudre, de ses Formes, et de ses Effets sur l'Homme, les Animaux, les Végétaux, et les Corps bruts, des Moyens de s'en préserver, et des Paratonnerres." Par le Dr. F. Sestier. Rédigé, &c., par le Doct. C. Méhu. Paris: J. B. Baillière et Fils. 2 tom. 8vo. 1866.

SCIENTIFIC SUMMARY.

ASTRONOMY.

ASTRONOMY, in England at all events, has lately been taking holiday; so that were it not for the British Association, we should not have much progress on this side the Channel to record; as it is, the Luminous Meteor Committee and the Moon Committee have reported, and the latter has asked for and got £120 towards the construction of the map of the moon, to which reference has been made on a prior occasion. The report of the former committee is chiefly interesting from the fact that the spectroscope has been brought to bear on meteors for the first time. The coming November meteoric shower is expected to be a very interesting one, and the charts of radiant points will be completed in time for use on that occasion. The spectroscopes were directed towards meteors on the 10th of August last, and seventeen spectra were observed. For this purpose, Mr. Browning had constructed three binocular spectroscopes on a plan approved by the committee. No difficulty was found in mapping the course of the meteors in the spectroscope by the stars, of which a whole constellation—as, for example, the seven stars of *Ursa major*—can be seen in the instrument at a glance. The spectra of the meteoric nuclei were seen distinctly in a few cases only. They were commonly hidden by the light of the streak when that was yellow, and presented highly-coloured and continuous spectra, like the spectrum of white-hot solid matter when the streak was greyish white. A better night for observing nucleus spectra will be the 12th of December, when meteors leaving no trains are for the most part very brilliant. The observations of the August meteors appear to indicate the existence of an extraordinary amount of sodium vapour. As it is difficult to suppose that the vapour of the metal sodium already exists in any sensible quantity at the confines of the atmosphere, it must manifestly be brought into the atmosphere by the meteors themselves from without, so as to be deposited by them in their flight in the luminous trains that mark their course. The nucleus is, therefore, probably a fragment of mineral matter, of which sodium is one of the chemical ingredients.

The report of the Moon Committee states that they have determined to use lunar photographs, and to construct a map of 100 inches in diameter. The only photograph available for laying down positions was taken by Mr. Warren De La Rue, October 4th, 1865. This has been enlarged to 10 inches in diameter, and employed for this purpose, as the measures taken from it are either without appreciable error, or require but a small correction.

Mr. Birt has laid down during the past year, on one sheet, the whole of Quadrant IV. (meridians and parallels), 50 in. radius, and inserted Beer and Madler's 23 points of the first order. The greatest error in the position of these points is ·0008 of the moon's semi-diameter. The whole of the objects on a surface of 15° of longitude and 10° of latitude have been laid down on this sheet from the full-moon photograph, and several of them have been identified with objects seen conspicuously when near the terminator. A portion of this surface, 6° in longitude and 5° in latitude, is completed, and enlarged to 100 inches diameter. On it are laid down the positions of 89 objects, from three independent sets of measures, made on three separate photographs, the magnitudes, which are given in the catalogue in seconds of an arc, being determined by a separate set of measures. Let us hope that ere long the whole moon may thus be sketched, in order that all may be able to assist in such an admirable undertaking, and one which is especially fitted for amateur work.

The present progress of the work of reduction of the sun observations taken at Kew, will best be gathered from the following extract from a letter written by Mr. De La Rue, and printed in the Kew Committee's Report:—

"The pictures taken by means of the Kew heliograph are all measured by means of my micrometer; the positions of the spots are then reduced to distances in terms (fractional parts) of the sun's radius, and the angles of position corrected for any error in the position of the wires. Pictures of the pagoda are taken from time to time, and the measurements of the various galleries of the pagoda serve to determine the optical distortion of the sun's image and the corrections to be applied to the sun-pictures. The heliocentric latitudes and longitudes of the spots are then calculated. The areas of the spots and the penumbra are also measured, and the areas corrected for perspective are tabulated in terms (fractional parts) of the area of the sun's disk. The areas of the spots, &c., on all of Carrington's original pictures have recently been measured, and an account of these measurements will be shortly published."

This is good news, although we could wish that the pictures taken by Mr. De La Rue's 13-inch refractor were already in question.

Our notice of the Association would be incomplete did we not allude to Mr. Grove's admirable discourse, in which astronomic progress is so ably and fully discussed, by one who is no mean worker with the telescope. The president's remarks on the specific gravity of the globe are suggestive enough to bear reproduction:—

"Surprise has often been expressed that, while the mean specific gravity of this globe is from five to six times that of water, the mean specific gravity of its crust is barely half as great. It has long seemed to me that there is no ground for wonder here. The exterior of our planet is to a considerable depth oxidated; the interior is, in all probability, free from oxygen, and whatever bodies exist there are in a reduced or deoxidated state,—if so, their specific gravity must necessarily be higher than that of their oxides or chlorides, &c. We find, moreover, that some of the deep-seated minerals have a higher specific gravity than the average of those on the surface; olivine, for instance, has a specific gravity of 3·3. There is, therefore, no *à priori* improbability that the mean specific gravity of the earth should notably exceed that of its surface; and if we go further, and suppose the interior of the earth to be formed of the same ingredients as the exterior, minus oxygen, chlorine, bromine, &c., a specific gravity of 5 to 6 would not be an unlikely one. Many of the elementary bodies entering largely into the formation of the earth's crust are as light or lighter than water,—for instance, potassium, sodium, &c.; others, such as sulphur, silicon, aluminium, have from two to three times its specific gravity; others, again, as iron, copper, zinc, tin, seven to nine times; while others, lead, gold, platinum, &c., are much more dense—but, speaking generally, the more dense are the least numerous. There seems no improbability in a mixture of such substances producing a mean specific gravity of from 5 to 6, although it by no means follows,—indeed the probability is rather the other way,—that the proportions of the substances in the interior of the earth are the same as on the exterior. It might be worth the labour to ascertain the mean specific gravity of all the known minerals on the earth's surface, averaging them in the ratios in which, as far as our knowledge goes, they quantitatively exist, and assuming them to exist without the oxygen, chlorine, &c., with which they are, with some rare exceptions, invariably combined on the surface of the earth. Great assistance to the knowledge of the probable constitution of the earth might be derived from such an investigation."

We have received from M. Hermann Goldschmidt a paper on the physical constitution of the sun, in which he broaches an original and somewhat startling hypothesis, which is something like this:—

If the sun is travelling along an orbit in space, as we suppose, and in the direction we suppose, it is next to impossible that the axis of rotation we see is the real one. Therefore there is a nucleus inside the photosphere with an axis of rotation differing from that of the photosphere. The nucleus is a spheroid, and its axis is inclined at an angle of 20° or 25° to the orbit of translation through space. M. Goldschmidt ascribes the production of the spots to the attraction between the spheroidal nucleus rotating on one axis and the spherical photosphere rotating on another, and this he does in a manner which is certainly ingenious if it be sound physically. At all events, those of our readers who can obtain access to M. Goldschmidt's *brochure* will do well to read it.

We have two other communications on the sun to notice, one by M. Faye, the other by Mr. Huggins. M. Faye is rather disappointed that in England, where he acknowledges the physics of the sun are studied more than anywhere else, we will not accept his theory, more especially with regard to the spots. He remarks, "We know that gases heated nearly to the luminous point, do not raise themselves to the incandescent state. This seems to be a property belonging to solid bodies, even when reduced to the most extreme tenuity. Imagine, therefore, a gaseous medium, on the surface of which is formed by chemical condensation, little clouds of incandescent particles, and you have a faithful representation of the photosphere. If from any cause clouds are wanting in any particular region, that region will appear dark; there will be a spot between the neighbouring clouds; there will be small intervals, much less bright and almost dark.

"To this it is objected that, if gases emit but little light, they are at all events transparent; if, therefore, we get an opening in the photosphere, we ought to see the photosphere of the opposite side, through the gaseous interior of the sun, with a scarcely diminished brightness (provided we do not happen to see another spot), and so spots would become impossible. If we assume that the gaseous mass is but slightly transparent, then it should emit light, and openings would not appear as spots."

The objections here referred to are, we believe, due to Mr. Stewart, and first appeared in the *Reader*. M. Faye then refers to those who insist upon a liquid surface under the photosphere, pointing out that this liquid would also be incandescent, and that therefore spots are not more easily accounted for. In reply to the first-named objection, M. Faye denies that the law of exchanges applies in this case, and pictures chemical combination and decomposition always at work in that thickness of 800,000 miles through which that law states we should see clearly.

Further, he urges that the theory of the cold-absorbing atmosphere can scarcely apply to spots, several rotations of which are observed, unless, at at all events, equal currents were set up in a contrary direction. We look upon this as a weak objection, for no one denies the counter currents, and it is known that very often, in those spots which remain visible a long time, the area they occupy and the changes which occur in them are enormous.

The other communication to which we referred is a most careful paper by Mr. Huggins in the *Monthly Notices*, which, in our opinion, gives, if we may be allowed the expression, the *coup de grace* to the "Willow-leaf Controversy." Mr. Huggins, who, to judge from his diagram, was favoured with surprisingly fine definition, writes thus of the form of these bodies :—

"When the granules are observed with powers of about 100 diameters, no comparison which has been made appears to me so appropriate as that to "rice-grains," suggested by Mr. Stone. If, however, higher powers are employed, this apparent regularity of figure and of size of the granules disappears to a great extent. Many of them are then seen to be nearly round, and not of the elongated form of rice-grains. Besides the oval and nearly round granules, may be observed irregular-shaped masses of almost every form. An important character common to all these bodies, whatever their form, is the irregular broken outline by which they are bounded. If, however, these smaller irregularities of figure be disregarded, the granules may be described generally as possessing a more or less oval form. The granules appear to me not to be flat disks, but bodies of considerable thickness." "Their average size," he remarks, "may be taken roughly at 1″ in diameter, and the average larger diameter of the more oval particles at about 1″5."

Finally, we read—"Mr. Dawes states that, after years of careful observation of these bright bodies, he considers them to be 'merely different conditions of the surface of comparatively large luminous clouds themselves—ridges, waves, hills, knolls, or whatever else they might be called—differing in form, brilliancy, and probably in elevation.' I would venture to differ from this distinguished observer only so far as to suggest that the bright granules were originally *separate* clouds, though it may be that their under-surfaces soon begin to unite with the less luminous stratum of clouds beneath them."

So much for the solar "*Diatomaceæ*."

Silliman's Journal for July contains some accounts of early glimpses of the new variable which we reproduce, as the question of its sudden appearance is really of extreme importance, and we believe doubt has been thrown on the early date communicated to Mr. Hind. It seems that Mr. Chandley, of the United States Coast Survey, saw it on May 14, at eleven p.m., when it was brighter than Böotis. Mr. Farquhar, Assistant Librarian United States Patent Office, saw it between eight and nine o'clock on the 12th of May. His uncle, Mr. Benjamin Hallowell, speaks of having seen it then for three weeks, varying in magnitude from time to time.

Father Secchi has lately communicated to the Paris Academy a further paper on the analysis of the stellar spectra, accompanying it with a diagram of Antares, a star remarkable for its red colour, observed with a high power and dispersion. The spectroscope now employed by Father Secchi consists merely of a cylindrical lens placed in front of the direct vision Amici prism, and both placed in front of the eye-piece to which the ordinary micrometer may be attached. With a power of 200 on the 9-inch Merz, the bands in Antares are easily analyzed. Secchi is now disposed to divide stellar spectra into three classes:

1. Coloured stars, like α Orionis, α Scorpionis, β Pegasi,—large band spectra.
2. White stars,—line spectra—like Arcturus, α Ursæ Majoris, β Aquilæ, Capella, Procyon, &c.
3. Blue stars—Syrius, Vega, α Aquilæ, &c. These have a large band in the blue—*f*—one in the violet, and sometimes another more refrangible one, with fine lines only visible in the larger stars.

M. Chacornac has communicated to the Paris Academy a note on the moon, pointing out what he considers to be strong evidences of tidal action, and drawing the inference that the rotation of the moon must once have been widely different to permit a tidal action to take place at all.

The asteroids now number 88. The last was discovered by M. Stephan at the Marseilles Observatory, on the 6-7th August, in Capricornus. "87" was discovered on June 15th by C. H. F. Peters; both are of the 12th magnitude "86," which has been named *Semele*, is of the 9th.

M. Coulvier Gravier thus sums up his observations of the shooting stars seen in the beginning of the month of August. "The number per hour at midnight on the 5th, 6th, and 7th August, was $16\frac{2}{10}$; on the 9th, 10th, and 11th, $39\frac{7}{10}$; and on the 13th and 14th, $18\frac{7}{10}$." Thus the brilliancy of the August shower is rapidly diminishing; the hourly number in 1865 was seven less than in 1863; it is now $18\frac{3}{10}$ less than last year.

There will be a partial eclipse of the sun on the 8th October.

Since we wrote the above, Hermann Goldschmidt has died at Fontainebleau, aged 64. In him we loose a most zealous and eagle-eyed observer. At thirty he studied painting in the studios of Schnorr and Cornelius, and subsequently came to Paris, where he exhibited at the Louvre with considerable success. He occupied a room in the Rue de l'Ancienne Comèdie, and there, with a common telescope, discovered thirteen of the minor planets. Arago and Le Verrier acknowledged the eminent services he had rendered, and the *grand prix* of astronomy, founded by Lalande, was awarded to him, as well as the Cross of the Legion of Honour, at the demand of these distinguished men. He has also received the gold medal of the Royal Astronomical Society.

Mr. James Breen has also died at an early age, since our last summary was written.

BOTANY.

Effects of Fungi in Flowering Plants.—M. C. Davaine presented a memoir on this subject to the French Academy at one of its recent meetings. His observations were confined to the effects of some half-dozen species, and refer in greater part to the discolouration which they produce. Fungi develop themselves on fruits with greater or less facility, according as they are hard or soft, sweet or acid. It sometimes happens, too, that one mould which has just attacked a fruit is succeeded by another species, for which, as it were, it has prepared the way. Certain fruits, such as the cucumber, and certain fatty plants, as Stapelia, oppose the inoculation of fungi by means of a peculiar gummy fluid, which surrounds the spores and prevents their development. Humidity is the most favourable condition to the development of these parasitic fungi. M. Davaine inoculated sound apples with the spores of *Penicilium;* some he kept in a dry and others in a moist atmosphere. The former remained uninjured, but the latter were soon invaded by the fungus. Hence he concludes that apples, pears, and wall-fruit may be kept for any length of time if entirely excluded from air, as by immersion in oil. He remarks, however, that fruit may rot even when it contains no trace of fungi. The "rot" determined by a *Mucor* or *Penicillium* offers certain distinctive features of consistence and colouration, and in rapidity of development. The other *Mucedineæ* produce "rots" having special characters. An *Helminthosporium* which attacks the carrot gives a black rot; a *Selenosporium,* which M. Davaine has found in the carrot, and which he has propagated on this and other plants, gives a fine red colour to the vegetable tissue; whilst the "rot" developed in this plant by a *Mucor* or *Penicillium* has no distinct colour. From his various researches M. Davaine concludes as follows:—The common moulds which develop themselves on inert organic substances may also attack living organisms. It is not necessary that these organisms should have been previously in an unhealthy condition for the invasion of the fungus to take place. The consequence of the development of these fungi is the condition known as rot or decay, which consists in the invasion of all the tissues by the spawn of the fungi.—*Comptes Rendus,* Aug. 20th.

Spontaneous Generation.—The controversy upon spontaneous generation has again been opened. This time M. Donné, one of the old opponents, has become the advocate. He alleges that the air found in hen-eggs, after being heated to destroy all traces of organic life, produced mould in large quantity. The eggs were first washed, dried, and surrounded with "carded cotton," and were then heated to 150° centigrade. A needle, previously heated to prevent germs attaching themselves to it, was then driven into the top of each egg. All the eggs thus pierced were surrounded by hot coals, and the whole were covered with a bell-glass. The development of the fungi took place in about a month after this operation. M. Pasteur thinks the experiment recorded by M. Donné to be of too loose and unprecise a character to have any importance.—Vide *a Paper read before the French Academy,* Aug. 13th.

An anomalous Structure of the Roots of Myrrhis odorata has been recorded by M. A. Trécul. The roots have in the first instance the normal character, but after a while they undergo a series of modifications which give two different structures, corresponding to two periods of development. The different layers are as follow :—1st period (1), the outer bark, (2) a generative layer, (3) a vascular zone, (4) a cortical layer, and (5) a vascular axis. In the second stage there are :—(1) Outer bark, (2) ordinary generative layer, (3) a vascular zone with a normal direction of its bundles, (4) a generative layer, (5) a cortex layer with proper vessels, (6) a zone of vascular bundles also directed in the usual manner, (7) a zone of inverted vascular bundles, (8) a generative layer (9) a cork layer, (10) a vascular bundle.

Wolffia Arrhiza in England.—Dr. Henry Trimen has discovered this plant in a pond near Staines, Middlesex, as recorded in our last. Dr. Trimen, in a paper published on his discovery, remarks that a good description of the plant is to be found in Hoffmann's paper in " Weigemann's Archives." In no figure, however, is shown satisfactorily the oblique way in which the new frond springs from its parent ; nor, according to Dr. Trimen, does any plate express clearly the peculiar sort of convexity of the upper surface of the frond. This convexity is from side to side, the upper surface seeming, as it were, to overlap the sides of the frond, so that it is only by the want of the stomata, and the lighter colour, that it can be seen where the upper surface ceases.

The Phylloid Shoots of Sciadopitys.—In certain plants when the leaves become reduced in size, the young shoots take on part of the functions of the foliar organs, and expand into leaf-like growths. This peculiarity in the above-named plant has been well and carefully described by Dr. Alexander Dickson, who states that in Sciadopitys the leaves of the growing shoots are really leaf-scales. In each year's growth the lower scales are placed at some distance from each other, and for the most part do not produce axillar branches. The scales toward the extremity of the year's growth, on the other hand, are closely approximated to each other, and in their axils are produced those bodies which have hitherto been termed the leaves of the plant. They are green linear organs, bearing a considerable resemblance to the leaves of other conifers, and occur singly in the axils of the scales. They are slightly bifid at their extremity, and exhibit a pretty deep mesial furrow on both upper and under surface. Dissection shows two vascular bundles, one on either side of the mesial line, in which respect they differ essentially from those scales which in young specimens of this plant are occasionally developed as elongated green leaves, and which invariably exhibit a middle vascular bundle. It follows, therefore, that the phylloid organs in Sciadopitys differ from true leaves not only in position but in structure.—Vide *The Journal of Botany*, July.

Plants in Egyptian Bricks.—Some curious discoveries have been made by Professor Unger, who has been examining certain bricks from the Pyramid of Dashour (3400 B.C.). The bricks, which must have been made of the Nile mud or slime of the period, have been found to contain many vegetable and animal remains. By this discovery Professor Unger makes us acquainted with wild and cultivated plants which were growing in the pyramid-building days ; with freshwater shells, fishes, remains of insects, and so forth, and a swarm of organic bodies, which, for the most part, are represented without alteration in Egypt at the present time. Besides two sorts of grain—wheat and barley — he found Teff (*Eragrostis Abyssinica*), the Field-pea (*Pisum arvense*), the common Flax (*Linum usitatissimum*),—the latter having, in all probability, been cultivated as an article of food, as well as for spinning. The weeds are of the familiar kinds : wild Radish (*Raphanus Raphanistrum*), Corn Chrysanthemum (*Chrysanthemum segetum*), Wartwort (*Euphorbia helioscopia*), Nettle-leaved Goosefoot (*Chenopodium murale*), bearded Hare's-ear (*Bupleurum aristatum*), and the common Vetch (*Vicia sativa*). The relics of manufacturing art consist of fragments of burnt tiles, of pottery, and a small piece of twine, spun of flax and sheep's wool, significant of the advance which civilization had made more than five thousand years ago. The presence of the chopped straw confirms the account of brickmaking as given in Exodus and by Herodotus.

The *Foliicolous Sphæriæ* have been well described by Mr. M. C. Cooke in a recent paper. He thinks that the classification of these fungi should properly be based upon characters of the fructification. But he thinks it doubtful that " any new arrangement in which no regard is given to the fruit will supersede the Friesian system." Mr. Cooke and Dr. E. Capron have been lately investigating the forms of leaf-sphæriæ, and they have discovered some new species.

How Plants get Introduced.—In the *Gardeners' Chronicle* an interesting account is given by " W. M." of the circumstances attending the introduction into Britain of *Lepidium draba*, a plant which gives much annoyance to the agriculturist. This plant appears to have been one of the many disastrous results of the Walcheren expedition. "When our troops returned to England, many disembarked at Ramsgate ; the poor fellows were suffering under malarious fever, and their beds were ripped up, and the straw, &c., was placed in an old chalk-pit belonging to a Mr. Thompson. Time passed on, and this heap of refuse was mixed with seaweed and manure, and finally employed to fertilize the fields. Wherever this was done, a plentiful crop of the new weed was produced, and which to distinguish it was called Thompson's weed. We have traced its introduction and its spread over many parts of the Isle of Thanet ; it now remains to show its future progress. It seems to take to the edges of ditches, the edges of footpaths, &c., in preference to the open fields, and may be traced through Canterbury, Chatham, and to Sittingbourne, Gravesend, Deptford, and Peckham."

An Orchid Tea.—The leaves of an epiphytal orchid of the island Bourbon have been recently introduced into Paris, and have been used in decoction as a substitute for ordinary tea. Those who have tasted the new beverage do not speak very highly of its agreeable qualities. The leaves are merely dried, and not half burnt, as is the case with tea. The technical name of the plant is *Angræcium fragrans*.

The Development of Œdogonium.—A very able Swedish paper, in which the development of Œdogonium is minutely detailed, is translated into the last number of the *Microscopical Journal.* The development of the spores is thus described :—Previous to germination, the spore has an egg-shaped figure ; the cell-contents are densely crowded, and composed of minute brownish-green granules, closely surrounded by a distinct cell-membrane. Outside this membrane there is found, besides, a quite distinct cell-membrane. Upon germination there are formed in both membranes slit-like openings, whereupon the cell-contents emerge, surrounded by an extremely delicate hyaline covering. The cell-contents are composed, not of one, but usually of four green masses, each surrounded by its cell-membrane. Sometimes, also, as it appears, abnormally, the masses are two or three in number. The four cells which proceed from germination possess an oval form, and their cell-membrane is hyaline. After the contents of the spore have emerged, there remains behind the outer membrane, enclosing the inner one. After the four cells have remained some time enclosed in the hyaline covering, this becomes resorbed subsequently, and the four cells lie still and motionless; but after the course of a short time there sets in a remarkable change—the cells burst, namely, at one end, by means of an annular slit, and the apex, separated thereby from the remainder of the cell-membrane, becomes raised up like a lid. Through the circular opening the cell-contents now emerge, which, at the part turned towards the opening, is colourless. This apex moves with vigorous motion backwards and forwards, and, after the brief space of an hour, the cell-contents, in the form of a zoospore, leave their place of detention, which we now find to be a doubly contoured cell-membrane. The little zoospore wheels about in a lively manner with a circling movement, whereby the colourless point becomes directed downwards towards the mirror of the microscope. Its appearance is puzzlingly like that of an ordinary zoospore, and, like it, it possesses an oval form and a lighter apex, furnished with a crown of cilia, which during the motion is always directed forwards. After the course of some time the movements become faint, and finally cease altogether. The cilia disappear, and the light end becomes elongated into a root, which sometimes becomes formed into an organ of attachment, quite like that which is produced in the germination of the ordinary zoospores. The rounded end of the germinating zoospore acquires a little point-like apex, indeed, herein much resembling the ordinary zoospores. This young unicellular growth becomes divided by a transverse septum, and a little two-celled Œdogonium has now originated.

Structure of the Anthers of the Aroideæ.—In one of our late summaries, we gave an abstract of a paper by M. Chatin in which it was stated that "anthers which open by means of terminal pores are devoid of fibre-cells." The general application of this expression has been denied by M. Van Tieghem, in a memoir recently published upon the structure of the anthers in Aroideæ, which latter, he says, is incompatible with such an arrangement as that alleged by M. Chatin. He gives the following example:—The sessile anther of *Richardia Africana* has two chambers, each of which is further divided into two thecæ by a thin longitudinal partition, which opens externally at the summit by means of a small vertical tube, hollowed out of the thick layer that the connection in expanding forms above the chambers; beneath this pore the septum is resorbed to allow the chambers to communicate with each other. The inner wall of the chamber is lined when mature by a layer of prismatic cells, arranged perpendicularly to the surface, and provided with strong spiral bands. In each of the secondary chambers or thecæ this layer of spiral cells ceases at the two borders where the septum arises; here they curve a little towards the interior of the chamber, and come in contact through the medium of smaller cells with the corresponding layer of the adjacent chamber, thus forming with it two longitudinal crests. The other details of structure are too numerous for an abstract. It may, however, be mentioned that M. Van Tieghem alleges that this fibrous layer contracts under atmospheric influences upon the chamber, and thus expels the pollen grains. He thinks that drought or desiccation causes, or may cause, contraction of the fibres ; but when he considers M. Duchartre's observations, he thinks that even this explanation is unsatisfactory.

The Synonymy and Distribution of Jussiœa repens.—M. de Martins considers that the supposed numerous species of this plant are really referable to one species, which, owing to its extensive distribution, becomes modified to a great extent. That these modifications are not hypothetical he has proved by submitting the plant to various conditions of soil, temperature, water, etc. Subsequently to his experiments he applied to several European botanists for specimens of *J. repens,* and from an examination of them he concludes that the species described by Linnæus in 1747 as *J. repens* has received the following twelve names :—*adscendens, diffusa, grandiflora, peploides, polygonoides, fluvialis, ramulosa, swartziana, stolonifera, alternifolia, Australatica,* and *fluitans.* He gives the following as its distribution. It is found in Asia, Africa, America, and Australia. In Africa, from Algiers to the Cape of Good Hope, and from Senegal to the Isles of Mauritius and Réunion. In Asia, from Syria to India and Ceylon. In America the extreme points are Kentucky and the Rio de la Plata, Mexico and Bahia.

Euphorbia palustris in Sussex.—The Rev. Thomas Hutchinson writes to inform us that this plant was really discovered by Mr. James Edwards, who found it in Blackbrook Wood, Ditchley. The wood has lately been cut down, so that specimens cannot be found, but Mr. Edwards hopes next year to find the plant as plentiful as ever.

CHEMISTRY.

The Sources of Fat in the Animal Body.—On this subject a paper was read by Mr. Lawes and Dr. Gilbert before the late meeting of the British Association. Some time since, Baron Liebig asserted that the fat of herbivorous animals was in great part derived from the hydro-carbon of their food, but might also be produced by the nitrogenous substances. This theory was opposed by Dumas and Boussingault, who afterwards in part supported it ; but at the Congress of Agricultural Chemists, held last year at Munich, M. Voit denied this conclusion, and asserted that the fat of herbivora is derived from the nitrogenous elements of the food. Messrs. Lawes and Gilbert having taken the subject up, have arrived at the following conclusions :—(1) That a large proportion of the fat of herbivora fattened for human food must be derived from other substances than the fat in their food ; (2) That when fed on the most appropriate fattening food, much of the stored-up fat must be produced from the carbo-hydrates ; (3) That the nitrogenous constituents may also serve as a source of fat, more especially in defect of a liberal supply of the non-nitrogenous elements.

What is an Ozonogene?—It is the name given to an instrument like that employed to disengage hydrogen continuously, but in which nitric oxide is generated by the action of nitric acid in copper turnings. A little of the gas being allowed to escape, produces nitrous acid, which acts as a powerful disinfectant. It is suggested that a small instrument upon this principle might be constructed for domestic use, on the same plan as a Dobereiner's lamp.—*Chemical News*, Aug. 31st.

A Compound of Oxide of Cadmium and Potash.—M. Stanislaus Meunier has described a curious compound of this kind to the French Academy. Some time ago he stated that oxide of cadmium dissolves readily by fusion in potash or soda, a definite cadmiate of potash being formed. He gives the following account of the process :—Fused potash is saturated with oxide of cadmium, and while the mixture is kept in a state of fusion a cold solution of potash is carefully added. After each addition of the solution a white precipitate forms, which redissolves ; but after a time this precipitate becomes permanent. When this happens the author stops the process, and allows the mixture to cool slowly. It thus becomes a crystalline mass, but at the bottom some of the white precipitate is found. The crystals do not entirely dissolve in water. The liquid is seen to be full of pearly shining scales, which, when collected, are found to be quite insoluble in water, and to be rich in oxide of cadmium. They are, in fact, according to the author, hydrated cadmiate of potash, but he has not yet obtained them in sufficient quantity to analyze. The compound is hydrated, he says, for a prolonged boiling with a solution of potash decomposes it, and causes a deposition of oxide of cadmium ; it contains cadmic oxide combined with potash, for acids cause the disappearance of the scales, and produce amorphous hydrate of oxide of cadmium soluble in an excess of the acid.—Vide *Comptes Rendus*, Aug. 20th.

Peroxide of Hydrogen.—Schoenbein has been pursuing his investigations upon this compound. He states that a solution of peroxide of hydrogen may be concentrated by boiling, and almost completely dehydrated by evaporation over sulphuric acid and under an air-pump, at the ordinary temperature. The peroxide, though less volatile than water, yet possesses a distinct degree of volatility, as M. Schoenbein's experiments demonstrate. Filter paper saturated with solution of $H\,O_2$, and dried at the ordinary temperature, will give all the reactions of the peroxide. Such a strip of paper touched with acetate of lead is rapidly coloured brownish-yellow ; touched with a mixed solution of ferrid-cyanide of potassium and a persalt of iron it becomes blue ; with a diluted mixture of sulphate of iron and of iodide of potassium with starch, a deep blue colour is produced ; a solution of chromic acid containing sulphuric acid also gives a blue colour. M. Schoenbein has found that when a piece of this prepared paper is placed in a bottle of ozone, it ceases to give the reactions of peroxide of hydrogen ; for the peroxide is converted by the ozone into water. He records several other reactions, all of which show that for purposes of testing, the paper is equally valuable as the solution of peroxide.—Vide *Journal für Praktische Chemie.*

Composition of Oil of Samphire.—The common plant so much used in certain parts of England as a pickle has been analyzed by M. Hérouard, who has given the following minute account of the properties of the volatile and fixed oils which this umbelliferous plant contains :—The oil of samphire is composed of a light and a heavy oil, the latter separating from the milky distilled water on standing, the former, which is the aromatic oil of the plant, floating on top. This is limpid and mobile when recent, has a sweet odour, and hot aromatic taste. It boils at about 350° Fahr. Its specific gravity is 980° at 55° Fahr. It is oxidized by the air, becomes thick and heavier than water ; when recent it remains fluid at 49° Fahr., but the old oils deposit silky needles when cooled. Further investigation found this body to be a result of oxidation, and to be an acid, and the oil itself to yield, by the action of weak nitric acid, a hydruret of a compound radical parallel with benzyl, which the author calls "crithmyle," and which forms combinations with chlorine, bromine, and iodine. The acid by oxidation is crithmic acid. The fixed oil of the fruit is siccative, of an orange-yellow colour, and oxidizes readily in the air to a brown soft solid.—Vide *Journal de Pharmacie.*

The Montpelier Spring at Harrogate.—The mineral springs of Harrogate seem to possess a composition different from those of other localities, and appear to be undergoing a gradual change of constitution. Dr. Sheridan Muspratt states, in a communication to the *Chemical News*, that though Hofmann's analysis in 1854 did not indicate the presence of chloride of iron, that substance has since been found in them by himself. Sulphates have disappeared from the springs, and chlorides seem to have taken their place. In the Kissingen water Dr. Hofmann found nearly forty-two grains of carbon of magnesia and no carbonate of lime ; now it contains about half a grain of the magnesian carbonate and sixteen grains of the lime. The following is the composition, as from the latest analysis :—

	Grains in Imperial gallon.
Iron carbonate	3·106
Baryta ,,	·517
Lime ,,	16·262
Magnesia ,,	·497
Calcium chloride	124·112
Magnesium ,,	56·074
Potassium ,,	5·408
Sodium ,,	650·409
Strontium, lithium, &c.	Traces.
	856·385

Simple Process for obtaining Soda from Salt.—An ingenious and cheap process for this purpose has been devised by Mr. Walter Weldon. It consists in placing within a vessel capable of resisting the necessary pressure, common salt and carbonate of magnesia, with a small quantity of water ; and then, by pumping into the vessel, the carbonic acid formed by causing atmospheric air to traverse coal in a state of ignition. The carbonate thus becomes bicarbonate of magnesia, which dissolves in the water, and then decomposes the chloride of sodium, chloride of magnesium, which remains in solution, and bicarbonate of soda, which precipitates, being formed. The whole process lasts but a quarter of an hour at most, and the cost is only that of the coal used in forming the carbonic acid. A moderate heat drives off the second atom of carbonic acid from the bicarbonate of soda, changing it into carbonate ; and the magnesia may be recovered from the chloride by evaporating the solution containing it to dryness, and raising the residue to a temperature below redness.

Concretions in Pears.—Those peculiar granular concretions of pears, with which almost every one is familiar, have been examined by Herr Erdmann, who has discovered a new principle in them, to which he gives the name of Glycodrupose. When this substance is touched with an acid, it splits up into glucose and a new substance *drupose*, which is insoluble, and whose formula is $C_{24} H_{20} O_{16}$. Herr Erdmann was led to the discovery by an analysis of the concretions discharged from the intestines of a patient, who had eaten largely of the pears.—*Annalen du Chemie*, cxxviii.

The Essential Principle of Aniseed.—It has been pointed out by MM. Landenberg and Leverkus, in a recent memoir, that aniseed contains a peculiar essential principle, which they call anethol. It is a crystalline body, distilling without decomposition at 234°. It appears to be the methylic ether of Allylphenol.—*Comptes Rendus*, July 16th.

Reactions of Quinine and Quinidine.—An important and useful distinction between the natures of these two substances has been pointed out by Herr Schwartzer. It relates to the behaviour of chlorine water, ferrocyanide of potassium and ammonia, toward sulphate of quinine and sulphate of quinidine. With both these salts, a red colouration is produced, but in the case of quinine, the colour rapidily disappears, whilst in that of the quinidine a bulky and persistent precipitate is obtained.

Combination of Ferro-cyanide of Potassum with Nitrates of Potassium and Sodium.—Herr Dr. Martins has found this curious compound in the mother liquor of the prussiate of potash when saltpetre has been used in preparation. It is of a pale yellow colour, and forms very beautiful crystals which become phosphorescent in a high degree when rubbed together in the dark. In the laboratory it may be prepared, by adding solution of the prussiate to boiling solutions of the nitrates of potassium and sodium. The saltpetre is first allowed to crystallize out, and then the crystals of the new compound are poured from the mother liquor by slow evaporation. At a high temperature the crystals explode like gunpowder.—*Journal für praktische Chemie.*

The Chemical Constitution of Albuminoid Bodies.—A very interesting essay on the above has been published by M. A. Commaile, who records some novel facts. The analysis of gluten showed this substance to consist of five others : (1) *Inesine*, the fibrin of gluten ; (2) *Sitesine*, the casein of gluten ; (3) *Glutine ;* (4) *Mucin ;* (5) *Sitosine*, the albumen of gluten. Coagulated and fresh albumen differ in chemical as well as physical properties ; they have different solubilities in acid, and the latter holds in suspension a peculiar principle which is eliminated by heat. M. Commaile put a recently-struck coin in fresh albumen, and having coagulated the latter by heat, he removed the coin, which he found absolutely corroded and blackened. Uncoagulated albumen has no action on silver ; nor has the yolk of egg any such action either in the raw or coagulated condition.—Vide *Journal de Pharmacie*, August, 1866.

Action of Neutral Tersulphate of Alumina on Water.—Mr. Bird, of Birmingham, who has just read a paper on the above subject before the British Association, has sent us a specimen of the fluid he employs in purifying water. We must question the accuracy of Mr. Bird's assertion, that the tersulphate removes all the organic matter from water. When it is added to water which contains much organic colouring matter, it throws down this latter ; but we doubt that its purifying action extends beyond this.

A Peculiar Ironstone, which was found about eight miles from Neuban, was described by Dr. Phipson at the last meeting of the British Association. The specimen was that of a fine red quartz rock, penetrated by a brilliant steel-looking ironstone, appearing more like the metal itself than an ore. Analysis showed it to contain 57 per cent. of per-oxide of iron ; 23 per cent. of magnetic oxide ; 19 of quartz ; and traces of manganese. It yielded iron of an excellent quality, but difficult to smelt. From the nature of the hæmatites in this district, Dr. Phipson draws the conclusion that they have been formed under geological circumstances, different from those attendant on the formation of our English hæmatites.

GEOLOGY AND PALÆONTOLOGY.

A Peculiar Conglomerate.—Mr. John Kelly, of the Irish Geological Society, has addressed a letter to the editor of the *Geological Magazine*, describing a peculiar conglomerate bed which is on the shore at Cushenden, in the county of Antrim. The mass is about fifty feet above the sea, and some thirty yards long and wide. It is composed of round pebbles of quartz rock, from two to four inches in diameter ; and they occur so closely packed, that every one is in contact with another, and no room left, except for the sand which cements them, and which fills the openings between the pebbles, when originally heaped together. These pebbles, as just stated, are of quartz rock, and therefore all of one kind. There is no actual rock of the same kind, on the shore, nearer than—(1) Malin Head, or Culdaff, in Donegal ; (2) Belderg, east of Belmullet in Mayo, where it occupies the shore for fourteen miles ; and (3) in the twelve bins, near Clifden, in Connemara, where it forms bands interstratified with Mica Slate. This mass is backed by a hill of brown Devonian grits and shales interstratified, which extends from Cushendun to Cushindall. In both those rocks are a few round pebbles of quartz rock, similar to those in the mass on the shore, but in the rocks of the hill they are thinly disseminated, perhaps six or ten of them to a cubic yard. Mr. Kelly desires to know how the quartz pebbles came together unmixed with any other species of rock. The answer which the editor of the *Geological Magazine* gives, in a footnote, seems very like the correct one. It is to the effect that in the grinding of the several elements which were being rubbed together to form the conglomerate, the softer ones became reduced to powder.

The Metamorphic and Fossiliferous Rocks of Galway.—These, which have been thoroughly described by Professor Harkness, of Queen's College, Cork, in a paper lately read before the Geological Society, appear to consist in great part of a contorted gneissose rock, striking east and west, with a prevailing southerly dip toward the granitic area of Galway Bay. Quartzose rocks, exhibiting great folds, give rise to the bold mountainous scenery of

Connemara; and reposing on these, and passing underneath the gneissic strata, is a band of serpentinous limestone, the structure of which is not of animal origin, but results solely from mineral association. The gneissose rocks on the north are covered unconformably by sandstones, the fossils of which indicate the horizon of the Upper Llandovery rocks. These metamorphic rocks correspond with those of the Highlands of Scotland, representing the Upper Quartz rocks, upper Limestone, and Upper Gneiss, the positions of which are known in consequence of the Lower Limestones at Durness having been determined to be not lower than the Llandeilo Flags.

The Bohemian Gneiss and the Eozoon.—A very important memoir by Professor Hochstetter has been read before the Vienna Academy of Sciences. The Professor gives in the first instance a sketch of the discoveries in Ireland and in Canada, and then proceeds to discuss the relations of the Bohemian gneiss. This he describes as consisting of two great series of gneissose and granitic rocks, great enfoldings of which form the mountain-range of the Böhmerwald. The lower (1) is Gümbel's "Gojic Gneiss," and the upper series (2) is his "Hercynian Gneiss;" this latter contains (like the Laurentian Gneiss of Canada) beds of graphite and of serpentinous marble. Pebbles of quartz in it, and its bituminous odour when struck with a hammer, had already satisfied Dr. Hochstetter of the sedimentary character of the marble; and he sent some of the green variety (from Krummau) to Dr. Carpenter, who determined the presence of *Eozoön* in it. The upper gneiss is succeeded unconformably by (3) mica-schist, here referred to the Upper Laurentian; this by (4) clay-slates; and (5) the "Przibram schists" (with Annelid-marks,—*Fritsch*), which are tabulated together as equal to the Lower Cambrian or Longmynd rocks of Britain, and the Huronian of Canada. In the diagram, however, No. 4 is conformable to No. 3; but there is a violent unconformity between No. 4 and No. 5. The Przibram grauwacke follows next, and, with the "Ginetz beds" (or "Primordial beds" of Barrande), is grouped as the Upper Cambrian of Britain, and the Taconic beds, or Potsdam sandstone, of North America.

Historical Researches on the Stone Age.—This is a subject which has recently engaged the attention of M. Chevreul, who has been delivering some essays upon it before the French Academy. The French chemist has brought the light of Chinese literature to bear upon the problems of the "Stone Age," and has discovered in certain writings of the date of 1122 B.C. distinct allusions to the use of arrows pointed with stone. Having communicated the fact of this discovery to M. Stanislaus Jullien, that gentleman stated that in recently digging in the ruins of an ancient Chinese fortress stone-headed arrows were found in abundance.

The Geology of Mount Sinai.—A highly interesting paper upon the geology of this mountain was read before the Geological Society at one of its late meetings, by the Rev. W. Holland. Mr. Holland describes the physical features of the peninsula as being in the north an extensive plateau of cretaceous limestone, bounded on the south and underrun by a mountain-range compound of schists, porphyries, and syenite. Near Jebal Serbal is a mountain of Nummulitic limestone; and a limestone apparently of more recent date occurs near Tor and Ras Mohammed. The author further stated that in some parts of the peninsula the syenite mountains are capped by a considerable thickness of horizontal beds of sandstone, which are unaltered at their contact with the syenite. This sandstone formed the great mining district of the Egyptians in Sinai, and is now worked for *turquoises*, which appear to occur more or less in veins. Raised beaches were discovered by the author on the western side of the peninsula, at elevations of from twenty to thirty feet.

The Belgian Bone Caves. — Quite recently a paper was presented on these caverns to the Cotteswold Naturalists' Field Club. It was, we believe, the product of the joint labours of the Rev. W. S. Symonds and Sir W. V. Guise, and treated of the Caves of Furfooz, near Dinant. The authors expressed the opinion that the geological period of the entombment of the human jaw, with the remains of the extinct animals with which it was associated, may be assigned to the epoch known to geologists as the *low level drift period* of Prestwich, a period recent in a geological sense, but enormously remote when measured by *time*, for the cold of the Glacial epoch was not altogether passed, and the extinct mammalia were still in existence. It was the period of the deposition of the old river drifts of Menchecourt, near Abbeville, which contain their human flint implements, interbedded with the bones of the mammoth and rhinoceros; the period of the deposition of the ancient river beds near Salisbury, and other parts of England, which teach the same history, and also, they believe, of the English bone caverns. It happens, however, that a good deal of the materials of Mr. Symonds' paper were obtained from M. Dupont, who is employed by the Belgian Government to investigate the caverns, and who was visited by Mr. Symonds during his tour. This, at least, is the assertion of a contemporary, and, if it be true, Mr. Symonds is much to blame. However, we have no doubt that something is to be said on the other side, and we trust that in our next issue we shall be able to offer some contradiction to the following assertions made in a letter addressed to the *Reader*, of September 8th, and referring to Mr. Symonds' paper on the Belgian Caves: — "Taking, as I do, some interest in these caves, I cannot reprobate too strongly this disingenuous and underhand publication. All those who have visited the Belgian caves near Dinant know that M. Edouard Dupont is employed by the Belgian Government to make the scientific investigations into these caves. M. Dupont will, in time, publish his own report; and it is a breach of good faith for any person who may have visited Dinant, and inspected M. Dupont's collection, or who may have enjoyed that generous man's hospitality, to publish without the knowledge of the original discoverer a garbled and untrue version of the facts."

Geological Gold Periods. — The various periods of the world's geological history at which gold has made its appearance on the earth's crust is a subject of the highest interest and importance, and has been ably dealt with in a paper by Mr. David Forbes, and which has been just published. He divides the Gold-epochs into two, thus:—(1) The older or auriferous granite outburst; (2) The younger or auriferous diorite outburst. The first occurred some time between the Silurian and Carboniferous periods. The gold formations belonging to this period present themselves in Australia, Bohemia, Bolivia, Brazil, Buenos Ayres, Chile, Cornwall, Ecuador, Hungary, Mexico, New Granada, Norway, Peru, Sweden, Ural, Wicklow; and also such deposits of gold as are found intruded as quartz nodules and veins, as if interstratified in the Cambrian and Silurian systems, which he believes to have been rendered auriferous solely from their proximity to invisible or now superficial granites. The newer outburst cut through strata containing fossils of decided Post-oolitic forms, and possibly may be as late as early Cretaceous.

The Dolichosaurus.—This name has been applied by Mr. H. G. Seeley to a peculiar, lizard-like serpent of the Chalk formation. Mr. Seeley's description of the creature indicates for it a position between the serpent and the lizard.

Drift Deposit on the Weaver Hills.—Mr. E. Brown's paper on the above, which was read before the British Association at Nottingham, records some useful observations. It dealt with the remarkable deposit of sand and clay in the south and south-west flanks of Weaver and of Caldon low, and which seems to be of considerable antiquity. It has been preserved at an elevation of between 1,000 feet and 1,100 feet from subsequent entire denudation by a ridge of York-dale rocks that stretches to a considerable height to the south-west of the above-mentioned hills. The deposit consists of pure white siliceous sands, of white plastic clay, and of other materials derived apparently from the degradation of the Millstone Grit, the Bunter, and other rocks of the district. The clay and sands consist almost entirely of silica and alumina, and they are extensively used for the making of fire-bricks, and for the building and lining of smelting-furnaces, and for other purposes when a capacity for resisting high temperature is required. This bed is overlaid by the boulder clay deposit of the district, and the author hazarded the suggestion that it may have been contemporary in its origin with certain of the later tertiaries, as, for instance, the Norwich Crag.

The Metamorphic and Lower Silurian Rocks of Ayrshire.—Mr. J. Geikie has published a memoir on the above rocks situate at Carrick, in South Ayrshire. He divides the metamorphic rocks into four series :—(1) Feldspathic rocks ; (2) diorites ; (3) serpentine ; and (4) altered limestone and calcacareous grauwacke. Further, he sub-divides the feldspathic rocks into (*a*) amygdaloid ; (*b*) porphyry ; (*c*) brecciæform ; and (*d*) finely crystalline felstones. He divides the serpentine rocks into schistose and compact. After giving numerous details, he arrives at the following conclusions :—(1) That the strata owe their metamorphism to hydrothermal action. (2) That the varying mineralogical character of the rocks is due principally to original differences of chemical composition, and not to infiltration of foreign matter at the time of metamorphism. (3) That the highly alkaline portions of the strata have been most susceptible to change. (4) That in beds having the same composition, but exhibiting various degrees of alteration, the intensity of the metamorphism has been in direct proportion to the amount of water present in the strata. (5) That in some places the rocks have been reduced to a pasty condition.

How many Crags are there?—In answer to this question, Mr. J. E. Taylor says four :—The coralline, red, Norwich, and upper. Published tables show that as regards the percentage of recent and extinct shells, and also the number of species, there is a greater difference between the red and Norwich crags than between the red and the upper. The difference between the two latter was hardly in the proportion of 3 to 2, whilst that of the two former was more than 3 to 1. Still there has for some time been a growing conviction of the closer relationship of the red and Norwich than of the red and coralline crags.

Mr. Taylor has given the following explanation of this apparent anomaly:—"In various parts of Norfolk, as at Coltishall, &c., there lies at some height above the true Norwich crag, another bed of shells, varying in height from three feet to fifteen. These two beds are widely different in their organic remains, the upper bed being peculiar from the total absence of fresh and brackish water shells, those it has being marine ; secondly, the shells of the upper bed indicate that it had been formed in deeper water ; and thirdly, the shells are also of a more Arctic character." The Norwich crag is everywhere distinguished by its littoral character, as also by the frequent occurrence of fresh and brackish water shells, constituting it a fluvio-marine deposit. Hitherto it has been the custom for geologists to class both these beds as belonging to the Norwich crag series ; hence the apparent difference between the latter and the crag. If the Norwich crag were confined solely to the beds always found resting on the chalk, it would approximate more nearly to the red crag ; but by taking the mean of the upper and lower beds, and summing up the total as belonging to the Norwich crag, they departed from the true character of each, as well as from their relations to the red and coralline crags. In his further observations, Mr. Taylor combats Mr. Searles Wood's idea that the true Norwich crag is the representative of the red, by showing the difference in the shell deposits of the two. Mr. Taylor concludes, as we have already stated, that there are four crags. *Vide* paper read before the British Association at the Nottingham meeting.

MECHANICAL SCIENCE.

The most interesting contributions to scientific engineering during the past quarter are to be found in the papers read before the Mechanical Section of the British Association at Nottingham. Of these we may briefly enumerate the following :—

Resistance of Water to Floating and Immersed Bodies.—Professor Rankine read the Report of the Committee appointed to make experiments on this subject, giving the results of 220 experiments, with two models, four feet in length. The Committee have deferred for the present deducing any general laws of resistance ; but Professor Rankine stated that the results of the experiments led to the following general conclusions. 1st. That agreeably to what was previously known of the behaviour of small bodies at low speeds, the resistance increased on the whole somewhat more slowly than as the square of the velocity. 2nd. That when the velocity went beyond the maximum velocity suited to the length of the model, as ascertained by Mr. Scott Russell's well-known rules, the resistance showed a tendency to increase at a more rapid rate. 3rd. In all cases the resistance seemed to be much more nearly proportionate to the mean girth than to the midship section. 4th. The resistance of model A when totally immersed to its own depth was almost exactly double of its resistance at the same speed when half immersed. 5th. The resistance of model B when immersed to about three and a half times its own depth, was sensibly more than double its resistance when half immersed.

In the discussion which followed the reading of this report, Mr. Bailey and Admiral Belcher having spoken with disapproval of hollow lines or wave-lines at the bows of sea-going vessels, Professor Rankine pointed out, that the wave-line theory consisted of two branches, one relating to the form of the bows, the other to the relation between the length of the vessel and the speed at which she was to be propelled through the water. He did not attach much weight to the hollow bow, but thought that much was to be said in favour of the theory that the length should have a certain relation to the speed.

Friction of Steam in Cylinders.—Professor Rankine communicated a paper, in which he pointed out that the loss of power caused by the friction of steam is compensated by the heat generated by the friction, the work done and the heat expended being both diminished by the same quantity ; the heat generated tending to prevent liquefaction in the cylinder.

Penetration of Projectiles.—Captain W. H. Noble, R.A., read a voluminous paper on the penetration of projectiles, containing the results of a series of experiments lately carried out by him, under the direction of the Ordnance Select Committee. The conclusions arrived at may be summed up as follows :—1st. Where it is required to perforate armour-plate the shot should be of steel or chilled iron, the latter being nearly as effective as the former in the case of solid shot. 2nd. The form of head best suited to the perforation of plates is the pointed ogival. 3rd. To attack ironclads effectively the guns should be at least twelve tons weight and nine inches calibre, firing an elongated projectile of 250 lb. with about 40 lb. of powder. 4th. When the shot is of hard material the power of perforation is directly proportional to its *vis viva*, and universally proportional to its diameter. 5th. The resistance of wrought-iron plates to perforation by steel projectiles varies as the square of their thickness. 6th. Striking a plate obliquely diminished the power of penetration in the proportion of the size of the angle of incidence. 7th. The resistance of wrought-iron plates is very little, if at all, increased by a backing of wood, but is much increased by a rigid backing of iron and wood combined, or other suitable material. 8th. Iron-built ships with wood backing offer more resistance than iron-clad wooden ships. 9th. The best form of backing seems to be that in which the wood is combined with horizontal plates of iron.

The formula arrived at by Captain Noble is similar in form to that published by Dr. Fairbairn, and is essentially different from one recently proposed on theoretical grounds by Dr. Rankine.

Tunnel under the English Channel.—Mr. Hawkshaw is engaged in making trial borings with a view to develope a project for a railway tunnel under the Channel between Dover and Calais, and communicating on the English side with the Chatham and Dover Railway, and on the French side with the Northern of France Railway. He proposes to carry on the excavations for the tunnel from both ends, and also from shafts in the Channel, at the top of which powerful engines will be erected for pumping and winding up the excavated material, and for supplying motive power to the machinery by which the excavation is effected.—" Y." *in the Times.*

On the other hand, Mr. George Remington is of opinion that a tunnel on the site proposed by Mr. Hawkshaw is impracticable on account of the difficulty he anticipates in keeping down the water in a chalk excavation of that magnitude. He therefore proposes another line for the tunnel between Dungeness and Cape Grisnez, which, entirely avoiding the chalk, passes through the Wealden formation, consisting chiefly of strong clay. The tunnel would be twenty-six miles in length from shore to shore. On this route in mid-channel there is an extensive shoal with only eleven feet of water upon it at low-water spring tides, where Mr. Remington proposes to construct a shaft protected by a breakwater.

MEDICAL SCIENCE.

Muscular Force the Consequence of Combustion.—It has been hitherto supposed that muscular energy was the result of certain changes in the nitrogenous or albuminous constituents of food and of the tissue; but recent researches show that this view is no longer tenable, and that the only intelligible hypothesis is that the combustion of the hydrocarbons is the source of all the mechanical power which animals display. Of the recent investigations upon this point, a very capital summary was given by Mr. Grove, in his late address to the British Association. Trauee, says Mr. Grove, has been prominent in advancing this view, and experiments detailed in a paper published this year by two Swiss Professors, Drs. Fich and Wislicenus, which were made by and upon themselves, in an ascent of the Faulhorn, have gone far to confirm it. Having fed themselves before and during the ascent upon starch fat and sugar, and avoiding all nitrogenous compounds, they found that such food was amply sufficient to supply the force required for the journey, and that they felt no exhaustion. By appropriate chemical examination they ascertained that there was no notable increase in the oxidation of the nitrogenized constituents of the body. After calculating the mechanical equivalents of the combustion effected, they then state as their first conclusion, that "the burning of protein substances cannot be the only source of muscular power, for we have heard of two cases in which men performed more measurable work than the equivalent of the amount of heat which, taken at an absurdly high figure, could be calculated to result from the burning of the albumen."

Poisonous Effects of Bisulphide of Carbon.—The toxicological consequences of the administration of the vapour of sulphide of carbon to animals, have been very fully demonstrated by M. Cloëz. When air, containing $\frac{1}{20}$ of its volume of the vapour, is allowed to act upon the system, it produces serious effects, which, if not counteracted, end in death. M. Cloëz has performed numerous experiments on mammals, birds, and reptiles. Those on rats are most instructive. A rat of large size was placed under a bell-glass, of a capacity of 17 litres, and a piece of cotton wool saturated with sulphide of carbon was placed beside him. For a few moments the animal remained perfectly quiet, seeming to take in long breaths; in about half a minute he began to rush wildly about, as if trying to avoid the vapour; soon, however, he became calmer, he had a few convulsive fits, and then he fell upon his side, still breathing. However, in a very short time respiration ceased, and the rat died in four minutes from the commencement of the experiment. On making a *post-mortem* examination, M. Cloëz found that the whole tissue of the lung was congested, the brain presented no distinct lesion, the cavities of the heart were filled with a blackish blood, the right auricle continuing to contract for more than two hours after the death of the animal. The blood globules, as seen under the microscope, were not altered in form or general appearance.

Action of Different Coloured Lights on the Retina.—It is known to physiologists that when a ray of light falls upon the retina, the impression it produces remains for a definite period, according to calculation about the *third of a second.* It is this fact which is used to explain why a burning brand, when twirled rapidly round, gives the appearance of a ring of light. But till quite recently it had not been shown whether the different colours of light had the same degree of persistence upon the retina. The subject has quite lately been taken up by the Abbé Laborde, who shows that, just as the prism separates the colours at different angles, so the retina absorbs the colours, or the impressions produced thereby, in different times. In conducting his experiment to prove this, the Abbé receives the sunlight through an aperture in a shutter into a darkened chamber. The aperture is about three millimetres wide by six high. In the course of the beam and in the middle of the chamber there is placed a disk of metal, the circumference of which is pierced by apertures corresponding to the aperture in the shutter. This disk is caused to revolve by clock-work. Behind the disk is placed a plate of ground glass to receive the spot of light. The disk being then caused to revolve rapidly, the spot appears at first white, but as the revolutions become more rapid the borders of the spot and the colours which successively appear are in their order of succession as follow: blue, green, red, white, green, blue.—*Vide Comptes Rendus.*

Contractile Corpuscles of the Colostrum.—According to the inquiries of Herr Stricker colostrum contains two varieties of corpuscles, which are interesting objects when viewed under the microscope. The corpuscles at first change form and then allow fatty globules to escape, and hence the author concludes that the envelopes of the cells must be made of some very plastic substance, since they show no indication of rupture. Contractile corpuscles have been seen by Herr Stricker in colostrum; these resemble the same bodies in pus and blood, and are capable of peculiar amœba-like movements, and throw out prolongations of a sarcode-like material. To witness the appearances which Herr Stricker describes it is necessary to keep the colostrum at a temperature of forty degrees centigrade.

The Contractions of the Heart.—Dr. Paton, of Toronto, gives a paper detailing many experiments and observations upon the movements of the heart. The essay is published in full in the Dublin *Quarterly Journal of Medical Science*, but the more important conclusions are as follows:—1. The dilatation of the ventricles is synchronous with the contraction of the auricles.

2. No pause or interval of repose occurs during the dilatation of the ventricles. 3. The diastole of the ventricles precedes the systole. 4. The diastole is produced with a power and vigour which lead to the supposition that it is a vital active movement, and not simply resulting from the mechanical action of the entering stream of blood. Dr. Paton's experiments were conducted chiefly upon fishes and reptiles.

The Pacchionian Bodies.—These peculiar growths, which are met with in the membranes of the brain, and are supposed to be connected with certain diseased conditions of the nervous system, have been very carefully investigated by Dr. Charlton Bastian, of St. Mary's Hospital, who concludes from numerous observations that they have no serious pathological importance. They are, he says, perfectly continuous with the arachnoid and have much the same structure as this membrane of connective tissue. Their epithelium is sometimes arranged in multiple layers. They are developed from a structureless hyaline substance, which grows in the form of a branched net-work.—*Vide Microscopical Journal*, July.

The State of the Blood-corpuscles during Inanition.—M. Panum's inquiries on this point are of much interest, and seem to have been very carefully worked out. M. Panum concludes as follows :—"(1) The proportion of colouring-matter in the red globules does not vary materially during inanition. (2) The relation of the quantity of blood to the weight of the body, as well as the relation of quantity of the principal constituents of the blood, does not vary. (3) The absolute quantity of the blood diminishes, but not in a greater ratio than the total mass of the tissues. (4) The relative proportions of the several constituents of the blood do not vary. (5) The blood must be regarded not as a material of nutrition, but as the medium through which such material is transmitted. (6) The fibrin and globules are not nutritive matters ; but the albumen is, and it is this element of the blood which suffers a slight diminution in quantity during inanition."—Vide *Gazette Medical*, July.

Termination of the Nerves in the Muscles.—The views of Professor Lionel Beale have met with a very determined opponent in a French microscopist, M. Rouget, who has laid a memoir, accompanied by numerous microphotographs, before the French Academy. This observer states that the nerves do not end in a fine net-work of delicate fibres, but in a peculiar terminal plate or disk connected with the sarcolemma. He uses the argument of authority against Dr. Beale, and says that "all other observers who have devoted themselves to this subject, viz., MM. Krause, Kühne, Waldeyer, Engelmann, and Letzerich, and more recently MM. Kohnheim and Vulpian, have all admitted the existence of the terminal plate, and its entire independence of any nervous net-work." M. Rouget's observations and microscopic photographs lead him to conclude, (1) That [the terminal division of the axis cylinder of the motor nerve-fibre constitutes, by anastomosis and fusion, a terminal expansion of finely-granular substance, identical with that of the terminal filaments of the corpuscles of Pacini, and in immediate contact with the contractile substance of the primitive bundle. (2) That this nervous expansion is traversed in every direction by minute canals, establishing a connection between the numerous nuclei of the plate, and communicating probably, on the one hand with the space between the sarcolemma and the contractile fibrillæ, and on the other hand with the interstice between the matrix of the nervous tube and the medullary layer.—Vide *Comptes Rendus*, June 25.

An Artificial Eye for Restoring Sight.—An apparatus of this kind, whose efficiency we much doubt, has been described by M. Blanchet, in a paper in which he details the operation for its insertion under the title of Helioprothesis. The operation consists in puncturing the eye in the direction of the antero-posterior axis with a narrow bistoury, and introducing a piece of apparatus to which M. Blanchet gives the name of "*phosphore*." The operation in most instances produces little pain, and when the globe of the eye has undergone degeneration there is no pain at all, and the "phosphore" apparatus is introduced without difficulty. The description of this contrivance is this: "It consists of a shell of enamel, and of a tube closed at both its ends by glasses, whose form varies according to circumstances." M. Blanchet thus describes the operation: "The patient's head being supported by an assistant, the upper eyelid is raised by an elevator, and the lower one is depressed. The operator then punctures the eye with a narrow bistoury, adapting the width of his incision to the diameter of the 'phosphore' tube which he intends to insert. The translucent humour having escaped, the 'phosphore' apparatus is applied, and almost immediately, or after a short time, the patient is partially restored to sight!" Before introducing the apparatus it is necessary to calculate the antero-posterior diameter of the eye, and if the lens has cataract it must be removed. Inasmuch as the range of vision depends on the quantity of the humour left behind, M. Blanchet recommends the employment of spectacles of various kinds.

Cure of Diabetes by the Employment of Citrate of Soda.—The theory that diabetes results from the imperfect combustion of glucose has found a warm advocate in M. Guyot Danecy. This physician, therefore, proposes to employ citrate of soda in order to supply, by decomposition, the alkaline carbonate which is requisite for the combustion of the glucose. His reason for employing the citrate instead of using the carbonate in the first instance is that it tends less to upset the digestive functions. He recommends medical men to employ the citrate in doses of from four to eight grammes. His analyses of the urine of patients who were under this treatment demonstrate that under the influence of the citrate the secretion of sugar is arrested. He states that the salt may be administered mixed with bread.

Explanation of the Origin of so-called Spontaneous Cow-pox.—M. A. Chauveau has given what appears to us satisfactory proof that there is no such condition as spontaneous cow-pox, and that the train of symptoms to which this term has been given, results from the ordinary virus which has been introduced through an unusual channel. M. Chauveau supposes the powder of the vaccine scab to be suspended in the air, and in this way to be introduced into the lungs of cattle. To try this experimentally, he injected the matter directly into the vessels of eight horses: in four animals it was introduced into the blood-vessels, and in four into a lymphatic vessel. The following were the results:—In the first series there was no perceptible consequence. In the second, all but one showed, on the seventh to the twelfth day, a fine eruption, having all the characters of what is called "spontaneous horse-pox." This, says the writer, proves manifestly that one can produce what is called spontaneous cow- or horse-pox at will, simply by introducing the virus into the lymphatics instead of into the blood-vessels.

Absorptive Power of the Skin.—In the earlier numbers of this journal, numerous abstracts will be found of papers on this subject, but now we have to hand the statements which have recently been formulated by M. Scoutetten. These are :—(1) The rapidity of absorption depends on the tenuity of the moelcules of the substance applied and its facility of mixing with the fatty secretion of the skin. (2) Gases traverse the pores of the skin with great rapidity. (3) Liquids which pass easily into the gaseous state are quickly absorbed. Such liquids are :—ether, chloroform, essential oils, benzoin, and turpentine. (4) Solid bodies susceptible of volatilization also penetrate the skin rapidly: such are—camphor, musk, castoreum, &c.: cantharides is absorbed because of its essential oil—cantharadine, which may be volatilized. (5) The solid bodies, non-volatile, require to be mixed with fatty or oily substances, and to be applied with friction. They thus unite with the natural fatty matter of the sebaceous glands, and become absorbed.—*Vide The Lancet, Record of Medical Science,* July 7th.

METALLURGY, MINERALOGY, AND MINING.

The Origin of Diamonds.—A curious, and it seems to us very improbable, theory of the origin of diamonds was put forward by M. Chancourtois in an essay published in the *Comptes Rendus* for June 25th. The author tries to show in this that diamonds have been produced by an incomplete oxidation of the carbides of hydrogen, in pretty much the same fashion as the sulphur of the *Solfatara,* described by Professor Ansted in one of our late numbers, results from an incomplete oxidation of sulphuretted hydrogen, all of whose hydrogen is converted into water, while only a part of the sulphur is changed into sulphurous acid. It is by a similar process that petroleum has given rise to bitumen, and this again to graphite. "If, then," says the author, "a mixture of hydrocarbon gases and vapour of water be submitted to slow oxidation, diamonds may possibly be obtained." It is even possible, he observes, that the tubes which convey common coal gas along the streets of Paris may contain such artificial diamonds in abundance.

A curious Lode in a Cornish Mine.—It appears from a paper read by Mr. C. Le Neve Foster, at the British Association meeting, that the lode described by him is to be seen in New Rose Warne Mine at Gwinear. The lode is remarkable from the circumstance that it contains a large quantity of rounded pebbles. From an examination of the vein, Mr. Foster concludes that there were six distinct periods occupied in its formation. The several deposits show a gradual change from pure subsulphate of copper to copper pyrites; in fact, it would seem that at one time the mine consisted entirely of copper pyrites, and that the sesquisulphide of iron was being gradually removed. In connexion with this, Mr. Foster remarked that in some of the fragments of elvan in the mines the crystals of felspar have been gradually removed, and replaced by chlorite; in fact, "they had pseudomorphs in process of formation." Among other curious phenomena in this mine, were the so-called *caps*; some of the chlorite having formed over the crystals of quartz, over the first other secondary layers were formed, and these easily separated from each other, thus giving rise to the term "caps." Mr. Foster's observations of some of the fissures in the mine lead him to conclude that the various deposits had been introduced at different periods.

Black Spinelle.—This mineral forms the subject of a memoir by M. Pisani. It forms one of the constituents of the cherzolite of Auvergne, and presents itself generally in the form of simple octohedra, being occasionally, however, of a pyramidal shape. It is infusible, of great hardness, and takes an excellent polish, and is not affected by acid reagents.—*Comptes Rendus*, July 9th.

Iron Founding.—The value of the iron made in 1860 in the United States was 28½ million dollars, being 8½ millions in excess of the returns for the year 1850.

Hexagonal Blende.—Two papers describing this substance, and especially its phosphorescent properties, were presented to the French Academy by M. E. Becquerel and M. Sidot. The mode of preparation adopted by the latter being to volatilize the natural blende, or artificially prepared amorphous sulphide, in a current of pure and dry sulphurous acid. The sulphide is placed in a porcelain tube, and is strongly heated for four or five hours, after which crystals will be found at the cold end of the tube. M. Becquerel has examined the properties of the crystals so produced, and has found them phosphorescent in the highest degree after insulation. He remarks that the outer crystals in the mass he examined were white, while the inner ones had a yellow tint resembling that of uranium compounds, and this yellow tint, he thinks, is due to a molecular arrangement, which is the cause of phosphorescence. Yellow crystals are generally phosphorescent. M. Becquerel examined the light by the aid of the phosphoroscope, and found that the white crystals, with a moderate velocity of the instrument, showed a beautiful blue light; the yellow crystals showed a greenish-yellow with the lowest velocity, which passed to a blue as the velocity increased, but a blue less deep than that furnished by the white crystals, thus indicating a mixture of the green with the blue light of shorter duration. The coloured crystals thus afford rays of different refrangibility and of unequal duration, like diamonds, silicate of lime, and other bodies. It is observed, however, that the bodies showing blue light are very few in number. M. Becquerel has also studied the effects of the different rays of the spectrum upon hexagonal blende, and has found that the maximum of action is between the lines G and H, rather nearer G than H.—Vide *Comptes Rendus*, July 23rd; and *Chemical News*, August.

Old Roman Mines in Spain.—In the mines of San Domingo, in Spain, some discoveries of Roman mining implements and galleries have been made, which show us the colossal character of the labours undertaken by that ancient nation. In some instances, draining galleries nearly three miles in length were discovered, and in others, the remains of wheels used to raise water were found in abundance. The wood, owing it is thought to penetration by copper, is in a perfect state of preservation, and there appears to be evidence that the wheels were worked by a number of men stepping on the flanges somewhat after the manner of prisoners on a tread-mill. There were eight of these water-wheels, the water being raised by the first into the first basin, by the second into the second basin, and so on, till it was conveyed out of the mine. The age of these relics has been set down at 1,500 years.

An Improved Mode of Manufacturing Steel Tyres.—Some useful improvements have been suggested in a paper read by Mr. John Ramsbottom, at a meeting of the *Institution of Mechanical Engineers*, on the 31st of July. Mr. Ramsbottom, who is the Superintendent of the Engineering Works of the London and North-Western Railway Co. at Crewe, stated that his object was the reduction to an insignificant amount of the waste of material in the processes of manufacture, compared with the weight of the ingot of steel employed, and also to ensure the production of finished tyres of the required dimensions. A third advantage sought, was the reduction of the time hitherto necessary in the operation. The ingots were made for Bessemer steel, cast in conical moulds, 22in. diameter at the base, and 22in. high, the apex of the cone being cut off at 6in. diameter, and thus forming the opening for filling the mould. This was sufficient to make a 5ft. tyre. The moulds are of cast-iron, protected in various ways, the centre of the base being covered with fire-clay, which can be readily renewed. The ingot is then first hammered laterally, all round the lower edge of the cone, to consolidate the skin of the metal, after which it is forcibly hammered in the direction of its axis, and reduced to 9in. in height, with a 10-tons duplex hammer—or two hammers, each of this weight, meeting horizontally. The ingot, during this powerful treatment, is supported upon a carriage, and can be readily made to rotate, as required. At a further stage, a hole is punched in the centre, to form it into a ring, this centre opening being gradually enlarged, by a conical punch and the aid of a beck-anvil. When the bloom is brought to 34in. diameter, and the centre hole to 19in. diameter, it is then removed to a circular rolling-mill, which was invented by Mr. Rothwell Jackson, a member of the institute, where it is rolled into a finished tyre, both outside and inside ; the latter operation is completed in one heat, of about $5\frac{1}{4}$ minutes. The whole process from the cast ingot is accomplished in four heats, and it was stated that on one occasion six tyres were made in 5 hours and 12 minutes. The quality of the steel is believed to be improved in the operation.

MICROSCOPY.

A Mechanical Finger for delicate microscopic manipulation has been devised by Mr. Smith, of Kenyon College, U.S., the inventor of the apparatus for illuminating opaque objects under the highest powers. We cannot here describe Mr. Smith's contrivance, for its mechanism is complex, and the description in the inventor's paper occupies a couple of pages. The reader is referred for details to *Silliman's Journal*, No. 123. Mr. Smith says the mechanical finger can be moved about with the utmost precision over every part of the stage, and can be employed to shift the position of such delicate structures as diatomaceæ.

The Exhibition of Microscopic Objects to Classes is attended with difficulties, since each object has to be placed separately on the stage. To obviate this, Dr. J. Barker, of the College of Surgeons, Dublin, suggests a plan for placing a number of slides so that they may without difficulty be brought successively beneath the microscope. This contrivance consists of a large disk of wood with a number of round openings near the circumference, of about an inch in diameter, over each of which a slide is placed and retained in its position with the object over the aperture, by an elastic ribbon passed through some round holes in the disk. The disk itself is fastened to the stage by a piece of propelling brass work, made to fit and hold in the central opening of the stage, and projecting out beyond the stage in front, and bearing the pivot or axis adapted to the centre of the disk, and on which it revolves. Dr. Barker thinks the apparatus of great advantage for class demonstration, but we have very serious doubts as to the benefits attending its employment.

Section of Hard Structures.—Dr. Halifax gives the following account of the method followed by him in the preparation of the sections of hard parts of insects, etc. He thinks that glass is the best surface on which to cut the parts ; it seems to do less injury to the razor's edge than other substances, whilst by offering a perfectly unresisting medium it allows of the sections being made regularly and with uniformity. The razor works very easily over the surface, and is less liable to injury from scratches. The object must, of course, be fixed, in order to be available for the cutting of the razor ; and this he effects by placing the object in a paper cell, and imbedding it in wax. Then the plug or block, which is to be received by the well of the cutting instrument, will consist of a little cylinder, made up partly by a small cylinder of wood, and partly by a small cylinder of wax, and wax contents. In some cases the objects become almost useless, from the difficulty of removing the wax afterwards ; and, to avoid that, he previously immerses the object in stiff gum, and allows it a very short time to harden before inserting it in the wax capsule.—Vide *Proceedings of the Microscopical Society of London.*

A Graduating Diaphragm of an ingenious kind has been constructed by Mr. S. B. Kincaid. It consists simply of a piece of India-rubber tubing stretched between two brass cylinders, one of which slides within the other. When the cylinders are caused to revolve on their common axis, and in opposite directions, the tube becomes twisted ; by this means its bore can be diminished to any required extent, whilst a central, uniformly round aperture is always preserved. We have not seen Mr. Kincaid's apparatus, and cannot speak therefore as to its efficiency.

A New Form of Leaf Holder, and also a revolving slide holder for the microscope, combined with a selinite stage, have been described by Mr. James Smith, F.L.S., in the *Microscopical Journal* for July.

Titles of papers on histology, of which abstracts are given in other parts of this summary :—

Botany :—	Structure of Myrrhis odorata.
	The Foliicolous Sphæriæ.
	The Development of Œdogonium.
	Structure of the Anthers of Aroideæ.
Medical Science :—	Contractile Corpuscles of Colostrum.
	The Pacchionian Bodies.
	Termination of Nerves in Muscle.
Zoology :—	The Disease of the Silkworm.
	The Sarcodic Tissue of the Sponge.

PHOTOGRAPHY.

M. Claudet's Paper at the British Association.—At the first ordinary meeting of the London Photographic Society, January 20th, 1853, a paper was read by Sir William J. Newton, "Upon Photography in an Artistic View, and in its Relation to the Arts." This paper was written "with a view to establish that photography can only be considered as a science to those who investigate its properties ; but that to the public, its results, as depicting natural objects, ought to be in accordance (as far as it is possible) with the acknowledged principles of Fine Art." Sir William first pointed out the want of that harmony and union of parts, and that truthfulness of light and shade, which should characterize a fine work of art, as due to the non-recognition of atmospheric effect on the part of the photographer. His remarks were fully appreciative of completeness and accuracy of detail, but so far from considering that every part should be equally defined, he thought all the objects should be a little out of focus, as there would then be greater breadth of effect, and more suggestiveness of the true character of nature. For other than pictorial purposes, however, he thought "it was impossible to be too particular in getting the exact focus." At that time these views were regarded as very startling and heterodox, and Sir W. Newton found it necessary to state at the next meeting that he alone, and not his fellow-members of the council, was responsible for what was regarded as a false principle. At a meeting held not long after, another artist photographer, Mr. R. W. Buss, followed in Sir William Newton's steps, and pointed out that correct definition was chiefly important where minute forms and varieties of texture were the things required, but that a general and truthful effect was inconsistent with such completeness of definition. He thought that photographs a little out of focus would give artists "the effects of Rembrandt, Carravaggio, Sir Joshua Reynolds, Opie, Jackson, the early style of Sir Thomas Lawrence, that of Sir H. Raeburn, and many others distinguished for breadth of effect in the English School of Art." A paper to the same effect was also read at the same time by another artist, Mr. John Leighton, "On the Relation of the Camera to Science and Art," in which its author upheld the views of Sir William Newton, and denounced as false to both art and nature those photographs which represented "near and distant objects on the same plane; backgrounds and foregrounds of equal intensity." In the discussion which followed these papers, party-feeling grew so high that the society in consequence lost many of its more valuable members. Sir William Newton said on behalf of the artists, "We do not want at all to interfere with the photographer, we want rather to assist him; to give him artistic views as much as we possibly can, and we will take advantage of what he does for us. We are not scientific men, we have not time for it, but we want the aid of scientific gentlemen." Sir Charles Eastlake also took part with his brethren of the brush, but did not appear to consider perfection of detail and unity of parts were in any degree inconsistent one with the other. Some years after, the question was again revived by another artist and photographer, Mr. A. H. Wall, and a discussion almost equally warm again arose. So far from arguing for putting the lens out of focus, Mr. Wall considered there could be no softness without perfection of definition, inasmuch as gradation could only depend upon completeness of parts. But he argued against that hardness which was miscalled sharpness, and showed that it was neither consistent with nature, art, nor scientific exactness. Since then, converts to the artistic side of the question have become so numerous that our leading opticians have found it worth their while to manufacture new lenses specially intended to distribute that intensity of focus which was formerly concentrated upon one plane only, and spread it in relative degrees over as many planes of distance as it will cover without losing its defining power too greatly. These are now our most popular lenses, and they are in great demand. In this brief historical review we may see that the paper M. Claudet read before the British Association, "On a New Process for Equalizing the Definition of all the Planes of a Solid Figure, represented in a Photographic Picture," was not only "a day after the fair," but advocated an old-fashioned, imperfect, and inexact means of getting certain effects for which we already have legitimate and suitable instruments. M. Claudet's very unscientific process is simply that of allowing the front lens of a portrait combination to remain stationary during the exposure of the plate to light, while by means of a rack and pinion the back lens is moved at successive intervals the twentieth part of an inch. By this means all the planes of distance within certain limits are supposed to be successively in and out of focus. But M. Claudet appears to have overlooked the fact that the action of the in focus and that of the out-of-focus planes are neither relative to their nearness or remoteness from the eye of the camera, nor calculated to equalize definition in all the planes of a solid figure represented in the photograph. The part first in focus is subjected to the action of the out-of-focus image during the time that the other parts are exposed to the changing images, and therefore must be more out of focus than the parts last exposed, which for the same reason must be most in focus. Artistic softness is not inconsistent with crispness of definition, nor with perfection of detail, to both of which M. Claudet's process is opposed, although it certainly is with the concentrated intense sharpness due to the condensation of the image by the lens, and the opticians endeavour to secure for one plane all the defining power the glasses possess. There is another consideration to be noticed, and that is that the number of planes M. Claudet could put successively in and out of focus would in too great a degree depend upon the length of the exposure. For instance, in taking the portraits of children, when there is usually only time enough to remove and replace the cap of the lens, the back lens could not well be moved at all, while in dull weather the rack could hardly be moved slowly enough, and the intervals between the movements of the back lens would probably have to be seriously lengthened. A process so variable in its results, and which is so dependant upon numerous and ordinary chances for its success, cannot be a good one, nor can we agree with M. Claudet in regarding it as "the greatest improvement which will have been introduced in photography." But supposing it really did equalize the definition of various planes of distance. Is this a desirable result? Does the human eye, which M. Claudet accepts as the ideal of what the photographic lens and camera should be—does this see all objects or planes, near and remote, with equal distinctness? No one can imagine it does so, and therefore our best artists are careful to give to these planes their relative degrees of distinctness in accordance with the aim of art and the facts of nature, as demonstrated by science. Upon this principle should photographic lenses be manufactured, and upon this principle should the operator work when focussing the images in his camera. M. Claudet is a veteran photographer, and was one of our first Daguerrean portraitists. Many valuable hints and suggestions have emanated from him at different times, but the long paper he read before this year's meeting of the British Association is an exception.

Action of Light upon Iodide of Lead.—M. Schönbein has published some conclusions based upon experiments with iodide of lead subjected to the action of light, which are interesting and suggestive. When perfectly dry the iodide remained undecomposed, but it decomposed when kept constantly moist and in contact with air. Mixed with starch or tincture of guaicum it remains unaltered in vacuo, but on the admission of air is at once affected, the blue coloration showing the liberation of iodine. In the decomposition of pure moist iodide of lead by light it grows lighter in colour, loses iodine, and gives rise to the formation of peroxide and carbonate of lead. Any substance having a tendency to unite with iodine will assist in determining the decomposition of iodide of lead in sunlight. A mixture of starch-paste and iodide of lead is not acted upon by diffused light although strong direct light affects it immediately. It is singular to find the iodide of lead under the action of light so similar to the iodide of silver. Chloride of lead undergoes no change from light.

The New Use of Peroxide of Hydrogen and Chlorine Water.—In our last photographic summary we called attention to Dr. Angus Smith's discovery as to the use of peroxide of hydrogen in eliminating from photographs the destructive hyposulphite. Since then this new process has found opponents. Mr. F. W. Hart suggests that the hydrochloric acid used in its preparation, and the fact of its decomposing when in contact with gold or silver, render it a very unsuitable agent. In reply, Mr. Dawson affirms as the result of experiments that the preparation does not decompose when in contact with a silver print, and that the trace of hydrochloric acid is too trifling to exert any injurious influence. Dr. J. Emerson Reynolds, after using some extremely delicate tests, and carrying out a series of very carefully conducted experiments, from which he believes that all possible sources of error were eliminated, concludes that the application of peroxide of hydrogen to a print is in fact washing it in a very weak solution of sulphide of sodium, and thereby increasing the evil rather than decreasing it. Dr. Adrian, of King's College, who has been conducting experiments on the action of peroxide of hydrogen and chlorine water on hyposulphites, has published the following laboratory notes :—

Solution No. 1.—One ounce of hyposulphite of soda to four of water.

Solution No. 2.—Peroxide of hydrogen of the ten volume strength, very slightly acid.

Solution No. 3.—Chlorine water, freshly prepared, and not quite saturated, also very slightly acid.

"Peroxide of hydrogen added in excess to the above strength of hyposulphite solution did not, after the lapse of some hours, convert the whole of the hyposulphite into sulphite. Reactions with salts of silver and baryta proved this. No *sulphite* is formed as an intermediate stage of conversion. An appreciable trace of sulphur was liberated after some time. The smell of sulphurous acid evolved was also perceptible. Chlorine water added in excess to the same strength of hyposulphite solution behaved similarly, but more of the hyposulphite salt was decomposed ; so that the indications, namely, the precipitation of sulphur and liberation of sulphurous acid, which were only faint with peroxide of hydrogen, were much more marked with chlorine water." Mr. Dawson, who conducted similar experiments, adds that "in weaker solutions of hyposulphites, containing a fractional part of a grain of the latter in an ounce of water, the conversion into sulphate seems to be rapidly completed without any deposition of sulphur or liberation of sulphurous acid by both oxidizing agents." The very small amount of soluble hyposulphites in even a large number of photographic prints renders their complete conversion into sulphates without decomposition by peroxide of hydrogen extremely probable, and Mr. Dawson hopes to demonstrate this in the course of yet further experiments.

New Process of Photographing on Wood.—The Philadelphia Photographer gives the following as a reliable process :—Take a block of box-wood in the state in which it is prepared for the draughtsman, and saturate it with melted white wax for a few seconds only. Remove the wax with a scraper, and coat it with flake white. Then flow over it a solution of water three parts, albumen three parts ; to each ounce of which has been added three grains of salt. When dry, with a piece of paper you spread over it a solution of nitrate of silver, 15 grains to the ounce, acidified with two drops of glacial acetic acid to the ounce, and given the consistency of oil by the addition of a little gelatine. After again drying it is exposed to the fumes of ammonia for about fifteen minutes, and then printed on by the usual process. The print may be toned, but as this is not required we omit the process. It is fixed with hyposulphite of soda in the ordinary way. The *Philadelphia Photographer* says, "By this simple and easy process quite a revolution is being made in wood-cutting, much to the improvement of the pictures." If this is the case in America it is very unlike the case in England, for although photographs on wood are no novelty here they are found to be comparatively useless, and certainly when used are no improvement. To convert the tones of a photograph into lines demands considerable artistic skill and experience, such as few engravers bring to their work, and we have seen many engraved photographs on wood which were vastly inferior to drawings made from photographs by experienced draughtsmen.

PHYSICS.

Three New Hydro-electric Piles.—At the meeting of the French Academy on the 20th of August, M. Monthier described three new forms of hydro-electric piles. The first depends on the employment of sulphuric acid and iron. In a cylindrical vessel of iron he places a prism of carbon, and then he pours in diluted sulphuric acid. The carbon and the iron form the two poles. Two of such batteries are sufficient to ring the ordinary bell employed at telegraph stations. This battery is very cheap, and the proto-sulphate of iron which results from the reaction may be utilised in battery No. 2, which is constructed as follows:—In a cylindrical vessel containing a concentrated solution of protosulphate of iron the author places a cylinder of zinc and a prism of carbon, forming the two electrodes of the pile. The zinc dissolves, hydrogen is disengaged, and hydrated sesquioxide of iron precipitated. Two elements of this kind served for an electric bell for several months. The third form consists in the employment of putrid urine (carbonate of ammonia) and zinc. If, says M. Monthier, you put a plate of zinc into a solution of carbonate of ammonia, the metal dissolves, hydrogen is disengaged, and forms a precipitate consisting of zincate of ammonia and carbonate of zinc. M. Monthier gives a table which shows that three batteries with the same number of elements of the same size, viz., a pile of "Marie-Davey" with sulphate of sub-oxide of mercury, gave deflection of the magnetic needle equal to 22 degrees, that of putrid urine and zinc gave a deflection of 13°, and that of proto-sulphate of iron and zinc gave a deflection of 11°.

Mode of Correcting Compass Variations.—An extremely simple and ingenious mode of ascertaining the deviation, or rather the extent of the deviation of the compass, has been devised by an American naval officer connected with the Naval Academy of Annapolis, Maryland, U.S. He proposes to take an ordinary compass card and erect upon its centre a fine copper wire, from 4 to 6 or 8 inches in height, and perpendicular to its plane. At the moment of the sun's meridian passage, as indicated by the noon observation for latitude, note the direction of the shadow cast by the wire on the compass card. The angle contained between this direction and that of the north and south line of the card will give the variation and local attraction combined. Small errors are involved in this method, but the approximation is close enough for the purpose for which it is intended. As there would, of course, be no difficulty in making this wire a permanent fixture to the card, it will be obvious that this arrangement would enable the deviation of the compass to be daily tested.—*Mining Journal.*

A Defect in the demonstrating Polariscope, and a remedy for it, have been discovered by Mr. J. Trail Taylor, the well-known editor of the *British Journal of Photography*. Mr. Taylor read a short paper upon his discovery at the last British Association meeting. He stated that his observations of polarized light projected on a screen, led him to discover that even the best instruments constructed are liable to error, inasmuch as none but the axial rays transmitted through the condensers are polarised, the main body of the luminous cone undergoing reflection from the polariser without being really polarised. He remedied this by intercepting the light with a flint concave lens before it reached the polariser, so that the whole mass of rays being projected in a parallel direction was completely polarised. On leaving the polariser the rays were again converged before passing through the crystal or other object to be exhibited, by a small achromatic lens which thus acted as an achromatic condenser. It was stated that this arrangement effected a most important increase in the brilliancy of the object exhibited on the screen.

The Production of Ozone.—M. G. Planté has found that during the electrolysis of water much more ozone is produced when the electrodes are of lead than when they are of platinum, in fact, nearly half as much again. He considers that the explanation is rather difficult, but he attributes it to the presence of a layer of oxide on the electrode, which thus gives rise to a secondary action.—Vide *Comptes Rendus*, July 23rd.

The Heat-conductibility of Mercury.—M. Gripon, who has been making experiments after Peclet's method, thinks he has demonstrated that if the conducting power of silver be regarded as 100, that of mercury is equal to 3·54. He places mercury, therefore, the lowest in the scale of metals, as far as the conductibility of heat is concerned. It is strange that electric conductivity is quite different, being represented by the figures 1·80.

Penetration of Platinum and Iron by Hydrogen.—From time to time we have reported the discoveries of Troost and Deville in this field of research. These conclusions have recently been collected by the Master of the Mint, Mr. Thomas Graham, in an admirable paper published in the *Proceedings of the Royal Society*. He thinks that this wonderful penetration is connected with a power resident in the above-mentioned and certain other metals to liquify and absorb hydrogen, which latter is possibly in the condition of a metallic vapour. Platinum in the form of wire or plate at a low red heat may take up and hold 3·8 volumes of hydrogen, measured cold ; but it is by palladium that the property in question appears to be possessed in the highest degree. Palladium foil from the hammered metal, condensed so much as 643 times its volume of hydrogen, at a temperature under 100° C. The same metal had not the slightest absorbent power for either oxygen or nitrogen. The capacity of fused palladium (as also of fused platinum), is considerably reduced, but foil or fused palladium, a specimen of which Mr. Graham obtained from Mr. G. Matthey, absorbed 68 volumes of the gas. Mr. Graham thinks that a certain degree of porosity may be admitted to exist in all these metals, and to the greatest extent in their hammered condition. It is also thought that such metallic pores, and, indeed, all fine pores, absorb hydrogen very rapidly, especially in the liquid condition. Hence Mr. Graham concludes that the phenomenon of penetration above alluded to, may be explained by supposing that a certain amount of dialytic action occurs in certain thin metallic septa, enabling them to separate hydrogen from other gases.

The Spectrum of Aqueous Vapour.—M. Jannsen records some very interesting experiments on the spectra of steam. In his experiments he employed an iron tube thirty-seven metres long filled with steam, of a pressure of seven atmospheres. The light was obtained from sixteen gas-jets. The spectrum showed five dark bands, of which two well marked answered to D and A (Fräunhofer), and reminded the observer of the solar spectrum seen in the same instrument towards sun-set. According to the first comparisons made between the spectrum of steam and that of solar light it appeared that the group A of Fräunhofer, B (in great part at least), the group C, two groups between C and D, are due to the aqueous vapour in the atmosphere. The experiment gave another interesting result. The spectrum was very dark at the violet end, and brilliant in the red and yellow, showing that aqueous vapour is very transparent to the latter rays, and suggesting that it will appear orange-red by transmission, and redder according to the thickness of the layer. This result, the author states, requires to be verified with care, but if established, he says, it will explain the redness always observed at sunrise and sunset. M. Jannsen hopes soon to be in a position to pronounce upon the existence or non-existence of aqueous vapour in the atmospheres of the planets and other stars. At present he is only able to say that it is not present in the atmosphere of the sun.—Vide *Comptes Rendus*, August 13th.

Meteoric Stones. — M. Daubrée records his observations on a great shower of meteoric stones which fell on the 30th of May, in the territory of Saint Mesmin, in the Department of the Aube. M. Daubrée gives the following account of the phenomenon:—The weather being fine and dry, and only a few clouds in the sky, at about 4.45 in the morning a luminous mass was seen to cross the sky with great rapidity, and shedding a great light between Mesgrigny and Payns. A few seconds after this appearance, three loud explosions like the report of cannon were heard at intervals of one or two seconds. Several minor explosions, like those of muskets, followed the first, and succeeded one another like the discharge of skirmishers. After the detonations a tongue of fire darted towards the earth, and at the same time a hissing noise was heard like that of a squib, but much louder. This again was followed by a dull, heavy sound, which a person compared to that of a shell striking the earth near him. After a long search he perceived, at the distance of about two hundred feet from the place where he was when he heard the noise, a spot where the earth had been newly disturbed; he examined the place, and saw a black stone at the bottom of a hole nine inches deep, which it seemed to have formed. This stone weighs nearly ten pounds. On the following day a gendarme named Framonnot picked up another meteoric stone of the same nature, weighing nearly seven pounds, at about two thousand feet distant from where the first fell. A third stone was found on the 1st of June by a man named Prosat, five to six thousand feet from the two spots above referred to. This last meteorite weighs nearly four pounds and a half.

The Atlantic Cable. — The French *savants* do not seem to believe much in the Atlantic Cable as a commercial success, but they think it may be put to great and valuable scientific purposes. At a recent meeting of the French Academy M. Babinet, after expressing doubts as to the success of the cable, recommended that we should profit, and that at once, by the electric cable which connects the New and Old World, in order to determine the exact longitude of the American station.

A new Spectroscope has been constructed by Father Secchi, and seems to be a very excellent instrument. It absorbs a very small quantity of light, and is therefore admirably adapted for stellar observations. The inventor has analyzed with it the spectrum of the light emitted by the star Antarés. It is of a red colour, the luminous bands have been resolved into bright lines, and the dark ones are chequered with light and dark lines, so there is no black foundation.—*The Reader*, August 25th.

A New Magnesium Lamp.—An ingenious form of magnesium lamp, the invention of Mr. H. Larkin, and which was first exhibited at the Royal Institution a couple of months since, was shown at the soirées of the British Association at Nottingham. Instead of the ordinary ribbon or wire of the commoner forms of magnesium lamps, magnesium powder is employed. Hence all machinery is dispensed with, the magnesium being contained in a reservoir, from a hole in the bottom of which it falls like sand from an hour-glass. The powder is allowed to fall upon the flame of a small gas jet, and by this it is inflamed, giving all its usual illumination. In order that a sufficient quantity of powder may be employed, and that the hole in the reservoir may be large enough to allow of a regular flow, without waste of magnesium, the latter is mixed with fine sand. The size of the aperture is regulated by a stop-cock. When it is desired to light the lamp, the gas is first turned on, just sufficiently to produce a small jet at the mouth of the tube, which small jet, being once kindled, may be allowed to burn any convenient time, until the moment the magnesium light is required. All that is then needed is to turn on the metallic powder, which instantly descends and becomes ignited as it passes through the burning gas. This action of turning on and off the metallic powder may be repeated without putting out the gas, as often and as quickly as desired ; so that, in addition to the ordinary purpose to which lamps are applied, an instant or an intermittent light of great brilliancy, suitable for signals or for light-houses, may be very simply produced with certainty of effect and without the smallest waste of metal. The first evening an objection was made that the blue tone of the light created a cold and somewhat ghastly effect. On the second occasion Mr. Larkin remedied this by mixing with the magnesium a certain quantity of nitrate of strontia.—Vide *Journal of the Society of Arts*, September.

What is the Cycloscope ?—It is an instrument for setting out railway or other curves without the aid of a theodolite, and has been devised by Mr. H. Temple Humphreys, Assoc. Instit. C.E. It is composed of two essential parts, viz., two plane mirrors, one entirely silvered and the other silvered on only one-half of its surface. In accordance with the "law of successive or combined reflections," a series of images are formed in the half-mirror which may be rendered available to set out any curve, of any given radius, by applying the eye to an aperture in the entire mirror, and at the same time setting the two mirrors at an angle equal to the required tangential angle. By this operation the several successive images of a ranging rod are seen to lie on the circumference of a mathematically true circle. "The curve was then readily set out in the field by simply placing other ranging-rods in line with these several images. This could be done by looking through the unsilvered half of the half-mirror, and planting the rods opposite to and overlapping the successive reflections. No error could arise in the manipulation, and the whole process of setting out a true curve was shortened and simplified. After setting the mirrors to the requisite tangential angle, no further adjustment or support was needed than could be afforded by the top of the ranging-rod placed at the commencement of the curve, and shifted occasionally to any stake on the curve that the limits of distinct vision might require."

How to Obviate the Concentration of the Heat-rays in Solar Observations.—In examining the sun with telescopes, the concentration of the calorific rays renders observation unpleasant and often dangerous. This unsatisfactory condition has, however, been done away with by means of a device adopted by M. Leon Foucault, who has conceived the idea of utilizing the property which certain metals have of absorbing heat-rays, whilst allowing the merely luminous ones to pass through. Silver, when deposited by a particular chemical process, in very thin layers, possesses this property in a very high degree. M. Foucault has sheathed the objective of a telescope with a layer of this metal, and there is produced at the focus of the instrument an image perfectly clear and agreeable to the eye. It exactly resembles one which a violet-coloured glass would produce.—Vide *The Reader.*

ZOOLOGY AND COMPARATIVE ANATOMY.

The Habits of the Lemming.—The habits of this creature (*Lemmus Norvegicus*) have been described in a paper by M. Guyon, read before the French Academy. M. Guyon kept the animal alive from the 15th of August, 1863, to the 18th of June, 1864, when it was accidentally killed. The Lemming was never tamed. It left its den towards night, and re-entered it towards dawn. It also came out at certain hours during the day for its food, and also to drink water, of which it was extremely fond. But even by the side of the food a little cage full of moss was always placed, and if the dish was not exactly to its liking, it retired until something more to its taste was provided. Sometimes it would carry a portion of it into the cage, a fact which M. Guyon thinks enough to prove that this Lemming, like the others of its genus, lays up provisions for the winter, contrary to the general opinion of travellers. When awake, it was perpetually gnawing at the doors, the wainscoting, and even iron bars. If interrupted in this occupation it would utter loud cries and pour forth a copious saliva on anyone who tried to seize it. It manifested a disposition to attack a bird which flew about the apartment in which it was kept, but perhaps this was the effect of curiosity alone. It exhibited sometimes a certain amount of *sociability.* If its own habitual cry of *cui-cui* was imitated, it would come forth, but seldom advanced towards the person who spoke, and then it remained at some distance ; nor did it ever approach the fire throughout the winter.—*Comptes Rendus,* August 20th.

The Terebriporæ have been very carefully investigated, and have had their distribution defined by M. Fischer, who has published an important paper on the subject. His inquiries extended also to the distribution in time of these organisms, and indicate that the Terebriporæ are different in the secondary and tertiary beds. He has detected four or five species in the former and as many in the latter. In September, 1865, he luckily found in the Harbour of Arcachon an oyster perforated by a colony of Terebriporæ, and he has found them since in the Mediterranean. Besides Terebriporæ, M. Fischer has found on the coasts of the Gironde a Bryozoan belonging to the same family and having the same habits, but differing in having its cells borne upon alternate axes. It leaves upon the shells elegant impressions resembling the ramifications of the *Sertulariæ.* He proposes to name it *Spathipora.* The living Spathiporæ are not numerous. There are only two living species known, one from the coasts of France and the Mediterranean, the other from the Pacific.—Vide *Quarterly Journal of Microscopical Science,* July.

Two extreme forms of Human Crania were exhibited by Professor Huxley at the Biological Section of the British Association. The first was the skull of an adult form from the collection of the Royal College of Surgeons, and exhibited unusual breadth and round, the breadth being $\frac{997}{1000}$ of its length. It was arched, and the jaws did not project. The palate was short and broad, and the suture joining the two parietal bones was completely obliterated, the other sutures being still open. The second skull was said to have come from New Zealand, but of this Professor Huxley was doubtful, as it did not present all the features of the Australian type. It was the narrowest skull, in proportion to its breadth, that he had seen recorded, the breadth being only $\frac{629}{1000}$ of the length. The first was arched and dome-like, and the contours almost semicircular, whilst the second had compressed and wall-like sides, and was roofed in like a house. The occiput of the second was remarkably flattened, the jaw projected very far, and the palate was very long and broad. Although there was a great deal of dissimilarity, the two agreed in certain particulars. The length of the basi-cranial axis was nearly the same, so that it may be concluded that the length of the axis of a skull has no necessary relation to its absolute or relative breadth.

The Angola in the Colony of Victoria. — Three years ago the Acclimatisation Society of this colony communicated a series of experiments on the subject of the value of Angola wool, and having been convinced of its commercial importance, they proceeded to introduce ninety-three specimens. The animals are spreading rapidly, and it is thought the Angola wool will have as high a value as the Merino wool has at present.

The Acclimatization Society of Paris has been presented by General Khereddin, of Tunis, with a magnificent collection of animals. The series consists of a fawn of the deer of Barbary, three goats to supply it with milk, six gazelles, a fox, a jackal, and several birds, amongst which may be named —a superb ostrich, a bustard, two wild pigeons, three falcons trained to fly at hares, two sparrowhawks trained to fly at quails, an eagle, a yellow vulture, &c. The eagle and the vulture were offered to the Museum of Natural History in the name of His Excellency the General Khereddin. The falcons and sparrowhawks have been placed in the hands of M. Barr, the able falconer of M. Alfred Werlé, of Rheims, who will put them into training, and try their capabilities in the plains of the Camp of Chalôns, and compare their acquirements with the birds of his own training.

Simple Net for the Capture of Oceanic Animals.—In a paper read before the Microscopical Society of London on the fauna of mid-ocean, Major S. R. Owen gives the following directions for the preparation of a simple form of net for the above purpose, and which may be rigged out at a few hours' notice. A grummet * should be made for the mouth, to which three cords may be attached to connect it with the towing-line ; that line should be a good stout piece of stuff, and capable of bearing a great strain. To the grummet should be attached, first, a bag, the upper part of which may be made of a thin canvas, the lower part of strong jean, ending in a piece of close calico or linen ; the bottom must be left open, and tied round with a tape when used : this will be found convenient for taking out the contents ; and by leaving it open and towing it so for a short time it can be thoroughly washed. Over the whole an outer covering of the strongest sail-cloth should be put, the upper part, in like manner, attached to the grummet, the lower part left open, and a portion for a foot or eighteen inches of the seam left to be coarsely laced up with a piece of cord, the same being done for the bottom itself. If necessary, a third covering may be put between these of any strong but rather porous material ; but this in its turn should be left open at the bottom, and only tied when required for use. Its length should be so adjusted, when tied, that the inner lining of calico may rest against it, and be relieved from the strain. The outer sail-cloth should, in like manner, be laced up to receive and support the whole.

Works about to be published by the Ray Society.—From the Report of the Ray Society for the present year, we learn that the next work to be issued is a translation of Nitzsch's important treatise on Pterylography, edited by the distinguished secretary of the Zoological Society, Dr. P. L. Sclater. The Council have accepted a proposal by Mr. W. K. Parker for a work " On the Structure and Development of the Shoulder-girdle and the Sternum in the Vertebrata generally." This, which will be illustrated by thirty plates, imperial quarto, will be a very valuable contribution to science, and the Committee of the Government Grant Fund of the Royal Society has shown its high opinion of the proposed work, by voting £100 in aid of its execution. Other volumes in preparation are Messrs. Alder and Hancock on the " British Tunicatæ ;" Professor Allman on the " British Corynidæ ;" Mr. Bates on the " Mantidæ," with illustrations by Professor Westwood ; the remaining volumes of a complete edition of the works of the late Robert Brown, edited by J. J. Bennett, F.R.S. ; Messrs. Douglas and Scott on the " British Hemiptera Homoptera ;" Dr. Gaertner on " Hybridism in Plants " (Bastarderzeugung), translated from the German by W. Carruthers, F.L.S. ; Dr. M'Intosh on the " British Annelids ;" Dr. Masters on " Vegetable Teratology ;" Mr. Andrew Murray on the " Coniferæ ;" and a Synopsis of the Fauna and Flora of Palestine, by the Rev. H. B. Tristram, F.L.S.

The Brain of Fishes. — On this important branch of comparative anatomy

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* Major Owen states that any nautical friend will explain to the reader the nature of a grummet.

an elaborate paper has been published by Mr. Hollard, who has traced out the several homologies between the brains of fishes and mammals — no easy matter. He states that the brain of fishes may be regarded as being made up of three ventricular divisions, which correspond to the three primitive cerebral vesicles. The anterior and posterior regions become divided into two distinct sections. The inferiority in the cerebral organization of the fish has reference to the posterior sections, the middle cerebrum or nucleus, and the anterior brain or the hemisphere. The middle or "intermediate" brain corresponds to the fundamental part of the nucleus of the cerebrum. The inferior lobes correspond to the corpora striata. The anterior lobe of the brain of fishes corresponds to that portion of the hemispheres which is nearest the corpora striata. The plates which accompany Mr. Hollard's paper demonstrate the above conclusions clearly.—Vide Robins' *Journal de l'Anatomie*, No. 3.

Metamorphoses of the Nematoid Worms.—MM. Van Beneden and Leuckart, two of the most distinguished helminthologists of Europe, have been making a series of researches upon the development-history of the nematoid worms; and in a memoir presented to the Belgian Academy of Sciences, they have announced some startling conclusions at which they have arrived. It seems, from their investigations, that many of the nematoidæ undergo several distinct changes of form, which are associated by a change in the "host" in which they live, or in the conditions under which they exist. There appears to be a very decided relationship between the Ascarides and the genus Oxyuris. It is alleged that the *Ascaris nigrovenosa* of the frog acquires its full sexual development after it has left this animal and has taken up his abode in a moist soil. Whilst in its parasitic form, the male sex is the only one that has been observed. Both males and females appear when it becomes resident in the soil.—Vide *L'Institut*, August 1st.

The Disease of the Silk-worm.—M. A. Béchamp's experiments and observations on this point are of interest. He states that the disease known as *pebrine*, is due to the presence in the tissues of the animal of a number of dark vibratile corpuscles. The malady, he says, is not constitutional, it is parasitic. The vibratile corpuscles are only a pathognomonic sign, and are a pathologic condition. The corpuscles are the producing cause of the affection. M. Béchamp states, that when the black spots with which the affected silk worms are covered, are washed or brushed, numbers of those vibratile corpuscles are found. He formulates the following conclusions:—(1) The corpuscles are situate on the external surface of the egg; the more the latter is washed, the less the quantity of corpuscles becomes. (2) Larvæ, which have just left the egg, may contain these corpuscles; but washing removes them. (3) The larvæ spotted with pebrine may have no corpuscles in their tissue, although a washing may discover several of them on the outer surface. (4) Even in larvæ in which there are no spots, there may be the characteristic corpuscles of pebrine on the surface, but none in the tissues. Hence, says M. Béchamp, the malady is one derived from without; it is not like the corpuscles of pus, cancer, or tubercle, but is, in fact, a vegetable cellule.—Vide *Comptes Rendus*, August 13th.

The Sarcodic Tissue of the Sponge.—It is generally stated, says M. Grave, in a paper read before the French Academy, on the 9th of July, that the soft tissue of the sponge is a gelatinous amorphous mass. But far from being so, it is composed of three perfectly distinct layers, possibly of four strata even. The first, the epidermic layer, is homogeneous, thin, transparent, and is composed of cells of a slightly yellow colour, and of extremely small size. It is well characterized by the absence of tricuspid spicules, and especially by the presence of irregularly-oval or circular vacuoles, more or less numerous, and which play the part of stomata, probably facilitating the absorption of nutritive liquids by the *sarcosome.* The second, or medium layer, is sensibly thicker than the former. It is formed of yellow cells, arranged so as to have a number of irregularly-traced spaces, which look like canals hollowed out of the substance of the layer. It is further characterized by the presence of star-shaped bodies, sparingly distributed, and of three-pointed spicules. The third, which is the deepest layer, is delicate in substance, and very difficult to prepare for examination. It is homogeneous; formed of cells (?). It is devoid of stomata. M. Grave thinks that the fourth layer is placed between the middle and deep layers, but he has not yet been able to isolate it and study its minute characters.

Zoological Section of the French Academy.—The place of correspondent in the zoological section, lately held by M. Leon Dufour, has been given to M. Van Baneden, the Belgian naturalist. The thirty-five votes were divided as follows :—For Van Beneden thirty-two, for Pictet two, for Vogt one.

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END OF VOL. V.

COX AND WYMAN, PRINTERS, GREAT QUEEN STREET, LONDON, W.C.