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KNOWLEDGE

AN ILLUSTRATED MAGAZINE OF SCIENCE LITERATURE & ART.

Founded by RICHARD A. PROCTOR.

"Let Knowledge grow from more to more."
—TENNYSON.

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THE MYCETOZOA, AND SOME QUESTIONS WHICH THEY SUGGEST.—I.

By the Right Hon. Sir EDWARD FRY, D.C.L., LL.D., F.R.S., and AGNES FRY.

WE are desirous to make known some small friends of ours to those who are hitherto unacquainted with them; but we are embarrassed as to how to introduce them—by what name to present them. It is true that they bear several names derived from the Greek language, Mycetozoa, Myxomycetes, Myxogastres, Myxothallophyta, but these are not familiar words. In German these organisms bear a name which has been translated into English, but it is so repulsive that we would willingly suppress it if we could, just as one would not like to introduce a charming girl to strangers by some name of a distinctly disagreeable suggestion :—

> "A name? if the party had a voice,
> What mortal would be a Bugg by choice?
> As a Hogg, a Grubb, or a Chubb rejoice?"

And so what beautiful little thing would, if it had a voice, be introduced as a "slime fungus"? and yet this is the only English name of the organisms in question. Some intimates of these ill-named beings try to get over the difficulty by inventing pet names, and call them "myxos," or "myxies," and, on the whole, we incline to adopt the latter word. It is short, and it rhymes with pixies.

But what are these myxies? someone will be impatient to say. Are they fungi? No. Are they mosses? No. Are they ferns? No. Are they lichens? No. At any rate, plants? That is doubtful. Then surely they are animals? We do not know. They are living things—and beyond that we will not go for the present.

There is another difficulty in the way of presenting these organisms to the novice: that their forms and structure are so far unlike those of plants or animals with which every one is familiar that we cannot use very well-known terms in describing them, and we shall have to ask permission to employ some special terms, when common ones fail. But we shall endeavour to be as clear as we can, and to readers who will give us their attention we believe that we shall overcome these obstacles, and we believe, too, that a little difficulty in following the exposition will be more than repaid by the interest of the subject. It appears to us that many most interesting biological problems are presented in very simple form by this class of organisms, and we shall not hesitate to refer to these from time to time in the following pages.

If our reader will turn over the pages and look at the illustrations which follow, he will by his eye get a general notion of the kind of thing about which we are going to talk.

LIFE-HISTORY.—We propose in the first place to sketch the life-history of one of these organisms as an example of all, and then to retrace our steps and dwell a little more in detail on points of interest which emerge in the consideration of the several stages of its existence.

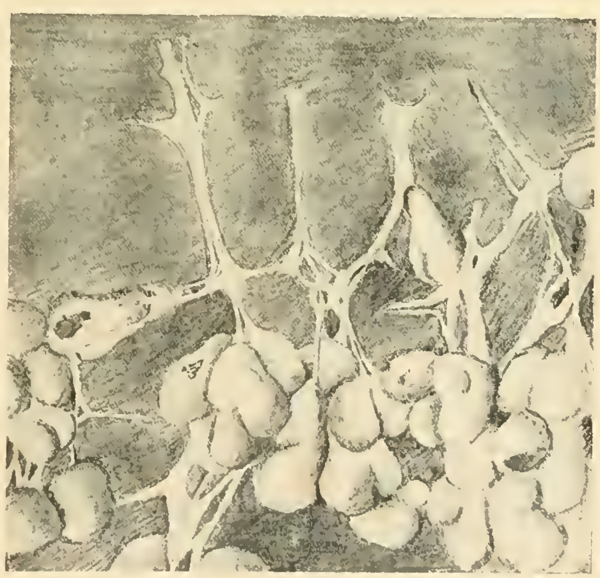


FIG. 1.—*Badhamia utricularis*, showing Sporangia.

If our reader will look at Fig 1., he will see depicted an organism consisting of a number of bodies somewhat like grapes in shape; he will see that each little berry is attached by a tender stalk to a substance which is a piece of dead wood, and he will notice that these berries are so grouped together as to suggest the notion of a common origin. This little organism is known as *Badhamia utricularis*, the generic name being derived from a Dr. Badham, a labourer in the field of cryptogamic botany, and the specific name describing the bladder-like form of the principal part of the structure. This species is not uncommon, and is to be found on stumps and logs of decaying wood.

The bladder-shaped vessels which we have spoken of are the spore cases of the organism, *i.e.*, they are cases in which the spores are stored, much as seeds are stored in a seed vessel. They are known as *sporangia*. We have chosen to begin with the organism in this form because it is the most conspicuous, and therefore the most easy for a beginner to get hold of.

If now a specimen of this Badhamia be placed under the microscope, it will be seen that the coat of the sporangium is a delicate shell containing minute granules of lime, and that the dark appearance of the body is due to the brown spores which lie beneath the transparent shell. Next if a sporangium be broken and the contents examined under the microscope (as shown in Fig. 2), it will be found that the delicate white shell contains a network of threads, also white from the lime with which they are charged, and that they occupy the interior of the sporangium, and pass from wall to wall much like the cancelli in a long bone. In addition to these threads there are the small round spores. In these threads we have come upon a very characteristic structure in these little organisms; it is found in the sporangia of most of them but in very varying forms, and very diversely arranged, of which we shall say more hereafter. This system of hairs in the sporangia is known as the *capillitium*.

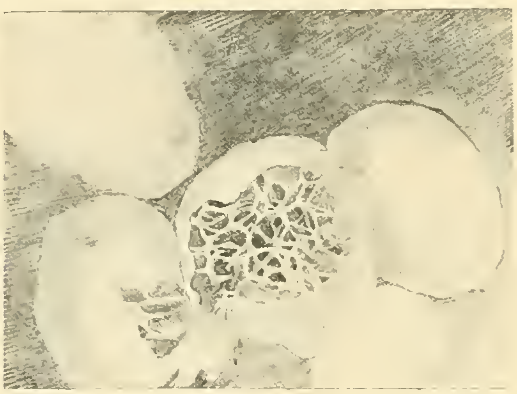


FIG. 2.—*Badhamia utricularis*, broken Sporangia showing Capillitium.

As the sporangia contain spores it will be at once understood that we stand on the threshold of a new generation, and we must now follow the history of the spores. These, when carefully looked at, are seen to be covered with minute spines, and thus present a somewhat rough appearance.

If now the spores be placed under favourable circumstances, *i.e.*, with sufficient moisture and warmth, small translucent bits of naked protoplasm will be seen to emerge from them, leaving a mere shell behind them; these bits of protoplasm have a movement of their own in the water, and can be seen both to shake themselves, and to move forwards; they push out a part of their protoplasm as a whip or *flagellum* at one end of the body, swimming with this in front of them, the whip having a sort of lashing movement. Fig. 3 exhibits some of these bits of protoplasm. Their motions are particularly amusing to watch; they swim, they wriggle, they revolve, they shake themselves, they are full of life and motion; they seem at once wilful and purposeless; they gambol with one another, and their frolics remind one of young lambs in spring. They are capable not only of motion but of digestion, and of the capture of food in a manner to be hereafter described. These little pieces of protoplasm bear several names, and as the variety of phraseology is apt to puzzle students, we pause to say

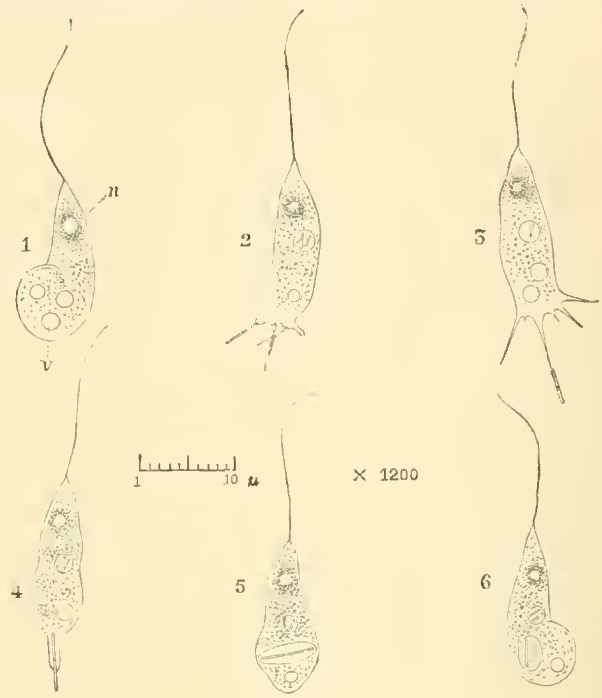


FIG. 3.

1.—Swarm Spore of *Stemonitis fusca* of the usual form when swimming. *n.* Nucleus; *v.* Vacuoles.

2.—Swarm Spore with three Bacilli adhering to expanded posterior extremity.

3.—A Swarm Spore with delicate pseudopodia, to one of which a Bacillus is attached.

4.—The same Swarm Spore. The Bacillus in the act of being drawn in and partly invested with a tube-like extension of the body surface.

5.—The same Bacillus contained in a long vacuole, and bulging out the sides of the Swarm Spore.

6.—The same Bacillus bent double after violent jerking movement of the Swarm Spore.

(From *Journ. Linn. Society, Botany*, Vol. 25, p. 440, by permission of the Linnean Society and Mr. Lister.)

that they are called sometimes swarm spores, or swarm cells, sometimes zoospores, and as individual pieces of protoplasm they are sometimes called protoplasts. The spore of a moss, or of a fern, is a small structure, endowed with no power of motion; these swarm spores, as we have seen, have a power of motion; the spore of the moss, or the fern, is capable by itself of reproducing the plant from which it has come, but these swarm spores are only reproductive after fusion with others, as we shall hereafter see. The name swarm cell is likely to mislead, because the thing so called is protoplasm without any containing wall, and therefore does not answer to the notion of a cell as it exists in a beehive or in a police station. We shall therefore speak of them as *swarm spores*, though even that name seems to us to be far from felicitous.

The next step in the life of these swarm spores is that they rapidly increase by bi-partition, *i.e.*, splitting into two parts. An occasional phenomenon here sometimes intervenes. At times the swarm spores assume a globular form, and become covered with a hard coating, and in that condition are known as *Microcysts.* But from the wall of this cyst the contents afterwards escape, and renew their movements.

The swarm spores (whether after encystment or not) now enter upon a new stage. They gather together and fuse into masses of naked protoplasm, the swarm spores losing their individuality in a common mass. This mass is called a *plasmodium.* This plasmodium grows in bulk by the digestion of food, such as bits of fungus or dead wood, and attracts to, and unites with itself, other smaller plasmodia of the same species. In the *Badhamia utricularis* this plasmodium is yellow; it is white in many species; green or orange, or red or grey in other kinds. This plasmodium moves, sometimes through the substances of dead wood, in other cases on the surface, expanding in an irregular fan shape, and marked irregularly by streaks or veins, as may be seen in Fig. 4. It appears to move in

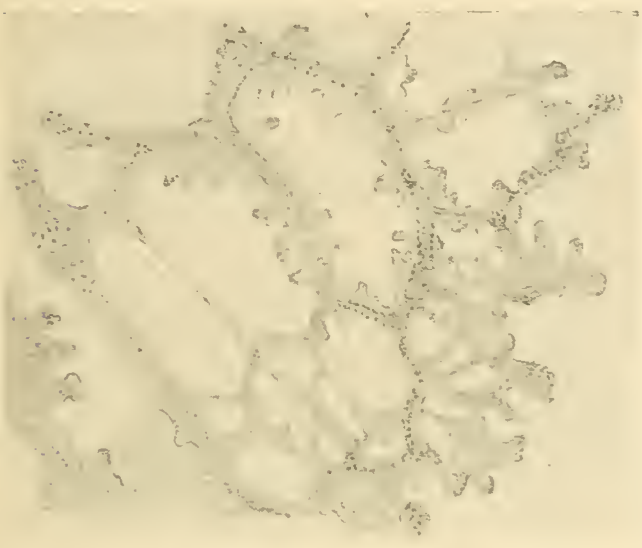


Fig. 4.—Streaming plasmodium of *Didymium leucopus.* (After Cienkowski.)

search of its requisite food. The Badhamia is much devoted to fungi, and will extend itself over the surface of a fungus till it has devoured all its more delicate parts.

In the substance of this plasmodium there arises a strong alternate movement of the more fluid protoplasm, a rush of circulation through the channels of the plasmodium. The granules move for a short time in the one direction, then pause, and then move in the opposite way. The strongest currents are indicated in Fig. 4 by the letters *st.*

The plasmodia of different species differ much as regards size. In some genera they are very visible, and were known to some of the older botanists as Mesenteriæ, and were believed to be a species of fungus. In some cases they can only be discovered by the microscope; and, haunting the interstices of dead wood, they are rarely visible. Such are the plasmodia of Lycogala, Arcyria, and of some species of Trichia.

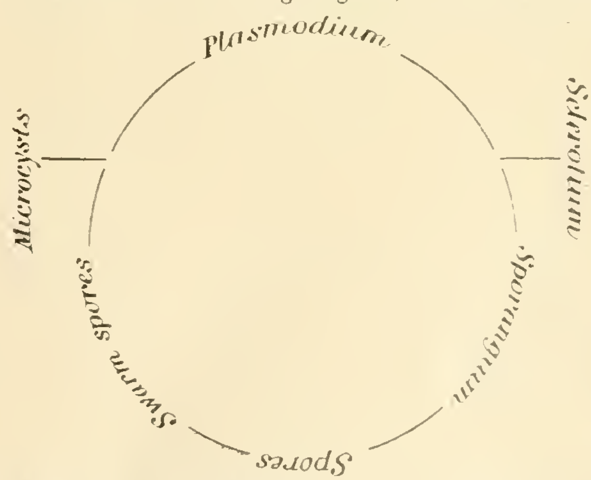
Here, again, a phenomenon of encystment sometimes occurs. During drought the plasmodium may become quite dry and hard without losing vitality. In this stage the hard plasmodium bears the name of *sclerotium.* That of the Badhamia is quite horny, and orange-red in colour. On being wetted it will resume its old plasmodium form, and move as before.

This conversion from an active into a passive condition of the plasmodium seems to be brought about by two conditions—the want of moisture and the want of food. This last fact is illustrated by a case in which a plasmodium placed on wet cotton wool, but without food, was found to turn into a sclerotium. The capacity for rest and awakening is thus a protective one, and enables the organism to tide over a time of famine or drought. It is certainly a better plan even than the Lydian practice of playing games to forget hunger.

From the plasmodium stage, whether broken into by a sclerotium condition or not, the organism, after a time, prepares for its next effort. It seeks some spot, on the surface of dead wood or leaves, sometimes a rather exposed and elevated position, at other times a sheltered one, and there forms sporangia, so that what before was a mass of more or less amorphous protoplasm has differentiated itself into several parts, into delicate pedicels, the coating membrane of the sporangia, the hairs of the capillitium, and the spores—which in due time are to begin again the circuit of the life-history of the Badhamia, which is in all essential features that of the whole group of myxies. The sporangia in the course of their development sometimes undergo a great change in colour; for instance, the young sporangia of Comatricha are an ivory white, and they gradually change into a glossy black; and the groups of little tree-like growths with their developing forms and varying colours, all gathered together within a few square inches, is a sight of great beauty. In the maturity of this sporangium stage of the organism it has lost all its powers of locomotion, it has lost its powers for digestion, and in its stationary condition devotes its energies to the reproduction of the species. The motion of the granules of the protoplasm continues to some extent until the formation of the spores.

Now, pausing here for a moment, and taking merely the outline of the facts as we have drawn it, we have surely abundance of matter for thought and surprise. Some seventy years ago, Fries, one of the first naturalists who grasped the series of changes through which these organisms pass, compared these changes to the metamorphoses of insects. We get, too, an inkling of the difficulty which naturalists have felt in assigning the myxies either to the animal or the vegetable kingdom: their locomotion and rapacious youth seem to shut them out from the plants; their stationary condition and their production of sporangia from the animal world.

The life-history of our organism may be briefly summarized in the following diagram, in which the circle



shows the essential stages of life, and the outliers show occasional and non-essential stages.

We wish to dwell a little more on some of the points of interest which arise from the brief narrative we have given, and from other facts which may be brought in relation to it, and in doing so, we shall find it best to consider the life-history of the organism in a different order from that previously used. We started with the sporangium, as the most easily grasped and the best known stage of life; but we shall now ask you to consider the life-history by passing from the simpler to the more complex stages.

SWARM SPORES.—And first let us revert to the swarm spores, those little bits of mere translucent protoplasm which escape from the spores of the myxie (Fig. 3), leaving the shells of the spores, from which they have emerged, behind, as in like manner the spores leave behind them the membrane of the sporangium. We have seen that in some cases the myxies form a membrane or coat—as in the sporangium, the spores, the microcysts, and the sclerotium; and it is probable that this membrane is in some, though comparatively few, cases of the same or a similar nature to the material of cell walls in the higher plants, *i.e.*, is formed of cellulose. But what is to be noted is this, that these membranes are used only as protections; they are allowed no part or lot in the vital actions of the organism, and, so soon as their protection is no longer wanted, they are cast off and allowed to perish. It is evident that the contained protoplast and not the containing membrane is the dominant partner in the concern.

A swarm spore has been defined as "a mobile, ciliated, asexual, reproductive cell, destitute of all membrane," or, in other words, it is a piece of protoplasm without any covering membrane, which is produced without any sexual action, and which of itself possesses the powers of motion, of putting out cilia or hairs, and of joining in the reproduction of the species to which it belongs. That all this should be true of a little bit of jelly is marvellous enough, and presents some of the mysteries of life in a very simple and condensed form.

Swarm spores, in the sense of the preceding definition, are common in both the great kingdoms of organized life. There is a whole group of protoplasts which, under the name of Monads, are reckoned to belong to the animal kingdom; there is the group of somewhat larger organisms known as "Amœbœ"—a group of which a suspicion has sometimes been entertained that they are an immature form of other organisms; there are the white particles of the blood which are almost, if not quite undistinguishable from Amœbœ; there are the swarm spores, whether belonging to the Algæ, the Fungi, or the Myxomycetes; in all these cases the protoplasts are of the same kind, endowed with nuclei and vacuoles, capable of putting out cilia, and endowed with the power of motion and assimilation. To all appearances there is no essential difference between them, and yet, in point of fact, they are organisms as distinct as possible from one another in their nature and their future careers.

One thing marks off the swarm spores of the myxies from all other swarm spores which reproduce the organism; they are reproductive only in conjunction. The swarm spore of an alga is capable by itself of reproducing an alga; in the myxies, on the other hand, the swarm spores only reproduce when they have merged with their fellows and formed a plasmodium. This phenomenon of the union of a large number of individual swarm spores into a new and larger individual which carries forward the course of life is unique in the myxies, and distinguishes them broadly from all other known organisms.

In all cases in which reproduction depends on swarm spores it seems essential that there should be water enough for the swarm spores to live and move about in; and, in the case of myxies, to enable them also by their movements to join together into a plasmodium. Nothing is known of their reproduction except in water.

It would at first sight appear that this condition of their reproductive activity cannot be otherwise than inconvenient and restrictive, especially in the case of such myxies as, *e.g.*, the Comatrichæ, which often produce their sporangia on the upper sides of wood, or on the tops or sides of wooden posts. But it is probable that a very little moisture is enough, and that in a shower of rain, or in a morning's dew, they find sufficient water for the swarm spores to live and unite. But we confess that the point seems to us to require further attention.

Water being the medium in which most of the lowest organisms exist, it is generally thought that the doctrine of evolution involves this—that the earth has been peopled by migrations from the water: and the migrations of amphibious animals from the one element to the other have been dwelt on as assisting us to understand such migration. In this connection the cases of the myxies and of the mosses, and no doubt of other mainly terrestrial organisms which need water as a necessary condition to fertilization, are worthy of note. One of the most important functions of life still depends on the presence of the original medium of their lives.

CELL THEORY.—The swarm spore is, as we have said, a bit of naked protoplasm; so is the plasmodium. Let us consider briefly what is meant by the expression naked protoplasm.

When in the seventeenth century the microscope was applied to vegetable tissues, especially by our countrymen Hooke and Grew, and by the Italian Malphigi, they were struck with the presence of small walled cavities in the fleshy parts of plants. These Hooke called cells, and Grew and Malphigi utricles or bladders. Hooke's name has stuck to them, and plays a great part in botanical writings from his day to the present. We are accustomed to regard the cell division as the determining factor in growth, the mode of division providing, as it were, the form which the plant is to assume: and especially since the days of Schleiden and Schwann—when the cell came to be regarded as the structural unit in the growth of plants—the tracing of cell development, and the structure of the parts of the cell (especially the cell walls), and the behaviour of the cell, have been studied with the utmost care. Presently it came to be seen that the cell walls were inert and by no means the most important part of the structure, but that the slimy contents of the little box, which had been treated with scant attention in the earlier stages of study, were, after all, the most remarkable part of the cell, and were to all appearance the basis of both animal and vegetable life. When attention was first called definitely to it in the vegetable kingdom it was termed protoplasm, by Mohl; when first accurately observed in animals it was named sarcode by Dujardin; and by-and-by it was found that protoplasm and sarcode were one and the same thing. Then instances were found in which small masses of protoplasm lived and moved without any cell walls at all, but so firmly was the notion of the cell rooted in the minds of many physiologists, that these naked pieces of protoplasm have often been called naked cells, a most confusing term as it seems to us, for it is like calling a man with nothing on "a naked great coat." Another name, and a much more convenient one, is protoplast.

The accepted cell theory received something like a shock when the life-history of the myxies came to be carefully studied. "All the phenomena," said Cienkowski, in the year 1863, "which are observed in plasmodia are calculated to force the observer from the accustomed path of safety to those of doubt. The fundamental conception of morphological investigation of the cell leaves us wholly in the lurch in the case of plasmodia. Neither cell membrane, nor nucleus, nor other histological elements can be established in this case by the most benevolent interpretation of the facts, and, twist the cell theory as we may, it certainly cannot be fitted to the naked flowing protoplasm of the Myxomycetes." Nuclei, however, have since been found in plasmodia.

The cell walls of ordinary plants are composed of a peculiar substance known as cellulose, and within these the protoplasm of the cell is contained, with all that may be contained in the protoplasm—the nuclei, the chlorophyll, the colouring, and the oily matter, &c. The cell is thus a highly organized unit, and it is, moreover, capable of carrying on most marvellous operations, physical and chemical.

An organism which commences life in the simple form of a piece of protoplasm, in many cases produces cell walls and rests in these, and thus builds a home for itself in which it lives and labours. But in the case of the Myxomycetes this does not occur, or occurs only very exceptionally, and all the actions which these organisms perform, and all the beautiful forms which they assume, are reached without ever forming a cell wall or constituting a true cell, except in the spore itself. In these actions and in these forms we see the capacities of simple and naked protoplasm. The extreme simplicity of the mechanism seems to bring to the mind more powerfully the inherent powers of the worker.

(*To be continued.*)

OZONE AND ITS USES.

Among the many interesting bodies which the researches of modern chemists have brought to light, few are more remarkable than the substance to which Schönbein gave the name "Ozone" in the year 1840. Little studied, this useful form of matter had been recognised for fifty years before receiving its name, which, as every reader with an elementary knowledge of Greek will know, is meant to accentuate one of its chief properties, its peculiarly strong smell. Ozone was originally thought to be an oxide of hydrogen, having a composition represented by the symbol H_2O_3, but when several chemists independently succeeded in obtaining it by passing electric sparks through perfectly dry oxygen this was seen to be impossible. Further researches conclusively demonstrated that ozone was nothing more than a condensed form of oxygen.

Though ozone has never yet been obtained in a pure state, chemists have a very satisfactory knowledge of its properties. Its smell resembles that of weak chlorine. When compressed, ozone has a blue colour, and is eventually converted into an indigo-coloured liquid, which, according to Troost, boils at $-119°$. It is a strong oxidiser; that is to say, it readily decomposes into ordinary oxygen, at the same time combining with suitable substances which may be present. It has been used in this way to bleach engravings discoloured by age, but the method is not altogether satisfactory. The possible applications of the strong oxidising powers of ozone are very numerous, since, while being so energetic an oxidiser, its action is also very simple. Unlike other substances used by chemists to give up their oxygen, ozone leaves no residue behind. It has consequently been suggested that ozone should be used to bleach beeswax, starch or bones; in the manufacture of varnishes, and also to accelerate the maturing of wines and spirits. Though considerably more experience than is at present available will be necessary before these applications of ozone can be successfully accomplished, there seems no reason why, after the effects of successive additions of the gas, and the adjustment of the proper amounts necessary in each particular case, have been studied, ozone should not become a very important commercial product.

It must, however, be at once pointed out that these have only recently become practicable possibilities. Until the advent of the process which we shall presently describe, ozone had been prepared on a small scale only, either by the action of the silent electric discharge on air or oxygen, by the electrolysis of dilute sulphuric acid, or by the slow action of clean phosphorus on moist air; but by none of these methods can it be obtained in any quantity. Of these three plans for obtaining ozone that of the electric discharge is the one most commonly employed in the laboratory, and the form of apparatus in most general use is known as "Siemens' induction tube." This consists of a sort of Leyden-jar, formed of a smooth metal tube which fits into a wider tube coated with tinfoil on its outer surface, leaving a narrow annular space between them. Between the two tubes a stream of dry oxygen gas is passed, which, when the inner and outer coatings are connected with the terminal wires of an induction-coil, becomes electrified by induction, and from ten to fifteen per cent. of the oxygen is thus transformed into ozone.

But though pieces of apparatus like that of Siemens prove satisfactory enough in preparing small quantities of ozone suitable for chemical research, they are quite inadequate for the generation of quantities large enough to be used commercially. Mr. Andreoli has recently patented a process which, though fundamentally similar to the laboratory plan of Siemens, is yet able to produce ozone at a marketable price. The construction of this patent is based upon the familiar tendency of an electric discharge to flow off a point, and in the apparatus designed by Mr. Andreoli, serrated grids of aluminium, each carrying seventeen thousand seven hundred and sixty points, are used. These grids form electrodes, and each one is placed opposite a sheet of aluminium with a plate of glass between. The three things, the grid, the glass, and the aluminium plate, are bound together by suitable wooden clamps. Though the construction of the apparatus would naturally lead one to suppose that occasional large sparks would occur from the metallic points, and so cause the union of some of the oxygen and nitrogen in the air which is acted upon, Mr. Andreoli states that no such compound of nitrogen and oxygen is formed. If this really is so, the production of ozone is uninterfered with, but this point requires to be more thoroughly investigated by chemists before a definite statement can be made with reference to it.

The applications of ozone seem likely to rapidly increase in number. It has become very popular among sanitary specialists as a means of purifying contaminated air. It is employed medicinally for the cure of persons suffering from fœtor of the breath, the inhalation of ozone causing a complete disappearance of the unpleasant symptoms. In the treatment of ulcers and wounds of all kinds it has proved invaluable, for under the influence of ozone such diseased parts readily become healthy, rapidly exhibiting an active tendency to heal. It is becoming common to ensure the sanitation of hospital wards by diluted ozone. The organic germs are destroyed by the oxidising power of the ozone, and consequently the bacteria of typhoid, cholera, dysentery, small-pox, fevers, etc., are killed.

In all those industries where oxidation plays an important point, ozone is becoming more and more used. Thus it has been employed for sterilizing foul casks and vats; for the rapid oxidation of drying oils; for seasoning wood; in vinegar making, and in bleaching textiles and tissues. These facts afford justification for believing that ozone will soon be one of the most familiar instances of the application of scientific knowledge to everyday processes.

TWO MONTHS ON THE GUADALQUIVER.

By Harry F. Witherby.

I.—THE RIVER.

To the ornithologist, the Guadalquiver, at all events from Seville to its mouth near Cadiz, is one of the most interesting rivers in Europe. In times gone by most of the country on each side of the river for about twenty miles from its present mouth was covered by the sea. But the land has been reclaimed, not by the Spaniards, but by the river itself. For countless years the river deposited at its mouth, layer upon layer, the innumerable particles which its waters brought down to the sea, and thus, gradually, the sea-bottom was raised, until at length the sea was ousted and level plains appeared. Then the sea began to fight for the land, but it fought against itself, for it threw up sandbanks round the margin of this newly formed land. The wind blew the sand, and the sandbanks increased in length and breadth until they completely shut out the ocean. Thus, the river, the sea, and the wind combined to form a great flat expanse of many square miles in extent. The plains so formed are known in Spain as the *marismas*. A small part of them is wooded with pine and cork-oak, or covered with a dense undergrowth of tamarisk, gorse, cistus, and other shrubs, but by far the greater portion consists of mud and marsh, flooded by the river in winter and burnt up by the sun in summer. The human population of these plains consists only of a few herdsmen—wild picturesque-looking men, armed with long sticks and wearing rough sheepskin coats and long apron-like leather gaiters. These men live during the summer in rude huts built of reeds, and they, with the help of their dogs, watch over great droves of horses, bulls and sheep.

Fig. 1.—Stalking in the *Marismas*.

An ornithologist visiting this country recognises at once that it is an ideal place for many kinds of birds. Food and nesting sites are plentiful and varied, and the country is very little disturbed. Moreover, this corner of Europe lies in the track of a vast number of birds of many kinds, migrating from Africa to the north of Europe in spring, and from the north to their winter quarters in Africa in the autumn. Many of these migrants are induced, by prospects of food and seclusion, to break their journey for a few days in this congenial wilderness.

Towards the end of March, 1898, my friend, G. Chenevix Trench, and myself left England to follow in the footsteps of such noted ornithologists as the late Lord Lilford,

Fig. 2.—The Stalker from the Bird's Point of View.

Messrs. Abel Chapman, H. E. Dresser, and Howard Saunders, who have all explored this wonderful country. Our principal object was to collect *Limicolæ*, or wading birds, for a special purpose. We also hoped to get many other birds, and we knew that we should see many sights in the way of bird-life which possibly might have been seen many years ago in England but will never be seen again, owing to the great marshes of the East Coast having been drained and cultivated.

Once arrived in Spain, delays innumerable and unlooked for occurred, and we soon learnt to know the meaning of that much abused word *mañana*, which signifies any day but to-morrow. It was not therefore until April 4th that, with all preparations made, we boarded our boat at the little village of C. and sailed off down the river. The boat, or "sheep," as the owner called it, which was our home for six or seven weeks, was a half-decked barge-like lugger, by no means extravagantly fitted, but roomy and well suited for our purpose. The Guadalquiver is noted, amongst other things, for its thick and muddy water, its strong tides, and for the wind which is nearly always blowing on it. Never once did we see more than three or four inches below its surface, never once was the tide favourable, and as to the wind it was either not blowing at all, or, when it was blowing, it was, owing to the winding nature of the river, of little use. As a consequence, instead of four hours we took ten to arrive at our first camping place. But when one is in Spain one must do as the Spaniard does. If one cannot be moving, then, surely, it is much more pleasant to sit still and smoke the delicious *cigarillo*. What true Spaniard ever loses an opportunity of employing himself in this way? But there were many things to attract our attention on this slow voyage, and consequently it was not always possible to adopt the Spaniard's methods. We were passing through the wonderful *marismas* for the first time in our lives, and although there was very little of the country to be seen from the river our field glasses were constantly in use. Parts of the river bank were thickly grown with reeds from which proceeded the hoarse and incessant song of the great reed warbler.* We were very anxious to see the birds, but they clung to their reeds and we did not catch sight of one until some time afterwards under more favourable circumstances. There were many ducks on the river, and waders on its banks, to be carefully looked at, while now and again we passed a reed-hut or a stack, the top of which was occupied by a stork† sitting upon her nest. Once, on turning a sharp corner as we were drifting down close to the river bank, we came face to face with a great bustard‡ in all his glory. We were so struck by the suddenness of the meeting, and by the imposing size of the turkey-like bird standing on the bank above us, that we had scarcely time to realise what we saw before the bird had turned and

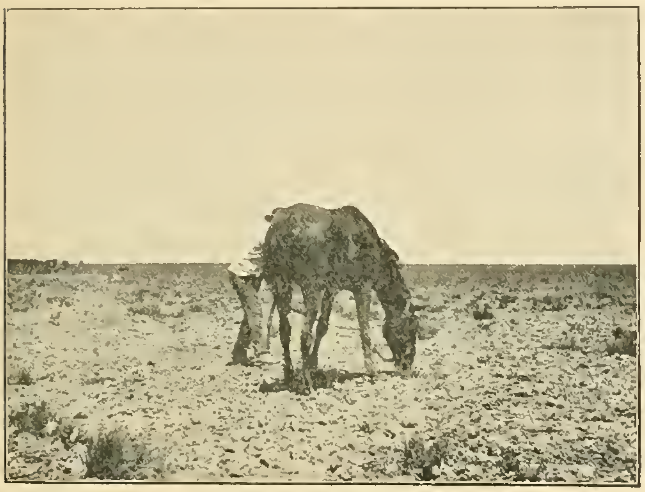


FIG. 3.—About to turn the Horse.

fled from our sight. I hope to say more of the great bustard, for we both saw and shot them afterwards. We saw many kites soaring in the distance, and once we were treated to a very fine sight in bird-life. Some two hundred or three hundred yards from the river there was evidently a carcase, which we could not trace from the boat, but the kites and vultures, those excellent scavengers, had found it. We counted two hundred black kites§ and four Egyptian vultures|| in the air, and there must have been many more on the ground. They were evidently gathering from far and near. Many appeared as mere specks floating up aloft, but as one's eye passed down the "column" of birds, it could be seen that each individual with wings outstretched was sweeping round and round in gigantic circles, ever coming nearer and nearer to the earth, while its place above was taken by another speck intent upon the feast. So they succeeded one another, and what was but a dot in the sky grew gradually larger and larger until one could see the real size of the bird, and then its markings and feathers. We saw many such sights during our stay in Spain, but never again on so grand a scale.

It was dark before we had tied up our boat alongside an island in shallow water. Our ever cautious commander remarked that the steamers plying up and down this river were very careless as to whom they ran down, but, said he, if a steamer tries to come where we are she will run aground before she can get near us. So we felt safe as we turned in to our little cabin and dosed off to the accompaniment of many strange cries from birds flying over our boat.

* *Acrocephalus arundinaceus.* † *Ciconia alba.* ‡ *Otis tarda.* § *Milvus migrans.* || *Neophron percnopterus.*

The next day (April 5th) we explored the island to which our boat was anchored. This island was almost entirely covered with reeds, not ordinary reeds such as one sees in England, but reeds as thick as one's wrist, and from twelve to fifteen feet high. Moreover, they grew so thickly together that it was exceedingly hard work to force a way through them. Here and there we came to a comparatively open spot, covered with broken reeds to the depth of two or three feet. In three of these open spaces we found nests in the shape of large heaps of broken reeds, on the top of which were hollows lined with finer stuff. Two of these nests contained round dirty white eggs, which we were able to identify with certainty by shooting two female marsh harriers* as they rose from them. We often caught sight of a purple heron† flying above us, and seeing some rise up a little distance off we forced our way through the reeds to the spot. Our labours were rewarded by the discovery of several nests, built high up amongst the reeds. We soon cut them down, and possessed ourselves of the bluish-green eggs which they contained.

Perhaps our most interesting find on this island was a nest of the black kite. The nest, which contained two eggs, was placed like a heron's, in the reeds. The black kite usually breeds in trees, and sometimes in cliffs and towers. There could be no doubt about this nest in the reeds, for we shot the bird as it flew from it, and the eggs were typical kites' eggs. Our men said it was a common habit of the black kites to build in these tall reeds. Kites were numerous in the neighbourhood, and trees were very scarce, but the reeds seemed to form an efficient substitute.

As we were nearing the boat, after a four hours' "fight"

FIG. 4.—Turning the Horse.

with the reeds, we saw three harriers in the air: a pair of Montagu's‡ (the male slate-grey, and the female dark brown), and a marsh harrier, a much larger bird, with grey wings and tail, and dark body. The smaller birds were stooping at their larger cousin, while he kept tumbling in the air in his endeavours to evade his tormentors. What was the cause of the disagreement I do not know, but the effect formed a very pretty sight.

We visited this extraordinary island again on May 13th, and found a nest of Montagu's harrier, containing five

* *Circus æruginosus.* † *Ardea purpurea.* ‡ *Circus cineraceus.*

eggs. Here, again, we were lucky enough to shoot the female bird, and thus identify the eggs without a doubt. This nest was nothing more than a few pieces of old broken reeds placed on the ground, and well hidden in the midst of a patch of young reeds. We also found on this day a beautiful nest of the marbled duck,* containing thirteen rich cream-coloured eggs.

Arrived at the boat, we sailed some way down the river, and eventually anchored at the mouth of a small creek, which was to be our camping place for a week or so while we explored the *marismas*. I shall reserve for my next article the description of what we saw and obtained in this wilderness of water and mud, scantily covered with coarse vegetation. There was little to be seen from our boat. A great expanse—flat and unbroken, save for a few cattle, a reed hut or two, and a distant clump of trees—stretching away to the horizon in front, while the river, with its muddy waters and calm surface, flowed evenly behind us.

There is a very general idea that in a wild and uncultivated country where few human beings are to be found the birds are much tamer than in a populous country such as England. We did not find this to be the case in Andalucia; indeed, many birds which we had always considered tame and confiding in England were quite the reverse in the *marismas*. Those who have collected in other wild countries will bear me out in this, the reason for which I think must be that in a country where man is rarely seen the birds never have a chance of becoming accustomed to him, and consequently shun him in the same way that a horse will shy at a strange object by the roadside. There was no cover above a foot high in this part of the *marismas*, and it may well be asked how we managed to get near enough the birds to shoot them.

The wild-fowler in England uses a punt to approach

FIG. 5.—Tying Head to Tail.

his birds, or he stalks them through some short cover, or he hides himself and waits for the birds to come to him. The *patero*, the wild-fowler of the *marismas* of Andalucia, uses a specially trained horse, from behind which he steals unawares upon the flamingo, goose, or duck. We were accompanied by two *pateros*, each with his stalking horse, or *cabestro*, and I may safely say that we should have collected very few birds in these open plains without the help of our *cabestro*. They were small and poor looking animals, but they never seemed to tire, and were exceedingly well trained to their work.

If the reader will turn to the accompanying illustrations he will get a general idea as to how these horses are used. Suppose you wish to approach a flock of birds feeding far out in a shallow lake. You go as near as you dare, walking upright behind the horse, but you must be careful. The birds take no notice of anything under the horse's belly, but if they catch sight of your head or hat above his back they are alarmed directly. They are already

FIG. 6.—The Shot.

looking suspicious, although you are still a long way off. You stop, and the horse is so well trained that he immediately stops also, and puts his head down as though he were feeding. There is nothing for him to eat except dry caked mud, but the birds do not know that, and seeing him quietly feeding, they take no more notice of him than of the thousands of half-wild horses and bulls which inhabit the *marismas*. Your *patero* arranges the halter, studies the wind and the situation of the birds, and then the stalk begins in earnest.

The *patero* has the halter in one hand and his gun in the other. With his body bent, so that nothing appears above the horse's back, he walks slowly and carefully along, keeping close to its shoulders. He guides his beast by means of the halter and his elbow, the latter being kept pressed into the horse's ribs (Fig. 1). Now and again he takes a look at the birds from under the neck of his *cabestro*. You follow exactly in his footsteps, keeping close to the horse, with one hand on his hip, so that when he takes a long or quick stride you may not be left behind, and thus be seen by the birds. Meanwhile, the horse itself is acting with great intelligence. He goes along slowly, lifting his legs carefully, and putting them down with great deliberation, and all the while his head is kept low, as though he were browsing or drinking. You have been approaching the birds at an angle, and it soon becomes necessary to turn and make another tack. The *patero* stops, and, going a step away from the horse, motions you to step aside too, and crouch behind him. He then gives the halter a sharp pull, and the horse turns round so quickly that the birds scarcely notice the action (Figs. 3 and 4).

On you go again, and are soon trudging through the water. There are many things to try you. The horse stirs up the mud, and you cannot see where you are putting

* *Anas angustirostris.*

your feet. As a consequence you are continually plunging and slipping into some deep hoof-mark in the mud. You suddenly feel a wet stinging slap, and you find your face has formed a barrier between the horse's wet tail and a villainous fly on his flank. The perspiration is streaming off you, and your back is aching unbearably. Just as you are beginning to think that you must give it up to stretch your back at any cost, the *patero* suddenly stops. The relief is great as you squat down, and your surprise is greater when you take the field glasses, and looking under the horse's belly discover that the birds are quite close. Before proceeding further a rope is fastened to the halter, passed between the horse's legs and tied to its tail. (Fig. 5.) This is a necessary precaution to ensure the horse keeping his head down. Were he to raise it when so near the birds they would probably become alarmed. At last you get within shooting distance, the signal is given, the horse stops, and, cocking your gun, you stand up. The relief to your cramped and aching back is so great that for a moment you stay stock still and survey the birds to which the *cabestro* and his master have brought you so cleverly and so successfully. Now the unsuspected danger suddenly dawns upon the flock—there is a straining of necks and a flutter of wings. Raising your gun you fire over the horse's back, or, if there is time, rush out from behind him and fire in the open. The well-trained *cabestro* never moves while you shoot. Drooping his head, he remains like a block of wood until the spoil is collected and you return to him.

These beloved *cabestros* were our constant companions during our stay in the *marismas* and many were the birds we watched, photographed and shot from behind them.

WITT'S PLANET DQ.

One of the most important astronomical discoveries of recent years is the finding of the planet DQ, by Witt. This object will come nearer to the Earth than any other similar object, except the Moon. Its minimum distance is about fifteen million miles, and the corresponding parallax nearly a minute of arc. To determine the photometric brightness of this object, the stars, —6°5567, —6°5579, —6°5600, —6°5608, and —6°5626 were each measured on five nights with the meridian photometer, eight settings being made each night, with the resulting magnitudes, 7·87, 8·65, 8·71, 8·56, and 9·57, respectively. The probable error of these values varies from ±0·020 to ±0·033. The brightness of the stars, —6°5550, —6°5560, and —6°5588 was later determined differentially from these, with the resulting magnitudes 8·80, 9·89, and 8·37. Mr. Wendell compared the planet on six nights by means of the photometer with achromatic prisms attached to the fifteen-inch equatorial. The number of settings on each night was forty-eight. On September 5th and 6th, 1898, it was compared with —6°5626, on September 9th with —6°5608, on September 12th with —6°5579, and on September 13th and 14th with —6°5588. The resulting magnitudes were 12·19, 11·97, 12·10, 12·01, 12·20, and 12·29. Mean, 12·13 ±0·04. As the logarithms of the distances of the Sun and Earth, on the mean date, September 10th, were 0·2366 and 9·9115, the magnitude when these distances are both unity becomes 11·39.

It is not easy to obtain photographs adapted to determining the photographic brightness of this object, owing to its faintness and rapid motion. With a short exposure the image is very faint, and with a long exposure a trail is obtained which cannot be compared with the circular images of adjacent stars. Measures of the photographic brightness have been made by Mrs. Fleming on plates taken with the eight-inch Draper telescope, and having exposures of about fifteen minutes. The planet was not far distant from the variable star T Aquarii and was compared with four of its comparison stars whose photometric magnitudes had already been determined. Plates taken on September 6, 12, 13, 13, 13, 13, 14, 17, 20, and 21, 1898, gave the magnitudes 12·78, 12·75, 12·80, 12·85, 12·78, 12·75, 12·75, 12·72, 12·65, and 12·68. Mean, 12·75 ±0·01. Similar measures of two isochromatic plates taken on September 17th and 20th, gave the magnitudes 12·80 and 12·61. Mean, 12·70 ±0·08. Since the planet is fainter photographically than photometrically, it is probable that its colour, like that of the Sun, is redder than an average star.

Several interesting photometric problems present themselves in connection with this object. First, the approximate diameter may be determined by comparison with the brighter asteroids and satellites, assuming that the reflecting power is the same. Secondly, the great variation in the distance of this object from the earth will afford an excellent test of the law that the light varies inversely as the square of the distance. The existence of an absorbing medium in the solar system will thus be tested. Thirdly, owing to the proximity of this object to the Earth at opposition, its phase angle will vary by a large amount. It will, therefore, afford an excellent test of the law connecting this angle with the variation in brightness, which has been found by two or three observers independently.

NEBULA IN ANDROMEDA.

A comparison of photographs of the nebula in Andromeda taken with the eight-inch and eleven-inch Draper telescopes on September 20th and 21st, 1898, with similar photographs taken in 1893, 1894, 1895, and 1896, fails to show the new stellated appearance recently announced by Seraphimoff, of Pulkowa. See also *Astron. Nach.* 147, p. 223.

Edward C. Pickering.

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CONSIDERATIONS ON THE PLANET SATURN.

By E. M. Antoniadi.

Receiving from the sun less than one-ninetieth of the heat sent us from that luminary, the thermal conditions of the planet Saturn, supposed destitute of intrinsic heat, or of a heat imprisoning atmosphere, cannot be much above the absolute zero of temperature. Lavoisier, who clearly foresaw the eventual liquefaction of gases, upon examining what would take place if our earth were transported to the distance of Saturn from the sun, suggested the idea that our refrigerated atmosphere would alter its gaseous state and condense itself into a liquid or solid mass upon the planet's surface. The subsequent liquefaction of sulphurous acid gas by Monge and Clouet in 1800, that of chlorine by Northmore in 1805, and, above all, the liquefaction of oxygen, hydrogen, and carbonic acid gas by MM. Caillette and Raoul Pictet in 1877, is merely the experimental verification of a physical conception whose force lay in its anticipating the unknown.

As a consequence, we find that, in virtue of their great distances from the sun, the four superior planets, if not self-hot, would be deprived of atmospheres, comparable at least in composition to our own. The presence of gaseous envelopes round these worlds would thus imply relative youth in their planetary evolution.

Strong reasons have been adduced to show that Saturn is one of the youngest, if not the very youngest planet of our system. The chief of these is its low mean density. Density increasing with age, a very low mean density is only compatible with youth. "This noble ball," says Webb in his fascinating style, "has so little density that it would float like oak on water, which is actually heavier, and, therefore, if any were found there, would sink to its centre."*

The changes in the mottled appearance of the planet's belts, brought forward by modern discovery, is another argument in favour of its youth. At the distance of Saturn solar energy seems too enfeebled to produce the phenomena actually seen; so that we are obliged to have recourse, for their interpretation, to the assumption that the planet still retains a part of its original heat, and we have seen that intrinsic heat in a given stage of a planet's life is only a synonym of youth. But, inasmuch as the shadows of the satellites in transit across the planet have been repeatedly described as being quite "black," such heat is at best *dark* heat, the oscillations producing which send through the ether undulations of greater wave-length than those appropriate to vision.

The first feature which strikes the student when observing Saturn in a powerful telescope is the rapid waning of the luminosity of the globe towards the limb. This appearance, which is also observable on Jupiter and Uranus, is a necessary consequence of the law of irregular reflection or diffusion of light, according to which the intensity of the illuminated surface varies inversely with the angle formed by the incident rays with the normal to the surface. Such is the deportment of a white unpolished globe illuminated by a powerful distant light. Consequently, terrestrial analogies lead us to the probability that the visible surface of the major planets would seem to be composed of more or less uniform, dull oceans of precipitated vapours—clouds—with scarcely any light-scattering medium above.

Diametrically opposed phenomena are shown by the brighter limbs of the inferior planets, whose dazzling atmospheres extend high above the 'cloud region.' Here, as suggested by Sir William Herschel, the line of sight encounters an increased number of luminous particles towards the limb, whose luminosity is thereby, of course, increased.

In 1805, with a slight opening of the ring, Herschel drew attention to a peculiar appearance of the globe of Saturn, which presented itself as "square-shouldered." Various explanations have been given of this remarkable phenomenon, but none, to the writer's knowledge, that seems plausible. Thus Proctor speaks of Herschel's observation as a "discovery that the planet's outline occasionally fluctuates in such sort that instead of the normal ellipse we have abnormal peculiarities,"† and proceeds to explain the phenomenon by a hypothetical variability of Saturn's surroundings to the depth of *several thousand miles*, becoming at times transparent, at others opaque. Ingenious as the interpretation doubtless is, we must confess that it strikes us *à priori* as somewhat forced and unnatural. Strikingly abnormal planetary appearances are, as a rule, products of the most trivial causes, and rather than launch into the uncertainty of fearlessly explaining away what we know next to nothing about, we ought to keep our minds alertly vigilant to detect the unsuspected action of some elementary physical law. Optical science proves usually a valuable auxiliary in such cases, for more than once innoxious contrast effects have given birth to the most marvellous interpretations.* Returning to the question of the square-shoulder of Saturn, we see at a glance that the usual darkness of his polar cap (Fig. 1) must partly check irradiation, thus paving the way to an *optical* "square-shoulder." This ought to happen, and really happens, whenever the opening of the ring is not very considerable, and when the joint action of both the sombre polar caps is brought to bear in the production of the optical illusion.

Fig. 1.—Saturn's Dark Polar Cap, 1895, August 9 (9⅓ O. G., power 220).

The abnormal outline of the shadow cast by the planet on the ring next deserves our close consideration. Many eminent observers have seen this outline assume a form scarcely compatible with the theory. Proctor saw in this a confirmation of his suggestion of a variable outline of the ellipsoid, while Herr Wonaszek concluded that "the plane form of the system of rings . . . . . assumes a conical curve on which the shadow of a sphere can appear as a concave curve."† Somewhat different are the writer's impressions. The shadow has presented to him, during the last twelve years, nothing truly abnormal; nothing that could not be most thoroughly accounted for by the known laws of optics. The convexity towards the globe (Fig. 2) is only what we ought to expect (*a*) from the effect of irradiation and vagaries of vision in blunting the bright angles of the ring along the shadow, and (*b*) from the varying luminosity of the ring, and the consequent exaggerated effect of irradiation towards the outer edge of the interior bright ring—the brightest part of the system.

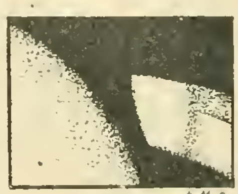


Fig. 2.—Irradiation and Contrast Effects in the Shadow of Saturn, 1890, May 26 (3-in. O. G., power 150).

The white spot bordering the shadow of the planet on the ring, to which Dr. Terby called the attention of the scientific world in March 1889, is another optical phenomenon. Although entirely illusory, this spot was so obvious a feature to the writer at the time as to be readily accessible to a three-inch telescope (Fig. 2). In 1894, with a moderate opening of the system, the spot was also very remarkable, this time on the northern surface of the ring (Fig. 4). In 1895 it was less distinct, while scarcely any traces of it were noted in 1896, 1897, and 1898. It would thus appear that a moderate opening of the system is, in some way, essential to the production of this appearance of contrast.

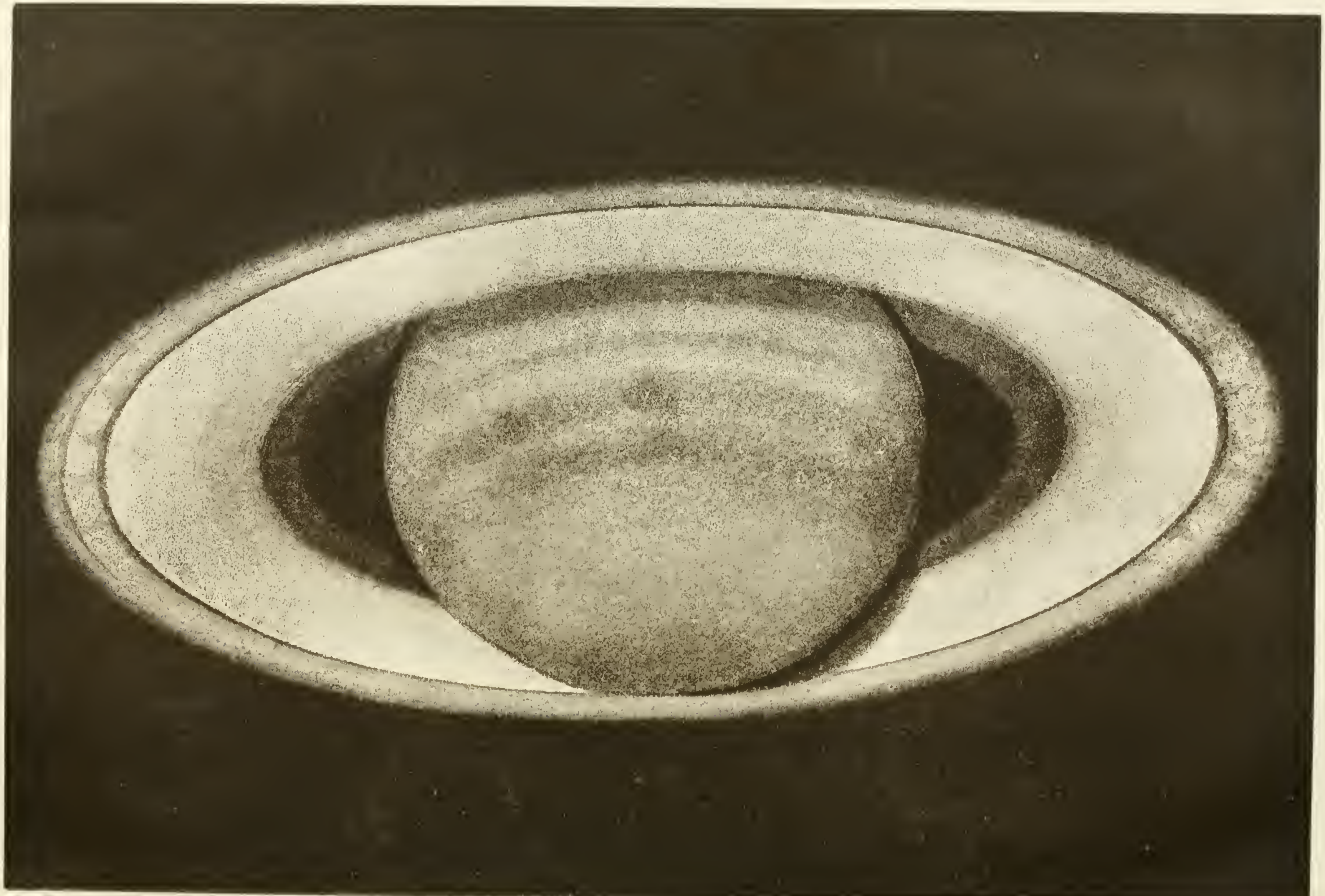
As in the case of Jupiter, the temperate regions of Saturn are marked by a dusky band of apparently variable intensity. The equatorial zone is separated from the temperate latitudes of both hemispheres by a prominent dusky belt, of which broad duplicity seems a characteristic feature. One

* "Celestial Objects," 4th ed., p. 172.

† "Old and New Astronomy," p. 627.

* Observers do not seem to pay sufficient attention to optical products generally, and to contrast effects in particular. Contrast explains the bright borders to the Martian "Seas," the exaggerated cusps of Venus in dichotomy, and I have recently shown (*Monthly Notices*, R.A.S., March, 1898) that the 225d. rotation period of Venus rests on a misinterpretation of contrasts between light and shade. The self-same reason which prevents our seeing stars by daylight masks the real surface of the planet Venus. Hence the hopeless defeat of all attempts to determine her rotation period by visual methods.

† *Bulletin de la Société Astronomique de France*, 1897, p. 485.



SATURN, 1898, September, 13d. 6h. 40m. G.M.T.

Reproduced from a Drawing made specially for KNOWLEDGE by Mons. E. M. ANTONIADI.

or two observers of great reputation have challenged the reality of this duplicity, and in this they were for a short time confirmed by the writer, at a time when his eyes had not the training necessary for the detection of such delicate details. It was subsequently found, however, that the broad appearance of this belt is merely an imperfect view of its really double structure. And as this conclusion has been subsequently confirmed by photography, dissent on this subject is necessarily silenced.

The equatorial zone is the brightest region of the planet, though its brightness falls far below that of the inner bright ring. A narrow band often marks the equator. The colour of the zone is a strong yellow, in which adequate aperture shows, as in the case of Jupiter, a decided "wool-pack" structure. At times, some of these cumuli become so brilliant as to offer easy marks for any rotational displacement of spots.

The rotation period of Saturn was discovered by the illustrious W. Herschel in 1793 from changes in the appearance of the famous "quintuple belt," in the planet's south hemisphere. From one hundred and fifty-four rotations, Herschel gave the value of 10h. 16m. 0·4s., "exact to much less than two minutes either way."*

For a long time Herschel's results remained unconfirmed, when, in 1876, Prof. Asaph Hall detected a bright spot in the equatorial zone. A careful discussion of his observations gave him the value of 10h. 14m. 23·8s. ± 2·30s.†

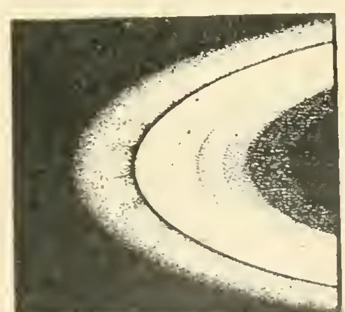
The subject was attacked with the most severe consistency in 1891 by Mr. Stanley Williams. Having obtained, between 1887 and 1891, nearly four thousand observations of transits of spots across the central meridian of Jupiter, this great observer was better prepared than anybody else for the investigation of the arduous problem. Mr. Stanley Williams saw not only the white spots in the tropical regions of Saturn, but, further, had the good fortune of seeing his persevering efforts crowned by the discovery of a series of dark spots on the great double belt, south of the planet's equator. The observations of four bright spots and a dark one, discussed by the late Dr. Marth, gave the value of 10h. 14m. 21·84s. In 1892, the bright equatorial spots gave to Mr. Williams the period of 10h. 13m. 38·4s. In 1893, the Brighton observer saw easily both the bright and the dark spots of the northern hemisphere, and confirmed, by observation, Proctor's suggestion to the effect that "the equatorial zone of Saturn has a rotation period measurably shorter than that of the non-equatorial zones."‡ Mr. Williams further found that the surface material of the self-same latitude did not rotate at a uniform period in different values of kronocentric longitude.§

These remarkable results have been confirmed in 1894. The comparison of the annual rotation periods determined from 1891 to 1894 showed a decrease in the period of rotation amounting to 1m. 46s. "This difference" says Mr. Williams, "means a very considerable increase in the velocity of motion of the surface material, amounting to sixty-six miles an hour. In other words, the great equatorial atmospheric current of Saturn was blowing sixty-six miles an hour more quickly in 1894 than it was in 1891."‖

The same sceptics whom we have seen denying the duplicity of the belts, questioned the reality of the spotted appearance of Saturn.¶ But, inasmuch as their observations have invariably dealt with "the most prominent features," it would seem that, in throwing doubt on the reality of details whose delicacy is beyond their reach, they are going beyond their own department, and their opinion is no longer of weight. The spots of Saturn have been seen by observers of great practical skill, among whom we might mention Messrs. H. MacEwen, at Glasgow, A. Henderson, at Liverpool, G. L. Brown, at Stirling, the Rev. P. H. Kempthorne, of Wellington College, and the late Rev. A. Freeman. At Juvisy the dark spots have been held steadily, and their rotation followed, by M. Camille Flammarion; also by persons who knew nothing about their existence. It was only after two years' fruitless attempts with the nine and three-quarter inch equatorial that the writer saw them in 1896, when the observation of three spots gave him 10h. 14·3m. for the rotation period.

This powerful array of evidence establishes the objective reality of the spots of Saturn on an indestructible basis. Their discovery is one of the most remarkable achievements in planetary work of our times. And when we recollect that the instrument used in their detection was only a six and a-half inch reflector, we deem it impossible to do adequate justice to the steady perseverance and unrivalled skill of Mr. Stanley Williams, whose name we feel assured will pass down to posterity in company with those of the greatest observers who have ever lived.

The question of the nature of the ring system, whose eccentricity to the globe is manifest at present* (*see* the Plate accompanying this paper), has been attacked by Laplace, to whose theory very valuable contributions were brought by two distinguished lady astronomers, Madame Sophie Kowalewski and Miss Dorothea Klumpke.† Bond and Pierce also investigated the subject, but it is to the genius of Edouard Roche and J. Clerk Maxwell that we owe our knowledge of the constitution of that marvellous configuration. As a result of his studies on the figure of a fluid mass submitted to the attraction of a distant point, Roche found, in 1849, that when a satellite, supposed of the same density as its primary, is situated at a distance of less than 2·44 radii, any ellipsoidal figure of equilibrium becomes impossible through the tidal action of the primary. The semi-axis major of the orbit of Mimas, the first satellite, being 3·10 radii, this moon could form and subsist; but the ring, being entirely within the theoretical limit (1·48 to 2·30), has actually remained in a state of cosmical dust.



E. M. A.

FIG. 3.—Amphitheatrical Gradations separated by Rarefaction Zones, seen on the Inner Bright Ring on 1896, April 18 (9¾in. O.G., power 300).

Thus, for Roche, as well as for Clerk Maxwell, the only possible system of rings would be composed of a number of discrete particles revolving round Saturn with varying velocities—a theoretical conclusion, which the application by Keeler of the Doppler-Fizeau principle to the revolution of the ring has confirmed in such a striking manner. These particles are either united into a series of narrow

* *Philosophical Transactions*, 1794, p. 66.

† "Saturn and its Ring," App. II. to *Washington Obs.*, 1885, p. 15.

‡ "Old and New Astronomy," p. 624.

§ *Monthly Notices*, R. A. S., March, 1894.

‖ *Ibid*, May, 1895.

¶ Mee's "Observational Astronomy," App. II. to Second Edition.

* Since 1895 the writer invariably found that the eastern vacuity is greater than the western—a somewhat normal appearance.

† *Thèses présentées à la Faculté des Sciences de Paris pour obtenir le grade de Docteur ès Sciences Mathématiques*, par Mdlle. D. Klumpke. Paris, 1893.

rings, or cross each other irregularly in their motions. The frequent observation of sub-divisions, permanent or otherwise, in the rings (Fig. 3) is thus only what should naturally be expected; but under such circumstances final disintegration is inevitable.

An interesting corollary of the discrete character of the system is the intimate relation existing between the grouping of the particles and the luminosity of the ring.

There where the particles are grouped nearer together (outer edge of inner bright ring), we have increased luminosity; there where they are more coarsely scattered (outer ring), the brightness is diminished. Should the particles be too widely strewn (dusky ring), then we have the conditions necessary for the production of transparency. There can be but little doubt that the outer ring is also slightly transparent; not, of course, to the extent of showing us the planet's limb through it, but still sufficiently transparent to render its shadow grey and not quite black (Fig. 4).

As its epithets of "crape ring" or "gauze veil" imply,

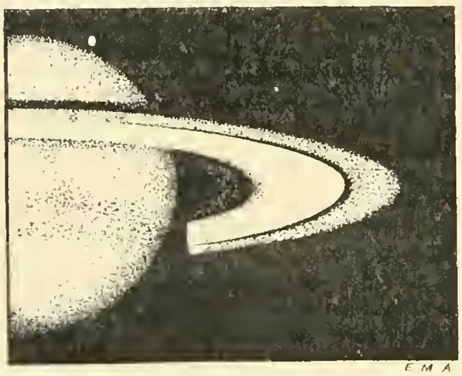


Fig 4.—Duskiness of Outer Ring's Shadow, suggesting the idea of Transparency. 1894, July 4 (9¾ in. O.G., power 220).

the dusky ring of Saturn has been hitherto considered as "one of the greatest marvels of our day."* But the remarks we have made on the subject of the wonders associated with the square-shouldered appearance of the planet, have warned us to be sceptical of irrational interpretations. Of explanations of the nature of the dusky ring the writer knows none, excepting "Burton's ingenious suggestion, that the separate particles, though brighter than the sky, may be less luminous than the ball."† But the very ingenuity of this assumption casts a doubt on its correctness.

We can scarcely believe (*a*) that one part of a system of discrete particles, having manifestly a common origin, is white, another grey; and (*b*) that the sombre meteors all managed to group themselves near the planet to the absolute exclusion of the white ones. The probabilities of such a state of things being natural are but few. "The moon," said Tyndall, "appears to us as if—

"'Clothed in white samite, mystic, wonderful;'

but were it covered with the blackest velvet it would still hang as a white orb in the heavens, shining upon our world substantially as it does now."‡

Starting from the hypothesis that the luminous diffusive power of the particles is everywhere the same, and seizing all natural conditions likely to be found here, we might perhaps scan the true nature of the "gauze" ring. We saw that the relation between the agglomeration of the particles and the luminosity of the ring implies that the bodies constituting the "dark" ring are more coarsely scattered than those constituting the bright rings. In this case the segments at the ansæ would be, just what they actually are in the telescope, parts of a nebular annulus; while, across the planet, the passage of the ring would be invisible *as far as the particles themselves are concerned.*

But, inasmuch as the stream casts its shadow on the globe of Saturn, every individual meteor yielding its own modicum of shade, we readily perceive that the trace of the "dark" ring across the planet would be a dusky shading, due solely to the shadow of the particles on the ball, a shadow which would be visible through the gaps separating that flight of meteors (Fig. 5).

The correctness of this theory may be checked by its consequences. Should the sun be higher above the plane of the ring than the earth, the breadth of the shadow across the planet would shrink along the minor axis; should the sun be lower than the earth, the breadth would be increased by the additional shadow of the inner edge of the bright ring. In both cases, however, the outline of the shadow cast on the globe would not be a rigorous continuation of the nebular ansæ. But, as the heliocentric latitude of Saturn cannot exceed 2° 30′, and as the proximity of the ring to the planet is very great, the slight differences of outline we have mentioned would, under all ordinary circumstances, be entirely masked by errors of vision.

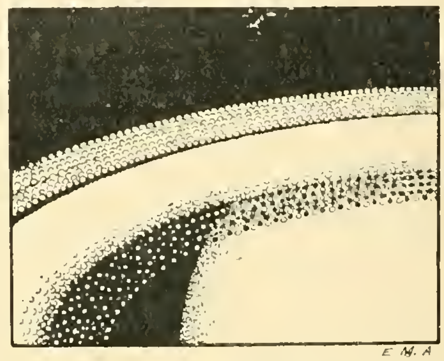


Fig. 5.—Diagram illustrating the writer's theory on the probable constitution of the Crape Ring. (Dimensions of particles and their shadows monstrously exaggerated.)

As a last consequence of the theory we are examining it ought to be expected that the darkness of the dusky belt across the globe would be, to a slight extent, a function of the opening of the system. When the value of the angle formed by the plane of the ring and the visual ray is small, the particles of the "dark" ring ought in an appreciable measure to hide their own shadow, while their apparently closer grouping would in this case slightly interfere with the usual transparency of the ring, a conclusion which seems to be actually corroborated by observation.

Science Notes.

Lord Iveagh has made two munificent offers to the nation, the fulfilment of which will involve a cost to the donor of a sum amounting to not less than half a million of money. The first offer, which has already been accepted, is that of a quarter of a million to be employed in the endowment of scientific research. It is explained in the following letter which was addressed to the Press on December 22nd by Lord Lister, the Chairman of the Council, and Sir Henry E. Roscoe, the Honorary Treasurer of the Jenner Institute of Preventive Medicine:—"We ask permission to announce in your columns a splendid offer in aid of scientific research which has been placed in our hands. British and Irish men of science have long

* Webb, "Celestial Objects": Saturn.

† *Ibid.* ‡ "On Light," 5th ed, p. 33.

deplored the fact that the opportunities in this country for research directed to the prevention of disease are not equal to those possessed by foreign nations. Lord Iveagh wishes to help in removing this reproach to our country, and, on the conditions named below, has offered the sum of £250,000 (two hundred and fifty thousand pounds) for the purposes of the highest research in bacteriology and other forms of biology as bearing upon the causes, nature, prevention, and treatment of disease. He has proposed to the council of the Jenner Institute (lately the British Institute) of Preventive Medicine—a body which includes leading men in medicine and allied sciences in the British Isles—that the donation shall be handed over to the institute on condition that in future the control and management of the affairs of the institute shall be placed in the hands of a new board of seven trustees—three of the seven to be chosen by the council of the institute, three by the donor, and one by the council of the Royal Society. The offer has been cordially accepted at a meeting of the council. The donor further proposes that part of the new fund shall be appropriated to the enlargement of the buildings of the institute at Chelsea, part to increasing the at present sadly inadequate salaries of the director and other members of the scientific staff, part to the expenses of administration and maintenance, and the remainder chiefly to founding valuable Fellowships and studentships, tenable for limited periods, for research either in the laboratories of the institute or in centres of outbreaks of disease, whether at home or abroad. The conditions on which these Fellowships and studentships may be held are not yet determined upon; but it is hoped to open them to all classes of Her Majesty's subjects. Lord Iveagh, in our opinion, deserves the gratitude of the nation for thus munificently providing for the cultivation in the British dominions of biology and allied sciences for the good of mankind in an institution which henceforth will compare favourably with any similar establishment in other parts of the world."

In a letter to the *Times*, far from hostile in spirit, Sir John Lawes and Sir Henry Gilbert criticise the statements made by Sir William Crookes in his address as President of the British Association on the wheat supply of the world, and it is satisfactory to learn that the outlook is not so gloomy as was depicted in that address. "That we may have considerable fluctuations in produce and in price," say these authorities, "the result of war, or of the vicissitudes of the seasons in different countries, is very probable; but we believe that there will always be a sufficient supply forthcoming for those who will find the money to purchase it at a remunerative price."

Prof. Chun, the leader of the German deep-sea expedition, has sent to Sir John Murray an account of the progress of the work. On the 7th August, 1898, in the cold waters of the Faröe Channel, from a depth of three hundred and twenty-two fathoms, the trawl produced a rich harvest of deep-sea sponges, sea-lilies, sea-stars, and sea-spiders. Many deep-sea crustacea and fishes which were taken in the dredge and trawl by earlier expeditions, and were therefore supposed to live on the bottom, have been proved to live a pelagic life, floating or swimming in the intermediate waters. Gorgeous *radiolaria*, violet-coloured jelly-fishes, large *astracoda*, the size of nuts, living gelatinous sea-slugs, strange cuttle-fishes, and large new sea-butterflies have been captured by the *Valdivia's* closing nets in the deep intermediate waters of the North Atlantic.

Mr. Charles W. Andrews, recently returned from Christmas Island (Indian Ocean), has given a detailed account of the expedition to the Royal Geographical Society. He describes the climate as delightful and healthy; there are no stagnant pools, and there is a fair supply of good water; forests are extensive, and many creepers and ferns lend beauty and variety to the scenery. There are only five species of mammals—two kinds of rats which swarm everywhere, a shrew mouse, and two bats; reptiles are few and small, and insects fairly abundant. There are several species of land crabs, and the robber crab is very plentiful, and if one sat down for a short time in the forest, at any spot, that spot speedily became the centre of a circle, and along the innumerable radii the crabs could be seen wending their way securely, if slowly, to the place of meeting around the sitter.

A scientific expedition under the leadership of Herr Meyer, the explorer, left Hamburg on the 1st December, 1898, for South Brazil and Argentina, where the party will conduct anthropological and geological researches. The expedition, which takes its own doctor, numbers thirty members, and will be absent for two years.

The medals of the Royal Society have this year been awarded as follows:—The Copley Medal to Sir William Huggins, for his researches in spectrum analysis applied to the heavenly bodies; the Rumford Medal to Prof. Oliver Joseph Lodge, for his researches in radiation, and in the relations between matter and ether; a Royal Medal to Dr. John Kerr, for his researches on the optical effect of electrical stress, and on the reflection of light at the surface of a magnetized body; a Royal Medal to Mr. Walter Gardiner, for his researches on the protoplasmic connection of the cells of vegetable tissues, and on the histology of plants; the Davy Medal to Prof. Johannes Wislicenus, for his contributions to organic chemistry, especially in the domain of stereochemical isomerism; and the Darwin Medal to Prof. Karl Pearson, for his work on the quantitative treatment of biological problems.

Dr. A. M. W. Downing, chief of the "Nautical Almanack" office, gives some particulars on the total solar eclipse of 28th May, 1900, which will be useful to those who contemplate an expedition to Algiers—a place easy of access and in the centre of the shadow.

The death of Mr. Edwin Dunkin, F.R.S., occurred on the 4th December, 1898, a gentleman whose name is familiar as the author of several books: "The Midnight Sky," "Familiar Notes on the Stars and Planets," and a work on "The Movement of the Solar System in Space," determined from the proper motions of one thousand one hundred and sixty-seven stars. He was born at Truro in 1821, and joined the staff of Greenwich Observatory while yet a youth of seventeen, and remained there nearly half a century. Mr. Dunkin was elected a Fellow of the Royal Astronomical Society in 1845; served as Secretary from 1871 to 1877, and in 1884 was elected President; he attained to the Fellowship of the Royal Society in 1876, and from 1879 to 1881 was a Member of the Council of that august body. Mr. Dunkin represented the Astronomer-Royal in several eclipse expeditions, conducted many important operations in determining the telegraphic differences in longitude of widely separated places, and he was the responsible agent in the famous pendulum experiments undertaken at Harton coal-pit, near South Shields, in 1854, by the Astronomer-Royal, with the object of ascertaining the mean density of the earth.

British Ornithological Notes.

Conducted by HARRY F. WITHERBY, F.Z.S., M.B.O.U.

COMMON BUZZARD AND DOMESTIC FOWL.—The Buzzard on the right-hand side of the accompanying illustration was taken about seven years ago in Wales. In 1896, the bird laid a couple of eggs, which I took away and replaced by two fowl's eggs. She sat on these for a time and then eat them. In 1898 she again evinced a desire to nest, and I supplied her with materials as on the former occasion. She built a nest in a corner of the cage, which is about

twenty feet by eight feet by eight feet, and laid two eggs. I again substituted two fowl's eggs, one of which she hatched out, but the chick disappeared, and whether she eat it or not I do not know. As the bird still seemed inclined to sit, I put three fowl's eggs in the nest. Two of these were hatched, but one chicken died. The other is the one shown on the left of the Buzzard in the illustration. I fed the chickens on hard-boiled eggs, chopped small, and the Buzzard used also to eat this food. Gradually the Buzzard fed the chicken on meat, and now the latter feeds on both meat and corn; it will not, however, eat maize. The chicken and Buzzard roost side by side on the perch at night, and are most friendly. The chicken is fond of birds and has even tried to help the Buzzard to kill them. It is now large, and appears to have thriven well on meat.—ALAN F. CROSSMAN, St. Cuthberts, Berkhamsted, Herts.

HONEY BUZZARD AT PETERHEAD.—There was shot at Kinmundy, on September 19th, an immature specimen of the Honey Buzzard. The plumage was dark brown, with a slightly lighter shade on the cheeks, throat, and belly; there were three bars of a slightly darker colour on the under side of the tail feathers; these feathers were likewise tipped with grey. The plumage was very close, and when separated showed abundance of white. There was one shot at Pitfour, in the same neighbourhood—probably a young male—seven or eight years ago, and is in the possession of the gamekeeper there.—WILLIAM SERLE, Musselburgh.

WOOD-SANDPIPER IN CO. MAYO.—At a meeting of the British Ornithological Club held on November 16th, 1898, Mr. Howard Saunders exhibited, on behalf of Mr. W. Drury, a specimen of the Wood-Sandpiper (*Totanus glareola*), shot by the latter near Lough Cullin, in Co. Mayo, Ireland, on September 5th last. Only three examples of this species have previously been recorded from Ireland, and all of them from one locality, viz., in Co. Wicklow.

GREATER SPOTTED WOODPECKER AT PETERHEAD.—On the 30th October I was shown two woodpeckers that were shot the previous day at Grange Gardens, behind the town. They were both young males; on the one the cardinal colour was developing on the head, and showed fully on the vent, but the white on the upper lesser wing coverts did not show largely. The head of the other showed the cardinal colour fully, as likewise the white on the lesser wing coverts, but the cardinal colour on the vent only slightly.—WILLIAM SERLE, Musselburgh.

Spotted Crake in County Down (*The Field*, November 19th, 1898).—"J. R." reports that he shot a Spotted Crake, which is rare in Ireland, at Seaforde, County Down, on November 5th, and that the specimen is now in the hands of Messrs. Sheals, taxidermists, of Belfast.

Vernacular Names of Birds (*The Naturalist*, December, 1898).—Interesting lists of vernacular names of birds, by Oxley Grabham, F. R. Collins, and Max Peacock, appear in this number.

Ospreys near London (*The Field*, December 3rd, 1898).—Mr. J. E. Harting gives here an account of the various visits of the Osprey to the neighbourhood of London. "Best," in a letter to the *Standard*, of September 20th last, described the actions of an Osprey, which he watched at the Penn Ponds, Richmond Park, on September 16th. Dr. Albert Günther saw an Osprey soaring over Kew Gardens on September 15th, 1898. Mr. Harting gives many records of Ospreys shot or seen near London since 1855, and considers that "these instances serve to show that Ospreys may be annually looked for near London during the autumn months."

Additional Notes on the Great Auk or Garefowl. By Symington Grieve (*Transactions of the Edinburgh Field Naturalists' and Microscopical Society*, Vol. III., Part 7).—These notes are additional to a paper printed in Part 6 of the *Transactions* of this Society. One newly recorded skin, belonging to M. Le Baron de Vilmarest, of Nielles-les-Ardres, is specially dealt with.

A Pet Cuckoo. By Charles Campbell (*Transactions of the Edinburgh Field Naturalists' and Microscopical Society*, Vol. III., Part 7).—We have here an account of a cuckoo which has been in captivity for over two years.

All contributions to the column, either in the way of notes or photographs, should be forwarded to HARRY F. WITHERBY, *at 1, Eliot Place, Blackheath, Kent.*

Notices of Books.

Birds of the British Empire. By Dr. W. T. Greene, F.Z.S. (The Imperial Press.) Illustrated. 5s. net. It has never been our misfortune to criticise a more inaccurate book than the one before us. Where the author has obtained his information we know not, but, with so many standard works on ornithology at command to refer, it is most astonishing how Dr. Greene could have filled his book with such startling errors. The following are two samples of the author's ornithology:—Page 23, "The Pied Wagtail is only found, out of Britain, in the Scandinavian peninsula." The Pied Wagtail is found in Denmark, Holland, Belgium, France, Portugal, and other countries. Page 154, speaking of the Knot, the author says: "Some, however, remain to breed." The first and only authenticated eggs of the Knot were only lately discovered in the Arctic regions. Besides containing a number of glaring errors like the above, the book is very carelessly constructed. For instance, descriptions of many birds which should have been included are omitted, and many which are included should have been omitted. Long and often most inaccurate descriptions of the plumage of each bird are inserted, whereas it is only necessary in many cases to say how one bird differs from another. In most cases the author describes the summer plumage, but this is only to be guessed, for no mention is made either of summer or winter.

Eclipses of the Moon in India. By Robert Sewell. Continuation of the "Indian Calendar." About a year ago we noticed the appearance of the "Indian Calendar," a volume of the utmost importance to those engaged in the decipherment of Indian inscriptions and the compilation of Indian history, and also in the Indian Government offices and judicial courts. That work contained tables of all the eclipses of the sun visible in India for a period of one thousand six hundred years, and it has now been supplemented by tables of the lunar eclipses for the same period (A.D. 300 to 1900); the calculations being, as in the chief volume, based upon Von Oppolzer's *Canon der Finsternisse.* We heartily welcome this completion of so valuable a work. We regret to notice the death of the Pandit Sankara Balkrishna Dikshit, who collaborated with Mr. Sewell in the "Calendar," and who rendered assistance in the present supplement to it.

An Introduction to the Science and Practice of Qualitative Analysis. Inorganic. By Chapman Jones, F.I.C., F.C.S. (Macmillan.) Illustrated. 6s. It is fitting that Mr. Jones should incorporate the words "Science and Practice" in the title of his book, for it is just this feature of reducing the numberless operations of the analytical chemist to a scientific, as distinct from the mere empyric form, which constitutes the value of the work. Indeed, considering that there are scores of books on qualitative analysis already in the market, nothing less than a radical innovation of the kind in question would be sufficient to justify the addition of one more to the already long list. We are at one with Mr. Jones where he says that "for teaching the *method* of work, it is not only unnecessary but undesirable to attempt to include either all classes of compounds, or all the reactions of those that are considered." The object of all teachers should be to help the student to acquire a sound method rather than to fill his mind with innumerable isolated reactions, so that, understanding the principles of analysis, instead of enslaving himself to the mystic rule-of-thumb routine, he can easily extend his work to other substances than those set for practice in the laboratory. We have known students quite helpless, after a long course of instruction, to set about the investigation of an unknown mineral, where there is but little externally to indicate the nature of its composition. This weakness is due to the fact that the student, in general, acquires his analytical knowledge by operating on bodies of known composition, which serve as a sort of alphabet for the construction of words—words, which if properly put together, will spell the composition of the body under examination. Now, in the book before us, the author has put forth his utmost powers to concentrate the light of reason on every experiment, observation and inference; from innumerable reactions he evolves an orderly system—a system that may be adapted to various circumstances, and the student is encouraged to consider the tables given as guides rather than as rigid rules, when he has had a little experience and can judge for himself.

The Parallaxes of 61^1 *and* 61^2 *Cygni.* By Dr. Herman Davis. (New York, 1898.) This is No. 13 of the series of memoirs upon the reduction of the measures of the photographic plates taken by Dr. Lewis Rutherfurd in the years 1871–1874, and which are now being published by the Observatory of Columbia University, New York. The high value of these photographs is now widely recognized, but several points of especial interest are brought out in Dr. Davis's paper. In the first place it was found that the probable error of an observation in the displacement on the arc of a great circle is little greater in measures of angle than of distance. Secondly, the parallax is different for the two components 61^1 and 61^2.

For 61^1 it is $+ 0{\cdot}360'' \pm 0{\cdot}0146''$.
For 61^2 it is $+ 0{\cdot}288'' \pm 0{\cdot}031''$.

This bears out the opinion of Prof. Burnham that this pair forms only an optical double, and that no true orbit can be drawn through their positions. But since the two stars have very nearly the same velocity in space, Prof. Davis advances Wilsing's theory, that there may be a third dark body round which 61^1 Cygni revolves. Incidentally, Prof. Davis brings a very serious indictment against the value of the Oxford parallactic results. "I have examined," he says, "the eight sets of normal equations given in the work on 61 Cygni, pages 17-63, and among the eight sets have not found one which is correct in every quantity. This criticism applies not only to the normals for 61 Cygni, but for many of the other stars as well."

Weather Lore. Compiled and arranged by Richard Inwards. (London: Elliot Stock.) Illustrated. 7s. 6d. This is the third edition of a work intended to present a complete view of weather science from its traditionary and popular aspects. It contains two hundred and four pages of proverbs, curious rhymes, quaint sayings, archaic wise-saws, and out-door rules, and will be of especial interest to the man whose good fortune enables him to live in the country. The volume, in addition to these interesting features, contains the essence of observations made by close observers of the skies, and has an instructive picture of the forms of clouds occurring at different altitudes. It is only necessary to note the conversations which one over hears or takes part in during a single day to convince one's self of the widespread nature of these sayings about the weather. Who has not heard "Plenty of berries indicates a severe winter," p. 184, and yet, since the berries, of course, indicate *past* conditions and *not future* ones, it is difficult, unless providential foresight is imported into the case, to account for its origin. There are many sayings with which one is familiar, and which defy any rational explanation, but the reader must be referred to Mr. Inward's exhaustive and interesting collection itself in order to discover how trustworthy, and also how contradictory, weather predictions preserved in folk-lore can be.

Remarkable Eclipses. By W. T. Lynn, F.R.A.S. (London: Edward Stanford, 26 & 27, Cockspur Street, Charing Cross, S.W.) 1898. Third Edition. Revised. The success of Mr. Lynn's convenient and carefully written little handbooks is apparent in the rapidity with which successive editions are called for. The first edition of this summary of the leading facts connected with the chief eclipses of history appeared in 1896, and the third is now before us. A brief notice of the two last total solar eclipses, 1896 and 1898, and of the circumstances of the two approaching ones are included in it.

Introduction to Algebra. By G. Chrystal, M.A., LL.D. (Adam & Chas. Black.) 5s. According to the author of the book before us the old methods of teaching algebra are at fault, and intended rather for the solution of examination problems than for the purposes of every-day life. We are convinced that Prof. Chrystal has made a refreshing departure, and although there is a rather forbidding appearance about the treatise, students may take heart, for the new method of treatment of the various theorems of algebraic science we think will gain supremacy over the old systems of teaching algebra. A mathematical truth is not made part of the mental furniture of a pupil by merely furnishing him with an irrefragable demonstration; he must see not only where it succeeds, but where it fails to apply, and this book will contribute towards that end.

Practical Mechanics. By S. H. Wells. (Methuen & Co.) Illustrated. 3s. 6d. The Battersea Polytechnic, up to a recent date, was almost the only institute in London which contained a mechanical laboratory, furnished with the apparatus for verifying all the principal laws of mechanics by the students themselves. We therefore welcome a text-book based on the course of study pursued in that laboratory, and cannot but think such a book will be a substantial aid to the principals of other institutes in combining a course of practical mechanics with the ordinary lectures. The text is written in an intelligible style, and is illustrated in a suitable manner by photographs of the actual apparatus used at the Battersea Polytechnic. With the help of this book a teacher may convey information which the student can assimilate without that verbose waste of energy which characterises the work of many preceptors.

Social and Political Economy. Essays and Letters by Thos. Judge. Edited by his son, T. Geo. Judge. (London: Simpkin, Marshall & Co.) 3s. 6d. We cannot discover any adequate reason for the publication of these essays and letters, which are as discursive as they are inconclusive, and we fear must disappoint the modest hope of their editor, that they "may introduce some light, however small," into the consideration of some interesting and important subjects.

Handbook for Literary and Debating Societies. By Laurence M. Gibson. (London: Hodder & Stoughton.) 3s. 6d. A useful volume for the purpose in view, containing an outline of the leading arguments on both sides of a large number of subjects, together with a list of references in each subject.

An Introduction to Practical Physics. By D. Rintoul. (Macmillan.) Illustrated. 2s. 6d. Based on the laboratory notes which have been in use at Clifton College for some years, this book is intended for beginners—a book which "will present no difficulty to the average boy" of thirteen or fourteen years of age, and "all the experiments described are capable of being performed with the most simple and inexpensive apparatus." An inspection of the contents does indeed indicate that the author has contrived to extract a maximum amount of practical knowledge out of a minimum outlay in the way of materials, and although there is little evidence of originality of treatment and disposition of facts, the admirable illustrations and precise instructions for verifying the fundamental principles of physical science are sufficient to commend the work to the preceptors in our schools and colleges.

Provident Societies and Industrial Welfare. By E. W. Brabrook, C.B., Chief Registrar of Friendly Societies. The Victorian Era Series. (London: Blackie & Son.) 2s. 6d. An experience which is unique, and a sympathetic treatment, born of long and intimate acquaintance with the facts, are the invaluable aids which Mr. Brabrook brings to bear upon the subject on which he writes so well. There is no more honourable record in our history than that of the industrial population of our country in regard to provident societies and savings banks, and the official position of the author of this invaluable work will really tend to make the book a sort of informal State document, dealing in a most comprehensive manner with a subject of the highest importance.

Photograms of 1898. Illustrated. 1s. net. (Dawbarn & Ward.) This well-known annual from the editors of the *Photogram* contains a careful and well-judged selection of the year's work in photography. The bulk of the volume consists of a collection of beautiful photographs, which are duly criticised in the text. One or two general articles complete a capital photographic record of 1898.

How to make Lantern-Slides. By S. L. Coulthurst. 1s. (Dawbarn & Ward.) To those who really require a new handbook on the above subject, we can recommend this one, which is up-to-date and clearly expressed. We might remark that twenty or so of its pages are filled with various developing formulæ.

The Reliquary and Illustrated Archæologist. (Bemrose.) 12s. net. We have in former years had occasion to point out the many claims to our regard of this quarterly journal and review, the bound volume of which for 1898 is before us. We have nothing to retract from what we then said, and can only reiterate with, perhaps, more pronounced emphasis, that the journal is worthy of the attention of all persons interested in the study of the early pagan and Christian antiquities of Great Britain, mediæval architecture and ecclesiology, the development of the arts and industries of man in past ages, and the survivals of ancient usages and appliances in the present. The wide margins, superb printing, and beautiful illustrations in wood and reproductions from photographs, all combine to make the volume a choice possession.

First Stage Inorganic Chemistry (Practical). By F. Beddow, D.SC. (Clive.) Illustrated. 1s. Dr. Beddow's book is one of the many inspired by the innovations made in the syllabus of the Science and Art Department. It is a neat, cheap, and excellent little manual in every way for its purpose, and if the many branches of chemistry dealt with in the space of some one hundred and sixty pages are, so to speak, an attempt to make the less contain the greater, that is the fault of the Department rather than the author, who has managed the business of compression with skill, and succeeded in making intelligible a wide range of facts which would tax the powers of most authors with much more space at their disposal. The ordinary operations of fitting up apparatus, preparing gases and compounds, qualitative analysis and quantitative analysis, all come in for a share of the author's attention, and any one who carefully works through the book will acquire a sound knowledge of the groundwork of chemical manipulation.

All photographers should obtain Mr. W. Tylar's 1898 Catalogue of Photographic Specialities and Appliances. Price 6d. The Catalogue consists of over two hundred full and well-illustrated pages, containing, amongst other information, full particulars of many novelties and improved patterns.

BOOKS RECEIVED.

Annals of the Lowell Observatory, Vol. I., Observations of the Planet Mars during the Opposition of 1894-5. By Percival Lowell, Director of the Observatory. (Houghton, Mifflin & Co., New York.)

Quæro: Some Questions in Matter, Energy, Intelligence and Evolution. By Dr. James H. Keeling, F.R.C.S. (For Private Circulation.)

Whitaker's Almanack, 1899. 2s. 6d.

Earth Sculpture. By James Geikie, F.R.S. (Murray.) Illustrated. 6s.

The Life and Letters of Lewis Carroll. By Stuart Dodgson Collingwood, B.A. (Unwin.) 7s. 6d.

Michael Faraday: His Life and Work. By Prof. Silvanus Thompson. (Cassell.) Portrait. 3s. 6d.

The Way the World Went Then. By Isabella Barclay. (Stanford.) Illustrated. 4s.

On the Springing and Adjusting of Watches. By F. J. Britten. (Spon.) Illustrated. 3s.

The Magic Lantern—Nutshell Series. (Iliffe.) 6d.

Flashlights on Nature. By Grant Allen. (Newnes.) Illustrated. 6s.

A New Astronomy. By David P. Todd. (Sampson Low, Marston & Co.) Illustrated. 7s. 6d. net.

The "Mechanical World" Pocket Diary and Year Book, 1899. 6d.

London University Guide and Calendar, 1898-9. (Univ. Corr. Coll. Press.) Gratis.

Tutorial Algebra: Advanced Course. By W. Briggs and G. H. Bryan. (Clive.) 6s. 6d.

Der Ursprung der Afrikanischen Kulturen. By L. Frobenius. (Borntraeger, Berlin.)

Trigonometry at a Glance. By G. W. Usill and F. J. Browne. (Philip & Son.) 2s. net.

The "Queen" Almanack, 1899. 1s.

A Determination of the Ratio of the Specific Heats at Constant Pressure and at Constant Volume for Air, Oxygen, Carbon-dioxide, and Hydrogen. By O. Lummer and E. Pringsheim. (Smithsonian Collection.)

Letters.

[The Editors do not hold themselves responsible for the opinions or statements of correspondents.]

THE NEW OBSERVATORY AT KODAIKANAL.

To the Editors of Knowledge.

Sirs,—The readers of Knowledge will perhaps be interested with a short account of a visit I made yesterday to the new observatory which is building at Kodaikanal. On my way to Shang-hai, I could not help breaking the voyage to pay a visit to the observatory of old repute at Madras, where the late Mr. Pogson did, during so many years, such valuable work in planet discovery, as every astronomer knows. Mr. Michie-Smith, now in charge of the Government Observatory, kindly suggested that on my way back to Tuticorin I should pay a visit to the new buildings at Kodaikanal, where he intends going himself in January next, when the astronomer's house will be ready to receive both his apparatus and himself. As many amateur astronomers already know, the new observatory will stand on the highest point of the Pulney Hills, a branch of the Southern Ghats, protruding on the western part of the Madura district in the Presidency of Madras. Its geographical co-ordinates are, approximately, Lat. 10° 14′ N., Long. 77° 33′ E. The distance from the Ammayanayakanoor station, on the S. I. R., to the foot of the Pulney Hills is thirty-one miles. The trip is made in about seven hours in the Indian cart. The long two-wheeled vandy is indeed mounted on springs, but these springs are oftentimes of very little use to diminish the pitching and tossing one has to suffer more or less on every Indian highway. The sturdy little bullocks, however, do their work well. From the "Tope" at the foot of the hills up to Kodaikanal, another twelve miles, is done on horseback in about four hours. The fatigue this old-fashioned style of travelling necessarily implies is splendidly recompensed when one reaches the dam of the lake, and still more when some hundred or a hundred and fifty feet higher one gets a general view of the lake itself and of the surrounding groves and villas. Owing to its high level above the sea, ranging from seven thousand to seven thousand eight hundred feet, this delightfully cool hill-station becomes more and more every year a favourite sanitorium for European residents of South India. Many of the cool-breeze seekers took their afternoon walk this year, I am told, in the direction of the new observatory.

The observatory stands a good mile distant from the west end of the basin-shaped valley, the bottom of which has been transformed by a dam into a handsome irregular lake. From the site chosen for the observatory, which is reported to be seven thousand seven hundred feet high, one has an extensive view of the plains of Madura in the east, where at sunset on fine days the elevated gopurahs of the great Vedic Temple may be clearly distinguished.

An irregular line on the horizon to the north marks the place where the far distant range of the Nilgherries lies, the rivals of the Pulney Hills. It was a question for a time of erecting the new elevated Indian observatory on the Nilgherry range, but the annual records of the necessary climatic conditions carefully observed in both places turned the balance in favour of the latter, for which the following data, as published by Mr. Michie-Smith in the *Publications of the Arts Society of the Pacific*, were reported in a local paper in June, 1895.

The mean daily temperature varied in one year from 54·2° F. in December to 62·2° F. in May, the mean for the year being 58·5° F. The mean humidity varied from forty-seven per cent. in March to eighty-three per cent. in August, the mean for the year being seventy-two per cent. The actual number of days on which ·01 inch and upwards of rain fell was one hundred and fifty-five, distributed through the twelve months thus:—

4, 5, 3, 16, 19, 19, 21, 24, 8, 21, 7, 8.

The total rainfall was 47·53 inches, but the average over a number of years, for a station a mile and a half distant, and nearer the edge of the cliff, was sixty-one inches. There were two thousand and fifty-six hours of bright sunshine throughout the year, and "my own experience," said Mr. Michie-Smith, "during a number of short visits, is that a night which remains cloudy throughout is very rare, and that a large proportion of the nights are brilliantly clear."

The building is erected on the rock, and has the form of an irregular cross, the main branch of which is shorter than the arms, and lies due east and west over a total length of seventy-two feet outside. The two arms are stretched north and south, symmetrically covering together a total length of eighty-eight feet. Each of them is terminated by a tower sixteen feet inside diameter and nineteen feet high, of which seven only remain to be completed. The upper floor of the observation room will be reached in each by an easy winding staircase, in small hexagonal towers, protruding symmetrically on the eastern side. The two arms will be completed first, and the towers will in March next be ready to receive their hemispherical domes, covered in papier-maché, the iron frames of which will not find their way up to the observatory without some trouble, as nothing is carried from the plain but by coolies or ponies. The remainder of the building has just now risen two or three feet above the foundation, but further directions must be waited for before the work can be continued. Whatever be altered, one thing now partly begun will remain, the spectroscopic room at the west end or head of the cross. The rays, either solar or stellar, it will admit for investigation, will be reflected by a clockwork polar heliostat, at the top of a long earthenware tube, of one inch to two inch bore, placed due north and south, on iron brackets, along the front part of the north tower. They will be analysed by a Rowland grating spectroscope, constructed by the late A. Hilger. The instrument is actually at Madras. Although the present intention is to study solar physics only, it is very probable that the astronomer in charge of such a favourably situated observatory will not be satisfied with this, but will also study stellar physics. Eye-witnesses alone can realize what nights are on tropical hills at this height, and my personal experience of three months spent on these hills ten years ago would induce me to speak in enthusiastic terms. Not once alone did I see Jupiter shining in such a manner, from near the zenith, that it cast on white paper a well-defined shadow of a hair, and its light passing through the foliage of the trees showed on the ground a shadow as neatly defined as if produced by an electric arc without diffusing globe. And yesterday evening, Venus, which attained on the 21st instant, its maximum of brilliancy after the "conjunction," cast, in spite of a brilliant six day old crescent moon, on a white wall a definite dark shadow of pillars supporting a verandah. The number of stars visible to the naked eye when the moon does not light up the atmosphere can be conceived only by those who have seen it for themselves. The first report of the Kodaikanal Observatory will contain interesting details on this subject, and stand advantageously in comparison with reports from other high-level observatories. Let us hope that when communication with Kodaikanal is cheaper owing to the railway line to be opened in January next from Ammayanayakanoor to the Tope, and a cable elevator worked by electric power which a Madras firm proposes to stretch over the Pambar falls and valley up to Kodaikanal, the trustees of the Observatory will be bolder to extend their work, and leave no advantage of so favourable and exceptional a position unused.

R. de Beaurepaire Lauvagny, s.j.
Astronomer of the Zi-ka-Wei Observatory.

Kodaikanal, India,
21st October, 1898.

[May I take the opportunity of Father Lauvagny's account of the important enterprise now progressing under Prof. Michie-Smith's able direction, to correct an error which crept into my description of the instrument employed by the latter during the late solar eclipse at Salidol, India? (Knowledge, July, 1898, p. 156.) Prof. Michie-Smith's telescope was not pointed to the Sun, but to the Pole, being placed parallel to the Earth's axis, and fed by a heliostat.—E. Walter Maunder.]

VARIABLE STARS.

To the Editors of Knowledge.

Sirs,—Among variable stars of long period there are few that stand more conspicuous for changes in colour and fluctuations of light than S. Virginis and R. Hydræ. And the interest in them is increased from the fact that they remain, in this latitude at least, a long time in view and within the power of small optical instruments. These stars have grown in interest in the last three or four years, and for these reasons, and also from the fact that R. Hydræ does not remain long above your horizon, I submit the following ephemerides:—

S. Virginis.

1898.	Mag.	1898.	Mag.
May 7 ...	9·00	June 15 ...	6·8
„ 9 ...	8·90	„ 20 ...	6·7
„ 12 ...	8 80	„ 22 to 26 ...	6·6
„ 14 ...	8·70	„ 28 ...	6·3
„ 15 ...	8·65	„ 29 ...	6·4
„ 16 ...	8·60	July 1 ..	6·6
„ 17 ...	8·40	„ 2 ...	6·8
„ 18 ...	8·30	„ 5 . .	6·35
„ 19 ...	8·30	„ 6 . .	6·15
„ 22 ...	8·1	„ 9 to 14 ...	6·5
„ 23 ...	8·0	„ 15 ...	6·4
„ 26 ...	7·9	„ 17 ...	6 6
„ 27 ...	7·8	„ 18 ...	6·7
„ 28 ...	7·8	„ 20 ...	6·9
„ 29 ...	8·1	„ 23 (very red)	
„ 30 ...	8·0	„ 27 ...	6·7
„ 30 ...	7·8	„ 28 ...	6·8
June 2 ...	7·3	„ 29 ...	6·9
„ 5 ...	8·05	August 1 ...	7·15
„ 6 ...	8·6	„ 3 ...	7·0
„ 7 ...	8·25	„ 5 . .	7·4
„ 8 .	7·8	„ 7 ...	7·15
„ 10	7·5	„ 10 ...	7·2
„ 12 ...	7·0	„ 14 ...	7·4
„ 14 ...	6 9		

The maximum which was computed for June 17th seems to have occurred July 6th, or twenty days late. The movements of the star were very perplexing, but not more so than those of

R. HYDRÆ.

1898.		Mag.	1898.		Mag.
May 17	..	7·65	June 26	...	5·20
„ 18	...	7·50	„ 29	...	5·10
„ 23	...	7·35	„ 30	..	5·15
„ 28	...	7·20	July 1 to 8	...	4·90
„ 29	...	7·15	„ 9	...	5·00
„ 30	...	7·10	„ 10	...	5·10
June 5	.	6·80	„ 12	..	4·90
„ 6	(very red)		„ 17	..	5·20
„ 10	...	6·70	„ 18	...	5·00
„ 12	.	5·50	„ 19	...	5·20
„ 14	...	5·30	„ 28	...	4·95
„ 17	...	5·20	„ 29	..	5·10
„ 22	...	5·10	August 1	...	5·15
„ 23	...	4·95			

The maximum was predicted for June 14th; apparently it may be placed on July 4th, or twenty days late. I have hesitated in showing a discrepancy of over a magnitude in this star on June 12th until, looking up its record, I found a similar discrepancy in Mr. Henry M. Parkhurst's record for 1897. See *Astronomical Journal*, No. 421, p. 99, where he says, "The discrepancy of a magnitude, 1897, April 15, is neither a typographical or clerical error." In this case, as in that of the fluctuations of Mira three or four years ago, finding myself in the best company, the figures are submitted to the common arbitrator.

There were many other observations of both stars made, but only definite changes are given.

o Ceti (Mira) reached a brilliant maximum, 1898, October 3rd, at 2·2 magnitude.

The star rose this season at later hours than I can keep, but I lost no available opportunity for an observation. My dates and estimates are as follows:—

o CETI (MIRA).

1898.		Mag.	1898.		Mag.
August 20	...	5·40	October 7	...	2·35
„ 21	...	5·20	„ 8	...	2·30
„ 28	...	4·80	„ 9	...	2·30
„ 29	...	4·70	„ 10	...	2·65
Septem. 4 (2 a.m.)		4·30	„ 11	...	2·55
„ 4 (10 p.m.)		3·90	„ 12	...	2·65
„ 7-8	...	3·70	„ 14	...	2·70
„ 13-14	...	3·2	„ 15	...	2·75
„ 15-16	...	3·15	„ 24	...	3·10
„ 17	...	2·95	„ 26	.	2·95
„ 18	...	3·05	„ 28	...	2·96
„ 22	...	2·80	„ 30-31	...	2·96
„ 22	...	2·85	Novem. 1-2	...	3·10
„ 23	...	2·70	„ 3	...	3·15
„ 24 (4 a.m.)		2·70	„ 5	...	3·20
„ 25 (4.30 a.m.)		2·70	„ 6	...	3·35
„ 25 (10 p.m.)		2·70	„ 7	...	3·45
„ 26 (3 a.m.)		2·30	„ 11	...	3·60
„ 26 (10 p.m.)		2·70	„ 13	...	3·45
„ 27	...	2·70	„ 14	...	3·50
„ 28 (4.40 a.m.)		2·70	„ 16	...	3·65
„ 28 (9 p.m.)		2·70	„ 17	...	3·80
October 2 (moon)		2·30	„ 18	...	3·80
„ 3 (max.)		2·15	„ 19	...	3·85
„ 4	...	2·10	„ 22	...	3·90
„ 5	..	2·35			

Following the terms of the second catalogue the maximum was due July 27th; it occurred October 3rd, about sixty-eight days late.

The seeming fluctuations were of a minor character, and may reasonably be charged to errors of observations; they may occur yet. Mira does not reach the meridian till near midnight, so there will be an opportunity to follow it down.

COMPARISON STARS USED.

66 Ceti	...	5·65	δ Ceti	.	4·20
70 „	...	5·62	α Piscium	...	3·90
ν „	...	5·20	γ Ceti	..	3·60
ξ¹ „	..	4·74	α „	...	2·50
ξ² „	...	4·50	β „	...	2·30

Memphis, Tenn.,
14th October, 1898.
DAVID FLANERY.

THE SUNSPOT PERIOD.

To the Editors of KNOWLEDGE.

SIRS,—In his very interesting article on "The Great Sunspot and the Aurora," which appeared in KNOWLEDGE, for October, Mr. Maunder intimates that the last spot maximum occurred in 1893, which I do not for one moment doubt. He then suggests that the approaching minimum will be reached about two years hence, or, in something less than seven years after the maximum. He is fully competent to make such a statement. Once more. In the *Journal of the British Astronomical Association*, Vol. I., No. 2, page 91, he is quoted as stating that the last sunspot minimum fell in 1889. Again, this accords with my own humble experience. But what puzzles me is to know how the "rule" mentioned in the first paragraph of the October KNOWLEDGE article is established. Are we to understand that the interval between minimum and maximum is generally between four and five years; and that the period separating maximum from minimum usually approximates to seven years? Or, are we simply to take it that the passage from minimum to maximum, as a rule, requires less time than does the opposite phase of the phenomenon? WILLIAM GODDEN.

38, Burrard Road, West Hampstead, N.W.,
19th November, 1898.

TREE STRUCK BY LIGHTNING.

To the Editors of KNOWLEDGE.

SIRS,—Perhaps some of your readers will kindly tell me what actually takes place when a tree is struck by lightning? I have in my mind a big ash tree which this summer was completely riven in two and split into match wood, and a large arm torn entirely off; what is the force which has been exerted? Is it that all the sap and liquid has been instantaneously turned into steam by the enormous heat produced, causing the wood to swell and burst; or what is the force exerted?

October 16th, 1898. A. C.

ERRATA.—In the December, 1898, number of KNOWLEDGE, on page 277, column 2, line 5 from bottom, for "crescends," read "crescendo"; line 3 from bottom, for "claricinists," read "clavicinists"; page 278, line 1, for "Ramsau," read "Rameau"; line 6, for "crescends," read "crescendo."

THE OVIPOSITOR OF A BEETLE (BAPTOLINUS ALTERNANS) AND THE TEETH OF THE DUNG FLY.

By WALTER WESCHÉ.

BAPTOLINUS *alternans* is a small beetle, about three-eighths of an inch in length. Mr. Waterhouse tells me it is rather rare, but he has found it in decaying wood, and this remarkable ovipositor, consisting of a number of curiously formed hooks, seems well adapted for scratching out holes in such a substance. The specimen figured was found in a garden in South Hampstead, on the edge of some turf, and I captured the male—which is precisely like the female externally—in a similar spot in a garden in Southwold, Suffolk.

THE TEETH OF THE DUNG FLY.

Four years ago I mounted the head of a fly, which showed a process of teeth at the end of the proboscis; I paid little attention to the subject till Mr. Pillischer, of New Bond Street, showed me a slide, which he informed me had been in his possession for thirty years, and considered unique, of the teeth of a fly. I had, some little time previously, mounted a whole insect, showing the teeth, which Mr. Austen, of the British Museum, at once identified as *Scatophaga stercoraria*, and this being a very common insect, I had no difficulty in obtaining specimens. I find that Mr. W. H. Harris has figured and published an account of the teeth, in the *Proceedings* of the Cardiff Naturalists' Society, so late as July, 1898, and earlier in *Science Gossip*, in 1885.

Fig. 1.—Ovipositor of Beetle (*Baptolinus alternans*), × about 40 diameters.

Prof. Packard, in his introduction to "Entomology," also refers to the teeth of the house-fly as being placed between the roots of the false tracheæ, but the tooth figured there has no resemblance to those of the dung fly. These are placed at the base of the labellum of the proboscis, and appear not to be between the roots of the false tracheæ, but to cover them: are of a very tooth-like appearance, chitinous, and stand out well coloured, making a nice object for microscopic examination, with a sixth of an inch power.

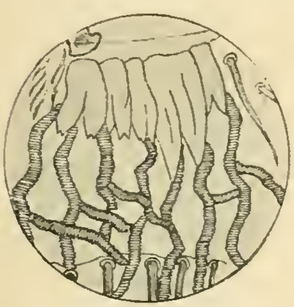


Fig. 2.—Teeth of Fly (*Scatophaga stercoraria*), × about 150 diameters.

Scatophaga is a predaceous fly, and is decidedly raptorial in appearance. It may be seen sitting on leaf, the head well raised on the forelegs, and the body sloped at an angle to its support, watching for smaller flies. A species of *Scatopse* is the smallest, and the house fly (*Musca domestica*) the largest I have seen captured, the blue-bottle (*Lucilia cæsar*) being beyond its powers. It does not hunt, but waits till its prey is within an inch, or an inch and a half, when it is seized with a rapid spring. The wings of its prey are then compressed with the hind legs, which are furnished with many strong spines, or spurs, to assist that operation. The thorax is held with the forelegs, which have a perfect *chevaux-de-frise* of setæ on the end of the tibia, as well as other setæ, arranged in very much the same way as those on the hind leg of the worker honey bee (*Apis melifica*). With the prey thus firmly held, the *Scatophaga* inserts its lancets into the membrane between the head and the thorax, and the tragedy is completed.

Fig. 3.—Proboscis, Lancets, and Maxillary Palpi of Dung Fly (*Scatophaga stercoraria*), × about 25 diameters, showing the position of the teeth.

I had an opportunity on several occasions of verifying an observation of Prof. Packard's, that the true voice of the house fly is a sound produced through the spiracles of the thorax, and not by a hum of the wings. When an unfortunate fly was seized and so firmly held by the *Scatophaga* as to be incapable of movement, I heard a peculiar, characteristic, shrill sound proceeding from it. The teeth obviously play an important part in these struggles, as they must be of great use in tearing and scraping the harder parts, to enable the tracheæ to suck the juices—indeed, I have found the abdomen of a *Scatopse* so treated, and the segments quite broken up. The dung fly also sucks some secretions of plants, as I have many times seen it busy with its proboscis on the viscid disc of the ivy blossom, though its presence there may be not wholly for such an innocent purpose, as these blossoms are much resorted to by other flies.

Fig. 4.—Clasper of *S. stercoraria*, × 75 diameters.

It has been said that, contrary to the rule in most insects, the male of *Scatophaga* is larger than the female. I have had several species under observation, *S. stercoraria*, *S. lutaria*, *S. merdaria*, and I cannot endorse this, as I found a great variability in size, some males, apparently of the same species, being a third larger than others, and the same with the females, and I have watched a small male mate with a large female, and *vice versâ*. The males are furnished at the end of the abdomen with two powerful clasping hooks, which are fitted with sharp hairs, arranged like a comb on the inner concave edge. This insect is therefore remarkably specialized in many ways for the "struggle for existence."

Fig. 5.—Part of Tibia and Tarsi of fore leg of *S. stercoraria*, showing spines used in holding prey, × 150 diameters.

It ought perhaps to be mentioned that the drawings are made from microscope slides, the objects being mounted under pressure, and consequently somewhat altered in shape.

ELECTRICITY AS AN EXACT SCIENCE.

By Howard B. Little.

I.—Tradition, Mysticism, and the Early Pursuit of Truth.

Tradition, even that tradition which clings, limpet-like to the adamantine sheath of a science, is, in one respect at least, like antique furniture. If, in the existing generation, the supply be not equal to the demand, then some enterprising child of the period will undertake its manufacture. This is to be regretted, because the poetry of a science rests (apart from the many instances of self-sacrifice among its devotees) entirely upon its traditions. This alone were good and sufficient reason for cherishing them; but we have another, and a better—we can learn from them.

We have been told by the lay press, told till we are weary, that "Electricity is still in its infancy." Yet we have traditions, which come to us in whispers from a realm of thought that existed six hundred years before the commencement of the Christian era, when Thales of Miletus lived. And we have heard other whispers of "The Secrets of the Gods." But these early traditions, both by accident and design, savour of mysticism. Indeed, the two are inextricably bound up. And we would not have it otherwise.

Let the sceptic cry "*Cum grano salis.*" He may so far forget himself as to ask us to come "up to date." And, as a preliminary step towards his level, we mention incidentally that Theophrastus lived in the year 321 B.C. We may also point out that both Aristotle and Pliny made some shrewd observations concerning the "torpedo" and "the electric eel," while the latter gives a good account of some of the properties of tourmaline.

So much for the infant which we know existed six hundred years B.C., and made its tiny cry heard in the year 70 A.D. A long, long minority, not ended even yet. But in the interval the child still cried. The wailing was long in reaching the ears of our countrymen, though it made itself plainly heard throughout the European continent. At length, however, it found a home here under the guardianship of Dr. Gilbert, of Colchester, about the year 1590. And now the little one began to accomplish articulate speech. We hear of such phrases as "attractive bodies"—remarkable from a child destined to remain an infant for nearly three centuries more, if not for a much longer period, but growing still.

This little one, at certain epochs of whose career we are compelled to glance, this little one, born, perhaps, in a piece of amber, grew phenomenally, yet appeared to be retaining a perpetual youth, outliving guardian after guardian. For when Dr. Gilbert's time came to say farewell (one can believe that it was a sad farewell), Robert Boyle and Otto von Guericke undertook the guardianship simultaneously, yet independently. Robert Boyle brings us up to within thirty years of the commencement of the eighteenth century. But we must revert now to a period when the child passed through a great danger, and was even like to die.

Somewhere about the year 1545 the Elector Frederick of Saxony dreamed a dream, in which he saw Martin Luther writing on the door of the Royal Chapel, at Wittenberg. As he wrote the pen grew—grew so fast and so far that it reached to Rome, and even struck the Pope's tiara. Concerted effort to break the pen was unavailing, for, as it was struck (according to one report), others grew from it. The story of this dream was circulated widely, and one is bound to own that its political aspect almost stamps it as a fabrication. Yet the dream, if dream it were, brought about one good result. It set people thinking, and turned their thoughts towards the ultimate possibility of communicating rapidly at a distance. But the first result was even more strange than the immediate cause. Baptista Porta, in his book "The Wonders of the Magnet" (circa. 1559), wrote:—"I do not fear but that with a far absent friend I can always communicate, by means of two compass needles, circumscribed with an alphabet." Another writer thus stated his conviction:—"Forasmuch as this is so wonderful a secret, I have hitherto hesitated about divulging it, and did so disguise my meaning in the first issue of my book as only to be understood by learned physicians and chemists. But now the time is come when I will communicate it for the benefit of lovers of science generally." One cannot but admire the apt use of that "generally." The writer, evidently himself a lover of scientific truth, goes on to describe the "sympathetic needles." It is curious to note that many writers in the sixteenth and seventeenth centuries speak of these needles as though their use was well-established, while others laugh at the growth of the "conceit." One could so easily draw modern parallels.

It must be remembered that all this was taking place at a time when priests were in the habit of standing in circles around three-legged stools, while one of their number (presumably he who had the greatest command of language) anathematised the stool, till a ring, previously placed upon it, began to roll around it, stopping to indicate certain letters of the circumscribed alphabet, and so interpreting messages from a world otherwise unknown.

Sir Thomas Browne (in his *Pseudodoxia Epidemica*, published in 1646), amongst others, put the needles to experimental test, and stated that he had found the idea to be absurd. Following shortly on this there was another incident. A certain wealthy man was approached by an impecunious individual who wished to sell the secret, and who explained that if the one were in Persia and the other in England it would still be possible to communicate. The man of wealth, telling the other that he would be most happy to test the matter, and give it due consideration, remarked, "But it is not at the moment convenient to me to set out for Persia; none the less, if you will make the journey with one of the instruments, I will gladly remain here with the other, and await the result."

And alchemists were rife in the land, and phlogiston had a recognized existence; so electricity, and every other exact science, was well nigh done to death.

The late Prof. Tyndall, writing of this time, tells us: "Seekers after natural truth had forsaken the direct appeal to Nature, by observation and experiment, and had given themselves up to the re-manipulation of the notions of their predecessors. It was a time when thought had become abject, and the acceptance of mere authority led, as it always must do in science, to intellectual death. Natural events, instead of being traced to physical, were referred to moral causes, while an exercise of the fantasy, almost as degrading as the spiritualism of the present day, took the place of scientific research."

This is in truth a just appreciation of the state of affairs existing then. But we have no great right to laugh. As heirs to the ages, it remains for us to show that we have done our best. We have heard in our own time of the production of electrical sugar, as also of certain belts! The blame for these things should be divided about equally, between those who do know and those who do not. It is a painfully mean spirit which prompts a man who has made a life study of a particular subject to laugh at the ignorance of that subject shown by another, who has spent his time in the pursuit of some other knowledge, though the latter is to blame when he turns a deaf ear to the warning given, ever so quietly, by the former. And very many writers of "Science Notes" in the lay press should not be quite so prolific.

But returning to the subject of tradition. A careful note of that tradition, and mysticism, which has hung about electrical phenomena leads us to assert the inevitable proposition that electrical science owes its present position to the facts, and distortions of facts, propounded by the ancients.

Democritus said "We know nothing really, for the truth lies deep down." And the same assertion has been made again and again, in varying terms. Yet we often meet the truth quite unexpectedly, and it is not always pleasant. Other truths, again, had been staring the world (including the seekers after them) in the face for years before they were recognized. Ancient India has a tradition to the effect that it was children who first found that the friction of certain substances rendered them capable of attracting fragments of straw, feathers, etc. We are bound to admit that here was a truth over which men might have stumbled.

It appears, then, that in the early stages of scientific discovery, first one or two facts are accidentally noted, these may, in logical sequence, give rise to the discovery or recognition of others, till ultimately a spirit of enquiry has its birth, though perhaps only in the minds of one or two. It is given to these pioneers to leaven the lump, and though there may be times when neglect and error will almost put out the first glimmerings, yet that neglect and those errors will work towards the ultimate discovery of truth. Consider the evolution of the telegraph. We have there a series of events which may well serve as a type of the struggles of a science. First, the alleged dream, which may have had its existence only from political, religious, or irreligious necessity. The immediate result was the notion of communication at a distance, and it was distributed broadcast. The next result was by no means so happy, for either a great number of people accepted with blind credulity a statement which was absurd, or deliberate untruths were told for purposes of self aggrandisement.

Yet, throughout that period, there were one or two honest men whose calm spirit of research saved them from being carried down with the stream. And these workers in time actually stemmed the torrent.

In the year 1753 the *Scots' Magazine* published an article (signed "C. M.") in which a perfectly practical scheme was set forth. Twenty-six wires and twenty-six pith balls suspended close to their ends, *and a circumscribed alphabet*. Can nothing good come from evil?

It is interesting to note, that for some two thousand years before Dr. Gilbert's time (1540—1603), we find only a disjointed series of electrical facts mentioned, usually, too, as matters of common knowledge. There was apparently no real effort made to arrive at well-founded conclusions from those facts. Boyle and Von Guericke brought us up to the close of the seventeenth century almost. The latter appears to have been the first to arrange a mechanical device for the generation of electricity, for he worked with a sulphur ball, which had actually been cast in glass that he deliberately broke! Mounting this ball on a spindle he rotated it, and, holding the hand against it, excited it. It was reserved for Newton to realize that the original glass globe would have answered the purpose better.

But the names of active workers come now so thick and so fast that it is only possible to make a selection.

Stephen Gray claims our attention. His work was vigorous and of real use. He published, in 1720, a report upon the results obtained by the friction of various substances. In 1729 he enunciated the first ideas of conductivity, and succeeded in conveying electrical energy a distance of eight hundred and eighty-six feet through a packthread suspended on silk supports. How many modern electricians, working with Gray's appliances, would care to undertake this? It was Gray, too, who showed that fluids would conduct. Finally, he wrote, "I hope that there may be found out a way to collect a greater quantity of electric fire, and consequently to increase the force of that power, which, by several of these experiments, *si licet magnis componere parva*, seems to be of the same nature with thunder and lightning."

Next, the prime conductor was added to the electrical machine. It is not without interest to note that this was at first "supported by a man, standing upon cakes of resin"!

Then Prof. Winkler added the cushion, about 1744. Gordon, of Erfurt, having himself improved the apparatus, arranged some really beautiful experiments, as, for example, the ignition of fluids by a jet of electrified water.

It was with the birth of the Leyden jar, 1745, that Gray's hope was to be realized. One hardly knows to whom it should be attributed.

Sir William Watson achieved one of the first practical results, for, by mixing camphor with gunpowder, he succeeded in discharging a musket electrically. Then, having coated the Leyden jar on both sides, he worked, under the auspices of the Royal Society, upon the velocity of electrical discharge. The conclusion then arrived at was perfectly natural, the report stating that the discharge through twelve thousand two hundred and seventy-six feet of wire was instantaneous.

Benjamin Franklin next claims our attention. First he told the world that the electricity obtained by friction was not created but collected. This seems to have done more to raise electricity to the level of an exact science than anything we have yet considered. So far we have found that experiment predominated over deduction to a very great extent; but now a change came. Franklin, appreciating the work of Gray, constructed his kite, and brought a part of the lightning to earth, so showing that "it was of the same nature with the electric fire."

The first electrician who became a martyr to the pursuit of truth, Prof. Reichman, of St. Petersburg, was working with what would now be called a lightning conductor, on August 6th, 1753, and died from the very success of his own experiment.

The atmosphere of thought, throughout the entire continent, was charged with electricity now. Beccaria, the Italian, did work upon atmospheric electricity which should be of great interest to meteorologists now.

But the march of time carries us on. Galvani was busy, and Volta's pile was in use with the dawn of the present century. Then Sir Humphry Davy decomposed "the solid earth."

Here was the heterogeneous collection of fact laid ready to the brain and the hand of the first really mathematical electrician. Coulomb came. The torsion balance had an existence. He adopted the hypothesis of two fluids, and investigated the *laws* of distribution and density. In short, he treated electrical quantities as being subject to accurate mensuration. Laplace, Levoisier, and Volta did work at about this time which appears to have been neglected. They entered upon investigations relative to the connection between electricity and evaporation.

Poisson placed electrical phenomena under the dominion of analytical reasoning, so that at his hands the study increased its right to be looked upon as an exact science. Oersted and Ampère followed, so that electro-dynamics became almost a separate study. Truly the infant was in no want of men who could and who would fulfil their duty as sponsors.

The story of Michael Faraday's induction coil is a grand lesson to modern workers. Also we have Joule's splendid error, which showed in after years the accuracy of his work and the inaccuracy of the ohm, according to the standards which prevailed then. Wilhelm Webber, Kirchoff, and Helmholtz now seem to head the crowd which comes thronging round us, and they introduce our contemporaries; but we can make no further mention of them here, for it seems we have clearly worked our proposition to a proof, and electrical science, like every other science, owes its present position to the facts, and distortions of fact, propounded by the ancients.

NOTES ON COMETS AND METEORS.

By W. F. Denning, F.R.A.S.

Discoveries of Comets.—The year 1898 forms a record as regards the number of cometary discoveries and observations. Altogether ten comets have been seen up to the end of November, and of these three were returns of the periodic comets of Pons-Winnecke, Encke, and Wolf. Perrine has been the most successful observer, having detected Pons-Winnecke's comet as well as three new comets. It is remarkable that two of these bodies were accidentally found during the year by means of photography, viz: one by Coddington, on June 11th, and another, in the Leonid radiant, by Prof. P. E. Chase, on November 14th. It was a curious circumstance that a new comet should be placed in a position within the sickle of Leo on the very date when a meteoric shower was expected, and when scores of cameras were directed to that particular part of the firmament. The wonder is that the comet was not independently detected by a large number of observers. It passed its perihelion on September 19th, but at the opening of January, 1899, will be a little brighter than on the date of its discovery, and situated about 8° northwards of the star δ Leonis. On January 11th the comet will be in R.A. 11h. 8m. and Dec. $+30° 32'$, while on January 15th its position will be R.A. 11h. 9m. and Dec. $+31° 18'$.

Brooks's Comet.—Is now invisible near the sun, but will probably be seen by observers in the southern hemisphere in February.

Wolf's Comet.—Is nearly stationary in Canis Major. On January 5th the comet will be $2\frac{1}{2}°$ west of the brilliant star Sirius.

The Leonid Meteors.—Though a brilliant display was far from being realized, it seems that, at some stations, a tolerably active shower was observed. At Alassio, on the Riviera coast, Mr. Hardcastle found the numbers remarkably constant at about thirty per hour. Prof. Young, at Princeton, U.S.A., observing with Prof. Reed on November 15th, 3h. 15m. to 5 a.m., counted about one hundred. There were about a dozen as bright as stars of the first magnitude, and all of them left streaks. The maximum was at 3.45 a.m. (= G.M.T. 8.45 a.m.), when for twenty minutes meteors appeared at the rate of two or three a minute. The radiant was not well defined, but its centre was nearly in $151° + 22\frac{1}{2}°$. At Rome fine weather favoured the observations. At the observatory there on the night of the 13-14th, during about two and a half hours before midnight, fifty-five meteors were counted, while in a similar period after midnight, one hundred and four were seen. On the night of the 14-15th, during two and a half hours after midnight, one hundred and twenty-six meteors appeared, and of these thirty-six were of the first magnitude and thirty-six of the second magnitude. Twenty-six left trains. The total period of observation during the several nights was 11h. 38m., and the aggregate number of meteors seen four hundred and eighty-six. The work was distributed amongst nine observers, who divided the watches on successive nights, but it is not stated how many of these were looking out at the same time. The recent observations, coming from different quarters, are singularly discordant as to the number of meteors visible. At some places no meteors appear to have been seen, while at others a well defined and somewhat numerous display of Leonids was witnessed.

The Bielid Meteors.—In England cloudy weather and moonlight effectively veiled all traces of this shower. It is highly probable that it quite failed to return in the strength expected, and that, even had clear skies permitted full observation, the results would have been negative. The period of thirteen years is evidently too short for maximum returns of the shower. It may furnish some meteors on November 23rd, 1899, and ought to give a very brilliant display on about November 17th, 1905.

The Quadrantids.—Many of these meteors are likely to be visible on the evening of January 1st, and the morning and evening of January 2nd. The best time to look for them will be before moonrise on the early mornings of the dates mentioned.

Microscopy.

John H. Cooke, F.L.S., F.G.S.

No one, probably, has done more towards increasing our knowledge of the nature and disposition of the cell contents of diatoms than Pfitzer. One of the difficulties that that distinguished worker experienced in the study of his subject was the differentiating of the fine colourless plasm in the plasm sac. This was chiefly due to the fact that the refractive index of the plasm differed but slighty from that of water. To overcome this he suggested the application of dilute hydrochloric acid. The result, happily, was the immediate shrinkage of the plasm sac and the disclosure of its structure. A one per cent. solution of osmic acid has been found to be even more effective, as it not only has an effect on the plasm sac similar to that of hydrochloric acid, but, by changing the oil globules, that are invariably present in the cells, to a black colour, it enables the worker to readily study the relations of the various matters that make up the cell-contents.

It is well known that, other things being equal, the higher the refractive index of a mounting medium the more effective is the medium for microscopical manipulations. The mounting fluids most commonly used are—oil of turpentine, refractive index, 1·475; castor oil, 1·49; Canada balsam, 1·549; oil of cloves, 1·535; balsam of tolu, 1·628; and oil of cassia, 1·641. It may be of interest to microscopists to have their attention drawn to a little known, but effective mixture, having a refractive index as high as 2·40, which was discovered by Prof. Hamilton Smith, of Rochester. The mode of preparation is as follows:—In two fluid drams of glycerine jelly, made in the usual way, dissolve, in the cold, ten drams of chemically pure stannous chloride. When solution is complete boil for a few minutes, and filter while hot. When mounting place a drop on the slide and heat in the usual way. The difference in the appearance of diatoms mounted in this medium and in other fluids must be seen to be appreciated.

In the *Journal of Applied Microscopy*, Mr. G. H. French describes the method that he adopts for imbedding and staining lichens. He recommends the immersion of the lichens in ninety-five per cent. alcohol for twenty-four hours, after which they should be placed in thin and thick collodion, alternately for another twenty-four hours. After imbedding in thick collodion, and hardening in seventy per cent. alcohol, the sections are cut, and stained with borax-carmine. The fungus part of the lichen will, after this treatment, acquire a pale pink hue, while the algal cells acquire a greenish-red shade. By this method the host cells may be readily distinguished from the fungus.

At a recent meeting of the Quekett Club, Mr. Goodwin gave the results of his experiments in illuminating microscopic objects without the aid of a bull's-eye condenser. Under ordinary conditions the lamp has to be placed at a distance of about eight inches from the back of the condenser in order to secure the best effects. By placing a plano-convex lens, of five-inch focus, in the screen-holder of the condenser, he has been enabled to bring the lamp to within three inches of the back of the combination, thus obtaining better illumination and definition, a matter of considerable importance when high powers are used. It is a simple and effective contrivance, and is worthy of the attention of those who desire to make the best use of their appliances.

There is no better cement for general "mounting" purposes than old gold size. The older the better for the purposes of the microscopist. Gold size is, in reality, nothing but good linseed oil rendered very drying by the usual methods. It has many advantages over damar, asphalt, and the many other cements on the market, as it may be laid on readily and quickly in successive coats, and, though it mixes with turpentine, it is unaffected by it when once hard and dry. The cement should be prepared in small quantities, and in the following manner:—Take a small quantity of old gold size, thin it with turpentine, and work in enough lamp-black or aniline dye to colour it. This will dry tough, and with a beautiful gloss. If a ring of shellac varnish be made round the edge of the cell, and, when dry, this cement be applied in a succession of coats as a "finish," the microscopist will have a mount which, with fair usage, will last for years.

THE FACE OF THE SKY FOR JANUARY.

By A. FOWLER, F.R.A.S.

THE SUN.—Although solar activity is probably on the wane, observations should by no means be discontinued. Even in the absence of spots, faculæ may frequently be observed.

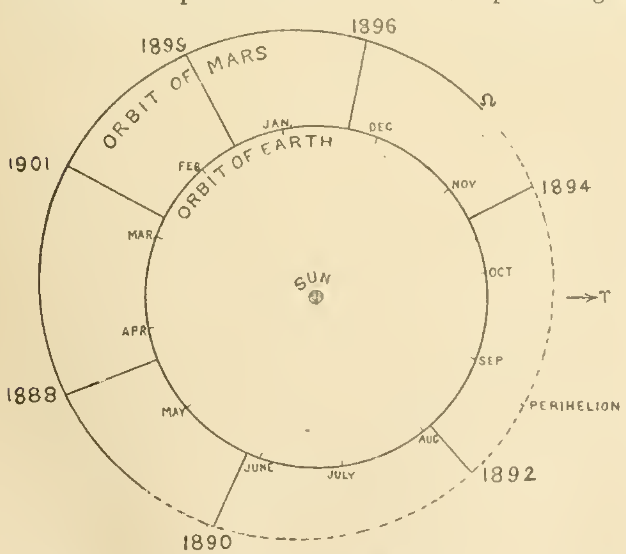
There will be a partial eclipse of the Sun (greatest magnitude = 0·7) on the **11th**, but as it will only be visible in the region of the North Pacific, further particulars are not considered necessary.

THE MOON.—The Moon will enter her last quarter on the **5th**, at 3.22 A.M.; will be new on the **11th** at 10.50 P.M.; enter her first quarter on the **18th** at 4.36 P.M.; and will be full on the **26th**, at 7.34 P.M. Of the various occultations during the month, the most conveniently observable is that of μ Arietis, mag. 5·8, which will occur on the **19th**; the disappearance will take place at 8.5 P.M., 45° from the north point (22° from the vertex), and the reappearance at 9.14 P.M., 282° from the north point (248° from the vertex), the position angles being reckoned through east.

THE PLANETS.—Passing from his recent inferior conjunction, Mercury will arrive at his greatest western elongation of 23° 35′ on the **12th**. He will accordingly be a morning star throughout the month, but his great southerly declination, which amounts to 22° on the 12th, makes the planet too low for easy observation in our latitudes.

Venus is also a morning star, and will attain her greatest brilliancy on the **6th**; she will then be about 16° south of the equator, but will be a conspicuous object in the morning sky, rising about three hours before the Sun. About one-third of the disc will be illuminated.

Mars will be in opposition at midnight on the **18th**, so that the present month will furnish the most favourable opportunity of observing the planet that we shall have for several years. Unfortunately, he is in the part of his orbit furthest removed from the Sun, so that his disc will not be very large. His distance at the present opposition, as compared with that at other oppositions, is illustrated in the accompanying diagram. At the time of opposition, his horizontal parallax will be 13·6″, representing a



Oppositions of Mars.

distance of about 143 millions of miles. The apparent diameter of the planet will then be 14·4″, but for observers in northern latitudes the northerly declination of the planet will partly compensate for the smallness of the disc. The north pole of the planet is tilted towards the earth. During the month he describes a westward or retrograde path through Cancer towards Gemini.

Jupiter is a morning star, and will be at quadrature on the **29th**. During the month he describes a short direct path in the preceding part of Libra, rising about 3 A.M. at the beginning, and before 1 A.M. towards the end of the month.

Saturn is also a morning star. He describes a short eastward part in the southern part of Ophiuchus, and does not rise very much before the Sun until the end of the month, when he rises about three hours before the Sun.

Uranus is a morning star, rising about four hours before the Sun towards the end of the month. He traverses a short direct path near ψ Ophiuchi.

Neptune describes an eastward path of 80′, starting from a point about 1° north-east of ζ Tauri. He is visible throughout the night.

THE STARS.—At the beginning of the month Canis Major will be due south about midnight, Orion about 11 P.M., Taurus about 10 P.M., and Aries about 8 P.M. These constellations will be in the same positions roughly half-an-hour earlier at the end of each succeeding week.

Conveniently observable minima of Algol will occur on the **2nd** at 7.14 P.M.; on the **22nd** at 8.57 P.M.; and on the **25th** at 5.46 P.M.

Chess Column.

By C. D. LOCOCK, B.A.

Communications for this column should be addressed to C. D. Locock, Netherfield, Camberley, and posted on or before the 10th of each month.

Solutions of December Problems.

No. 1.
(By F. W. Andrew.)
1. B to Kt8, and mates next move.

No. 2.
(By N. E. Meares.)

Key-move—1. P×Pch.
If 1. . . . K to Q4, 2. Castles (QR)ch.
1. . . . K to Q2, 2. R to Qsq ch.
1. . . . K×P, 2. Castles (KR)ch.

CORRECT SOLUTIONS of both problems received from D. R. Fotheringham, W. de P. Crousaz, H. Le Jeune, H. E. Gardner.

Of No. 1 only, from Alpha, W. Clugston, J. M'Robert, G. G. Beazley, J. G. Sheakston, G. F. T., G. C. Teddington, W. H. Stead.

H. E. Gardner.—We are glad to see that the sui-mate has found a solver and an appreciator.

G. F. T.—See answer to Alpha below.

H. S. Brandreth.—If 1. B to Q6, Kt to B3, and the Queen would like to mate at Q7. See also reply to Alpha.

Alpha, and others.—After 1. P×Pch, K to Q2, 2. Castles ch ?, K to QB2, White's QB is pinned. This, of course, is part of the composer's idea. In the three variations, White castles on both sides, and also moves his R to Q square. The composer informs us that he tried in vain to add a fourth variation to consist of "half-castling" on the King's side.

J. G. Sheakston.—When the King goes to Q4, White must castle. For after 2. R to Qsq ch, K×Kt, the Queen is pinned and cannot give the pretty mate at QKtsq (Q × P would not be mate in any case).

C. J. Shears.—In No. 1, Kt to K4 is met by P to Kt5ch. In No. 2 the White Queen, being pinned, cannot mate at Q6.

W. Clugston.—The delay was due to the omission to print Mr. Andrew's problem a month earlier.

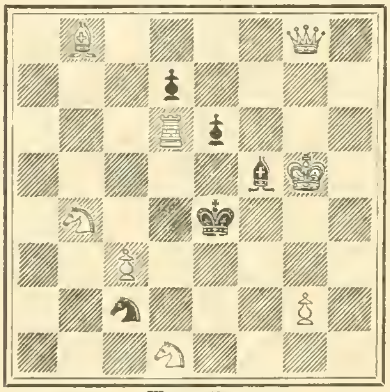
J. Nield.—Many thanks for the problems.

PROBLEMS.

No. 1.

By W. Clugston.

Black (5).



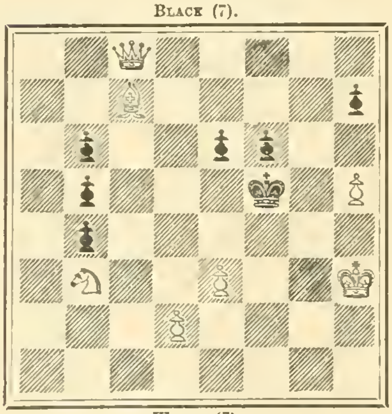
White (8).

White mates in two moves.

No. 2.

By C. D. Locock.

Black (7).



White (7).

White mates in three moves.

CHESS INTELLIGENCE.

We regret to announce the death of the Rev. A. B. Skipworth, for many years Rector of Tetford, Horncastle. We may safely assert that this address is more familiar to the chess world than that of any chess-player who ever lived. Mr. Skipworth was the founder, and, for some thirty years, the honorary secretary, and always the life and soul of the Counties Chess Association, which for more than twenty years held its annual largely attended tournaments in the provinces. As an amateur player he was quite in the front rank, but owing to ill-health was unequal to the strain of a prolonged tournament. He was a competitor in two international tournaments, London, 1883, and Bradford, 1888, but in both cases was obliged to retire before the conclusion of the contest. In the less arduous conflicts of the Counties Chess meetings, he was far more successful, in spite of the severe handicap imposed by the task of managing the work of the meeting, which almost entirely devolved on him alone. In this respect, indeed, as in many others, Mr. Skipworth's place will not easily be filled.

Messrs. Janowski and Showalter are engaged in a match in the United States. The French champion won the first two games, but Mr. Showalter soon got into form, the score at present being—Janowski, 3; Showalter, 2; drawn, 2. The match goes to the winner of the first seven games. On tournament form M. Janowski is the stronger player of the two, but Mr. Showalter is at his best in a match, and, unfortunately, even better than his best in the Anglo-American Cable Match, in which he has won his game in three consecutive years.

The British Chess Club defeated the St. George's Chess Club on December 10th, after a close contest, by $5\frac{1}{2}$ games to $4\frac{1}{2}$. The game between Messrs. Burn and Jackson, the respective leaders, was drawn; the same result occurred in their game last year, on which occasion the St. George's Club did not succeed in winning a game. On the present occasion the "tail" of the British team nearly succeeded in losing the match.

On November 19th Kent and Hampshire met for the first time in the history of the Southern Counties Chess Union. The result was a drawn match, each side winning eight games. There is little doubt that Surrey will, as usual, be the ultimate winners of the championship.

Communications for the Editors and Books for Review should be addressed Editors, "Knowledge," 326, High Holborn, London, W.C.

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CONTENTS.

ON THE TREATMENT AND UTILIZATION OF ANTHROPOLOGICAL DATA.

By Arthur Thomson, M.A., M.D.

I.– COLOUR.

ONE of the most interesting, as well as one of the most difficult, problems with which we are brought face to face in the study of man is the question of colour. At first sight nothing makes so strong an impression on us as the distinctive colours of the races with which we are brought in contact. Hardly any other subject within the domains of physical anthropology has attracted so much attention, yet in spite of many ingenious theories and speculations as to its origin and the mode of its production, we are confessedly very ignorant of its true nature and significance. Whilst some would have us believe that primitive man was fair complexioned, there seems no less cogent reasons for maintaining that his skin was of a darker tint. It is not necessary for us to accept the extreme position, and thereby assume that he was black. A middle course is open, as suggested by Dr. A. R. Wallace, who advances the view that primitive man was probably of mongoloid stock, and that his subsequent modification into the white, and brown, and black varieties was due to his migrations into geographical areas, where he was subjected to the influence of varied conditions and climates. Whilst not committing ourselves to the acceptance of any such opinion with regard to the colour of our primitive stock, the theory propounded is suggestive, because it implies that colouration in man depends on the disposition of a common pigment or pigments in varying amount, and enables us to realise that the transition from fair to dark is a gradual one, and therefore possibly produced by the organism reacting to the influence of its environment. Throughout the literature of the subject there are a vast number of so-called facts, but unfortunately in many instances the information supplied is rendered valueless because insufficient data have been supplied to enable us to form a correct estimate of, or draw definite conclusions from, these observations.

Our intention in the present article is rather to draw attention to those associated details which seem to us of importance in studying the question, rather than to enter into a discussion of the theories advanced to account for the presence or absence of pigment in the skin of man. Before doing so, however, it may be well to state briefly what is known of the anatomical distribution of this pigment. Confining our attention more or less to its presence in the skin, we must refer shortly to the structure of the integument.

The *cutis vera*, or true skin, of mesoblastic origin, is a felted layer, of more or less compact tissue, abundantly provided with vessels and nerves. Superposed on this, and filling up the many irregularities of its surface, is an epithelial layer of epiblastic origin—the epidermis, cuticle, or scarf skin. The thickness of this layer varies considerably in different parts of the body, but in all cases we are able to distinguish a difference between the character of its deep and superficial cells. The former are polyhedral, large, and juicy, and are separated from each other by a series of intercellular channels; this layer constitutes the *stratum mucosum* of *Malpighi*. The character of the superficial cells is altogether different; they are compressed, flattened, dry, and horny, and constitute the *stratum corneum*. In some situations better than in others, we can see between these two layers an intermediate zone, consisting of a layer of cells of highly granular appearance —the *stratum granulosum*. Overlying this we find a thin, clear, glassy-looking layer, the *stratum lucidum*. Be it noted that the blood vessels do not penetrate into any of the above epidermic layers. If, now, the skin of a negro be examined, the pigment will be found in granular form within the deeper cells of the *stratum mucosum*, more abundant in quantity in those cells which rest on the surface of the *cutis vera*, and gradually diminishing in amount as we pass from the deeper cells to the surface, until at length it disappears altogether, and the superficial layers of the epidermis are left clear and transparent.

This pigment, of which melanin is an important constituent, is a highly complex body, possessing remarkably stable qualities. What we know of its chemical constitution we owe largely to the researches of Sorby, whose monographs on the subject still remain the standard authority. That observer conducted his investigations on the pigment of hair, which for all practical purposes may probably be considered as identical with that of skin. He was able to isolate three pigments, a brown-red, a yellow, and a black constituent. In the lighter tints of hair the two former colours or admixtures of them are alone met with. When the shade grows deeper, it is due to the addition of the black constituent in variable quantity. In absolutely black hair, however, after the black pigment has been separated out, a large proportion of the red and yellow pigments may still remain; thus Sorby found that some very black negro-hair contained as much of the red constituent as an equal weight of very red European hair. It would be interesting to pursue this subject further, but the space at our disposal debars us from being led into diverting speculations. It may, however, be noted that "blackness," as indicated either in hair or skin, is a very unsatisfactory term. Sufficient pigment may be present in a given weight of hair to impart to it a

FIG. 1.—Photomicrograph of Section through Human Skin.

colour which to us appears black, whilst another sample of the same weight may yield three times the amount of pigment and yet present no difference to the naked eye from the first sample examined. It will thus be apparent that by our ordinary methods of classification blackness in the hair and skin may include a far greater range in the amount of pigment present than at first appears probable.

Without entering into a discussion of the probable sources from which this pigment is derived, it may be profitable to state that two opinions are held with regard to its production. Some maintain that it is elaborated by the cells of the deeper layer of the *stratum mucosum*, whilst others hold that the pigment is brought to the cells from other sources and is absorbed by them. The latter is more probably the correct view, and is supported by evidence of much weight. Thus, in the cells at the base of a hair follicle, the pigment may often be seen blocking and filling up the various inter-cellular channels; it finally appears within the cell and thus becomes intra-cellular.

In recent times, since surgeons have adopted the process of skin grafting to the healing of wounds and ulcers where the skin has been extensively destroyed, some interesting observations have been made. Thus, it has been noted that when the skin of a white man is grafted on to a negro the grafted patch assumes the normal tint of the individual, and, *vice versa*, when black skin is grafted on to white the pigment disappears. Such evidence seems to support very strongly the absorption as opposed to the elaboration theory. One more point with regard to the growth and structure of the skin may with advantage be referred to. The generally accepted view with regard to the regeneration of the superficial layers of the epidermis is, that the deepest cells of the *mucosum* gradually advancing to the surface undergo a horny change and are finally shed on the surface of the cuticle. So far such a view would meet all the requirements of the case in the white races, but, unfortunately, when we apply the same to the coloured varieties we are met with a difficulty at once. As we have seen, in the skin of the negro the deeper cells of the *mucosum* are the cells which contain the most pigment, whilst the superficial layers of the epidermis are free from colour. Now, if, as has been suggested, the deeper cells advance to the surface, it is only reasonable to suppose that they would carry their pigment with them, and hence the superficial layers would be as strongly coloured, if not more so, than the deeper strata. We have already seen that the pigment contained within these deeper cells is of a very stable character, resisting the action of the strongest acids and alkalies, and yet, if we adopt the accepted view with regard to the regeneration of the superficial layers, we must explain this disappearance of the pigment, which has not yet been satisfactorily accounted for. But may it not be that the accepted view with regard to the regeneration of the superficial layers is at fault? This is not the place to enter into a discussion of the matter, but possibly the growth of the epidermis is analogous to the growth of the cork cambium layer of plants. The *mucosum* corresponding to the green cells, the *stratum corneum* to the corky layer of the cambium, and, if such be the case—and there is much evidence in support of it—the deeper cells would advance towards the surface of the *cutis vera*, that is, they would grow inwards, whilst the horny cells would grow towards the surface.

Under these circumstances the active layers would be those to which attention has been already directed, viz., the *stratum granulosum* and the *stratum lucidum*. Such a view with regard to the regeneration of the epidermic layers would explain many of the difficulties which we encounter if we accept the current opinion. It would, as will be evident, do away with the necessity for explaining the mysterious disappearance of the pigment in the superficial layers, and would afford a reasonable explanation of

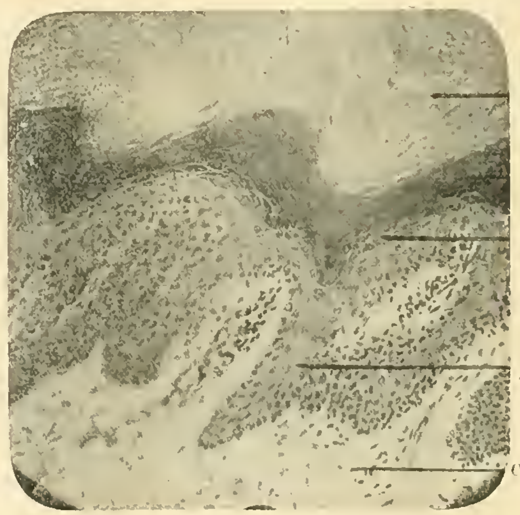


FIG. 2.—Photomicrograph of Section through Human Skin more highly magnified.

how it happens that in old age a negro's hair becomes white whilst his skin still retains its blackness, a detail to which we may subsequently refer.

Colour in man, then, may be said to depend on the presence or absence of these pigments. In the fair races there is probably a certain amount of the brown-red and yellow pigment present, but in so small a quantity as not to interfere with the translucency of the layers; in consequence of this the reddish tint of the highly vascular *cutis* *vera* shines through the semi-transparent layers, and any change in the vascularity of the cutaneous surface of the body is at once apparent, whether it be brought about by external or internal stimuli. The bronzing of parts of the body, due to exposure or to the influence of sunlight, is probably the consequence of the increased cutaneous blood supply bringing more of the red, brown, and yellow pigments to the deeper cells of the *rete mucosum*. Freckles, which, curiously enough, occur most frequently on those with hair of a pronounced red colour, do not differ in any respect from the pigmented skins of the darker races, except in regard to their colour and their circumscribed appearance. In persons of dark complexion there is, in addition to the red, brown, and yellow pigments, probably a very slight admixture of the black pigment. This may be present in sufficient quantity to impart a blackness to the hair, but not abundant enough to destroy the fairness of the skin, though in exceptional situations its presence may be very evident.

By gradual transitions we may pass to those races in which the cutaneous pigment is present in sufficient quantity to mask the colour of the underlying tissue and impart thereby a sallowness to the complexion. These are the yellow races, and if sections of their skin be studied they will be found to differ from the highly pigmented cuticle of the negro only in the depth of the tint of the pigment contained in their deeper cells. By further steps we can pass

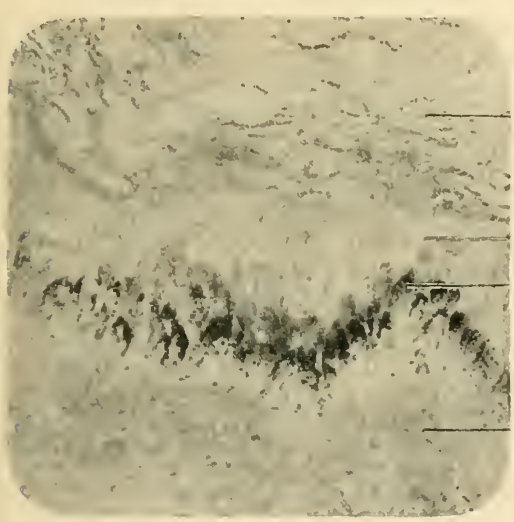


Fig. 3.—Photomicrograph of Section through Negro's Skin, showing distribution of Pigment.

easily from the yellow through browns of various sorts to the absolutely black races. Here the pigment is present in varying quantity, in some skins only the deepest row of the cells of the *mucosum* is loaded with the granules, in others the *mucosum* for several cells deep may contain the pigment, but it ceases to colour the cells before the *stratum granulosum* is reached. Thus, one skin, to all intents and purposes as black as another, may contain a much less amount of pigment, just as we have seen in the case of hair.

At present our method of classifying the colours met with in man is crude and not very trustworthy. The best means at our disposal is to employ the colour tables published either by the Anthropological Society of Paris or the Anthropological Institute of London. But even this is admitted to be far from satisfactory. The difference in the texture of the things compared causes a difficulty in the matching of the tints. For our part we think a much better plan would be the employment of carefully dyed pieces of kid, such as are used in the manufacture of gloves; these could be laid over the skin to be matched, and a much more reliable result obtained. Unfortunately, there would be some difficulty in standardizing the colours, but with some trouble this might be effected. Further, care must be taken to sample the colour of the skin on different parts of the body, for the more exposed parts are naturally those which display the darkest tint. In using either the English or French standard colour sheets, observers have found, as a matter of experience, that it is better to cut a hole in a piece of paper corresponding in colour with that on which the standard tints are printed, and then placing this on the skin to be examined, compare the patch exposed through the hole in the paper with the standard tints held side by side.

But a mere enumeration of standard tints does not assist us very much. In all cases it seems to us advisable that a lock of hair should, if possible, be obtained from the individual examined. As we have already hinted, we consider the hair a more important index of colour than the skin itself, because by taking given weights of hair, and extracting the pigments from it, we would be in a far better position to determine with accuracy the relative proportions of pigment present. It is assumed, of course, that the hair taken had not been subjected to the influence of lime or other "dressings," and that there was no evidence of senile change in the hair. No doubt the research would be arduous, but the results would amply repay the expenditure of time and trouble.

But, in addition, there are many other details which seem to have a more or less direct influence on colour production. Of these, temperature may be mentioned, diurnal as well as nocturnal. The moisture of the atmosphere. The nature of the soil. The diet. The manner of life, whether dwellers in dense forest or jungle—where, for example, the natives are screened from the sun's rays—or dwellers on the hills and plains, where they are most exposed to light and alternations of temperature. On the other hand, much information is wanted with regard to their susceptibility and immunity to disease of certain kinds. Apart from the anæmia consequent on the disease, whites, who suffer from malaria, appear to acquire a darker complexion. As has been hinted by Darwin, it is just possible that darkness of the skin may have been evolved, and is in some way connected with the immunity which coloured races possess from such diseases. There seems to be evidence, too, that in the dark races the size and consequently the weight of the liver is proportionately greater than in the white races. Unfortunately such data are not easy to obtain, but they would be of much service in enabling us to criticise certain theories that have been propounded. Certain it is that whites in tropical climates are much more liable to derangements of that organ than is the case with natives. Another line of enquiry which might much help us to solve the problems of the mode of production of this pigment, and the regeneration of the epidermic layers, would be a careful study of skin diseases in the dark races. We are not aware that it has been approached from this standpoint, but we are confident that it would prove a highly interesting field for research.

The above are a few of the facts which, it seems to us, would help in the elucidation of a problem about which in reality we know very little.

THE BAD LANGUAGE OF WILD BIRDS.

By Charles A. Witchell.

Judging by what one hears of the utterances of animals generally, it would seem that many of the notes of birds are interpreted too poetically by observers. In the case of many animals, the facial expression is capable of sufficient variation to clearly prove the character of the sounds by which it is accompanied. When a dog or a cat snarls, for instance, we know that the sound is intended to express hatred and a threat of attack. The lowing of a cow or of a calf, the bleating of a kid, the snorting of a horse, and its whinneying, can hardly be misunderstood.

But the meanings of the cries of birds are less obvious. The cooing of a dove, or the warbling of a fluent singer, may seem to be as expressive as any note of the quadrupeds just mentioned; but when attention is given to the actions which accompany the cries of birds, an observer finds that some very pleasant sounds are incidental to very unkind behaviour. In a few cases the combativeness of a bird is fairly well suggested by its cry—as occurs in the common fowl, whose "crow" is as defiant as a bugle blast. The shriek of the woodland jay, also, is very expressive. These sounds, however, do not represent the greatest passion. We must listen to birds actually engaged in combat in order to hear the expression of their utmost hate—their worst language; and, listening thus, we often make the discovery that the sound accompanying an attempt at murder is closely like (sometimes apparently identical with) sounds which seem to be joyous song.

The little brown wren mounts the top of the hedge and sings a sprightly song. The notes seem to be the spontaneous outpouring of joy. Twenty yards farther along the hedge another wren mounts to the topmost twig, perks his tail, and utters a similar lively tune. Number one flies a little way towards number two, and sings again. Here, then, is a pleasing sylvan duetto! But soon the wrens are fighting furiously, tumbling over and over each other at the bottom of the hedge, while at intervals snatches of the same little ditty are heard. They sing, in the intervals of fighting, what seemed a song of peace and love. In view of what the birds are doing, it may be surmised that their language at this moment is very bad indeed.

But instead of the sprightly wren, the sedate robin may be under observation. If a singing robin be watched, and especially in autumn, he will be seen to attack any other singing robin which may be near; yet the birds will be singing all the while, and their songs will be like the ordinary songs of the species, though a trifle sharper in tone. The music is evidently intended to convey the animosity of the birds. The hedge-sparrow twitters in quite a subdued tone when fighting; yet it nevertheless seems to be singing. The willow wren sings its ordinary song when about to attack a rival. The chiffchaff, however, does not employ his cheerful strain on the like occasion. The nightingale is somewhat pugnacious, and I have several times seen two fighting (I once saw three), but no song notes were then given.

Among the finches and buntings, a combat is often accompanied by a slight twittering, somewhat similar to rapid repetitions of the call note, malice and love having thus the same tone; but some species employ a particular note. The chaffinch has only one cry when fighting, be his enemy bird or beast. That cry is the common note "tink," or "fink." The greenfinch then utters a low rough cry, something like "gupgupgup," repeated very rapidly. The male house-sparrow is one of the most silent of fighters. (The casual observer will say that this is one of the most untrue of allegations.) When male sparrows intend to fight, they hop about restlessly near each other, their feathers held very close, and their tails flirting up and down almost continuously. Presently one of the birds darts at the other and tries to give him a lance-thrust with the bill, the other springs aside, and the aggressor alights near, and the flirting of the tails continues. But all this time the birds utter no cry, When the contest has reached the stage of a struggle in the nest-place, however, there is some noise, scuffling and screaming. The cries are not the tones of love; they are expressions of fury. When male sparrows are noisily clustering around a female bird, their cries may be those both of love and fear; but these assemblies require close attention before the nature of the cries employed can be ascertained.

There are many species which give the full song during combat. I have heard the full song of the tree pipit sung by a bird fighting furiously. When first seen the birds were fighting in flight; they fell to the ground together, and in this position, and when I was not more than three yards distant, one of them uttered the full song, including even the final "whee whee whee," which is usually uttered while the bird is descending on outstretched motionless wings.

The common pied wagtail, when attacking another, utters cries which seem to be his ordinary call-notes; and the same incident may be observed in the skylark. Last summer a lark was singing as usual above his meadow, and another singing lark approached and swooped at him. The new-comer was vigorously repulsed, though not until some pretty flying and stooping had been performed; and the birds were singing all the while. They were evidently rival neighbours, but in this instance, as in those above mentioned, mere rivalry and emulation would not account for the behaviour of the birds. This must be credited to hatred and ill-will.

In many species, therefore, we cannot easily distinguish the tone of love from that of hate, unless we also consider the contemporaneous behaviour of the birds. And even then we may easily err; for when a melodious singor is perched in a tree, or poised on the wing, we cannot tell whether his notes are addressed to his mate, or to his enemy. Unfortunately, it is not only among birds that the same tone is employed towards both of these objects!

So far, I have not met with anyone who is paying attention to this branch of bird-song; yet it is a really important one, with a basis of fact to indicate the lines of investigation to be followed. The sparrow and several other finches have cries which are preferably employed during combat. Some singers, as the robin and thrush, sing when fighting with others of their own species, but not when fighting birds of alien species, and there are many which do not sing at all when fighting. The starling is one of the last. When threatened by another, or meditating an attack, it is silent, and at the moment of the encounter only a slight cackling is heard. This sound may most often be heard in September and October, when the birds are striving for the possession of nesting sites in which to roost during the winter.

But though the starling never expresses malice in song, he undoubtedly often sings a love-song, for he will fan his mate with his wings while singing; and she, with head raised and tail drooping, adds a softer strain to his music.

The blackbird is another singer which never employs song as a threat. His combats are accompanied by a metallic clicking sound, with which most of us are familiar. The song thrush, however, never has a contest with another of his kind without twittering an accompaniment.

It cannot be said that any of these birds is restricted to one set of tones both for anger and for song (as occurs to some extent in the common duck), for all of them have special cries of alarm and anger, which they utter when frightened by a predaceous beast. The robin employs his rattling note of alarm; the thrush, when its nest is threatened by the jackdaw, makes a great outcry like that of the mistle thrush; the tree pipit has an alarm which is given when the nest is threatened; the brown wren repeats a common note when frightened; and the others have a similar variety of cries.

These remarks are intended to prove the importance of carefully analysing a bird's notes before attempting to define their meaning. The subject is so new that anyone who will carefully notice may do good work, and at no cost of bird-life. Nor can it reasonably be urged that this analysis would rob the poet of some common symbols. No one would unnecessarily deprive him of any, but he should know that while the blackbird, starling, chaffinch, and others may be pouring out the truest love-notes, the robin, thrush, hedge-sparrow, and others, though also singing, may be using the very "Billingsgate" of birds.

THE KARKINOKOSM, OR WORLD OF CRUSTACEA.—VII.

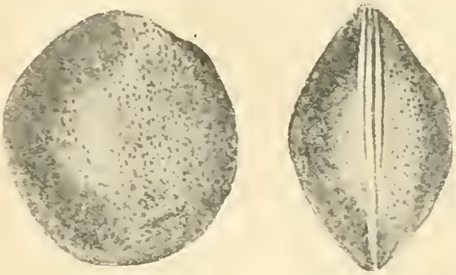
By the Rev. THOMAS R. R. STEBBING, M.A., F.R.S., F.L.S., F.Z.S., *Author of "A History of Crustacea," "The Naturalist of Cumbrae," "Report on the Amphipoda collected by H.M.S. 'Challenger,'" etc.*

THE BOX CRUSTACEA.

IN an essay on Boxes, a writer might find a cue for discussing the merits of thrift and the weakness of the miser, the proper and the improper discipline of children, the implements of a laundry, the arrangement of a theatre, the situation of a country seat, the structure of a cart-wheel, a pump, or a drain. He might speak of trees and their uses, of coaches, of coats, and of Christmas presents. He would, naturally, consider the receptacles which have been contrived for keeping the garments of the living and the remains of the departed. To add to this miscellaneous assortment a mention of the Box-crabs would be an unfruitful eccentricity, because the species of *Calappa* which have been so designated, though highly curious in themselves, are no more boxes than crabs in general. But, for all that, there is a veritable group of Box Crustacea. Here the boxes are alive, and, besides being just large enough for what the owner wants to keep in them, they have the magic faculty of increasing in size exactly to match the increase of the contents. The animals of this group are known to science as the Ostracóda, the shelly group, so-called because they bear an external resemblance to "shell-fish," to bivalved mollusca, such as mussels and cockles. They have, therefore, no sort of likeness, outwardly, to that popular ideal of a crustacean, which hovers between a crab and a shrimp, but must be compared with other entomostracans, such as the *Estheria* figured in our first chapter, or the *Daphnia* in our fourth.

The collector of crabs and lobsters is apt to scare the members of his household by the odour of the specimens, if he keeps them dry, or by the continued demand for bottles and corks of all sorts of unprocurable sizes, if the specimens are to be preserved in spirits or formalin. House-room also soon becomes a consideration. But with the Ostracóda it is different. Many of them are less than one millimetre in length, and they are seldom broader than long. Now, a millimetre is just a twenty-fifth part of an inch; see, then, how convenient it is for a naturalist, whose space accommodation is limited, to be able to place six hundred and twenty-five specimens on a plot of ground, or a piece of black card, an inch square.

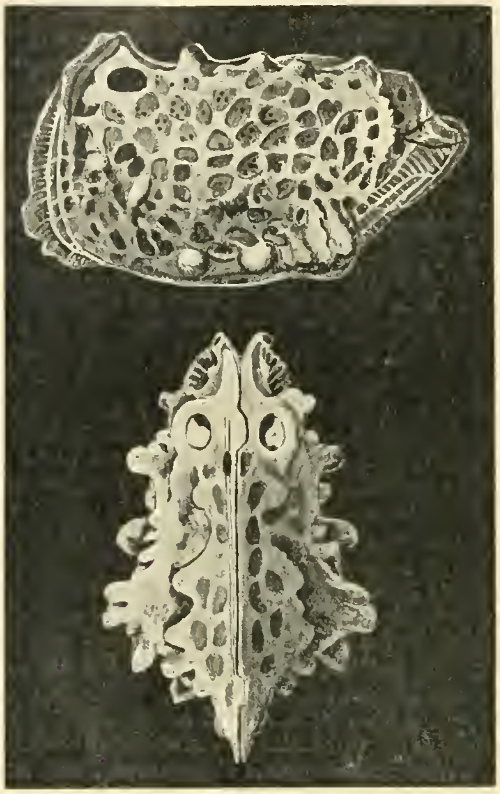
To the unscientific Briton it may appear pedantic, unpatriotic, and needlessly obscure to give scientific measurements in French millimetres. But there is this important convenience in it, that a millimetre means the same measurement all the world over, whereas the English word "inch" translated into the French "pouce," or the German "Zoll," changes its meaning at each step, the German inch being equivalent to twenty-six millimetres, while ours answers to twenty-five and the French to twenty-seven. Now that science has become more than ever cosmopolitan, it is a serious evil to use words such as inch and foot and fathom, which are untranslatable, except by the help of a sum in fractions.



Polycope orbicularis Sars, lateral and dorsal views. From G. S. Brady.

With the Ostracóda, at all events, the millimetre will be found to be a specially suitable unit of measurement. Their personal proportions never require to be reckoned in feet or in inches. Nevertheless, as in all other groups of animals, there are among them disparities of size, from the dwarfish to the elephantine, but still all within a modest, unalarming compass. Their delicate little corpses dry up within their own organic sarcophagus, and need no embalming to make them inoffensive. They remind one of that romantic country in which the old men never died but only shrivelled, and could, by process of steeping in hot water, be occasionally revivified to answer the enquiries of a younger generation. In regard to some of the specimens described in the "Monograph of the Marine and Fresh-water Ostracóda of the North Atlantic and of North-Western Europe" (1896), the authors, Dr. G. S. Brady and Canon Norman, say, "it struck us that, notwithstanding their dried condition, it might yet be possible by maceration to get some idea of the withered inmates of the shells. We therefore made experiments, and succeeded in restoring the animals beyond our most ardent expectations." The authors are evidently innocent of any suspicion that the process had ever been applied with equal success to human beings.

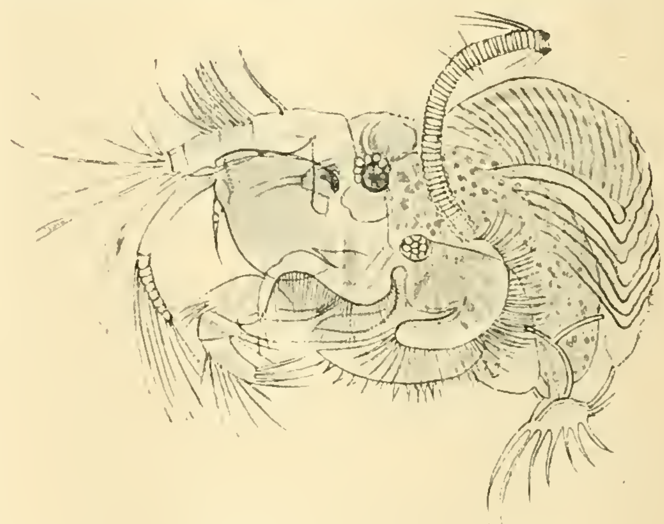
Besides being easy to keep and hard to decay, the Ostracóda have another advantage in the universality of their aquatic distribution, so that some of the species are extremely easy to obtain. Not only are these organisms distributed over all the water-covered floor of the existing world, but their range extends through the fossiliferous strata from the Cambrian to those which are now being formed. It must, however, be admitted, and should be borne in mind that we cannot macerate carboniferous or cretaceous forefathers of the Ostracóda. They no longer yield to any witchery of rejuvenescence to answer our questionings. Only the boxes, the external valves, remain, preciously imperishable, saved, as the moralist may be pleased to observe, not by any heroic grandeur but by their insignificant smallness, and a mean dwelling in the slumberous ooze. The strong likeness between the valves of some species still living and the fossil valves belonging to various geological periods makes it probable that in the inward parts also the ancient forms bore a near resemblance to the modern. The student of the fossils will find a voluminous literature at his disposal, foremost among the authorities being our own countryman, Prof. Rupert Jones, whose researches upon these organic remains have been continued during the last fifty years, and still continue. Half a century of work upon the same kind of material is some testimony to the fascination of a subject which can bring little in the way of fee or fame, but rather, like virtue, is its own reward. Another devoted student of the Ostracóda, both recent and fossil, was the late Dr. David Robertson, who, by living to be almost ninety years of age, showed that the pursuit was at least not inconsistent with longevity. How and when and where to obtain the freshwater forms will be found concisely explained in Robertson's own words in Appendix B to "The Naturalist of Cumbrae."



Eucytherura gibbera, lateral and dorsal views. From G. W. Müller.*

Here it may suffice to say that Ostracóda are to be found in the depths of the ocean and on its shores, in slow-running streams, in marshes, ditches, and ponds. The streams and the pools need not be very extensive, for Brady and Norman explain that *Scottia Browniana*, originally described as a fossil, was found on the shores of Loch Fadd, in the Isle of Bute, under the following circumstances: "A spring rises on a bank close to the loch, into which the water finds its way among the grass; the water is nowhere trickling more than two or three inches deep among the herbage. Here, amidst multitudes of *Difflugiæ*, *Scottia Browniana* lives, with *Ilyodromus Robertsoni*, *Herpetocypris reptans* and *tumefacta*, *Cypridopsis Newtoni*, *Candona candida* and *Candonopsis Kingsleii* as its companions." This is but a small rivulet to furnish seven species and almost as many genera of the group. Still more singular is the habitat of Fritz Müller's *Elpidium bromeliarum*. This species, which is now referred to the genus *Xestoleberis*, lives in fresh water, though belonging to the Cytheridæ, a family almost exclusively marine. It is nearly as broad as long, and much broader than high. In shape it is compared to a coffee berry, and, if reliance can be placed upon form, it appears to have no nearer relative than the *Elpe pinguis*, a Silurian fossil, five times as large as itself. In its ancestry, in its outline, in its absence from the sea, this little species is remarkable, but, above all, in the reservoirs that furnish its dwelling place. These are aerial though not in the clouds. They are the miniature cisterns formed by rain water in the leaves of parasitic plants, the Bromelias of Brazil. Those pools are visited by innumerable insects, by worms, isopods, arachnids, myriapods, batrachians, and even cobras, but, in the opinion of Fritz Müller, the little *Elpidium* is almost the only animal that lives in them from its birth to its death. As it has no means of migrating of its own accord from one Bromelia to another, whether on the same or different trees, and as almost every Bromelia has the Ostracóda, the inference is that, like the pollen of flowers, they are carried from plant to plant by some of the more freely locomotive visitors.

Without visiting the forests of Brazil, many species of Ostracóda can be procured from various waters by the use of a fine net at the end of a stick, by the washing of water-weeds, and the sifting of dredged-up mud. So far as the "boxes," or closed valves are concerned, there is not much to choose between fossil and recent specimens. A new interest begins with the study of the internal machinery and observance of the habits of tho living animal. The resemblance to a mollusc is at once seen to be purely superficial. There are here the eyes and the jointed appendages



Body of an *Astérope*, without the valves. From Claus.

of an arthropod. There are also the two pairs of antennæ in which crustaceans rejoice, while the poor insect has to be content with a single pair. There are the mandibles or jaws, without which no lofty destiny is complete, and after these come four or five other pairs of appendages, beginning with the first and second maxillæ, and ending with pairs to which in some instances the name of legs can only be applied by courtesy.

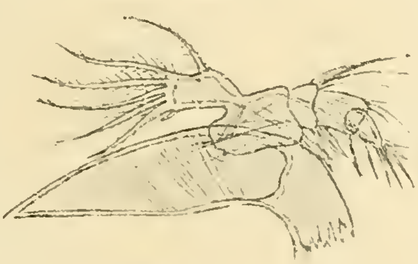
It is not to be denied that beginners may find themselves, at first, bewildered as to the sorting of all these organs or limbs. That they are where they are without the least undue crowding and crumpling is a miracle of natural

* Fauna und Flora des Golfes von Neapel. Ostracoden, von G. W. Müller, 1894.

packing. One can only feel that this is not an original design, but an adaptation gradually brought about. So anxious have the creatures been to have all the precious items of their apparatus shielded within the valves of their shelly portmanteau that they have wedged them together, without much minding the natural order so long as their efficient working was not interfered with. Even that point has perhaps been a little sacrificed, seeing that some of these essentially aquatic animals are without the essentially aquatic accomplishment of swimming. This is ignominious, but it is safe. They can walk, they can burrow, or they can cling. Thus they can secure food and a contemplative life without natatory gadding among the ferocious occupants of the watery empyrean.

There are four sections of the Ostracóda, one of which, under the name of Podocópa, comprises fresh-water species as well as marine, while only marine species are known in the other three. In all of them the appendages, though they can in general be identified in their serial order, differ often very strikingly in their forms. This is scarcely to be wondered at, since some of the species come from depths of the tropical ocean, others from little grimy puddles on land; some have shells of polished smoothness, while others show the most ornate rugosities; some are less than a millimetre long, others stretch their vast length to seven or eight millimetres; and one almost incredible monster from the Pacific is said to measure more than an inch.

The differences in the organs are not without a philosophic as well as, doubtless, a functional value. Observe, for example, the mandible of *Megalocypris princeps* Sars, a princely fresh-water ostracode from South Africa. Its basal joint forms a strong transverse trunk with a dentate biting edge, such as is so commonly seen throughout the Malacostraca, and from this trunk rises a jointed palp.



Mandible of *Megalocypris princeps.* From Sars.

It has been already explained that the joints of a mandibular palp must really correspond to the joints of a leg, in spite of the utterly unleglike appearance of the ordinary mandible. Turn now to the mandible of an *Astérope.* It will be seen to be completely leg-like. Its basal joint is not transverse but longitudinal, end to end with the joints which follow it, while the biting process, though present, is quite unobtrusive. This comparison is like the writing on a sign-post, only, instead of directing us how to reach a town or a village, it directs us how to reach a conclusion. It points towards this deduction—that the strangely diversified forms of mandible throughout the crustacea may have originated from a simple string of similar joints. The form of the mandible in *Megalocypris* forcibly intimates that the Ostracóda are not only connected with other groups of Entomostraca but with the Malacostraca as well. A genealogical unity of all the crustacea thus springs into view, and this can only be grounded on the theory of evolution. Fifty years ago, in public estimation, that theory was nowhere, and now it is everywhere. When it first came into the open sunlight it greatly affected not only the thoughts but the lives of men. It made some become naturalists who would otherwise never have given more than a passing glance to natural history. Now, indeed, it is so much taken for granted that men can hold it, as they hold other great doctrines, with no grounds for conviction and in placid companionship with a thousand inconsistent views. But that is not the fault of the Ostracóda.

Mandible of *Astérope,* sp.

To return to the genus *Astérope*, in which the mandible is like a leg, we find that here the penultimate pair of appendages, which according to custom ought to be a pair of legs, or at least leg-like, is more like a pair of flattened out dust-pans. Its principal or its most obvious use is not wholly out of harmony with the appearance. The strongly spined terminal part of the animal, known as the caudal fork, in repose is folded within the valves. In the alternate unbending and re-bending of this spring tail the animal finds its most powerful source of locomotion. But every alternate stroke protrudes the finely serrate spines into the muddy or gritty surroundings of the outside world, and some of the particles are carried back into the scrupulously neat but limited accommodation within the valves. There the legs, which have been modified into a sort of combination of dust-pan and brush, receive between their plates and hairs the bespattered spines of the tail, and cleanse them. But here the old difficulty arises. *Quis custodiet ipsos custodes?* Who is to brush the brushes? This question is answered by nature in a manner truly remarkable. The next pair of limbs are converted into what servants call "a general" and what their employers call "a maid of all work." In the family Cypridinidœ, to which the genus *Astérope* belongs, this leg "represents a long, vermiform, annulate, extremely movable appendage." It is employed to sweep the outside of the valves, thus passing into the water for its own purification, and within them it brushes the brushes, it plies between the laminar branchiæ or breathing organs, and above all it attends to the nursery, by working about among the eggs in the brood-pouch, making things wholesome for the hopes of the race, the coming generation of the Ostracóda. On these and a hundred other matters of interest concerning this group the student will find copious instruction in the works of Sars, and Claus, and Brady, and Norman, and Robertson, and many others, to whom their writings will introduce him, nor will he go far in his researches without discovering that the fine monograph by G. W. Müller is indispensable to satisfactory progress.

Brushing feet of *Astérope,* sp., slightly separated.

Annular cleansing foot of *Astérope,* sp.

SECRETS OF THE EARTH'S CRUST.

By GRENVILLE A. J. COLE, M.R.I.A., F.G.S., *Professor of Geology in the Royal College of Science for Ireland.*

INTRODUCTION.

IN this series of papers the writer proposes to touch on some of the questions that are prominent in the minds of geologists at the present day. In so doing, it must become clear in each case that the position now reached is the result of a long series of observations, extending back throughout the century. There is no "new geology," any more than there is a new heaven or a new earth. In this, as in other sciences, the great discoverer is preceded in his triumph by the veteran legions who have seen more service than himself. The records of patient labour, sometimes laid aside owing to their obvious incompleteness, the work of men in candle-lit laboratories, or in mining camps among the mountains, may at length receive their interpretation, and fall into their place in the great argument of reason. Everywhere these friendly linkings with the past provide new stimulus for research; and it is not always the young and undefeated who sound the *réveil* upon the field.

I.—THE UNSEEN CORE.

The public mind has always been impressed by the fall of strange bodies upon the earth, sometimes from our own atmosphere, sometimes from outer space. "Red rains," regarded as showers of blood, have been held to presage deadly evils; and the descent of small frogs, or even freshwater fishes, has been looked on as a dubious blessing. The explanation that red mud, and the accessory frogs, may be carried up from drying pools by whirlwinds, and that the contents of crater-lakes may be flung broadcast by volcanoes, has hardly allayed popular suspicion. Still more impressive have been the records of the fall of meteoric stones, at times accompanied by the flash of a visible meteor. The tradition of such occurrences was, in old time, passed from one hearer to another, and even ordinary lightning became credited with an accompanying "thunderbolt." Concretions of metallic ores, such as the marcasite nodules of the chalk, are even now pointed to as "thunderbolts"; and this fact, based on their superficial resemblance to true meteorites, shows that the latter must have been observed with tolerable frequency. Meteorites that had actually been seen to fall were, naturally enough, accounted precious and miraculous, and were occasionally preserved in churches. In still more ancient days they were objects of worship, and were associated with recognised divinities, such as Diana of the Ephesians. The philosophers of the Renaissance, however, swept aside a number of valuable traditions, in their very pardonable zeal, and they refused to believe that meteoric masses could reach our planet from without. Gassendi, who saw a meteorite fall in Provence in 1627, thus attributed it to some unknown terrestrial eruption; though a mass of fifty-nine pounds, descending in proud isolation on the soil of France, surely deserved further consideration.

Fig. 1.—Cut surface of Meteorite (Sporadosiderite) which fell at Mócs, Kolozs, Transylvania, 3rd Feb., 1882. ×12. Bright irregular specks of nickel-iron lie scattered in a ground consisting mostly of basic silicates. One of the globular "chondroi" shows as a light-coloured circular area in the section. (From a specimen in the Royal College of Science for Ireland.)

It was left for Chladni, in 1794, to revive, on scientific grounds, the well-founded belief of older days. He particularly commented on the mineralogical peculiarity of the "Pallas Iron," a huge block of nickel-iron and included olivine, found in Siberia in 1749. This appeared to him not to resemble any known terrestrial material. In the same belief, Sir Joseph Banks collected specimens from Siena (1794), Yorkshire (1795), and Benares (1798), and submitted them to Mr. Edward Howard. Aided by the Comte de Bournon, Howard published the first truly scientific report on "certain stony and metallic Substances which at different Times are said to have fallen on the Earth; also on various Kinds of native Iron."* Nickel was here recognised as a constituent of the iron masses; and Howard, while offering no conclusion, clearly inclined towards the meteoric view. When an idea has been denounced as superstition, it is slow to come again into favour; but the fortunate fall of stones at l'Aigle, in Normandy, in 1803, gave the French Academy an opportunity of forming an independent opinion. Biot's report converted those who sent him into the field; and the genuineness of the fall of stones "from heaven" has not been questioned subsequently.†

Among the meteoric stones investigated from time to time, a number were found to consist of metallic iron, with some five or ten per cent. of nickel. Only a dozen or so of these iron meteorites have actually been seen to fall, including one near the Wrekin in 1876; but many other conspicuous masses, found lying on the surface of the earth, have been assigned a meteoric origin, on account of their resemblance to specimens about which there is no manner of doubt. One of the striking features of many such irons is the development of characteristic figures when a polished surface is etched with nitric acid. Von Widmanstetter (also known as von Widmanstätten) observed these as early as 1808; and it has since been shown that the systems of crossing bands and lines are due to the varying degree of resistance of different alloys of nickel and iron. In the most easily attacked layers, there may be fourteen parts of iron by weight to one of nickel; in the most resisting parts, which remain as thin bright streaks above the dull etched areas, the proportion of iron to nickel may be only six to one. The bands thus developed on a polished surface are usually the edges of four sets of layers grouped parallel to the faces of an octahedron, and represent successive zones or stages in the growth of the crystalline mass. The iron particles contained in some stony meteorites are much richer in nickel than are the ordinary iron meteorites; which proves that highly nickeliferous ores may yet some day descend in mass from space. Indeed, the material from the province of Santa Catharina, in Brazil, with 63·69 per cent. of iron, and 33·97 per cent. of nickel, and that from Octibbeha, Mississippi, with 37·69 per cent. of iron, and as much as 59·69 per cent. of nickel, are commonly regarded as truly meteoric.

All these iron masses, ranging from mere pebbly particles up to blocks measuring several feet across, present striking differences from the ordinary materials of the earth's crust. Metallic iron is one of the least important constituents of the rocks to which we readily have access. Even now, it has not been recognised as a common mineral, though it may occur in the form of minute grains in a number of basic igneous rocks. The iron familiar to us in analysis, which forms, according to Mr. F. W. Clarke, some five per cent. by weight of the earth's crust, occurs as the oxides (magnetite, hæmatite, or limonite), as the sulphides (pyrite, marcasite, and pyrrhotine), as the carbonate (siderite), or shut up in combination in a variety of common silicates.

Terrestrial native iron, however, has long been reported from the platiniferous sands of Brazil, not to men-

* *Phil. Trans. Roy. Soc.*, 1802, pt. i., p. 168.

† *See* L. Fletcher, "Introduction to the Study of Meteorites," issued as a guide-book at the British Museum.

tion other more or less authenticated instances. In 1852, Prof. Andrews,* of Belfast, powdered up certain Irish dolerites and basalts in a porcelain mortar, extracted all magnetic particles by means of a magnet, and examined these particles under a microscope. When moistened with an acid solution of copper sulphate, the magnetic iron oxide (magnetite) undergoes no change; but metallic iron is attacked, and is replaced by a deposit of pure copper. Andrews found in this way a small number of particles of pure iron—three or four from one hundred grains of powdered rock—and the largest deposit of copper measured one-fiftieth of an inch in diameter. The dolerite of Slemish yielded the best results; but the basalt of the Giant's Causeway gave sufficient indications.

Other workers repeated these observations on Continental rocks, the result being that metallic iron seems regularly associated with the dark heavy "basic" rocks, basalts, and so forth, and to occur also, but more rarely in rocks rich in silica, such as granite.

But it is only in the last few years that geologists have been assured of the presence of considerable masses of native iron in the earth's crust. Nickel-iron has long been used by the Eskimo for knife-blades and hatchets; and it was suspected that some large meteorite was being worked as a convenient mine. Nordenskiöld, in 1870, observed a block of iron in some ballast taken on board near Godhavn, in Disko Island; and in time the true source was discovered by him at Uigfak, or Ovifak, a spot difficult of access, but now one of the best known mineral localities in the world. Here, on the shore, some magnificent blocks of nickel-iron were lying, exposed to the sea-waves. The largest, which is now in Stockholm, measures six feet long, and weighs about nineteen tons. On etching, the well-known "Widmannstätten figures" were revealed, and nickel, varying from 1 to 6·5 per cent. (usually about two per cent.) has been found on chemical analysis.

It is no wonder, then, that the Ovifak masses were at first believed to be meteoric. Even when nickel-iron was found in the adjacent basalt of the coast, it was thought that a meteoric shower might have occurred while the lava was still hot and viscid, and that the fragments had become consequently entombed. But other discoveries followed in the same neighbourhood, notably those of Steenstrup, in 1875, and it became admitted that the iron was a true constituent of the Miocene basaltic lavas. Several writers then saw in it the result of the reduction of iron oxides by the material of a coaly bed, which the lava was supposed to have absorbed; so reluctant were some geologists still to admit that native iron is, in any quantity, a true constituent of the earth's crust. The carbon present in the nickel-iron, amounting often to two per cent., might be attributed to the same source; but traces of carbon are well known to occur in most truly meteoric irons. Dr. Lawrence Smith showed that metallic iron was included in even the felspar of the Disko basalts, and the meteoric theory, at any rate, may be said to have been abandoned for fully twenty years.

Meanwhile, attention was called to other examples of terrestrial iron, commonly alloyed with nickel, and sometimes associated with magnetic pyrites (pyrrhotine). Let us note in passing that troilite, the iron sulphide frequently found in iron meteorites, is probably identical with the pyrrhotine of our own earth's crust. This later series of discoveries only confirms the belief that terrestrial iron is typically associated with the most basic masses of the crust. These basic masses have been, on many grounds, regarded as more deep-seated in their origin than the lighter granites and gneisses, which play so large a part in the constitution of the crust.

Near Biella, in Piedmont, grains of nickel-iron occur in a gold-bearing sand; here the nickel forms seventy-five, and the iron twenty-five per cent. In Oregon, pebbles have been found containing twenty-three per cent. of iron, with sixty per cent. of nickel, and twelve of silica. The most remarkable discovery of this nature, however, is probably the "Awaruite" of New Zealand. In 1885, Mr. W. Skey observed this substance as small grains in a sand from the Gorge River, near Awarua (Big Bay), on the west coast of the South Island of New Zealand. Its composition shows that it is a nickel-iron, in which there are two parts of nickel to every one of iron. Prof. Ulrich caused its true source to be traced in the wild country north-east of Awarua; and it is found to occur with pyrite and chrome iron ore, scattered through typical peridotites. The "peridotites" are rocks rich in magnesia and iron oxide, and containing only some forty-two per cent. of silica; they have been recognised, all the world over, as the natural matrix of ores of chromium and nickel. Metallic platinum is also traced to peridotites; and metallic iron is recorded, as we have seen already, from the platiniferous sands of Brazil.

Here we have a series of links, which make it now obvious that materials, once supposed to be entirely meteoric, may occur in mass in the lower regions of the crust. Mr. Skey compared his "awaruite" with the substance found at Octibbeha City, Mississippi, in 1857, which has been already referred to as containing some sixty per cent. of nickel. He was criticised for not observing that the "octibbehite" was of celestial origin; but the tables have now been turned by the suggestion that both this and the nickel-iron of Santa Catharina are not meteorites, but have been washed from some portion of our own crust. How many of the great iron masses found in spots difficult of access, and hitherto regarded as meteorites, may ultimately be traced to some igneous mass, intruded through the local strata?

Fig. 2.—Cut surface of Basalt from Ovifak, Disko Id., Greenland. × 12. Bright irregular specks, composed almost entirely of nickel-iron, lie scattered in a dark ground, which consists of the silicates of the basalt. Compare with Fig. 1. (From a specimen in the Museum of Science and Art, Dublin.)

Already the abundant specimens of "meteoric" iron from Cañon Diablo, Arizona, have come under suspicion. There is now, in fact, no certain character left to us by which we can decide whether a nickel-iron mass is of celestial or of terrestrial origin, except, perhaps, the nature of the surface. This presents remarkable pittings and depressions, in the case of iron that has been projected with great velocity through the air.*

* *Report Brit. Assoc.*, 1852, p. 34. See also "Scientific Papers of Thomas Andrews" (1889), pp. 231, 399, and 507.

* See on this matter, and for an examination of meteorites in general, the classic work of Daubrée "Études synthétiques de géologie expérimentale" (1879), pp. 473-703.

By far the commonest meteorites, however, are those called "sporadosiderites," in which small specks of nickel-iron lie scattered through a ground composed of silicates. Ordinarily, certain structures are present, notably the globular crystalline aggregates called *chondroi*, which were produced in the mass by some special conditions of consolidation. The minerals present, however, are in general those of our own basic igneous rocks. A number of substances regarded as peculiar to meteorites may yet be found in the deeper parts of the earth's crust. Even the strange form of silica, asmanite, so carefully separated by Story-Maskelyne from the meteorite of Breitenbach in Bohemia, is now believed to be identical with the mineral tridymite, which occurs in the cavities of so many terrestrial lavas.

Whether the internal core of the earth is a liquid under great pressure, or whether it is a solid mass, it is certainly of much higher density than the ordinary rocks of the outer crust. Mr. J. H. Poynting* has recently reviewed the long series of researches by which the mean density of the earth has been determined. Among the results, none stand out more prominently than those achieved by Cavendish with the torsion-balance in 1798. We now know that, while the crust has a mean density of about 2·6, the earth as a whole has a density of 5·5 ; and the simplest explanation of this is that the denser materials are accumulated within, while the lighter ones float, as it were, on the outside. The crust, by which we mean that part accessible to ourselves, is of trifling thickness ; already we seem to be within touch of the basic masses which underlie it, with their included blocks of metal. In Greenland and New Zealand, for instance, we find brought up to us the layer corresponding to the "sporadosiderites" of space ; and at Ovifak we seem to have glimpses of an actual iron core, corresponding to the metallic meteorites.

Is such a core an improbability—a core in which iron predominates, but in which other native metals may lie abundantly dissolved ? Astronomers agree that the meteorites, drawn from time to time to the surface of the earth, belong to swarms circling in the solar system. The remarkable uniformity in their characters points to one of two things ; they either originated in the disruption of a single planetary body, or else the great mass of extra-terrestrial matter is far more basic, far more rich in native iron and nickel and cobalt than are the common rocks of the earth's crust. Both these suggestions may be true ; they do not contradict each other. In the meteoric bodies that were, by some astronomical "accident," sent flying into space, we may find the best representatives of the inner layers of our earth. At present our attention becomes more and more directed to the olivine-rocks, the serpentines, the "picrites," and their allies, which here and there break through the crust, bringing up such a wealth of nickel-ores and iron-ores from below. The contents of such masses, particularly any nodular groupings that appear to differ from the ordinary rock, must be scrupulously examined. We are as yet only feeling our way on the outskirts of the unseen core.

* "The Mean Density of the Earth," Griffin & Co., 1894.

Notices of Books.

The Play of Animals : a Study of Animal Life and Instinct. By Prof. Karl Groos. Translated by Elizabeth L. Baldwin, with a preface and an appendix by Prof. J. Mark Baldwin. (Chapman & Hall.) 10s. 6d. Observations of the various activities of animals are of deep interest, and their value in tracing the course of psychological development cannot be over-estimated. But the tendency to consider all exhibitions of animal intelligence from an anthropomorphic point of view—and it is difficult to do otherwise—makes it essential to exercise extreme care in such observations, so that the acts shall be described without consideration as to the possible why and wherefore of their performance. Popular volumes on natural history topics often contain instances of the more human, but less scientific style of recording observations. In the present work, however, a sound and thorough statement of the facts and observations referring to one of the phases of animal intelligence is presented, and we think that few outdoor naturalists would fail to derive benefit from an examination of them. More than this, we will say that before valuable observations of animal psychology can be made, the naturalist must be acquainted with the contents of a volume of this kind. Prof. Lloyd Morgan has done yeoman service in the same field in his various works on the habits and mental processes of animals ; and the course of mental evolution is traced in Romanes's works. We have also Mr. Arthur Thomson's popular book on various aspects of animal life, and Houssay's work on the industries of animals. Prof. Groos's volume deals with quite a distinct aspect of animal activity, and supplements all that have preceded it. The anecdotes of intelligence in animals recorded in it have been selected with discrimination from a vast store, and their bearing upon biology and animal psychology is clearly pointed out. Play is regarded as a real instinct, and Mr. Herbert Spencer's theory that it represents "surplus energy" is discussed and abandoned. The observations described, the classification adopted, and the interpretations suggested command attention, and Prof. Mark Baldwin's notes give additional value to them all. As a contribution to the literature of animal life, in which the transition from animal to human intelligence is indicated, the volume should be cordially welcomed.

Creation Records. By George St. Clair. (David Nutt.) 10s. 6d. The theory which was put forward some time ago by Sir Norman Lockyer to explain the foundations of Egyptian mythology by astronomical considerations is brought into prominence again by Mr. George St. Clair. The idea of the book, briefly expressed, is that the myths of Egypt are all related to one another, and are neither separate fables nor idle fancies. That they reveal, moreover, a religion intimately dependent upon the stars, and tell a true story of astronomical progress and theological changes before the time of our written histories. But while the conclusions and explanations are very fascinating, they can be by no means accepted as final expressions of the exact state of things. Many archæologists who have studied the question from their point of view are not prepared to admit the conclusions. It seems as if one idea has got complete hold of Mr. St. Clair, and, like Mr. Dick and King Charles's head, it will keep on appearing at most inopportune moments. There is no doubt that observations of the sun and stars played a very important part in the worship of ancient Egypt, and that Mr. St. Clair's book is full of interesting statements made on good authority, but the best work suffers when it is evident that a preconceived notion has dictated many of the conclusions.

Aids in Practical Geology. By Prof. Grenville A. J. Cole, M.R.I.A. (Griffin & Co.) 10s. 6d. Third edition, revised and enlarged. We have examined the third edition of Prof. Cole's well-known book with great pleasure. Former editions have been a companion to all serious students of geology for more than eight years, and have been instrumental in clearing up many a difficulty and saving much valuable time. Prof. Cole is really practical. The student can turn to his book and learn where some necessary instrument can be obtained, and how much it will cost. He is given fatherly advice as to how to pack specimens, and the best way of getting them home. He is carefully conducted through the maze of petrological terminology, and has the chief morphological and other characteristics of typical fossils properly emphasized. The third edition has been thoroughly overhauled. Recent editions to the equipment of the geologist, such as the diffusion-column of Prof. Sollas, are described ; also new methods of observation, like the mode of determining relative refractive indices devised by Dr. Becke. Similarly, in view of the present state of zoological classification, the palæontological sub-divisions of former editions have been somewhat relaxed. We commend this volume to all students of geology, for no one of them can afford to be without it.

Elementary Practical Zoology. By Frank E. Beddard, M.A., F.R.S. (London: Longmans, Green & Co.) 2s. 6d. This book is intended as a guide to the elementary examination in zoology of the Department of Science and Art. We are rather at a loss to understand why Mr. Beddard calls his little volume "practical." A somewhat prolonged search has discovered no instructions for dissection, nor much guidance as to where the animals described can be found. For instance, the reader is informed that "the crayfish is common in many streams of this country, as well as on the Continent," and we believe no further help is offered to a student in the provinces who is anxious to obtain a crayfish and follow Mr. Beddard's description with the specimen before him. The author tacitly assumes that there is no difficulty in obtaining the types, and that dissection comes naturally to a reader of zoological narratives. But it is far otherwise in actual experience. We have known students working alone waste many valuable days searching for a vorticella or a hydra, and who have had eventually to look up advertisements and directories to find the name of a dealer where they could purchase specimens. If Mr. Beddard's book were really practical these difficulties would have been cleared up. As a theoretical book we have little but praise for the volume. The illustrations, drawn from the best sources, are clear and instructive, while the descriptions are concise and interesting.

The Groundwork of Science. By St. George Mivart, M.D., PH.D., F.R.S. (John Murray.) 6s. The author of this book lays it down that any science consists of some truths which are the results of other truths previously known, whether this primary knowledge has served as an incentive to more careful work, or as a premiss from which the newer truth has been logically inferred. These fundamental truths form the groundwork of the particular science under consideration. Every science, similarly, possesses such primitive truths, consequently, even if it consists only of a collection of all the fundamental truths of the several sciences, there must be a groundwork of science generally. But all science has been developed by the human mind, and the groundwork of science must also be sought here. The study is hence called epistemology, from two Greek words meaning a discourse on the understanding. The groundwork of science cannot be truths gained by reasoning, for such are not ultimate; nor can they depend on observation and experiment alone, for these imply the recognition of fundamental intellectual perceptions. The groundwork of science must, therefore, be composed of facts and truths which carry with them their own evidence. Such is, briefly, the object of the volume before us. The reader is taken in due course through a catalogue of the sciences and a consideration of the objects, methods, and physical, psychical, and intellectual antecedents of science. After the relations of language and science and the causes of scientific knowledge have been discussed, the nature of the groundwork of science is summarised in a final chapter. The answer to the question, "What is the groundwork of science?" is given by Dr. St. George Mivart in the following words:—"It is the work of self-conscious, material organisms, making use of the marvellous intellectual first principles which they possess in exploring all the physical and psychical phenomena of the universe, which sense, intuition, and ratiocination can anyhow reveal to them as real existences, whether actual or only possible."

From Matter to Man—a New Theory of the Universe. By A. Redcote Dewar. (Chapman and Hall.) Our author has selected a subject so vast that the sum of human knowledge is despicable in comparison therewith, and yet the fruits of his investigations in this immense field of research are compressed into less than three hundred very brief pages! One might, perhaps, give a fair idea of the manufacture of pins in the same amount of space, but to exhibit the process of making man and, more particularly, the universe with such a small expenditure in ink is either very clever or ridiculously absurd. We find that "*the bottom energy of the universe is magnetism;* every crystal, plant, animal, and man is a magnet; life is really magnetism, and thought electricity." This is the general trend of the ideas advanced. Some of the passages are very beautiful as prose poetry, but dreamy and incoherent from a scientific point of view.

Skiagraphic Atlas. By John Poland, F.R.C.S. (Smith, Elder and Co.) Illustrated. 5s. The inestimable advantages of the X-rays in future medical science will be apparent to those who peruse this atlas. Already many marvellous facts have been published relative to the disposition of the internal anatomy, fracture of bones, location of bullets in wounds, and so on, and in this book we have a series of plates showing the changes in the relative positions of the bones of the hand from the age of three to the age of seventeen—*skiagrams* of different hands. The results exhibit a most instructive view of the process of ossification as we pass from childhood towards man's estate. It is encouraging to know that workers in the Röntgen ray process have already shown in this way that previous views on the evolution of ossification must now be modified in conformity with the additional light thus brought to bear on the subject.

Earth Sculpture, or the Origin of Land-Forms. By Prof. James Geikie, LL.D., D.C.L., F.R.S. (John Murray.) 6s. This is a well illustrated volume on a fascinating subject. It may be popularly described as a book showing the incorrectness of the widespread belief in the "eternal hills" and "*terra firma.*" The land everywhere is at the mercy of never-ceasing and relentless forces of denudation. As Prof. Geikie graphically narrates, rain, frost, wind, running water, the waves, snow, and ice, all conspire together to wear away the land, obliterating existing features and sculpturing new contours. The perennial conflict between the internal forces tending to raise the crust, and the external forces to which we have referred, which by themselves would soon, speaking geologically, blot out the land, is described in the scientific and interesting manner of which Prof. Geikie is an acknowledged master. Chapter by chapter, the way in which the relation of hill and dale is affected by the arrangement of strata—whether horizontal, gently-inclined, highly-folded, or faulted—is passed under review. Altogether, to the reader with some previous acquaintance with geological terms, the book will prove stimulating and suggestive.

Whitaker's Almanack, 1899. 2s. 6d. Once again this useful work—the thirty-first annual volume—is available. A great improvement consists in the expansion of the index, an innovation which admits of about six hundred additional entries. Among new subjects introduced are the new "Employers' Liability Act," and the "National Debts of the World"; also a Municipal Directory of Scotland and Ireland. "Political Geography" has, during the past year, been considerably modified—to wit, the eating into China; the losses of Spain; and Khartum wrested from the Khalifa; and new maps are introduced into the geographical articles to indicate such changes. As illustrating the tendency in every section to expansion we may mention that there are now nearly eight hundred closely-printed pages in the present issue of the almanack.

Chemistry for Schools. By C. Haughton Gill. (Stanford.) Illustrated. 4s. 6d. A new edition—the tenth—of this popular school book is before us. Much enlarged, and in great part re-written to suit the later developments of certain branches of chemistry, it is a straightforward *résumé* of the fundamental principles of the science treated from a practical standpoint. Its past history is a sufficient guarantee that, with emendations considered needful to invest the work with a new lease of life, it will be found a reliable guide to the acquisition of a sound knowledge of the elements of chemical science. One thing, however, is not very stimulating to observe, namely, the illustrations, hoary with age and decrepit in form. Why not replace them with something in better keeping with present practice, and more agreeable to the eye?

A List of European Birds. By Heatley Noble. (R. H. Porter.) This list of the birds found in the Western Palæartic area is intended to be of use to collectors for reference and exchange of skins and eggs, and for labelling specimens. The list is really nothing more than a copy of Mr. Dresser's well-known list of 1881 brought up to date, with a supplement added containing the names of those birds of disputed occurrence. Had Mr. Dresser himself revised his list he would not have repeated, as Mr. Noble does, such mistakes as the spelling of Mistle-Thrush Missel-Thrush, or the naming of *Limosa belgica Limosa œgocephala. L. œgocephala* is undoubtedly a synonym of *L. lapponica.* The copy of the book sent to us is bound in cloth, which is an unnecessary expense if the list is to be cut up for labelling specimens.

Messrs. Bacon & Co. have sent us two charts of coloured figures, the one of British Birds, the other of Edible Birds. The charts are mounted on cloth, and are varnished. A little book called an Object Lesson Handbook accompanies the charts. The object of the charts and the book is to help teachers to give a systematic series of lessons on British birds. Both the charts and the book are accurate, on the whole, and should prove of use. The most grievous error is the figuring of grey plover in the chart of edible birds, and the description of it on page 89 of the book. The grey plover is certainly not a typical edible bird nor are its eggs considered a great delicacy; indeed, it is extremely doubtful if any European has ever tasted its eggs. We are told to teach, too, that "waders" are not often seen in England, whereas, of course, they may be seen in thousands on our coasts in winter. There are a few minor errors in addition to those we have pointed out. With these corrected, we think the charts and the book would be very useful; but it is naturally most important that elementary lessons such as these should be exact in every particular.

BOOKS RECEIVED.

Zoological Results based on Material from New Guinea, Loyalty Islands, etc. By Arthur Willey, D.SC. (University Press, Cambridge.) Illustrated. 12s. 6d.

Photo-Micrography. By Edmund J. Spitta. (Scientific Press, Limited.) Illustrated. 12s.

Autumnal Leaves. By Francis George Heath. (Imperial Press.) Illustrated. 7s. 6d.

Annual Report of the Smithsonian Institute, 1896.

An Intermediate Text Book of Geology. By Charles Lapworth. (Blackwood.) Illustrated. 5s.

River Development. By Prof. J. C. Russell. (Murray.) Illustrated. 6s.

A History of Astronomy. By Arthur Berry, M.A. (Murray.) Illustrated. 6s.

Recent Advances in Astronomy. By Dr. Alfred H. Fison. (Blackie.) 2s. 6d.

The Native Tribes of Central Australia. By Baldwin Spencer, M.A. (Macmillan.) Illustrated. 21s. net.

The Last Link. By Prof Ernst Haeckel. (Black.) 2s. 6d.

Mathematical Tables. By James P. Wrapson and W. W. Haldane Gee. (Macmillan) 1s. 6d.

The Principles of Stratigraphical Geology. By J. E. Marr, F.R.S. (University Press, Cambridge) Illustrated. 6s.

Mathematical and Physical Tables. By James P. Wrapson and W. W. Haldane Gee. (Macmillan.) 6s. 6d. net.

Results of Rain, River, and Evaporation Observations made in New South Wales, 1897. By H. C. Russell, F.R.S. (Gullick, Sydney)

A Text-book of Botany. By J. M. Lowson, M.A. (Clive) Illustrated. 6s. 6d.

Advanced Inorganic Chemistry. By G. H. Bailey and W. Briggs. (Clive.) Illustrated. 3s. 6d.

Fallowfield's Photographic Annual, 1898-9. Illustrated. 1s. 6d., post free.

The Heavens at a Glance, 1899. By Arthur Mee. (41, Hamilton Street, Cardiff.) 7d, post free.

The Studio: An Illustrated Magazine of Fine and Applied Art, January. 1s., monthly.

Through Arctic Lapland. By Cutcliffe Hyne. (Black.) Illustrated.

An Illustrated Manual of British Birds. By Howard Saunders. Second Edition, Parts 13, 14, 15. (Gurney & Jackson.) 1s. each.

Science Notes.

The recommendation by a Select Committee that the Buckland Fish Museum at South Kensington be abolished as "obsolete and dangerous, owing to the large amount of alcohol in which the fish are stored," and similar excuses for too apparent neglect, has caused great indignation among fishery boards, angling societies, and others. The late Frank Buckland, in 1881, bequeathed his museum of economic fish culture to the Director and Assistant-Directors of the South Kensington Museum, "to be for ever devoted to the use of the nation," and "five thousand pounds is to be placed in the hands of 'these trustees' as an endowment fund for a professorship." A memorial has been prepared for presentation to the Lord President of the Council protesting against the removal and distribution of the collection, and the memorial emphasizes the fact that for many years past the museum has been sadly neglected.

Sir Benjamin Stone, who gave a lecture recently at the Imperial Institute on "The Camera as Historian," has been permitted to take some interesting photographs of the Tower. One of them is "The Traitors' Gate with the Portcullis Down," showing the little door in the centre. The public of this generation have never seen the portcullis of the Tower shut down. The curious ceremonial of "Locking up the Tower at Midnight" was shown in a series of views. The chief warder is attended by a military guard, and on returning he is challenged at the main-guard with, "Who goes there?" He answers, "Keys." "Whose keys?" "Queen Victoria's keys." "Advance Queen Victoria's keys." The guard then turns out and salutes the keys. Sir Benjamin's idea is to have a permanent record of objects of interest in the daily life of the people, and the fidelity of the sensitive plate to Nature is considered invaluable as a means to this end.

A new use has been found for that well-known poison, prussic acid, or, as it is more commonly spoken of by the chemist, hydrocyanic acid. It has been recently employed in the United States to fumigate fruit trees infected with an insect called the "San José Scale" (*Aspidiotus perniciosus*). This insect attacks plum, pear, peach, cherry, and other trees, spreading over their leaves, trunk, branches and fruit, and soon completely destroys a whole orchard. The pest was discovered in California in 1879, and was, it is believed, introduced into the Eastern States in 1887 with some infected Californian trees. The ravages of the insect have extended over thirty-three States, being worst in the State of Maryland. Prof. Johnson, the well-known entomologist, has found that fumigating these trees with the gas of hydrocyanic acid has a satisfactory and beneficial effect.

The Board of Agriculture in their annual preliminary statement show that the estimated total produce of wheat, barley, and oats in Great Britain for the years 1897 and 1898 is as follows:—

	1898.		1897.		Yield per acre in Bushels.	
	Bushels.	Acreage.	Bushels.	Acreage.	1898.	1897.
Wheat ...	73,028,856	2,102,206	54 940,535	1,889,161	34·74	29·08
Barley ...	68,051,918	1,903,666	66,814,066	2,035,790	35·75	32·82
Oats	118,920,917	2,917,760	116,847,179	3,0 6,056	40·76	38·49

It is thus clear that in the case of barley and oats the acreage under cultivation during 1898 was considerably less than in 1897, and yet there is a remarkable increase in the total produce. Taken as a whole the produce of cereals this year is greater than in any year since the corn returns were first collected in 1884.

The seventh International Geographical Congress will meet in Berlin from 28th September to 4th October, 1899. All who wish to contribute communications to the Congress are requested to give notice before 1st April, 1899, and to send their manuscripts ready to print not later than 1st June, 1899, "To the Seventh International Geographical Congress, 90, Zimmerstrasse, Berlin, S.W."

An agitation is being got up to prevent the total extinction of the beaver on the River Rhone and its tributaries. Nine specimens only were killed in 1897, and the average for the last few years is but little more than this number. That beavers must have been common enough in 1855 to cause serious damage is evident from the fact that in this year the authorities responsible for the dams in connection with the Rhone offered a prize of fifteen francs for every animal killed. This offer remained in force until 1891, when it was cancelled owing to a special appeal. The naturalists who are interesting themselves to secure the preservation of the beaver abroad from the fate which has overtaken it in this country, are wise enough to bring forward the commercial as well as the scientific side of the question. They point out that the work might be extended and careful culture on a large scale be inaugurated, seeing that not only valuable fur but castoreum is obtained from the beaver. The success of the experiments in the National Park in New York, and here in England in private grounds, might be cited as an additional inducement to carrying out similar ones on the Continent.

Obituary.

We regret to record the death of the eminent physician, Sir William Jenner, which took place on the 11th December, 1898, at Greenwood, Bishop's Waltham, at the age of eighty-three years. The son of an innkeeper at Chatham, he was educated at University College, and his first public appointment was as one of the district medical officers of the Royal Maternity Charity. In 1844 he graduated M.D., and four years later became a member of the Royal College of Physicians; in 1861 he was selected by Sir James Clarke as Physician Extraordinary to Her Majesty, and in 1862 Physician in Ordinary to Her Majesty. In 1863, he was appointed Physician in Ordinary to the Prince of Wales, and in 1864 was elected a Fellow of the Royal Society. He was created a baronet in 1868, K.C.B. in 1872, and G.C.B. in 1889, when he finally retired from practice to his country seat near Bishop's Waltham. The establishment of the essential difference between two diseases which offer many points of superficial resemblance, typhus and the so-called typhoid fever, constitutes his greatest scientific achievement. Sir William was a devoted servant to her Majesty upwards of thirty years. It may interest some to know that, on his own statement, his professional fees had amounted to £13,000 in a year.

Sir William Anderson, K.C.B., Director-General of Ordnance Factories, died on the 11th December, 1898. Born at St. Petersburg in 1835, he received his early education there, and then studied the applied sciences at King's College, London. From 1851 to 1854 he was a pupil of Sir William Fairbairn at Manchester, after which, till the year 1864, he was chiefly engaged in the construction of bridges, cranes, signals, and other appliances for railways, particularly so-called latticed girders, then but little understood. In 1889 he was appointed Director-General of Ordnance Factories, which comprise the Laboratory, Carriage Departments, and the Gun Factory at the Royal Arsenal, Woolwich, the Royal Gun Factory at Waltham Abbey, and the Small-arms Factories at Enfield and Birmingham, at a salary of £2500 a year. Sir William was the author of many works on engineering and allied subjects, his "Lectures on Hydraulics and on Hydro-Pneumatic Gun Carriages" and "The Conversion of Heat into Work" being among the best known of his publications. In 1889 he received the degree of D.C.L. of Durham University; was made a C.B. in 1895; and a Knighthood was conferred on him as a Diamond Jubilee honour.

By the death of Sir John Fowler, in November last, a conspicuous representative of modern engineering achievement is removed from our midst. Born in 1817, he became, at the age of seventeen, pupil to Mr. Leather, a hydraulic engineer, and was associated with schemes for water supply in Yorkshire. After acquiring experience of an unusually varied and practical kind, he started on his own account as chief engineer to a number of railways, notably the Sheffield and Lincolnshire and the Great Grimsby Railways. When the full fury of the railway mania broke forth, his services were eagerly sought by railway promoters. Sir John Fowler's connection with the Metropolitan Railway—a scheme discouraged by prognostications of failure from many of the most eminent engineers—has paved the way to the possible construction of those cheaper tunnelled lines which now promise to relieve the congestion which has overtaken the street traffic—for instance, the City and South London, the Waterloo and City, and the Central London Railways, with which Sir John's name has been associated. The crowning effort of Sir John's engineering skill was devoted to the construction of the Forth Bridge, which occupied six to seven years in building. On the day when the ends of the ponderous cantilever arms, stretching one thousand seven hundred feet across the waters, were to be rivetted together in the centre of the span, it was found that a gap, only an inch or two out of that vast length, was left between the severed sections of the girder, and this staggering problem was settled by kindling great fires on the bridge, the increase of temperature causing expansion, and enabled the rivets to be driven home.

Letters.

[The Editors do not hold themselves responsible for the opinions or statements of correspondents.]

THE PLANET DQ.

To the Editors of Knowledge.

Sirs,—It may be of interest to supplement the article in the November number of Knowledge by giving some additional particulars which have been obtained since then. In the first place the provisional designation DQ has been replaced by the permanent number 433 and the name "Eros" (the only masculine title in the whole family of minor planets).

In the next place, the zeal of Prof. Chandler in computing accurate ephemerides, and the patience and perseverance of Prof. Pickering and Mrs. Fleming in submitting the immense storehouse of photographs obtained at Harvard and Arequipa to a searching examination, have been rewarded by the detection of the planet on twelve plates taken in 1893-94, and on four plates taken in 1896. This fortunate circumstance gives us at once the means of immensely improving our knowledge of the orbit. Perturbations will have to be computed before this can be done with strict accuracy, but, in the meantime, the following orbit deduced by Prof. Chandler may be accepted with confidence as being certainly very near the truth:—

Aphelion Passage, 1898, June 18·19, Greenwich Mean Time.

Longitude of perihelion ...	121° 9′ 53·1″	
Longitude of ascending node...	303° 31′ 57·1″	
Inclination to ecliptic... ...	10° 50′ 11·8″	
Eccentricity	0·222729	
Mean distance from sun ...	1·45810	The earth's mean distance from the sun being unity.
Least ,, ,, ...	1·13334	
Greatest ,, ,, ...	1·78286	
Average daily motion	2015·2326″	
Period	643·10 days	

It will be seen at once that these elements are very close to the original ones found by Dr. Berberich, and the difference would not be appreciable on the scale of the diagram given on p. 251, so that a new diagram is not required. It should be pointed out that there is a misprint on p. 250; Dr. Berberich's value of the period is 644·734 days, not 664·734 as printed there.

The opposition of 1894 was practically the most favourable one possible, the least distance of the planet from the Earth being only 0·153. An equally favourable opposition will not occur till 1931, or possibly longer. The opposition of 1900 is the best that we shall have till then. The following is an ephemeris for that opposition :—

	Right Ascension. h. m. s.	North Declination. ° ′	Distance from Earth.	Magnitude.
1900. Nov. 10 ...	1 56 24	54 23	0·3747	9·38
" 18 ...	1 41 8	53 37	0·3535	—
" 26 ...	1 30 40	51 52	0·3383	9·07
Dec. 4 ...	1 26 32	49 26	0·3268	—
" 12 ...	1 29 22	46 23	0·3200	8·88
" 20 ...	1 38 48	43 5	0·3162	—
" 28 ...	1 54 28	39 39	0·3154	8·78
1901. Jan. 5 ...	2 14 34	36 12	0·3176	—
" 13 ..	2 38 6	32 45	0·3219	8·78

The planet will have a very appreciable loss of light through phase; at times only three-fourths of its apparent diameter will be illuminated.

Arrangements are already being made for securing parallax observations at the next opposition, and it is hoped that as many as possible will co-operate in this work, so as to secure the best result attainable.

The planet is still under observation and is likely to be followed for several weeks longer. Its brightness is now pretty constant, its approach to the sun balancing its recession from the earth.

The other relations of the orbit, given last November, are scarcely affected by the new elements; the very singular fact that the planet does not retrograde when in opposition near perihelion is fully verified.

The synodic period is 2·3146 years, and the following table gives some of the multiples of this period :—

Number of Synodic Periods.	Years.	Number of Synodic Periods.	Years.
2 ...	4·6292	10 ...	23·1460
3 ...	6·9438	13 ...	30·0898
6 ...	13·8876	16 ...	37·0336
7 ...	16·2022	19 ...	43·9775
9 ...	20·8314	35 ...	81·0111
		89 ...	206·000

Hence there are three oppositions in seven years, one of which is not observable in these latitudes owing to the great south declination of the planet. Thus, after the opposition of 1900–1, the planet will not be observable in this country till 1905. In that year its position will be much the same as it was in 1898.

A. C. D. Crommelin.

THE SHOOTING OF RARE BIRDS.

To the Editors of Knowledge.

Sirs,—As the destruction of our rarer birds is greatly instigated by those who term themselves ornithologists and bird collectors, it may be not inopportune to address my remarks on this wanton destruction to the readers of a magazine through whose medium many interesting ornithological notes are constantly made public. In almost every issue of Knowledge we find that such and such a bird rare in such and such a neighbourhood has been shot there! Whatever reason is there for the immediate despatch of every rare bird that appears within gunshot of these collecting-maniacs or their agents? I do not say give up collections of specimens for scientific purposes, but I do say only collect them from where they can be fairly plentifully found, and where the loss of a few specimens will not mean the extinction of the whole species from that neighbourhood. Again, the excuse that if one collector does not shoot a rare bird another will is surely no reason for such conduct. For unless the minority starts by putting its principles of reform into practice never would any reform take place at all. Nor will I brand this collecting of stuffed skins (what else is it?) as intentionally or necessarily cruel, for I believe it is not, but I will say that it is antagonistic to the true interests of Nature observation—a trait which is the first essential in those who are worthy to receive the name of ornithologists. My plea for bringing this subject before the view of those who probably have had it brought before them often and often, is that only by constantly so doing can public opinion be brought to stamp out this disgrace to us as naturalists—public opinion which alone can effect any lasting change. C. E. Martin.

Red Hill Lodge, Compton, Wolverhampton.
6th December, 1898.

MIRA CETI.

To the Editors of Knowledge.

Sirs,—As in former years, I give a complete account of my observations of Mira Ceti.

This variable star has proved to be very interesting to the unaided eye at this apparition. Observations have been made on every possible occasion, the comparison stars used being α Ceti (2·68), γ Ceti (3·59), and α Piscium (3·99).

1898.	Mag.	Sky.
Sept. 16 & 17 ...	3·1	... Rather misty.
18 ...	3·1	... Very clear.
20 ...	3·0	... Moonlight.
21 ...	2·9	... Moonlight and misty.
Sept. 23, 25–28, 30, Oct. 2 ...	2·9	... Moonlight.
Oct. 11 ...	2·7	... Rather misty.
12 ...	2·8	. Extremely clear.
18 ...	3·0	... Extremely clear.
23 ...	3·1	... Rather misty.
24 ...	3·2	... Some fog.
26 ...	3·4	... Some fog.
30, 31, Nov. 1, 3	3·5	... Very clear; moonlight.
Nov. 5, 6 ...	3 5	... Misty.
Dec. 7 ...	4·3	... Very misty.
9 ...	4·2	... Very clear.

The sky was cloudy during the week in which the maximum evidently fell. The approximate date appears to have been October 6th, 1898.

70, Vincent Square, S.W., Walter E. Besley.
January 2, 1899.

TREE STRUCK BY LIGHTNING.

To the Editors of Knowledge.

Sirs,—In answer to your correspondent "A. C.," I think I am right in stating that the majority of electricians would (if they felt themselves called upon to do so) candidly own that this is a matter upon which they have but little definite information. The controversy anent lightning conductors does not actually rage now, but it has by no means been brought to a conclusion.

This much, however, seems certain, the first action in such a case is electrolytic, and following that there is combustion, more or less perfect. Your correspondent is probably right in his surmise as to the cause of explosion. It may even be that some of the liquid is brought to the spheroidal state.

The point raised is one calculated to produce a wide discussion. Will the botanists who are also chemists come to our assistance?

Howard B. Little.

23, Pembroke Road, Kensington,
London, W., 2nd January, 1899.

rledge.

PHOTOGRAPH OF THE NEBULA N.G.C. 1499 PERSEI.

By ISAAC ROBERTS, D.Sc., F.R.S.

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61 CYGNI.

To the Editors of KNOWLEDGE.

SIRS,—Dr. Herman Davis's results as regards the parallax of 61 Cygni, mentioned in your last, strike me as extremely improbable. That, if he is right, the two stars do not form a physical system may be conceded, but, it is to be added, that they do not possess common proper motions. Bring 61^2 as near to us as 61^1, and, according to Dr. Davis, the proper motion of the former will be 6·4″, and that of the latter 5·2″ per annum. But when we remember how very few stars possess as large a proper motion as either, the chance of finding two such stars (not physically connected) as close to each other as this pair would seem to be very small indeed. And in addition to this we are compelled to suppose that not only are these two stars moving in almost the same direction on the celestial sphere, but that their velocities are almost proportional to their distances from us, so as to produce an apparent common proper motion where one is really moving much faster than the other. A further coincidence is that both stars are nearly alike both in magnitude and colour. Mr. Gore has pointed out that when double stars are nearly equal in magnitude their colour is almost always the same, while if the magnitudes differ considerably the colour is different also. It is strange that such a law should be verified in a case where the equality of magnitudes merely results from the greater distance of the star that is really the brighter of the pair.

We could frame hypotheses according to which almost any of our binary stars would have no physical connection. The companion of Sirius, for example, might be much more distant than the bright star, and be revolving round a dark body, or else round a bright body which was lost in the glare of Sirius. But such hypotheses are out of place in science.

I hope an effort will be made to measure the velocity of the two stars in question in the line of sight. If they are not physically connected it will probably be different in each case; otherwise we may expect it to be nearly the same.

W. H. S. MONCK.

THE NOVEMBER METEORS IN 1898.

OBSERVATIONS of the meteoric shower of November 13th, 1897, were made at the Harvard College Observatory, and a description of the results will be found in the Annals, Vol. XLI., No. 5, and in Circular No. 31. More extensive observations were made in 1898, and the results will be published later in the Annals. Several investigations were undertaken, and some of the preliminary results are given below. As proposed in Circular No. 31, stations have been selected all round the earth in order that counts of the number of meteors visible might be made during the entire time that the earth traversed the meteor stream. The density of different portions of the stream would thus be determined. Reports from the distant stations will not be received for some time. The night of November 13th was cloudy in Cambridge, but on November 14th, eight hundred meteors, not including duplicates, were recorded at this observatory by thirty persons. The maximum occurred at three o'clock in the morning, when sixty-one meteors east of the meridian were counted in half an hour. Two hundred and twenty-seven trails of eighty different meteors, within thirty degrees of the radiant point, were charted. Similar observations were made at Providence by Prof. Upton, of the Ladd Observatory, aided by a number of students. The vicinity of the radiant was watched continuously by at least ten observers, who recorded four hundred meteors. This station is forty miles south of Cambridge, and was selected as suitable for determining the parallax visually. Ninety-six photographs were taken at Cambridge with the Draper telescopes and with eleven smaller instruments. Five photographic doublets were mounted equatorially and photographed the region within thirty degrees of the radiant, during nearly the entire night. Two cameras were carried to Tufts College, two miles north of Cambridge, and twenty-five photographs were taken simultaneously at both stations for a photographic determination of the parallax. In all, thirty-one trails of eight different meteors were photographed, of which three appeared on one plate. Four meteors were photographed at both stations, and can be used for determining the parallax photographically. The changing distance of the meteors is obvious by inspection of these photographs. A preliminary determination of the radiant was made by prolonging the trails of four meteors. They nearly intersect in a point, the greatest deviation not exceeding one millimètre, or ten minutes. The position of the radiant reduced to 1900 is thus given as R.A.= 10h. 6·8m., Dec.= +22° 16′, which is 9m. following, and 38′ south of the place given by Denning. Seventeen plates were taken with prisms, but they failed to show the spectra of any meteors. It appears from the photographs that the light of the meteors attained a maximum and then diminished as rapidly as it increased. In some cases, sudden changes due to explosions are well shown. The trail is sometimes surrounded by a sheath of light, and in one case the trail remaining after the meteor had passed was photographed. These results show that meteoric showers may now be studied to advantage by photography.

November 19th, 1898. EDWARD C. PICKERING.

PHOTOGRAPH OF THE NEBULA N. G. C. NO. 1499 PERSEI.

By ISAAC ROBERTS, D.SC., F.R.S.

THE photograph covers the region between R.A. 3h. 48m. 58·1s. and R.A. 3h. 59m. 4·2s.; declination between 35° 32·4′ and 37° 5·6′ north. Scale—one millimètre to thirty seconds of arc.

Co-ordinates of the fiducial stars marked with dots for the epoch A D. 1900.

Star	(.)	D.M. No. 792	Zone +36°	R.A.	3h. 51m. 3·6s.	Dec.	36° 11·9′	Mag.	7·0
„	(..)	„ 805	„ +36°	„	3h. 54m. 39·2s.	„	36° 43·6′	„	7·5

The photograph was taken with the twenty-inch reflector on 1897, December 18th, between sidereal time 2h. 44m. and 4h. 14m., with an exposure of the plate during ninety minutes.

Dr. Scheiner, in the *Astr. Nach.*, Band 132, No. 3157, pp. 203–206, gives some particulars, accompanied by a sketch, of this nebula.

Sir William Herschel, in the *Phil. Trans.* for the year 1811, notes the existence of fifty-two areas in the sky which he believed to be affected with nebulosity. Eight of those areas have already been photographed at my observatory, with the result that upon six of them no nebulosity has been found; therefore we are justified in inferring that upon these areas none exists of brighter luminosity than that of stars of the seventeenth magnitude; but upon the other two, dense nebulosity has been photographed.

The photograph annexed hereto is presented upon a scale that will enable astronomers to appreciate the extent, the structural details, and the stars down to the seventeenth magnitude that are apparently involved in the nebulosity, but judgment should be held in suspense until movements can be detected in the stars, or in the nebulosity, before a definite pronouncement is made that the stars are in reality involved, for the apparently finished stars may be either on the solar side of the nebula or else on the farther side, and owing to the vast distances of the stars and the nebulosity from us we cannot hope to be enabled to decide the question during our lifetime, or, indeed, that it can be decided by the next generation of astronomers, but with reliable data and sufficient interval of time between the epochs, the solution will undoubtedly be obtained.

The photograph shows the nebula to be cloud-like in character—as a thin fleecy cloud, irregular in form and in outline—with sinuous condensations of the nebulosity in several parts, in some of which are faint stellar condensations that may be the early stages in the development of new stars.

If the question should be asked: Does spectrum analysis not indicate the physical condition of this and of the other known bodies of similar appearance that exist in space? the answer would be that the nebulosities are so faint and diffuse in character as to be hopelessly beyond the light-grasping power of any form of spectroscope at present known, whether it be applied to eye observation or to the photographic plate.

The limit of the power of the spectroscope seems at present to be in the analysis of light (star-light) that is not feebler than that of stars of about the tenth magnitude. It is, therefore, evident that light so feeble as that of stars of the seventeenth or eighteenth magnitude, which may be the light of some of the nebulæ here referred to, is immensely beyond the range of the spectroscope. We must, therefore, be content in producing the best possible photographic records of the various bodies as they exist in these days, and leave our successors in the future to determine, by the correlation of their own photographs with ours, the solution of the problems which we can now only imperfectly deal with because of the absence of reliable data.

The nebula extends about 2° 36′ in length, in the direction *south following* to *north preceding*, and in breadth at the widest part about 40′.

COMPARATIVE PHOTOGRAPHIC SPECTRA* OF THE BRIGHTER STARS.

JUST a year has passed since we noticed in Knowledge the most important memoir by Miss Antonia C. Maury on the classification of the photographic spectra of six hundred and eighty-one stars. We have now to record the publication of the results of another spectrographic survey having a distinct bearing upon that of Miss Maury's.

The present research is the work of a single astronomer. Mr. McClean, whose munificent generosity to the science is well known, as shown both in his foundation of the Isaac Newton Studentships, and in the presentation to the Royal Observatory at the Cape of Good Hope of a splendid equipment for spectroscopic and photographic research, has himself carried out a complete survey of the heavens within the limits he thought well to adopt. He began the work first at his own observatory at Tunbridge Wells, using a prism of twelve inches aperture and twenty degrees angle before the object glass of his own photographic refractor. Here he fulfilled rather more than half his programme; then he completed it at the Cape Observatory, using the same prism as that which he had employed at Tunbridge Wells before the object glass of the Cape astrographic telescope. Mr. McClean's method, therefore, was essentially the same as that used in the Draper Memorial research at Harvard College. The apertures differed little—twelve inches as against eleven—the focal length was one hundred and thirty-five inches as against one hundred and fifty-three, and the dispersion Mr. McClean employed, though less than the highest used at Harvard College, was greater than the lowest. The photographs, therefore, were of the same general order, a fact which increases the value and importance of both series.

The chief differences between the two researches are as follow:—The Harvard College Survey was restricted to stars north of − 30° declination. Mr. McClean's extended over the entire heavens. The former included the spectra of six hundred and eighty-one stars; the latter, extending only to magnitude $3\frac{1}{2}$, includes two hundred and seventy-six stars. The chief object of Miss Maury's discussion of her material was to systematize afresh the classification of stellar spectra and to push it to further detail; whilst the primary object with Mr. McClean was to ascertain the distribution, with respect to the Galaxy, of types which had obtained general recognition.

Having this object in view, Mr. McClean adhered practically to the simplest of all the many systems of stellar classification—that of Secchi, modifying it only by dividing the first type, that of the "hydrogen stars," into three divisions. Of these divisions Secchi had himself recognized the existence of the first, as he saw that the Orion stars differed materially in their spectra from the stars like Sirius. The Orion stars form Mr. McClean's first division, together with those of all stars that are rich in the lines of helium. The remaining spectra of Secchi's first type are grouped with Sirius in Division II., or with Procyon in Division III., according as their great hydrogen bands are more marked, or are less marked, than the great calcium band K.

The number of stars examined being small for the purposes of the enquiry, it was absolutely necessary that their classification, either according to their spectral type, or according to their position with regard to the Milky Way, should be of the simplest. The following table gives the result of the enquiry when the stars are grouped together into four equal areas, one on each side of the galactic equator, and one round each of the galactic poles:—

	Galactic Regions.			
Stellar Types.	Upper Polar.	Upper Equatorial.	Lower Equatorial	Lower Polar.
Division I. ...	9	29	41	9
,, II.	13	10	6	7
,, III. ...	16	9	18	5
,, IV. ...	23	16	24	22
,, V. ...	4	5	5	5
Nebulæ.				
Planetary ...	4	10	11	2
Extended ...	2	8	11	5

Small as are the number of stars involved, the table is very suggestive. First of all it brings out clearly the preference which both the helium stars and the planetary nebulæ show for the region of the Milky Way; not an accidental similarity, since, as Mr. McClean has forcibly argued, the helium stars are probably in the earliest stage of development from the nebulæ. This disposition of early types to crowd towards the Galaxy appears a strong indication that the latter is a region where the process of the crystallization into definite world-forms of the primeval

* "Comparative Photographic Spectra of Stars to the Three and a half Magnitude" (reprinted from *The Philosophical Transactions of the Royal Society of London*), and "Spectra of Southern Stars, with Tables and Plates." By Frank McClean, F.R.S. London: Edward Stanford.

world-stuff is far from being complete. When we come to the two next divisions the evidence is conflicting; perhaps because the research deals only with the brightest stars, for the prevalence of small hydrogen stars in the Galaxy is very marked. On the other hand, Divisions IV. and V., that is to say, stars with spectra resembling those of our sun and α Herculis, appear very equally distributed. With regard to the latter, the small number of spectra concerned—only nineteen—must make us chary of putting too great weight upon the evidence their distribution affords. So far as it goes it would seem to show that the orange stars are not, as Lockyer has supposed, in an early stage of their development but in a late.

A most important result of Mr. McClean's research has been the identification of a large number of hitherto unknown lines in the spectra of β Crucis and other of the helium stars with the lines of oxygen. This identification leads him to divide the helium stars into two subdivisions—the earlier those in which the oxygen lines are marked, the later in which both the helium and the oxygen lines are dying out. This result, the establishment for the first time of the oxygen spectrum as a leading feature in celestial bodies, is of the very utmost importance, and would of itself render Mr. McClean's research remarkable. It is very significant, too, that it is in the youngest stellar spectra, and in those alone, that we find the evidence of this element the most abundant of all with which we are acquainted on our own planet.

There are several other points of interest in these two memoirs, and in the smaller papers which Mr. McClean has published in connection with the same work. First is the identification of the typical Wolf-Rayet star γ Argus as a helium star. This spectrum is one of special interest, for not only are the ordinary hydrogen absorption lines seen, but also the members of the series first discovered in ζ Puppis. The spectrum also abounds in bright bands. δ and μ Centauri are also classed as helium stars, although showing the hydrogen lines bright.

One most important feature of these two memoirs must not be overlooked. A benefit of the first order has been conferred upon students by the reproduction of the whole of the two hundred and seventy-six spectra in a series of excellent plates, Mr. McClean thus placing his readers in as nearly as possible the same position as himself with regard to them.

The entire research is a noteworthy example of the special class of work which is the distinguishing glory of English astronomy. On the Continent, astronomical progress has been usually effected at the great State observatories. The special characteristic of astronomical development in the United States has been the founding and endowment of well-equipped observatories by wealthy Americans, who have themselves taken no personal share in the work for which they provided the means. In England, the distinguishing national characteristic has been the enormous debt which astronomy has owed to amateur observers. From the days of Harriot and Horrocks, in the first dawn of telescopic astronomy; from the elder Herschel, the very father of the science in its wider, modern sense, to the days just passed of Carrington, Dawes, De La Rue, and Lassell, to Huggins, Denning, and McClean, who are still with us, the succession of noble names has been without a break. These amateurs, true lovers of their science, have, if wealthy, spent freely for its furtherance; but, whether rich or poor, have delighted to follow it up by their own exertions, their own thought and ingenuity, their own patient and laborious work.

E. Walter Maunder, f.r.a.s.

British Ornithological Notes.

Conducted by Harry F. Witherby, f.z.s., m.b.o.u.

Radde's Bush Warbler (*Lusciniola schwarzi*, Radde) in Lincolnshire.—On October 1st last I was fortunate enough to shoot an example of this species at North Cotes from a thick hedge about a quarter of a mile inland from the sea-bank. It was a most difficult bird to draw from its covert, and but for its loud and remarkable note might have been easily overlooked. The weather was fine and hot, with light south-west wind, but on the previous day there was a fresh easterly breeze.—G. H. Caton Haigh, Grainsby Hall, Great Grimsby, Lincolnshire.

[Mr. Caton Haigh is to be sincerely congratulated on the capture which he describes above. *L. schwarzi* appears to spend the summer in South-eastern Siberia, coming as far west as Tomsk. The bird has not before been recorded within the European area. That a bird whose usual habitat is in Asia should have been captured for the first time in Europe as far west as England is very remarkable, but it is questionable if any other observer is so indefatigable and systematic in searching for strange warblers as Mr. Haigh.—H. F. W.]

Little Bustard in Breeding Plumage.—Early in May, 1898, a beautiful male Little Bustard, in full breeding plumage, was killed at Kessingband, near Lowestoft, Suffolk. A considerable number of these birds have been met with in Norfolk and Suffolk, but hitherto always in the colder months of the year, this being the first instance of its occurrence in summer plumage with which I am acquainted in the eastern counties.—Thos. Southwell, Norwich.

Cuckoo in December.—On December 4th last, a Cuckoo rose out of a rhododendron bush here, and flew by me with a following of small birds, near enough for me to observe all its markings. On the 17th I was shooting at Fulford, about four miles off, and one of the beaters told me he had seen a Cuckoo there that morning, and evidently the same bird. Though I was perfectly certain the bird I saw in the grounds here was a Cuckoo, I was glad to have my evidence corroborated. This bird was in mature plumage. —E. C. A. Byrom, Culver, Exeter, January 8th, 1899.

Cuckoos in Winter in Devonshire.—With reference to reports which have reached me of Cuckoos having been seen in this county during the present winter, it is interesting to note that Polwhele records that cuckoos were heard in January, 1776, near Mount Edgcumbe, in several parts of the South Hams of Devon, the season being extremely mild. The winter of 1775-6 can scarcely have surpassed that of 1898-9 for mildness. The mean maximum temperature of November, 1898, at Exeter, was sixty-one degrees in the open, and fifty-two degrees in the shade, and the minimum was forty degrees. All through December, also, the readings of the thermometer were remarkably high, reaching in the open seventy degrees on the 4th, and being above fifty-five degrees on twenty-nine days, whilst the minimum readings were never below thirty-one degrees until the night of the 31st, when twenty-seven degrees was reached, though the previous day was very mild. Flies were active indoors and out during the month. Primroses were in bloom in many parts of the county, ripe raspberries for sale, and wild strawberries with ripe fruit in the hedges; many summer annuals in flower in the garden, broad-leaved holly in flower towards the end of the month, and blackthorn early in January.—W. S. M. D'Urban, Newport House, near Exeter, January 18th, 1899.

Great Shearwater (*Puffinus major*).—Mr. Bunn, of Lowestoft, sent me for inspection the fresh skin of a Great Shearwater, which had been brought in by one of the Lowestoft fishing boats about the 15th November, 1898.—Thos. Southwell, Norwich.

The Flamingo in Merionethshire (*Zoologist*, January, 1899, p. 29).—Mr. G. H. Caton Haigh shot a specimen of this bird on October 21st, 1898, on the estuary known as "Traeth-bach," in Merionethshire, North Wales. The bird had been observed in the estuary by Mr. Haigh's brother on September 28th. It was excessively wild, and proved to be in good condition, and showed no signs of having been in captivity. Only three or four examples of this southern species have previously been recorded as having visited our islands. Mr. Haigh remarks that there was a heavy gale from the south on the two days previous to the arrival of this specimen.

The Great Auk once an Irish Bird. By R. J. Ussher (*Irish Naturalist*, January, 1899, pp. 1-3).—Mr. Ussher here gives particulars of further bones discovered in County Waterford. Mr. Ussher remarks: "That my superficial searches among the sandhills, where but little of the old surface is now exposed, should have resulted in finding the remains of at least six Great Auks strewn about, suggests that these birds must have been used for food in some numbers."

Remains of the Great Auk from Whitepark Bay, County Antrim. By W. J. Knowles (*Irish Naturalist*, January, 1899, pp. 4-6).—This forms a complete list of the bones of Great Auks which have been discovered in Whitepark Bay.

The Black Grouse and the Ptarmigan formerly Irish Birds (*Irish Naturalist*, January 1899, pp. 17 and 18).—Under the title "Notes on Birds' Bones from Irish Caves," Mr. E. E. H. Barrett-Hamilton gives particulars of some bones from County Waterford which have been identified as those of the Ptarmigan and Black Grouse, neither of which species is known to have occurred in Ireland in recent times.

Hawfinch in North County Dublin (*Irish Naturalist*, January, 1899, p. 27).—Mr. J. Trumbull records the capture, on February 13th, 1898, at the Grange, Portmarnock, of a mature male Hawfinch, a rare visitor to Ireland.

Great Spotted Woodpecker in Scotland (*Annals of Scottish Natural History*, January, 1899, pp. 47-49).—A number of records appear in these pages of the immigration of Great Spotted Woodpeckers in October and November, 1898.

European Hawk-Owl in Aberdeenshire (*Annals of Scottish Natural History*, January, 1899, p. 49).—Mr. G. Sim reports that: "On 21st November an excellent female specimen of the European Hawk-Owl (*Surina ulula*) was shot by William Smith, factor on the Haddo House Estates." But one example, obtained near Amesbury, Wilts., of the European form of this bird obtained in Great Britain, has been satisfactorily identified. A bird obtained in the Shetlands, in the winter of 1860-1, was believed to be of this species.

Little Bustard in Aberdeenshire (*Annals of Scottish Natural History*, January, 1899, p. 51).—Mr. J. G. Walker, shot a Little Bustard, which is a rare visitor to Scotland, on October 24th, 1898, at St. Fergus.

Solitary Snipe near Elgin (*Annals of Scottish Natural History*, January, 1899, p. 51).—Mr. T. E. Buckley reports that a specimen of *Gallinago major*—rare in the north of Scotland—was shot on October 15th, 1898, by Mr. J. Brander-Dunbar, at Pitgaveny, near Elgin.

Fulmar Petrel breeding on Noss, Shetland (*Annals of Scottish Natural History*, January, 1899, p. 53).—Last summer Mr. Robert Godfrey found the Fulmar breeding on the Noup of Noss. This is the first breeding station observed on the eastern seaboard of Britain.

All contributions to the column, either in the way of notes or photographs, should be forwarded to Harry F. Witherby, *at 1, Eliot Place, Blackheath, Kent.*

THE NERVOUS SYSTEM OF OUR EMPIRE.

By John Mills.

Since the first cable was laid between Dover and Calais in 1850, nearly two hundred thousand miles of cable have been placed beneath the sea; their united length would stretch almost to the moon, or circumscribe the globe eight times; they represent an invested capital of about fifty million pounds, ninety per cent. of which has been provided by private enterprise. Sir Sandford Fleming has evolved a practical scheme in which he advocates the adoption of a system of State-owned cables for the British Empire—all parts of the Empire to be connected together by a network of submarine cables crossing the three great oceans of the world, and nowhere coming to the surface except on British territory. The Pacific cable, the construction of which is, in Sir Sandford Fleming's opinion, the first step to be taken, would start from Vancouver and find mid-ocean stations at Fanning Island, Fiji, and Norfolk Island; at the latter island the line would bifurcate, one branch extending to New Zealsnd and the other to the eastern coast of Australia; telegraphic communication across the continent would put the cable in touch with King George's Sound; thence, traversing the Indian Ocean, cables would find mid-ocean stations at Cocos Island and Mauritius, extending thence to Natal or Cape Town; from Cocos Island connection would be made with Ceylon, Singapore, and Hong-kong; and from Mauritius would be in touch with Seychelles, Aden, and Bombay; the cables in the Atlantic should extend from Cape Town to Bermuda, with mid-ocean stations at St. Helena, Ascension, and Barbados; from Bermuda the telegraphic circuit of the globe would be completed by connecting Bermuda with Halifax and the existing Canadian and Trans-Atlantic lines.

One great advantage of this scheme is that each point touched would be in connection with every other point by two routes, extending in opposite directions. The total distance for which new cables would be required to carry out this grand project is estimated by Sir Sandford at twenty-three thousand knots, and the approximate cost of construction at from five million pounds to six million pounds. An incident connected with the first Atlantic cable, laid in 1858, affords a clear notion as to the utility of ocean cables in cases of emergency; the line only worked for three weeks, during which time seven hundred and thirty-two messages were sent, and the British Government countermanded by telegraph the sailing of two regiments from Canada, and by so doing effected a saving of about fifty thousand pounds. But the advantages to be derived are manifold, and extend to every department of our national life—the promotion of commerce, scientific research, and self-defence as the first maritime power of the world; indeed, the investment of our Empire with an independent nervous system, such as is proposed by Sir Sandford Fleming, would modify the existing relations of England with her colonies, and the other nations of the earth, to a degree which cannot be foreseen in its entirety in tranquil times. The existing cables are in the hands of private companies striving chiefly to earn large dividends, and who adopt the policy of charging high rates, in consequence of which trade and commerce is unduly taxed, and its free development retarded. In the early pioneer days of ocean telegraphy, the Atlantic Telegraph Company started with a minimum tariff of twenty pounds for twenty words, and one pound for each additional word, and it was not until 1872 that a regular word-rate system of four shillings per word was instituted. At the present day the rate stands at one shilling a word with all the Atlantic companies. About six million messages pass over the entire network of the world's cables in a year, or about fifteen thousand for each day of twenty-four hours.

Arguing from the data afforded by the change from a telegraph service managed by private companies to a telegraph service owned by the State and administered under the Post Office Department, Sir Sandford believes that similar public advantages will follow in the wake of cheap sea cables; thus, in 1869, the year before the Government assumed control of the inland telegraphs of the United Kingdom, less than seven million messages were carried, the cost of sending a message from London to Scotland or Ireland at that time being about six shillings. At the transfer, in 1870, the rate was reduced to one shilling per message, and the traffic immediately doubled. After the first decade, in 1880, twenty-nine million messages were transmitted, with a surplus revenue of three hundred and fifty-four thousand and sixty pounds. In 1890, although the charge had previously been reduced from one shilling to sixpence, the annual business equalled ninety-four million messages, the operations still resulting in a surplus of two hundred and fifty-one thousand eight hundred and six pounds. With reference to the messages between London and Australia, in 1890, when the charge was nine shillings and fourpence per word, the gross business consisted of eight hundred and twenty-seven thousand two hundred and seventy-eight words, with a revenue of three hundred and thirty-one thousand four hundred and sixty-eight pounds; while in 1897, when the charge was reduced to four shillings and ninepence per word, the business increased to two million three hundred and forty-nine thousand nine hundred and one words, with a revenue of five hundred and sixty-seven thousand eight hundred and fifty-two pounds, or two hundred and thirty-six thousand three hundred and eighty-four pounds in excess of 1890, when the highest rates were exacted. Now, "were the cables owned by the State, large profits would not be the main object, and, precisely as in the case of the land lines of the United Kingdom, it would be possible to reduce charges so as to remove restrictions on trade and bring the service within reach of many now debarred from using it."

Further development of the already vast nervous system of our planet will be attended with beneficent results to science. Could anyone have dreamt that the discoveries of Galvani, who, having hung on an iron railing the legs of a frog fastened to copper hooks, observed that each gust of wind caused convulsions in the legs of the dead animal—who, one may ask, could have prophesied that this apparently insignificant observation would entirely alter the character of a future century? and yet it is but an application of this discovery, extended, it is true, by many intermediate researches, that annihilates space and time; that empowers our thought to travel with the speed and with the power of lightning to the most distant land, and enables mind to be reciprocated without being arrested by distance in space. Continents are thus joined, in spite of intervening seas, and, by rendering sudden invasion all but impossible, more security is given to nations than cordons of soldiers or fleets at sea could bestow. To the astronomer these cables are invaluable as a means of recording the transits of stars at places widely separated, and thus determining accurately the distance apart in longitude. In a mercantile aspect, the telegraph produces consequences no less individually important than its general results, such as when it sends information to distant provinces of the approach of a tornado, time being thus given to provide against the fury of the storm. In the last annual report of the Meteorological Council, it is shown, in this connection, that during the last twelve months fifty-five per cent. of their forecasts were correct, twenty-six were nearly so, six were failures, and thirteen partially so. This branch of scientific work is becoming more and more accurate as observing stations increase, and the scheme proposed by Sir Sandford Fleming would probably augment its utility to an extent which at present it is impossible to forecast. The more cables there are, and the more they are under our own control and protection, the greater will be the freedom of action among the many members of our otherwise unwieldly empire; a leg, an arm, or other appendage, will acquire a quickening impulse which will enable each and all to respond more promptly to the guiding genius at home entrusted with the direction of the affairs of State.

THE ICKNIELD WAY IN NORFOLK AND SUFFOLK.

By W. G. Clarke.

The landmarks of even a century ago are now many of them unknown. We cannot, therefore, wonder that the British trackways in use prior to the Roman occupation have, in many cases, become merely names—their courses unknown to the antiquary. One of the longest and most interesting of these trackways is the Icknield Way, which, originally British, was adopted and improved by the Romans. For the greater part of its course it is still used as a highway. In Anglo-Saxon charters it is termed the *Icenhilde Weg*—*i.e.*, the war path of the Iceni. In the time of Edward the Confessor, this road was one of the *Quatuor Chimini*, differing from the other three in apparently never having been re-made by the Romans. In the neighbourhood of Ashdown it is described as "a broad, grassy road, marked off from the surrounding fields by low banks, and called, in that part of the country, the 'Green Road.'"

The course of the Icknield Way from Dorchester to Royston, on the borders of Cambridgeshire, is generally well-known. It seldom leaves the dry and open chalk, and is guarded by a remarkable series of hill forts, peculiar, both in form and position. The villages of *Ickle*ton and *Ickle*ford are not far distant from the accepted route. At Royston, it crosses the Ermine Street almost in the centre of the town; and near the four crossways is a remarkable cave in the chalk, originally a British habitation, formed by means of shafts.

Mr. Arthur Taylor, F.S.A., added another link to the chain of evidence in a paper read before the Archæological Institute at their Norwich meeting in 1847, fixing Newmarket as the next important point. In a deed, *tempus* Henry III., in Mr. Taylor's possession, conveyance was made of a sollar with houses and chambers upon *Ykenildeweie*. This property was situate in High Street, Newmarket. Between Royston and Newmarket, the road crosses the *Via Devana*, the Brand Ditch, the Fleam Dyke, and the Devil's Dyke, and is flanked by the Pampisford Ditch.

After leaving Newmarket, Mr. Taylor favoured a route leading through Icklingham and Thetford to Norwich Castle Hill, but insufficient local knowledge precluded a detailed description. The greater part of the present main road between Newmarket and Attleborough, passing through Thetford, is of comparatively recent construction, probably having been made subsequent to 1695. The unmade road in use prior to that time was in all probability originally the Icknield Way. That this ran through Icklingham seems indisputable.

After leaving Newmarket, the road appears for a time as the county boundary between Suffolk and Cambridge, crossing the Kennet, a tributary of the Lark, at Kentford, and over that river itself at Lackford. The portion between Kentford and Cavenham is marked as "The Icknield Way" on the Geological Survey map. From Icklingham All Saints to Thetford, the Icknield Way follows the boundary line of the hundreds of Blackbourn and Lackford—the ford of the Lark—evidently considered one of the most striking features in the hundred. It is also probable that Blackbourn hundred was so named from Blackwater, the great ford near Rushford, where Peddar's Way crossed the Little Ouse. In those days it was of primary importance to make for the best river fords.

From Icklingham the road is well marked, although practically never used. This place-name, as with others on the Way, is derived from Ick, a British tribal name Latinized into Iceniling—*i.e.*, home of Icklings, children of

Ick (Coulton). Numerous Roman remains have here been found in Rampart Field, where earthworks formerly guarded the ford of the Lark. There are several tumuli near the Way, between Newmarket and Thetford, and both Paleolithic and Neolithic flint implements have been found in abundance. "Old Elveden Gap" was so called to distinguish it from its newer companion on the turnpike road. These gaps were, originally, cuttings through the forest. The Icknield Way crossed the present road between Barnham and Elveden, at a spot known as Marmansgrave, where it may yet be seen in all its pristine glory—although rarely used. A suicide was here interred, showing that at one time the four crossways were of equal renown, although there are more typical ones in the parish now. This road was used less than one hundred years ago for driving cattle to the London market.

From Marmansgrave (Elveden), Suffolk, to Larlingford, Norfolk, the course of the Icknield Way is not so clear. Some of the banking may yet be seen at the rear of Thetford Cemetery. The Icknield Way crossed the high road between Bury St. Edmunds and Thetford, a few yards north of Thetford Gasworks. In one of Gall & Inglis' recent maps of Suffolk this road is shown, and up to a short time ago its course could be accurately traced. It is well marked in a map of 1749. In the field where the gasworks are situate, remains of a populous British settlement were found in 1870, including pottery, bone awls, stone and bone amulets and remains of habitations. Similar remains have been found in a field on the opposite side of the road, also crossed by the Icknield Way. Three roads still remain at "Chunk Harvey's Grave," where another excommunicate was buried, and the Icknield Way formed the fourth. This obliterated trackway is still supposed to form the boundary between the hundreds of Blackbourn and Lackford. A short distance further the road turns abruptly at right angles over the river Little Ouse, a most pronounced characteristic of British track-

Fig. 1.—"Chunk Harvey's Grave," Thetford. The Icknield Way ran from (A) to (B).

ways. This was in most cases to find an easier passage. Within a hundred yards the road crosses the Little Ouse, a rivulet, and then the Thet, the bridges being termed the "Nuns' Bridges." Blomefield describes the Castle Hill, Thetford, as being "close by that ford or most frequented passage over the river, from whence the city had its name." The derivation, however, is by no means certain. If the terminal be taken as the Anglo-Saxon *ford*, it undoubtedly

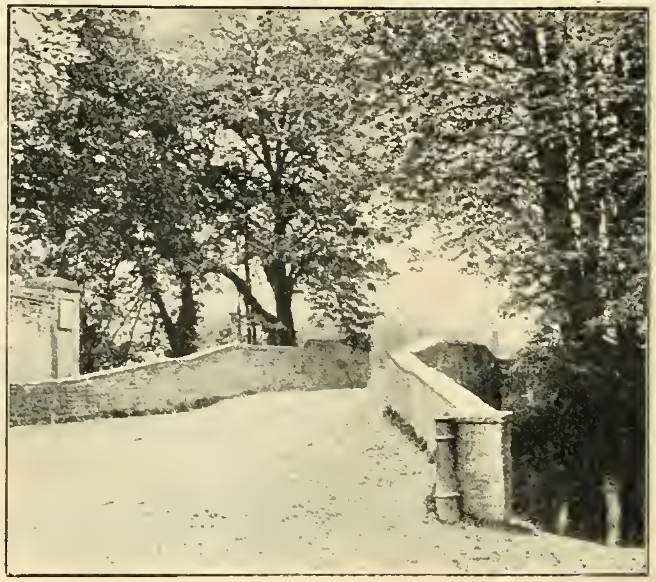


Fig. 2.—Bridge over the Thet at Thetford. Anciently the ford of the Icknield Way.

refers to this one. It is possible, though not probable, that the terminal is the Celtic *fford*, a road or trackway, relating to its position on the Icknield Way, as in ancient documents the place-name not infrequently occurs as Thefford. The prefix may be from the word Theod, a contraction of some personal name as Theodosius (Coulton). The most probable derivation seems to be from the Anglo-Saxon, Theote, a broken stream. In that case, Thetford would mean "the ford of the broken stream." In the Autobiography of Roger North, Attorney-General to James II. ("Lives of the Norths," Vol. III., pp. 10 and 11), he says: "There was a navigable river in the town (Thetford) which, above the bridge, branched into many brooks and scattered streams."

It is remarkable that not until 1697, or two years after the presumed construction of the highway between Thetford and Newmarket, is the erection of the Town Bridge, Thetford, by which the present highway crosses the river, mentioned. Reference to the repair of the Nuns' Bridges occurs in 1539, in a deed between the Prior of the Monastery of Our Ladye of Thetford, and Richard Cockerell, Mayor of the borough. Mention is also made of land abutting on "Lackefordeweye," which must necessarily have been the road through Icklingham.

From the River Thet, the logical and undoubtedly correct continuation of the Icknield Way is by the Castle Lane and Green Lane, Thetford. In the former, the road passed close by, if not through, the boundaries of the wonderful British earthworks known as Thetford Castle Hill, which Mr. Mark Knights, in "Peeps at the Past," termed the "most remarkable artificial earthwork in East Anglia." At the southern end of Green Lane, there were found in 1870, in a field adjoining the Icknield Way, Roman and Celtic pottery, an unground axe, and various implements of flint. Eight of Thetford's mediæval churches—of which three at least were Saxon—abutted on this portion of the Icknield Way, and several monastic establishments were in close proximity. Up to the beginning of the present century one of the streets uniting with the Icknield Way was termed Heathenman

Street, pointing across a thousand years to the march of the "heathen men" (Danes) of the Anglo-Saxon Chronicles.

In Robert Morden's map of Norfolk, in 1695, the present Norwich turnpike between Thetford and Larlingford is not marked. There is the road to Croxton, but the Norwich highway crosses the river at Nun's Bridge, and runs north-eastward by way of Castle Lane and Green Lane, and further by a road which can now be but imperfectly traced. The present high road and Magdalen Street are shown as lanes, between the Croxton and the then Norwich turnpikes. In 1749 the present road was

Fig. 3.—The Green Lane, near Thetford, showing the Icknield Way as an unmade track, banked on either side.

shown on a map of the county in addition to the old one. This was the case in 1777, but in 1808 the old road is omitted, and the same in Laurie and Whittle's map of Norfolk and Suffolk in 1811. However, in a map by Mr. Thomas Dix, presumably early in the present century, a continuation of the Green Lane is shown running parallel with the present highway until uniting with Peddar's Way. This road is also shown on one of Gall and Inglis' most recent maps of Norfolk, although Green Lane is omitted. From the northern end of Green Lane to its junction with the present Thetford-Norwich highway, presumably to the south-west of Larlingford, it is a matter of some difficulty to trace the course of the Icknield Way. In one of the fields between Green Lane and Roudham Heath, five hawthorns would seem to indicate the ancient track, which is continued by three in the next. On the heathland itself the road can be imperfectly traced by the old banks, chiefly in the near neighbourhood of that well-known British track, the Peddar's Way, which it crosses about half a mile from where the Peddar's Way is joined by the Drove, another British way leading from the fenland. So overgrown is the Icknield Way by ling and bracken, during the two hundred years that it has been superseded by the present turnpike, that it is difficult to dogmatise as to its exact course hereabouts. A Bridgham tradition makes mention of a waggon-road which formerly ran over Roudham Heath. This undoubtedly refers to the Icknield Way. In May, 1010, the great battle of Ringmere, in which Sweyn the Dane defeated Ulfketel the Saxon, was fought on this heath. There was undoubtedly a British trackway between Thetford and Norwich, connected with the British town of Attleburgh, and passing a tumulus at Cringleford. There was also a British settlement at Wymondham, and near the Way was the great camp at Buckenham. That Norwich Castle Hill was one of the most noted British earthworks in East Anglia is undisputed, and its connection with the Icknield Way has long been a matter of presumption. Between Thetford and Norwich the road crosses the Thet, at Larlingford, a name given in later days, but when fords were still an important feature in travelling; and the Yare at Cringleford (from the O.N. Kringla, a curve, the river here bending in the form of a horse-shoe). Relics of life in early Britain have been found not infrequently on the line of route between Thetford and Norwich. In 1845 a quantity of bronze weapons were found in a village near Attleborough. Five axes of flint were also found by the side of the river at Hargham, and similar instruments have been found at Attleborough, as well as a small disc of baked clay, about one-sixth of an inch thick and three inches in diameter (Roman).

From the preceding portion of its course one can reasonably conclude that the route between Norwich Castle Hill (chalk) and the sea, would also follow the chalk formation. Mr. Arthur Taylor favoured a route near Hickling, without further particularizing its course, but the most reasonable and logical way seems to be by Sprowston, Rackheath, Wroxham, Hoveton, Beeston St. Lawrence, Smallburgh, Stalham, and Happisburgh—a route which keeps to the chalk and avoids the marshland of the Broad district, which in pre-Roman times was undoubtedly almost wholly under water. In support of this it may be mentioned that Hoveton is derived from the Old Norse Hof, a temple, presumably showing a settlement here prior to Roman times (*vide* "Rye's History of Norfolk"); Smallburgh was probably a small Roman outpost. Near Stalham is a mound and ditch known as the "Devil's Ditch," which are most certainly artificial, and are probably British earthworks. They are situated about a quarter of a mile from the highway, and would guard the *Wayford*, the "ford of the way" over the River Ant, a continuation of the series of earthworks guarding fords, as Rampart Field at Lackford, and the Castle Hill at Thetford. About twenty years ago a splendid British shield was dug up in the marshland at Sutton, and Cotman narrates the discovery of flint implements at Ingham. Mr. W. H. Cooke, of Stalham, thinks the road from that place to Happisburgh the most probable continuation of the Icknield Way. Happisburgh was a Roman station, and was thought by Mr. Rye to be the southern termination of the coast road to Brancaster.

For assistance in philology, I must record my indebtedness to Mr. J. J. Coulton, of Pentney, Norfolk; and for local information to Messrs. G. Gathercole, of Thetford, and Mr. W. H. Cooke, of Stalham. The illustrations are from photographs specially taken by Mr. R. A. Howard, of Thetford.

Microscopy.

By John H. Cooke, F.L.S., F.G.S.

A solution of formaldehyde containing one part in from one hundred to one hundred and fifty parts of water makes an admirable medium for hardening tissues. The longer the tissues are left in it the better are the results.

The glare which is usually associated with low powers and a bull's-eye condenser may be modified and diffused by laying the slide containing the object on a slip of ground glass. This device not only eliminates the flare, but it also renders the work of observation much less tiring to the eyes.

Glycerine is one of the most useful preservative media for microscopical manipulations. Pure glycerine should not, however, be used, as confervoid growths are apt to appear in it. To obviate this, the addition of about two per cent. of camphor water is recommended.

In a paper read at the last meeting of the American Microscopical Society, Mr. B. D. Myers embodied the results of a series of experiments that he has conducted in the histologic laboratory of Cornell University on the uses of picro-carmine and alum carmine as counter stains. With hematoxylin the picro-carmine gives a more differential stain than picro-fuschin, and shows the characteristic alkaline re-action with hematoxylin, bringing out the hematoxylin as a beautiful sharp blue, while the acid picro-fuschin tends to fade it.

The Canada balsam of commerce is frequently contaminated with impurities, and is therefore not always suitable for mounting purposes. These impurities may be eliminated by filtration in the following manner:—Make a cone of Swedish filter paper, and affix to the outside of it, at equal distances apart, three short lengths of glass tubing. On placing this apparatus in a glass funnel of suitable size, the tubing will prevent the filter paper touching the sides of the funnel. Dissolve the balsam, which is to be treated, in sufficient benzole to make a mixture of a thin, syrupy consistency. Pour this into the filter, and to prevent evaporation cover the funnel with a greased glass plate. The filtered balsam should be put on one side until the benzole has evaporated sufficiently to allow of its being used.

To preserve microscopic organisms intact, it is necessary that they should be mounted without crushing, flattening, bleaching, or contorting their parts—that is, the organisms should, after the preliminary stages of preparation, be mounted in a medium of suitable density, and "without pressure." The following medium—viz., absolute alcohol, three parts; glycerine, two parts; and distilled water, one part—will be found to give very successful results with hard ova, zoœa, the young of crustacea, and most insects and plants. The specimens, which should be quite fresh, ought to be dropped into small tubes containing the above mixture, and allowed to remain there for any period varying from three to twelve months. Should the fluid become discoloured, decant it, and replace with a fresh supply. When ready, the specimens must be placed in a cell containing the fluid in which it is intended they shall be mounted. The composition of this may be six parts of distilled water and one part each of glycerine and alcohol, or such other proportions of these constituents as may be best suited to the object to be mounted, provided that the density of the mountant be *less* than that of the fluid which was used in the preparatory stages. This method of preparation has been successfully tested in marine biological laboratories both at home and abroad.

Microscopists, who have occasion to do much work with the camera-lucida, will find the following device of considerable assistance in their microscopical sketches:—Take a circular cover glass, rule it in squares, and drop it in the eye-piece so that the squares may be seen crossing the field of view in which the object has been placed. By carefully transferring to squared paper the observations obtained, a satisfactory and effective drawing of the object may be made. Mr. G. C. Karop suggested to the members of the Quekett Club the following method for etching the squares on the glass cover glass:—Cement the circle to a glass-slip, cover it with a thin coating of paraffin wax, and rule the squares required with a fine-pointed needle. Mix a small quantity of finely-powdered fluor-spar and concentrated sulphuric acid in a platinum crucible, heat the mixture, and allow the resulting fumes of hydrofluoric acid to play on the squares of the glass circle. The etching will soon be effected, after which, clean the glass and mount it in a circle of cardboard.

Bujwid was the first microscopist to systematically study the germ life contained in hailstones. The subject has now been taken up by Mr. C. F. Harrison, of Guelph, who has isolated and determined a series of bacteria and moulds, two of which, *B. flavus grandinis*, and *M. melleus grandinis*, are new to science. He has published a monograph on the subject, in the course of which he describes the methods that he adopted. The hailstones were washed in a mercuric chloride solution (one in five hundred), rinsed several times in sterilized cold water, and each stone thus treated was dropped into a tube of melted nutrient gelatine. The mixture was then thoroughly shaken, and the plates made in the usual manner. Four days afterwards the plates were counted, all the bacteria and moulds were isolated, and their cultural characteristics determined. The results have led him to support Bujwid's theory, that surface water is carried up by storms and frozen, producing hailstones.

NOTES ON COMETS AND METEORS.

By W. F. DENNING, F.R.A.S.

BROOKS'S COMET (discovered October 20th) is now invisible to observers in this country. At the middle of February the comet will be situated in Corona Australis, and very faint, for its distance from the earth will be about one hundred and ninety millions of miles.

CHASE'S COMET is favourably placed as regards its position in the heavens, but is too difficult an object to be seen in ordinary telescopes. The following is an ephemeris for Berlin midnight, by Möller (*Ast. Nach.*, 3531):—

Date.		R.A. h.	m.	s.	Declination. °	′	Distance in millions of miles.	Brightness.
February 4	...	11	7	48	+35	1	174	1·02
„ 8	...	11	6	23	35	40	175	0·99
„ 12	...	11	4	42	36	15	176	0·96
„ 16	...	11	2	47	36	47	178	0·92

The comet is therefore receding from the earth and gradually becoming fainter.

PERIODICAL COMETS DUE IN 1899.—A considerable number of these interesting bodies are expected to return to perihelion during the present year. Denning's Comet (1881 V.) is due in February. Tempel's Comet (1866 I.), which deserves particular notice from the fact of its close association with the Leonid meteors, should return in the spring. Barnard's comet (1892 V.), Tuttle's (1858 I.), and Holmes's (1892 III.) is expected in April or May, while Tempel's comet (1873 II.) should be seen in July. The latter comet ought to be well displayed at this return, for the conditions are nearly the same as in 1873 (five of its periods of 5·20 years being equal to twenty-six years), when the comet was on the same side of the sun as the earth.

THE LEONID METEORS.—Reports of observations continue to come in, but some time must yet elapse before a complete summary of all the results can be compiled. American observers appear to have been the most successful, but a really brilliant shower was not observed anywhere. Prof. Payne, at Northfield, Min., watched on November 14th, 12h. 30m. to 15h. 45m., and counted eighty-one meteors, nearly all of which were Leonids. Mr. H. R. Smith, at Philadelphia, counted seventy-six meteors between 12h. 20m. and 16h. 40m. on the same night. Prof. Landis, at Carlisle, Pa., reports that on November 14th, between 12h. and 13h., thirty-four meteors were counted; between 13h. and 14h., sixty-four; and between 14h. and 14h. 30m., fifty-four. Four to twelve observers were engaged, and he judged that the average hourly number from one hundred to one hundred and twenty-five. At Northfield, Min., two meteor trails were photographed. Prof. Wilson describes them as perfectly straight, and lines drawn through the two intersect at $151{\cdot}5° + 22{\cdot}3°$. This is in remarkable agreement with the place of the radiant as determined by four trails photographed at Harvard College, which nearly intersected at the point R.A. 10h. 6·8m. Dec. $+22° 16'$. This accordance encourages the hope that, though the recent shower was less brilliant than expected, photography has fully justified its employment, and furnished us with the place of the apparent radiant with a high degree of accuracy. He says, in summarizing the American observations, that on the morning of November 15th the probable horary rate of Leonids for one observer watching the sky continuously was about forty. This shows a great increase of strength as compared with 1896 and 1897, but the most siugular result is that the radiant was found to be nearly two degrees south of the average position ($149° 28' + 22° 52'$) indicated by observations during the previous sixty-five years.

At the Yerkes Observatory, Prof. Barnard had a clear sky shortly after midnight on November 14th, and watched until daylight. He saw several hundred meteors, many of them being of the first magnitude, and a few brighter. They left bluish-green streaks. The maximum was reached between 3 a.m. and

4 a.m. (10 a.m. G.M.T.), and perhaps nearer 4 a.m. He had five cameras pointed to different parts of the sky, but at the time of writing had found no trails on the plates he had developed. At the Observatory at Harvard College it appears, however, that Prof. Pickering secured a considerable number of photographic trails. He and his observational staff saw an aggregate of eight hundred meteors.

At Burgess Hill, Sussex, the sky was clear on November 13th, and Mr. Gregg reports in the *English Mechanic* that he watched—between 11h. 50m. and 18h. 10m.—and counted sixty-four meteors, of which forty-three were Leonids.

The Geminid Meteors.—These were tolerably numerous in 1898. On December 12th, 7h. 25m. to 11h., Mr. R. Service, of Dumfries, counted fifty-two meteors. Between 9h. 30m. and 12h. 30m., Mr. A. King, at Leicester, saw forty-one. Mr. Nielsen, at Hartlepool, observing from the cliff between 9h. 5m. and 10h. 5m., counted thirty-six meteors, of which thirty-five were Geminids. A number of meteors were also observed by Mr. Besley, Mr. Milligan, and others. The former found radiants at 104° + 31′ and 115° + 32′.

THE FACE OF THE SKY FOR FEBRUARY.

By A. Fowler, f.r.a.s.

The Sun.—On the **1st** the Sun rises at 7.41 a.m., and sets at 4.47 p.m.; on the **28th** he rises at 6.50 a.m., and sets at 5.36 p.m.

The zodiacal light may be looked for in the west after sunset.

The Moon.—The Moon will enter her last quarter on the **3rd**, at 5.24 p.m.; will be new on the **10th** at 9.32 a.m.; enter her first quarter on the **17th**, at 8.52 a.m.; and will be full on the **25th**, at 2.16 p.m. 19 Piscium (mag. 5·2) will be occulted on the **12th**, the disappearance taking place at 7.35 p.m., 78° from the north point (39° from the vertex); at the reappearance, fifty-three minutes later, the star will be setting. 103 Tauri (mag. 5·5) will be occulted on the **18th**; the disappearance will take place at 8.53 p.m., 96° from the north point (66° from the vertex); and the reappearance at 10.11 p.m., 273° from the north point (233° from the vertex).

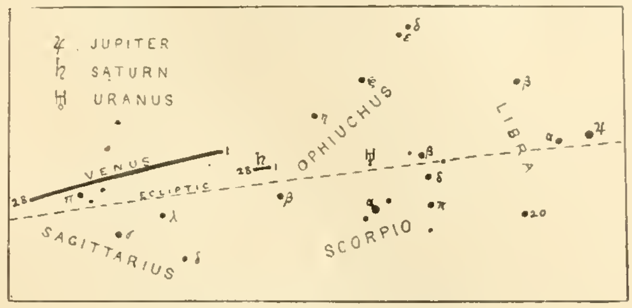
The Planets.—Mercury is not well placed for observation during this month. He is a morning star at the beginning of the month, reaching superior conjunction on the **27th**.

Venus is now a brilliant object in the morning sky. She reaches her greatest western elongation of nearly 47° on the **11th** at 7 a.m. During the month her apparent diameter diminishes from 28″ to 21·8″. At the middle of the month about half the disc will be illuminated. The path of the planet lies in Sagittarius. She rises about three hours before the Sun at the beginning, and about 2h. 40m. before the Sun at the end, of the month.

Mars will be readily recognized in Gemini, through which he traverses a retrograde path until the **27th**, when he will be stationary. He will be visible, practically, throughout the night, crossing the meridian at 10.57 on the **1st** and at 8.53 on the **28th**. The apparent diameter of the planet diminishes from 13·8″ to 11·2″ during the month, and his distance increases from about sixty-two million eight hundred and seventy-nine thousand to seventy-seven million eight hundred and fifty thousand miles.* The phase will be very slight, the illuminated part on the 14th being 0·969 of the disc.

Jupiter is becoming more favourably situated, rising at midnight about the middle of the month, and about 11 p.m. at the end. He is near α Libræ, and will be stationary on the **24th**, his path accordingly being a very short one. His polar diameter increases from 34·4″ to 37·4″ during the month.

Saturn is a morning star, rising about 4.30 a.m. on the **1st**, and shortly before 3 a.m. on the **28th**. He traverses



The Morning Planets in February.

a short direct path in the most southerly part of Ophiuchus. The northern surface of the ring is visible, and the rings are widely open.

Uranus is also a morning star near ω Ophiuchi. He will be in quadrature with the Sun on the **26th**.

Neptune is visible nearly all night. At the middle of the month he precedes ζ Tauri by 6m., and has a declination 49′ greater than that star.

The Stars.—At the beginning of the month, Gemini and Canis Minor will be on the meridian shortly before midnight, Canis Major a little after 10 p.m., Orion about 9 p.m., and Taurus soon after 8 p.m. At the end of each succeeding week these constellations will be in the south about half an hour earlier.

Conveniently observable minima of Algol will occur on the **11th** at 10.39 p.m.; and on the **14th** at 7.28 p.m.

Chess Column.

By C. D. Locock, b.a.

Communications for this column should be addressed to C. D. Locock, Netherfield, Camberley, and posted on or before the 10th of each month.

Solutions of January Problems.

No. 1.

(By W. Clugston.)

1. Q to B7, and mates next move.

No. 2.

(By C. D. Locock.)

[The composer's intention was 1. B to Kt3. Unfortunately 1. P to Q3 instead solves the problem, while it prevents the main variation.]

Correct Solutions of both problems received from Alpha, K. W., H. Le Jeune, D. R. Fotheringham, N. E. Meares, F. V. Louis, G. C. (Teddington).

Of No. 1 only, from W. H. Stead, G. G. Beazley.

Of No. 2 only, from H. S. Brandreth, A. W. Webb, W. de P. Crousaz, A. Gorham, Miss Theakston.

H. S. Brandreth.—In No. 1, if QKt7, B or P moves.

Miss Theakston.—1. R × P is met by 1. B to Kt5 or R6.

A. Gorham.—The King escapes at K6.

W. de P. Crousaz.—If 1. Kt to Q3, B to Kt5 or R6.

H. Bristow.—Thanks for the problem. Would it not be possible to get rid of a few of the pieces, even at the cost of one variation if necessary?

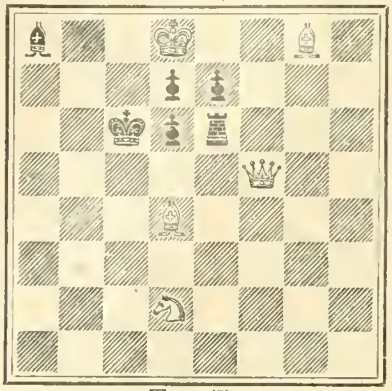
* The distance at opposition in January was about 60 millions of miles, not 143 millions, as incorrectly stated in the January number. —A. F.

PROBLEMS.

By J. Nield, Crompton.

No. 1.

Black (6).

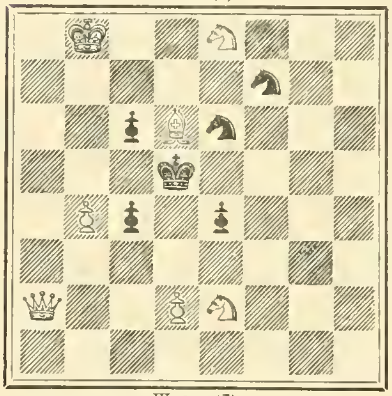


White (5).

White mates in two moves.

No. 2.

Black (6).



White (7).

White mates in two moves.

CHESS INTELLIGENCE.

The annual amateur tournament at Craigside, Llandudno, took place as usual during the first week in January, with the following result:—

First Prize	...	A. Burn	9
Second ,,	...	H. E. Atkins	7½
Third ,,	...	G. E. H. Bellingham	6
Fourth ,,	...	G. A. Schott	6

The other competitors were Messrs. Gunston, Owen, E. O. Jones, Wilmot, Dawbarn, Wahltuch, Thrift, and Dod. Last year it will be remembered that Mr. Burn was also the winner; Mr. Bellingham on that occasion was a good second, but seemed a little out of form during the present tournament.

The match between Messrs. Janowski and Showalter has been adjourned during the Christmas holidays and now resumed. The present score is Janowski, 4; Showalter, 2; drawn, 3.

The match between Sussex and Hants in the Southern Counties Chess Union competition resulted in a draw, the score being ten games to each side.

The game below was played in the recent Craigside Tourney.

"Four Knights' Game."

White. (V. L. Wahltuch, Manchester.)	Black. (H. E. Atkins, Leicester.)
1. P to K4	1. P to K4
2. Kt to KB3	2. Kt to QB3
3. Kt to QB3	3. Kt to KB3
4. B to QKt5	4. B to QKt5
5. Castles	5. Castles
6. Kt to Q5 (*a*)	6. Kt × Kt
7. P × Kt	7. P to K5
8. P × Kt (*b*)	8. QP × P
9. B × P (*c*)	9. P × B
10. Kt to K1	10. P to KB4 (*d*)
11. P to QB3	11. B to Q3
12. P to KB4	12. B to R3
13. P to Q3	13. P × P
14. R to B3	14. B to B4ch
15. B to K3	15. Q to K2
16. B × B	16. Q × Bch
17. K to R1	17. QR to Q1
18. Q to Q2	18. KR to K1
19. R to B2	19. R to Q4 (*e*)
20. Kt to B3	20. R to K7
21. R × R	21. P × R
22. Kt to Q4	22. Q to K2
23. Q to K1	23. P to B4
24. Kt × B2 (*f*)	24. Q to K5
25. Kt to R3	25. B to Kt2
26. Resigns.	

Notes.

(*a*) Since the discovery of 7. . . P to K5 for Black this move has fallen into discredit.

(*b*) 8. Kt to Ksq is probably better.

(*c*) Though this capture isolates Black's Queen's side Pawns, he has ample compensation in the freedom of his two Bishops and Rooks.

(*d*) Black can apparently win a Pawn at once by BR3, followed by B × Kt, but he is reluctant to part with his most valuable Bishop for an inactive Knight. As it is, White's position is already almost hopeless.

(*e*) In order that the Rook may be defended after the subsequent captures.

(*f*) This is fatal. 24. Kt to B3 would prolong the game.

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CONTENTS.

MOSQUITOES AND MALARIA.

By Percy H. Grimshaw, F.E.S., *Natural History Department, Edinburgh Museum of Science and Art.*

For some time past mosquitoes have been accused of taking an important part in the dissemination of certain diseases. This accusation was justified some years ago by the researches of medical men into the nature of the disease produced by a parasitic worm known as the *filaria*, or thread-worm, various species of which are found beneath the human skin, and which are quite common in hot countries. The mosquitoes, in sucking the blood of an infected person, are supposed to imbibe the parasites into their own system, and then by dying, or in other ways, to contaminate water, which may be afterwards drunk by some other person, to whom the disease is thus communicated. Quite recently, however, successful attempts have been made to connect the "bite" of a mosquito directly with the production of various forms of malaria, or malarial fever, as it should more strictly be called. It seems that the medical experts in London are now accepting the conclusions of Prof. Grassi, of Rome, as to the cause of black-water fever, which is one of the worst forms of malarial fever, and the scientific staff of the Natural History Museum, at South Kensington, are inviting travellers in all countries to collect as many mosquitoes as possible in the districts visited by them, with a view to properly identifying the various species, and tracing out still further the supposed connection between these insects and some of the fevers prevalent in tropical climes.

In the transactions of the society known as the "Reale Accademia dei Lincei," published at Rome during the last three months of 1898, Profs. Grassi and Bignami have given a most interesting account of their experiments and conclusions. As their communications are in the Italian language, and not generally accessible, it may be useful to give here a short *résumé* of their researches. In order to thoroughly understand the subject, however, my readers must have a proper idea of the insects concerned, and also of the nature of their so-called "bite."

The name "mosquito" has from time to time been applied to almost any small insect which sucks blood, but, properly speaking, it only refers to members of one group or family of two-winged flies, that which contains the true gnats. The latter name can therefore be applied with absolute accuracy to mosquitoes. In this country we have about twenty different species of gnat, in Europe there are about fifty, and in the world generally over one hundred and fifty. No doubt, with the increased attention which will now be paid to this family of insects, many more species will be discovered, although most people will be of the opinion that we have a sufficient number already! As I cannot describe all the species without devoting a small volume to them, and as they are all closely related to one another in structure and habits, it must suffice to say a few words about the best-known species, that bearing the name of *Culex pipiens*. This is structurally a very beautiful insect, about half an inch in length, which announces its presence by the peculiar "piping" sound to which it owes the second part of its scientific name. It has only a single pair of wings, thus proclaiming itself a true dipterous or "two-winged" fly, six long, slender legs, a pair of feelers or antennæ, and a proboscis which does all the harm. The antennæ differ greatly in the two sexes, for while in the male they take the form of a pair of beautiful feathery plumes, in the female they consist of a simple series of joints each bearing a ring of short hairs. The sexes also differ materially in the structure of their mouth-parts, and it is important to note that only the female "bites" or rather "punctures." The male is quite harmless owing to the deficient nature of its mouth-organs, and it is only necessary therefore to describe the proboscis of the gentler (?) sex.

Briefly, the proboscis of the mosquito consists of a tube, or rather trough, within which are concealed no less than six bristle-like boring implements, two of which are somewhat broadened and sharpened at the tip to form a pair of small lancets, and other two barbed or serrated, so as to form most effective saws. When the insect begins its work it fastens the end of the trough firmly down against the flesh of its victim. Then it places the bristles close together so as to form a solid boring instrument, which it plunges into the flesh and then sucks up the blood through the tube which is formed by the union of the bristles with the trough.

Now, as mosquitoes are almost invariably found in damp or marshy places, it is not surprising to learn that the early stages of their life-history are aquatic. The female insect lays about a couple of hundred eggs in a tiny boat-shaped mass, which floats like a raft upon the surface of ponds and stagnant water of all kinds. The eggs soon hatch and produce grubs which live entirely in the water, moving actively about by means of a series of curious jerks, and occasionally coming to the surface to breathe. This grub, which, by the way, differs from its parents in possessing a pair of true biting jaws and no sucking apparatus, soon transforms itself into an odd-looking creature, which never takes food at all, for the reason that it has no mouth. When the time comes for a further change, the skin of this grotesque creature splits open along the back, and out steps the dainty little gnat or mosquito, which, after drying its wings, flies off. to commence (if it happens to be a female) its torturing attentions to man or beast.

As the name "malaria" (meaning "bad air") would seem to imply, one of the earliest ideas was that the disease originated by the inhalation of various noxious gases which are generated in swampy districts. Decaying vegetation was also supposed to be an active cause, as were also great and sudden changes of temperature. The connection of bacteria with the disease was first mooted about the middle of the century, and by later researches has been established without a doubt. The germ or bacillus of malaria was first discovered in 1879, at Rome, by two Italian investigators, and since that time their fellow-countrymen have kept well to the front in the study of this important subject. Although the bacterial nature of malarial fever in its various forms has been thus clearly established for some little time, the method of its dissemination remained a mystery until the startling discoveries due to Grassi, Bignami, and others.

According to Prof. Grassi, the first person to hint at the curious relations between mosquitoes and malaria was an investigator of the name of Laveran, who latterly, however, limited himself to the conception that infection took place through the air or water, at the same time admitting that the bacillus spent some part of its existence in a lower animal or vegetable. Next, Dr. Manson supposed that the germ was normally present in mosquitoes or in some other sucking insect, and that on the death of the latter it would commence a free life in the air or water, entering the human body by inhalation or by the drinking of water. Koch at first held a similar theory, but Bignami went a stage further, and conceived the idea of *inoculation* by the bite of the insect, which might be a gnat or some allied insect inhabiting damp places. Last year Koch confirmed the American researches, showing an analogy between the behaviour of ticks in the propagation of the disease in cattle known as Texas fever, and that of mosquitoes in relation to malarial fever, both these diseases being due to bacilli undoubtedly related to each other. Later still, both Manson and Ross have made some interesting communications, the researches of the latter having reference to germs in birds which also have a species of mosquito as intermediate host.

The first thing Grassi set himself to do, therefore, was to find out what species of insect must be considered guilty of spreading the disease. As he tersely remarks, only some species can be culpable, because there are districts notoriously teeming with mosquitoes and yet not infested with malaria, while on the other hand the times or seasons of these insects, and the appearance of the disease do not always coincide. By a process of elimination the Professor sifted out the species until only a few were left for further investigation as at any rate suspicious. Among the results which followed, the two here given are the most important: (1) *three* species of gnat or true mosquito must certainly be regarded with great suspicion, and (2) *Culex pipiens*, whose life-history we have briefly sketched above, must be considered harmless.

With regard to *Culex pipiens*, Grassi reports that this species is the predominating one in non-malarial districts, while, on the other hand, it is scarce, or even wanting altogether, in not a few districts infested with the fever. Further confirmation of its innocence is also found in the following case cited by the Professor, as observed at Follonica, in Tuscany. This region is much infested by malaria, and in the house which serves as hospital for the foundries there the ground floor is set apart for the patients, while the upper stories accommodate the medical staff. In August last, when Grassi visited the place, the only species found there was the one in question, and, in accordance with this fact, we learn that the physicians never had to record the development *de novo* of a single case of malaria. On the contrary, among the workmen of the foundry who live a little distance away, the cases of fever were in daily evidence. By searching in their houses certain of the suspected species were found, which evidently accounted for the presence of the disease.

Unfortunately, the various species of mosquito have no English names by which they can be distinguished. Therefore, in speaking of the three more particularly concerned in the question now before us, we shall be compelled to use their scientific names. These names are *Anopheles claviger*, *Culex penicillaris*, and *Culex malariæ*. Of these, the first, which we shall refer to simply as *Anopheles*, according to Grassi, is constantly found in all malarial districts, and is much more frequent where the disease rages more fiercely. It may be distinguished from its relatives by having its wings spotted, with the spots arranged so as to form a capital letter T. Grassi calls it a "spy" of malaria, and says that the relations between it and the disease have been confirmed in Lombardy, Tuscany, the Roman Campagna, and in many other places. After giving the details of many cases where the disease and the insect either co-exist or are both absent, he refers to a locality near Saronno, where in the middle of a healthy district is a small circumscribed area infested by malaria, and, curiously enough, the *Anopheles* is found there, but not in the surrounding healthy zone. A similar instance occurs near the small lake of Ceriano.

The rice-fields are veritable hot-beds of malaria, and mosquitoes are exceedingly abundant there, too. An exception in both respects occurs near Veniano, where there is a very small rice-field so deficient in regard to its water supply that the rice does not prosper. Grassi found no mosquitoes there, and the medical authorities, likewise, have failed to record the presence of disease in its neighbourhood.

Up to the time of writing the first of the three papers we are now summarizing, Grassi only found a single exception to the co-existence of *Anopheles* and malaria. Near Saronno there is an expanse of artificial swamp containing a few mosquitoes, but cases of disease have not as yet been reported. Considering, as Grassi says, that the swamp is artificial and relatively recent, it can be readily seen that the opportunities afforded to the insects of becoming infected have not been frequent, as owing to the peculiar situation of the swamp very few persons have been bitten.

The second species, which bears the name of *Culex penicillaris*, is also undoubtedly instrumental in spreading the disease, especially in September, when the *Anopheles* begin to diminish in numbers. This species is more frequent, too, in places troubled by September malaria.

The third species put down as guilty appears to Grassi to be a new one, and he, therefore, gives to it the very appropriate name of *Culex malariæ*.

As to the time of day when the insects bite, our author states that the *Anopheles* prefers to attack within an hour on either side of sunset. In about an hour and a half at this time of day one may be bitten more than a hundred times, while throughout the rest of the day and night not five bites may be received. The second species bites more at twilight than at any other period of the day, as does also *Culex malariæ*. · All these facts fit in exactly with the common knowledge that the twilight hour is the most dangerous one in malarial regions. Moreover, the three species in question, and especially the first, enter houses much more readily than others.

Another important fact is that the mosquitoes of malarial districts, especially the guilty ones, rarely ascend to a great altitude. Therefore, in houses, the rooms of the second and third flats are not visited much by these pests, and this fact agrees well with the well-known comparative salubrity of these higher rooms.

It must always be borne in mind that in order to produce fever in a healthy person by its bite the mosquito must itself have previously bitten someone already stricken with illness, and therefore of necessity only a small proportion of the insects can be dangerous, even in a badly-infested locality. The greater number of them bite domestic animals, such as oxen, horses, pigs, dogs, pigeons, fowls, etc., as well as man. One might, therefore, be bitten thousands of times without being inoculated with the bacillus, while, on the other hand, a single bite might be sufficient. These possibilities must be taken into consideration when we read of the failure of the early experiments to demonstrate the actual transference of the bacillus from the blood of the patient to the body of the insect. In a joint note published by the three investigators, Bastianelli, Bignami, and Grassi, they announce that they have been able to follow with certainty certain phases in the development of a bacillus in a portion of the alimentary tract of *Anopheles claviger*. The specimen examined had been made to suck the blood of patients suffering from malarial fever, and the different phases observed seem to correspond to some described by Ross in the case of a bacterial parasite in birds. In a room where four malarial patients lived, these authorities collected half a dozen *Culex pipiens*, four *Anopheles claviger*, and one of another species. The examination of all these insects proved without result, except in the case of two of the *Anopheles*, which yielded bacilli in the stages of development just alluded to. In an appendix to this communication, the same authors state that they have succeeded in producing one of the varieties of malarial fever in a patient solely through the effect of bites made by this same species. The man was certainly not previously suffering from malaria, and lived in a place certainly free from the disease. They have also obtained, within the alimentary tract of the insect, later stages in the development of the bacillus than those mentioned in the account of their previous experiments.

Grassi records it as his conviction that not only do mosquitoes convey the infection of malaria, but they are probably the *only* means by which the disease is spread. This is a bold statement, and the author of it answers one or two objections that might be raised against it. One is that cases of malaria sometimes develop in great numbers after a heavy shower of rain. Grassi points out that these may be merely relapses of the fever, and that also before these showers mosquitoes are particularly troublesome. Many cases of malaria were reported to the Professor on very high medical authority as having been developed in places free from the presence of mosquitoes. In all the cases he was able to investigate, however, there was unmistakable evidence that the attacks of such insects had intervened.

I might go on multiplying these remarkable relationships to some length further, but must now draw my abstract to a conclusion. In so doing I can only say with the Professor, who has furnished the facts and conclusions upon which these remarks have been based, that the investigation of malaria is entering upon a new phase, and we can now indulge a little more than formerly the hope of being able soon to battle successfully with malaria in all its forms. It would not be difficult to make any particular species of mosquito rare in a malarial district by a wholesale destruction of the grubs.

TWO MONTHS ON THE GUADALQUIVER.

By Harry F. Witherby, F.Z.S., M.B.O.U.

II.—THE MARISMAS.

The small creek in which we were anchored proved a pleasant spot, at all events from our point of view. Birds were plentiful all around us, not only during the hot and glaring day, but also at night, when their notes—some well-known to us, some unknown, wild and weird—formed pleasing variations to the metallic buzz of the persistent mosquito.

This part of the *marismas* consists of dry caked mud, covered with short grass and dwarf bog plants. At intervals, even this scanty vegetation ceases altogether and mud and water reign supreme. These patches of water, some of which are very large, are called *lucias*. They are quite shallow, being seldom more than two feet in depth, and they are encircled by a belt of dry mud, the surface of which is pitted with hoof marks, and cracked in every conceivable direction. Being a luxurious feeding place for ducks, geese, and all wading birds, a *lucia* forms a perfect Eden for that eccentric being, the ornithologist.

To deal first with the dry land. Within a few yards of our camp were the nests of two different species of larks very common in this district. One, the calandra lark,* is a veritable giant amongst larks, being almost the size of a song thrush. We nearly walked upon this bird before she rose from her nest, and flew up with a tremendous flutter, tumbling in her flight, and running along the ground in front of us with trailing wings. The calandra has a bold, bright song, uttered when the bird is on the wing, and, like our skylark, it is given to imitating the notes of other birds. A few steps away from the calandra's nest we flushed a very small lark, which, unlike the calandra, rose quietly from her nest and disappeared. This was the Andalusian short-toed lark,† discovered by Lord Lilford in 1872, and first described by Mr. H. E. Dresser in his "Birds of Europe." These little larks, which are very numerous in the *marismas*, seem to be peculiar to this part of the world. They do not soar like the calandra and the skylark, but take short, upward flights, singing as they go, and, returning to the ground or a low bush, finish twittering there. We heard them imitate the notes of many birds—such as stilts and redshanks. By the 8th of April their nests were numerous. Those we found were invariably built of dry grass and fine roots, lined with a few feathers, and placed in a slight hollow in the ground, often hidden by a tuft of grass or a small bush. The only other diminutive bird that was at all common in this scorched-up wilderness was a beautiful blue and yellow wagtail—the blue headed wagtail.‡

Many peewits§ had their eggs or young amongst the grass, and the efforts of the parents to drive off the birds of prey afforded us constant amusement. They devoted their

* *Melanocorypha calandra.* † *Calandrella bœtica.*
‡ *Motacilla flava.* § *Vanellus vulgaris.*

energies chiefly to the kites. A kite comes swooping majestically along as though he were altogether too fine a bird to notice anything smaller than an eagle. Suddenly two peewits rise from the ground and dash straight at that kite. He swoops on as though he had noticed nothing. But the screeching peewits whirl round again and attack him hotly from above and below. Watch him carefully and you will see him flinch and swerve, as time after time the brave little birds dash into his face. When one pair of peewits has seen him safely off their preserves, another pair flies up and attacks him, and thus he is "escorted" across the *marismas*. A pair of peewits is quite a match for a kite. I have seen one forced to drop his meal—a piece of offal—and fly away hungry because he happened to be too near some peewits and their family. Strange to say, the peewits do not attack the harriers so vigorously and persistently, although they are even more numerous than the kites, and perhaps as great egg and chick eaters. In fact, I feel sure that a harrier has a far more profitable journey across the *marismas* than a kite; but he goes about his business in a quiet, unostentatious way, flying low and quartering the ground in a systematic manner, as though he were more of an entomologist than an ornithologist.

We had often wished to become intimately acquainted with the stone curlew,* sometimes called the thicknee or

Fig. 1.—Our Camp.

Norfolk plover, a bird which is to be seen in England only in certain localities. Our wish was gratified on these dry plains, where the bird was common. To a great extent it is a bird of the night, and it was at night, when their stirring notes broke the stillness round the camp, that we began our acquaintance with them.

The usual note of the stone curlew is a loud harsh cur-er-ree. One night, when sitting round our lamp skinning and writing, in the midst of an angry crowd of mosquitoes which one of our men was vainly endeavouring to keep moving with a towel, a stone curlew gave us an extraordinary solo. He appeared to be composing a song. Beginning by rapidly repeating his usual note very softly and in a very low key, he suddenly went up to a very high key, then down again, and so on for quite ten minutes. It was like a human singer going from bass to falsetto, but the bird accomplished it perfectly, without a break, and apparently without an effort.

* *Œdicnemus scolopax.*

In the day these birds are usually silent and in hiding, but they are not to be caught napping. They always seemed to see us before we saw them, which was not to be wondered at, since with their sandy brown plumage they were very inconspicuous, while we were plainly visible at quite three miles distance. Consequently we found it difficult to cultivate the acquaintance of the stone curlew. For the first few days, when one rose, as they generally do, about one hundred yards off, we rushed towards the spot knowing that its mate, having run from the eggs in alarm, would soon take to flight. But we were always outmanœuvred; the bird ran as fast as we did, rose suddenly at an impossible distance, and soon joined the other bird a mile or two away. We had more success by waiting quietly behind our stalking horses when the birds rose. Not being so alarmed they did not fly far, and several times we marked them down and stalked them successfully. Often, however, they were suspicious even of the *cabestro* and ran away from it like greyhounds. Only twice did we surprise these birds. On each occasion the bird immediately lay at full length, with head extended flat upon the ground, and when we had approached to within about twenty yards, it leapt suddenly into the air and was off and away before we recovered from our surprise. We found several pairs of their beautifully-marked eggs lying side by side in the merest scoop on the hard ground. In the more fertile country we came across the eggs among the sand, closed in on all sides by high tamarisk bushes—a curious place to be chosen by a bird which is a lover of the open country.

We were riding home one evening, tired and fly-bitten, across a sun-burnt plain, when we saw an Egyptian vulture give chase to a stone curlew, which we had frightened into flight. The curlew was evidently not at ease. It began by flying low and straight, then it dodged and turned and flew round and up, calling plaintively all the while. The ungainly vulture flew doggedly and silently after it, keeping well up in the straight flying, but getting sadly behind whenever it tried to follow the curlew's sudden twists and turns. We watched this curious chase until the birds were mere specks many miles away, and we wondered much if the vulture had a private spite against that stone curlew, or if it merely needed exercise after some unwholesome gorge.

Never shall we forget our first day in a *lucia*. From afar we had seen the water—a great glistening expanse, unbroken save for a group of cattle away on the left, and straight before us a straggling bed of tall greyish reeds. As we got nearer, the reeds gradually took the shape of birds, until at length a long line of flamingoes* was revealed standing in knee-deep water. They looked a dazzling white in the brilliant sunshine. Round them were hundreds of dark dots, ducks of various kinds, and a little way off a small group of white clumsy-looking birds, which we made out with glasses to be spoonbills.† Nearer to us, in shallower water, black and white avocets‡ and long-legged stilts§ were feeding, while round the margins of the water, dabbling in the soft mud, were hundreds of small wading birds of various kinds.

We determined to devote ourselves first to the flamingoes, and try to stalk these wary birds. Our men put their *cabestros* in stalking trim, and we started to crouch behind them when about two miles away from the birds. Before we reached the water we came across a group of fifty or sixty mounds of mud some eight or ten inches high. These were old nests of the flamingoes, and our men told us

* *Phœnicopterus roseus.* † *Platalea leucorodia.*
‡ *Recurvirostra avocetta.* § *Himantopus candidus.*

that the birds had laid there the year before, when water was plentiful, but that in this dry season the nests were half a mile away from the edge of the *lucia*. When we visited this place again at the end of May, the *lucia* had almost completely dried up, and it is extremely unlikely that the flamingoes nested that year in Spain. Even in the wettest seasons, although the flamingoes build nests and lay eggs, they never seem to hatch out young in Spain. We left the nests with some regrets that we had happened upon a dry season, and soon arrived at the edge of the *lucia*. Now we found that our stalk would not be an easy one, as there were many birds of different kinds between us and the flamingoes. If we went straight on we should disturb these birds, and they would disturb the flamingoes, so we had to make a big detour. With infinite trouble we worked to within one hundred yards of the birds in about an hour, but we had frightened several flocks of smaller birds on our way, and when we peeped at the flamingoes from under the horses, we saw that their suspicions had been aroused, and that they were walking rapidly away from us. However, we persevered, and followed them, but they would not allow us to come nearer, and away "like a blood-red flag the bright flamingoes flew."

We had not finished with these flamingoes. Our backs were aching dreadfully, owing to want of practice in walking, bent double, behind small horses. So when our men pointed out that the flamingoes had settled in another *lucia*, and were admirably placed for a drive, it was not for us to deny it. Accordingly, we kept behind the horses until we reached the dry land, and then we crawled some distance to a spot of land which divided the water we had left from the water in which the flamingoes now were. Here we lay down, scarcely concealed by the scanty herbage. About a quarter of a mile in front of us were the birds. We calculated the flock at about five hundred strong—a small flock compared to others we saw afterwards. Our "beaters" had to go a long way to get round the flock, so we had plenty of time to watch the birds with our glasses. Some were standing on one long pink leg—dozing with head and neck tucked away in the feathers of the back; others were striding about slowly and majestically; while others with necks bent and heads inverted, were "sifting" the water with their bills in search of food. They looked a happy party, but were soon to be disturbed by the ruthless arts of man. Suddenly the long necks went up in alarm, and then the bright white phalanx began to show pink here and there as a bird raised its brilliant wings; then followed a great blaze of pink, and with a deep-toned "gonk" from every throat the whole flock slowly rose. As the birds spread out, the rich crimson of their wings eclipsed everything, and a brilliant sunset seemed to flash across the sky. We gazed at them for a moment and then ducked our heads and lay pressed to the ground like a couple of stone curlews. So well had our men driven, that the whole gaggling crowd headed straight for us, with necks and legs outstretched as they flew. Not until they were right over our heads did we jump up. Above us was a bewildering mass of flapping wings—pink and black, and white necks and pink legs—stiff and straight. Four bangs in quick succession, and four flamingoes dropped their heads and legs, crumpled up, and fell spread-eagled on the mud. The Spaniards galloping up laughed loudly at two mad Englishmen leaping wildly round some dead flamingoes.

FIG. 2.—Flamingoes. (From a photograph by Mr. D. Le Souëf. By kind permission.)

We were much fascinated by the flamingoes, and had many other opportunities of interviewing them. One day we spent several hours in photographing a small flock. The results were unfortunately not successful, although we had the good fortune, by reason of every condition being in our favour, to approach within forty yards of the birds.

Our encampment was in the direct line of the evening flight of many birds from one stretch of water to another. Every evening, just at sunset, we sallied forth to sit and wait, in danger of being eaten alive by mosquitoes, for the flight. For ten minutes or so no bird was to be seen or heard. Then in the far distance a great flock of birds appeared silhouetted against the glow of the setting sun. For a quarter of an hour these shadows flew up and down, tailing out and bunching up, performing all sorts of

FIG. 3.—The Dead Flamingo.

evolutions, and forming all manner of shapes and patterns like a flock of knot or dunlin in an English harbour. At last they steadied down and flew towards us, looking larger and larger until we were astonished to find that these practised performers were flamingoes, which we knew to be accomplished runners and walkers, but had hitherto regarded as clumsy flyers.

No better way could be devised for observing shy birds than from behind the stalking horse, and many were the hours we spent thus with our field-glasses to our eyes.

We often approached to within a few yards of avocets and watched their curious method of feeding. The bills of these birds are flat like a piece of whalebone, and are curved upwards. The birds stand in shallow water, and instead of probing the mud as other waders, they sway their heads to and fro, and with their upturned bills scoop from the mud or water the insects and worms upon which they feed.

Many waders which are common on our English coasts in autumn were here in thousands. Most of them had, no doubt, wintered still further south, and were now but breaking the journey to their breeding places—the moors and tundras of the far north. Grey plover,* with white foreheads and black breasts—their beautiful summer dress—were everywhere in small flocks and in big flocks, from April 27th until we left on May 19th. Wild as the grey plover is in England, we found him wilder here, and, next only to the flamingo, he proved the most difficult bird to stalk.

The smaller waders we had no difficulty in approaching, and we often guided our horses right into the midst of a flock before the birds realised that dreaded man was behind the horse. These flocks were composed of many species of birds. To describe one such flock, let me take a page from my notebook written on the spot.

A dunlin,* so near me that I could have touched it with my gun, was tugging vigorously at a monstrous worm which refused to be "drawn," and by his brother's side was another dunlin, looking on with interest and anxiety. Just near them were a number of their miniature cousins the little stints,† while a little further off were curlew sandpipers,‡ with the rich red breasts of their summer plumage, and to and fro, and in and out amongst them, ran those active little birds the ringed plover§ and the Kentish plover.|| We moved on slightly to examine the rest of the birds, when with a sudden gasp a dunlin spied us and the whole flock flew off. Just at that moment we heard a swish of wings, and a peregrine¶ swept past us. In another moment he had caught up our little friends, and singling one out dashed straight at it, and seized it in his powerful grip. The falcon appeared to take no notice of us, but sailed round and settled upon the dry mud half a mile away. While one of us went off to stalk, the other waited and watched. It was a fine sight to see the noble bird standing on his prey and tearing at it, but presently he left his quarry and rose into the air, only to fall back upon the mud dead. We gazed upon them—slayer and slain—the one a perfect male peregrine, with his barred breast, glorious blue-grey back, and the other a poor little Kentish plover, already torn and headless.

* *Squatarola helvetica.*

* *Tringa alpina.* † *Tringa minuta.* ‡ *Tringa subarquarta.* § *Aegialitis hiaticula.* || *Aegialitis cantiana.* ¶ *Falco peregrinus.*

THE FLUCTUATIONS OF RAINFALL.

By ALEX. B. MACDOWALL, M.A.

BACON remarks, in his "History of the Winds," "It has been observed by the diligence of some, that the greater and more remarkable seasons of the weather, as great heats, great snows, great frosts, warm winters, and cold summers, generally come round in a circuit of thirty-five years." Again, in his essay, "Of Vicissitude of Things," "They say it is observed in the Low Countries (I know not in what part) that every five-and-thirty years the same kind and suit of weathers come about again, as great frosts, great wet, great droughts, warm winters, summers with little heat, and the like; and they call it the *Prime*."

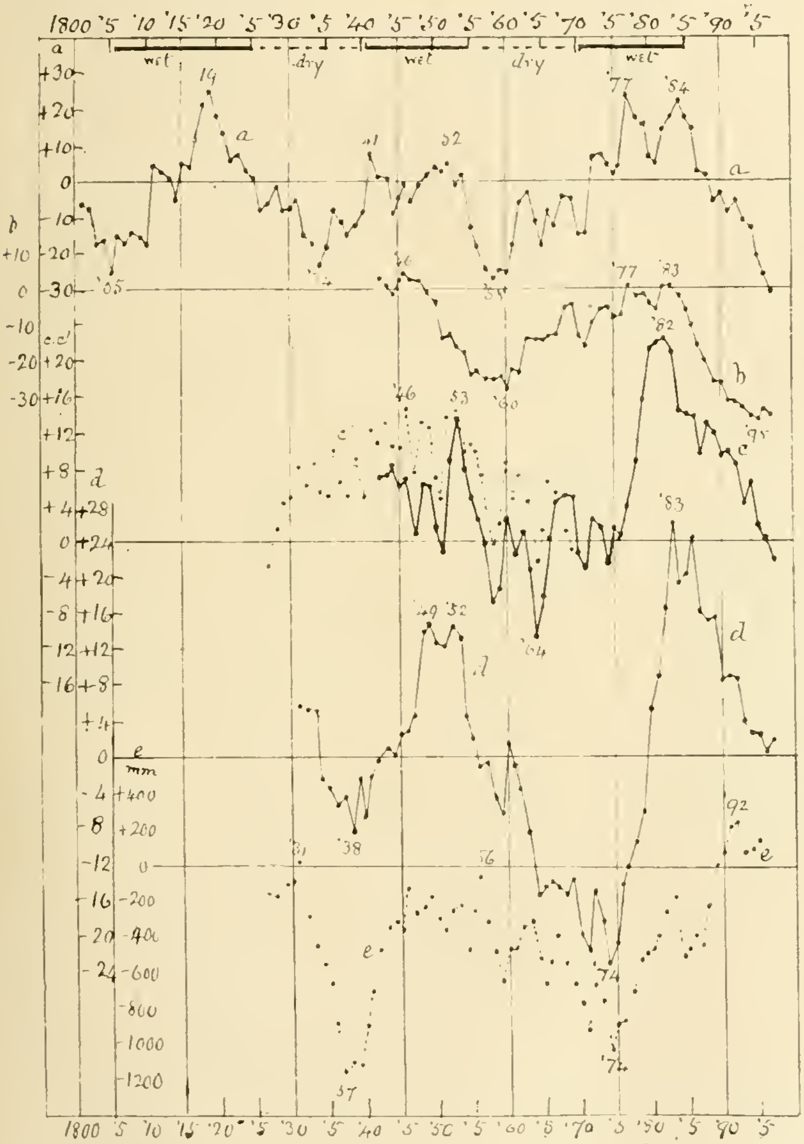
These passages have a special interest in relation to the remarkable work of Brückner, published some eight years ago. From a wide survey of weather changes, it is known, he concludes, that since 1700 at least, most of the land surface of the earth has been subject to a recurrence of cold and wet periods, alternating with warm and dry ones, and that the (varying) interval from the middle of one period to that of the next of the same kind is, on an average, about thirty-five years. Speaking generally, the wet periods in this century are 1806-25, 1841-55, and 1871-85, and the intervening ones have been dry. (The cold and warm periods tend to precede the wet and dry a little.) Putting the case otherwise, the years 1815, 1850, 1880, are given as approximately centres of cold and wet periods, and 1830 and 1860 of warm and dry ones. There are a few exceptions to the rule. For example, in Ireland, and islands in the North Atlantic, the variation is of an opposite character. Brückner considers that compensation occurs, not on land, but on the sea.

In KNOWLEDGE last year (June number) were given some weather-curves of a special type; they were obtained through algebraic addition, step by step, of a series of plus and minus values of temperature, or rainfall, representing the relation of actual values to an average. Each rise in such a curve, from one point to the next, indicates a plus value, and each fall a minus value; while the position reached by the curve at a given date shows the then state of the weather account, so to speak; it might be compared to the balance at a bank after a number of transactions in which money has been, now deposited, now withdrawn.

It is instructive, I think, to compare together a number of rainfall curves of this character, made out for different places, and to consider them in relation to Brückner's cycle.

In the diagram, accordingly, will be found such curves for Rothesay and Culloden, in Scotland (*a* and *b*), London (*c* Greenwich, *c'* Chiswick), Boston, in Lincolnshire (*d*), and Geneva (*e*).*

In all of these may be noticed long waves of variation, and the crests and hollows, the maxima and minima, may be taken as convenient and natural points of division.



Let us consider a pronounced curve like that of Boston, and ask what it means. It may be roughly interpreted thus:—From 1838 to 1849, a wet time, more wet years than dry; 1850 to 1874, a dry time, more dry years than wet; 1875 to 1883, a wet time, all the nine years wet; from 1884 to 1897, another dry time, still going on probably. The relation of dry to wet years in each slope can be easily ascertained by counting. We have here considered the year as merely wet or dry, but the degree of wetness or dryness should properly be also taken into account.

The intervals between maxima and between minima, in most of these curves, will be found to approximate closely to thirty-five years. Scotland, and the West of England, are considered by Brückner "temporary" exceptions; they sometimes conform to the rule, and sometimes not. In "permanent" exceptions the variation is opposite to the normal.

The detail of these curves need not be here dwelt on. We might note a tendency to retardation in the wave phases in lower members of the series as compared with higher.

The London curves, and the prospect they perhaps open up, may be shortly discussed. The Greenwich curve (1841-97) shows a minimum in 1864 and a maximum in 1882. The indications of the dotted curve (for Chiswick, 1826-69), must be reckoned inferior in value to those of the Greenwich curve; but if we may take 1846 as the culminating point of a long curve, we have the following relations:—A dry time from 1847 to 1864 (eighteen years); a wet time, 1865 to 1882 (eighteen years); and the dry time from 1883, still going on. How long will this last continue? Another eighteen years from 1883 would bring us to the end of the century. The curve should soon be turning up again; and we may fairly expect to enter soon on another wet period, ending, say, about 1918.

The periods indicated by those curves do not coincide *exactly* with those of Brückner (top of diagram); nor should we expect them to do so. The limits assigned are not rigid for all places.

The old question comes up: Has the sunspot cycle of eleven years anything to do with our rainfall? It is hard to trace any such influence in these curves; but that is not, of course, sufficient to close the subject. There are other points of view, and from some of these, certain curious and interesting relations may be perceived.

Thus, instead of considering how much rain falls in a year, and the relation of this to the average, let us ask, How many wet months occur in a year (calling a month wet where its rain is over the average for that month)? There are fewer wet months than dry; the yearly average is nearer five than six.

Now, in the sunspot cycle, we have a short period of increase of spots (say four years on an average), and a longer period of decrease (say seven years); and if we compare different year-groups in the cycle in respect of the number of wet months they contain, we meet with

* The vertical scale, it will be seen, is varied. In giving a curve for Greenwich, I gladly take the opportunity of correcting an inaccuracy in that formerly given.

certain rather persistent contrasts. Thus, comparing the periods of increase of spots with those of decrease, there seems to be a tendency to more wet (more wet months) in the latter.

An instructive comparison, I think, is that of the five years just after minima with the five years ending with minima—*i.e.*, (roughly) the period of growth of the spots with the latter part of the period of decline.

Consider this table:—

Five Years after Minima.	Wet Months.	Difference from Average (27).
1824–1828	24	−3
1834–1838	26	−1
1844–1848	25	−2
1857–1861	27	0
1868–1872	25	−2
1880–1884	22	−5
1891–1895	25	−2
		−14

Five Years ending Minima.	Wet Months.	Difference from Average (27).
1819–1823	33	+6
1829–1833	35	+8
1839–1843	29	+2
1852–1856	27	0
1863–1867	31	+4
1875–1879	30	+3
1886–1890	23	−4
		+19

Thus one group apparently tends to be dry and the other to be wet. The one exception (1886–1890), with preponderance of dry months in the second group, occurs, we may remark, in one of Brückner's dry periods.

Should this state of things appear to any merely fortuitous, they might, perhaps, further see reason for an adverse view in the fact that the relation indicated certainly does not hold good everywhere.

Are we not, however, beginning to see that sunspot influence on weather, if probably real, is probably, also complex in character, and that the rough generalizations, hitherto considered applicable to it, may be found to need revision?

THE MYCETOZOA, AND SOME QUESTIONS WHICH THEY SUGGEST.—II.

By the Right Hon. Sir Edward Fry, D.C.L., LL.D., F.R.S., and Agnes Fry.

Nuclei.—In the history of the theory of cells it was early discovered that there is in each cell a smaller structure called the nucleus, which was originally supposed to be a vesicle in the cell, but has been now ascertained to be a portion of a special substance distinct from protoplasm. The nucleus has been found to exercise something like a dominant influence on the destiny of the cell—"all the formative and nutritive processes seem to be dependent upon it," and, moreover, it plays an important part in each process of cell division—*i.e.*, in some or all cases of the division of the cell the nucleus undergoes a like division. This division occurs in three ways, of which two only need now be noticed. One of these modes of division is very simple. The nucleus gets constricted in the middle, the connecting link grows slighter and slighter, and breaks, and we have two nuclei where before we had one. The other method by which nuclei divide is a highly complicated and remarkable process, known often by the long name of Karyokinesis—*i.e.*, the movement of the kernel. In this process certain polar bodies appear, round which the constituents of the cell gather, and the nucleus assumes a curious spindle-like shape before the division actually occurs.

Now, in the myxies, we have, as we know, no true cells with cell walls, except, perhaps, in the spores themselves, but we have protoplasts, in the form of swarm spores, provided with nuclei, as shown in Fig. 3. In the plasmodium, too, we have nuclei, and it has been supposed that the original number of nuclei in the plasmodium corresponded with the number of the constituent protoplasts, but it has been shown that the nuclei increase vastly in number, and that this division and multiplication of nuclei takes place in all the stages of the swarm cells, of the plasmodium and of the sporangium. The question whether this multiplication of nuclei in the myxies at the various stages takes place by simple division or by the complicated process of Karyokinesis is one which has been carefully investigated, although the results can hardly as yet be considered as conclusive. They appear to be, first, that Karyokinesis is the method pursued in the swarm spores when they divide, and again at a later stage in the sporangium shortly before the formation of spores; and, secondly, that the multiplication of nuclei in the plasmodium is sometimes accomplished by Karyokinesis, but probably, also, by direct division.

Powers of Protoplasm.—What are the powers with which the simple naked protoplasm of the Myxomycetes is found to be endowed? It is endowed with—

(*a*) The power of motion;
(*b*) The power of seizing and digesting food;
(*c*) A capacity for excreting what is not suited for retention by the organism;
(*d*) A capacity to perform chemical work;
(*e*) A capacity to assume and change colour;
(*f*) The power of attracting and being attracted by and uniting with other protoplasm of the same species;
(*g*) A converse power of avoiding the protoplasm of other species;
(*h*) A power to assume a definite external shape, and to divide into spores and non-spores;
(*i*) A capacity to enter into a state of suspended vitality.

"Life never can arise out of or depend on organization," wrote John Hunter; and unless naked protoplasm be regarded as organized, his remark seems to be verified and proved past dispute.

Let us consider some of these faculties more in detail.

Motion.—The motions exhibited by the protoplasm of myxies are of the most varied kind. We have already mentioned the jumping motion of the swarm spores and the crawling action of the plasmodium: now we will ask our readers to turn again to Fig. 4, and to allow us to describe what is seen in a crawling plasmodium under a microscope.

The plasmodium is differentiated into two parts: the larger and interior part contains minute oil granules, or *microsomata*; the external layer is free from granules, and is perfectly transparent like glass or water. The darker and granular interior protoplasm is known as the *endoplasm*: the hyaline superficial layer is known as the *ectoplasm*. Fig. 4 is on too small a scale to exhibit this difference distinctly.

There are two motions here to be observed, though they are not disconnected with one another: first, the pulsating motion of currents of protoplasm; and, secondly, the advance of the entire mass of protoplasm.

Under a microscope currents are seen to be established in the endoplasm, generally up or down the lines of advance of the plasmodium; the letters *st* in Fig. 4 indicate some of these currents. The granules stream in one direction; then pause, from sixty to ninety seconds (in the case of healthy plasmodia); then the current turns and streams in the opposite direction. These streams sometimes unite and sometimes divide. It is familiar that protoplasm when enclosed in cells often exhibits movements, as in the well-known case of the *Chara*, but then the movements are naturally constrained by the cell walls; in the free protoplasm of the myxies no such restraint exists.

If the peripheral edge of an advancing plasmodium be examined, there will be found in advance of the granular endoplasm a strip of the colourless and perfectly transparent ectoplasm, of which we have already spoken; it runs like the foreshore along the coast of the body. Into this from time to time a granule will be seen to advance, and then another granule, and so on till the line of the land has been pushed out into the foreshore, and the foreshore itself is moved forward into the sea. In this way the front line of the whole plasmodium advances, and as the rear of the plasmodium is drawn back in the line of advance as the front line is pushed forward, the whole body of the plasmodium gradually changes its place and moves forward.

It is a very striking thing to watch these forward movements of the granules. You seem to see in a minute and most intimate form the locomotion of living things; and, moreover, you perceive an internal movement of part, resulting in a movement in space of the whole organism. Mr. Spencer has said that "we have as yet no clue to the mode in which molecular movement is transformed into the movement of masses in animals." Does not the motion which we have described offer, if not a clue, yet a visible example of such transformation? Be this as it may, the mystery of motion remains just the same; there is the same antinomy between sense and reason—the one says that there is motion, the other that it is impossible.

"Io dirò cosa incredibile e vera."

It must not be supposed that it is only on the surface of dead wood or leaves that the plasmodia of myxies move. Sometimes, and especially under the influence of cold, they retreat downwards, and the *Fuligo*, a species which lives on tan and is known as the flowers of tan, will, under this influence, disappear from the surface of a heap and retire to the bottom of it. Cold or other unsuitable conditions seem to cause them sometimes to retreat into the wood to appear again under more favourable circumstances. Some plasmodia inhabit the interior of dead wood, and only appear on the surface for the purpose of fruiting: in the search for a suitable home for reproduction it has been thought that they move away from damper to drier spots, and they certainly often produce their sporangia in the dry air and in high positions. It has been thought also that light has a tendency to make the plasmodia ascend and darkness to descend. Sometimes a plasmodium will ascend a tree or a post for a foot or more, and a species known as *Lycogala epidendron* is said always to affect the highest point of the substance on which it rests. It is by no means infrequent for plasmodia to leave the dead wood on which they have been living and to ascend the stalks of flowering plants, or to spread over mosses, and often we have been surprised at the distances travelled by plasmodia in a few hours. The appearance, we may remark in passing, presented by the sporangia of delicate myxies on the leaves of mosses or blades of grass is sometimes very beautiful.

Plasmodia, as we have said, sometimes move in an upward, sometimes in a downward direction; in a seed, as we know, these two tendencies are separated, and the radicle tends to grow in the direction of gravity, and the plumule against it; in the myxies it would seem as if the same protoplasm at one time had the one tendency, and at another time the other. Perhaps, in passing, we may observe that the fact that plants and trees for the most part grow upward—*i.e.*, against the force of gravity—is one worth a good deal of thinking about, and when we look at the mass of fluid and solid matter raised every year, especially in the springtime, against the constant operation of the force of gravity, we get a notion of the magnitude of a force exerted by plants, to which we can assign no other origin than life, and give no other name than that of a living force.

It has been found with regard to the plasmodium of the flowers of tan that it has a curious tendency to move against the flow of water; thus, if one end of a piece of filter paper be placed in a vessel filled with water and the other on the table, so that the water flows downward, the *Fuligo* will move up the paper, and if the paper be so arranged that the water shall move up the paper, the *Fuligo* will move down.

Some observers believe that the myxie takes only such food as comes in its way; Mr. Lister believes that it uses its vibrating cilia to detect food; whilst others think they have observed that food exercises an attraction on plasmodia and influences their movements; thus, to return to the flowers of tan, a piece of tan or of wood steeped in tan has been seen, according to some observations, to induce the plasmodium to draw itself towards it, and that without reference to its position as regards the force of gravity. There seems no reason to doubt the accuracy of these observations. Here, then, we see in the primitive form of naked protoplasm that search after food which exercises so enormous an influence on the whole animal and vegetable world as well as in the social affairs of man. How, one cannot help asking, is the plasmodium made aware of the proximity of its appropriate food? Has it some rudimentary perception—some common sense, of which sight, and smell, and taste are only more specialized forms? What the plasmodium does in the equally near presence of two equally attractive morsels we do not know; but we do not believe that it would starve.

Sunshine is, again, a condition which seems to exert an influence on the movements of plasmodia. If a glass, on which the network of a plasmodium is spread, be partly exposed to the sunlight, it has been observed to withdraw to the shaded parts, and yet when the time comes for the sporangia to be produced it would seem in some species as if there was a movement towards surfaces exposed to light. But, according to the observations of Mr. Lister, light apart from direct sunshine does not affect the movements of plasmodia.

The plasmodium has been found to be sensitive not only to sunlight, to dampness and dryness, to heat and cold, but to the influence of chemical substances: the weak solutions of some chemicals having been observed to render it more fluid, whilst stronger solutions of the same substances have made it contract or perish in parts. This sensitiveness on the part of the plasmodia to so many influences must, it would appear, render very delicate the conditions under which alone myxies can succeed in the struggle for existence. Furthermore, it would appear that in the selection of places for the production of the sporangia they have to select situations affording enough atmospheric exposure to ripen the spores, and enough moisture to enable the swarm spores to swim and move about, and it is no doubt due to the width of the dispersal of the spores that they find these situations, which are, one would suppose, comparatively few. It is probably from this delicacy of the requisite conditions for success that plasmodia are not unfrequently seen to fail in the struggle of life. They will sometimes reach the surface, and commence the formation of the sporangium walls and spores, and then fog off and decay, without ever reaching maturity or producing sound spores.

The observations with regard to the influence of heat, drought, light, and darkness, on plasmodia may be correct, but it does not follow from them that the needs of the organism dependent on the stage it has reached, or on other circumstances unknown to us, may not also operate on their motions. We know that the sporangia are produced on the surface, but we hardly know whether the organism seeks the surface when it is time to develop sporangia, or develops sporangia when it reaches the surface.

Negative Geotropism.—It is not only in the motion of the plasmodium as a whole, but in the motion of its parts when it develops sporangia, that we observe an upward movement. Sometimes, no doubt, the sporangia are developed on the under surface or the side of the wood on which they grow. We are inclined to think that different species prefer different situations for the production of their sporangia, and that no one law is applicable to them all; but in all cases the sporangia appear to stand vertically to the plane on which they grow.

If we examine the trunk of an oak, we find an elaborate structure of hard parts which maintains the tree in its upward growth, and by the force of cohesion resists and overcomes the force of gravity drawing it downwards. If we examine the stalk of even a delicate flowering plant, we find that it is constituted of cells, and that the cell walls, as well as the fibres, afford to the stem a certain amount of support; but in the naked protoplasm of the myxie we have no woody tissue, no cell wall, and yet this, too, lifts itself away from the earth and towards the sun and the air. We then see that the upward motion of plants does not depend on cell walls, but is an inherent, an original capacity of some protoplasm.

We can easily appreciate the advantage which this upward tendency gains for the organism, for it lifts it into the air and exposes it to the influence of light. We know the great results on the surface of the earth of this so-called negative geotropism. If all plants had crawled along the ground like the thallus of Marchantia or the hyphœ of some fungi, we should have had a keener competition for surface space even than now exists, and we should have lost the beauty with which the earth's surface is clothed. In the myxie lifting up its sporangia, we can see in the small and in its simplest and most primitive form, the existence of the same power which enables the sequoia or the eucalyptus to lift themselves to such enormous heights above the ground. But of this power, this impulse, this faculty, this gift of resisting the force of gravity, and the attraction of the earth—what shall we say? what account can we give? We can only keep silence.

Capturing Food.—The habits of swarm spores in the pursuit or capture of their food have been very successfully observed by Mr. Lister. In the case of *Perichœna corticalis* he observed a swarm spore with four vacuoles, each stuffed with from six to eight bacilli; and in the course of twelve minutes he saw four bacilli drawn in by the projecting parts, or *pseudopodia* of the swarm spore. In the case of *Didymium* (or *Chondrioderma*) *difforme*, he observed that the capture of a bacillus is sometimes effected by pseudopodia. More often, a funnel-shaped aperture was formed in the posterior part of the swarm spore, and when a bacillus was unwary enough to enter, it was enclosed by a folding over of the lips of the funnel. The bacilli thus captured were seen to dissolve in the vacuoles, but no refuse matter was observed to be rejected; probably the whole bacillus was of absolutely digestible matter. On another occasion, Mr. Lister observed a swarm spore come upon a group of motionless bacilli. It spread itself out so as to cover four of them, and in about two minutes resumed its former shape, and crept away, carrying two bacilli in its vacuole. In the case of *Stemonitis fusca*, he observed the capture by pseudopodia of a bacillus so large that when drawn up into the body of the swarm spore it forced the swarm spore to bulge out on either side. On this followed a violent jerking motion of the swarm spore, which frequently occurs after the ingestion of food, and in a few minutes the bacillus was bent double, and the vacuole decreased in size. These observations of Mr. Lister seem to prove that the view of De Bary that the swarm spores take in nutriment only in a fluid state cannot be upheld. These processes are depicted in Fig. 3, which is reproduced by the permission of the Council of the Linnean Society and of Mr. Lister.

It is a curious fact that where a plasmodium on its march meets with a microcyst of its own kind, it has been observed to commit an act of cannibalism—to treat it as if a foreign body, and to enclose it in a vacuole, and then absorb it. Probably the presence of the membrane prevented fusion until it was removed by an act of digestion.

Rejection of Matter.—Mr. Lister has been equally successful in observing the method pursued by the plasmodium in the rejection of undigested matter. He fed, and I am afraid overfed, the plasmodia of *Badhamia utricularis* on thin slices of fungus, and when a plasmodium had become loaded with food material, many of the large vacuoles became charged with undigested matter, which assumed the appearance of a dark ball, and he "repeatedly saw these vacuoles push out as bubbles to the surface of the plasmodium and burst, discharging a cloud of refuse, consisting of fragments of starch and broken fungus hyphœ, into the water." But when the plasmodium creeps over glass, he observed the rejected matter, with a certain amount of plasmodium substance, to be left "on each side of the retreating veins, leaving a mass of the network after the plasmodium has withdrawn."

In other cases rejected matter, particles of starch or spores of algæ, or other things which have been taken up by the plasmodium, are found thrown aside in the hollow cavity of the foot of the sporangium, or even amongst the contents of the sporangium itself.

Notices of Books.

Practical Inorganic Chemistry for Advanced Students. By Chapman Jones, F.I.C., F.C.S. (Macmillan.) Illustrated. 2s. 6d. Written to meet the requirements of the new syllabus of the Science and Art Department, Mr. Jones's little book traverses the same ground as scores of others, with, of course, slight changes interpolated here and there to satisfy altered conditions. It is understood that a preliminary course of practical chemistry has been followed, and the student thus initiated into the mysteries of chemical manipulation can face the exercises here presented without much difficulty The course is nicely graduated, commencing with the preparation of some of the non-metals and their compounds (a pleasing feature of which is that these are resolved into classes), preparation of gases by the use of cold liquids, hot liquids, or by heating dry subtances, and so on. As volumetric analysis is required, according to the syllabus, a little space has been devoted to this subject.

The Encyclopædia of Sport. Edited by the Earl of Suffolk and Berkshire, Hedley Peek, and F. G. Aflalo. Vol. II. (Laurence & Bullen.) Illustrated. This volume completes the Encyclopædia of Sport, the first volume of which we have already noticed. The whole work forms an admirable and trustworthy treatise on every branch of sport, and, indeed, everything connected with sport. No pains have been spared in obtaining authorities to deal with the various subjects, the volumes are well printed and bound, and the illustrations are generally excellent. We have nothing but praise for all those concerned in the production of this rich mine of information.

London in the Reign of Victoria (1837-1897). By G. Laurence Gomme. The Victorian Era series. (London: Blackie & Son.) 2s. 6d. In this new volume, the general editor of this excellent series may be congratulated upon the inclusion of an able and comprehensive sketch of the marvellous development of the great city during the Queen's reign. The nine square miles which formed the area of the London of 1837 has grown into the 120 square miles of 1897. As befits a statistical officer of the London County Council, Mr. Gomme is severely statistical, but he has exhibited great skill in collecting and compiling his storehouse of facts. Our author is happiest when describing the London of 1837, with the aid of Fenimore Cooper and some other less distinguished visitors of that day. But when shall London's story be told—her history and traditions, the life and character of her people, her contrasts and comparisons, her restless activities and far-reaching ambitions, the terrible helplessness and hopelessness of so many thousands of her people? Mr. Gomme has no room and "scarcely any heart" for this, but we hope to see arise a son of the city who shall proudly tell her story as it deserves to be recorded, not in the patronising air so unhappily adopted by Sir Walter Besant, not from the point of view of the statistician or the courier, but as the Life and Letters of a great heart. Until the advent of such a writer, such books as Mr. Gomme's, and the altogether admirable guide book of Mrs. E. T. Cook, do good service in the cause.

The Living Organism. By Alfred Earl, M.A. (Macmillan.) 6s. Chemical and physical changes, we know, enter largely into the composition of vital activity, but, says our author, "there is much in the living organism that is outside the range of these operations." True, too much is taken for granted by many of those who have the courage to grapple with the mystery of life, and the problems and generalizations of the science of living objects are regarded too complacently by most students. In this book an effort has been made to present a broad general view of living things—a clear conception of the distinctive features of organic activity so far as the present state of knowledge on this complex subject will admit. To those persons, however, whose acquaintance with biological problems is extensive, the book will no doubt appear sketchy, and to the general reader, it strikes us, the wide scope, trenching as it does on every department of scientific enquiry, will present an almost inextricable labyrinth. Certain it is that in spite of the author's attempt to convey general notions to the exclusion of details, he has often afflicted his passages with terms that cannot be appreciated without special knowledge, and it may be doubted whether he has added a new note to the dignified theme he has selected for his essay.

Seismology. By John Milne, F.R.S. (Kegan Paul & Co.) Illustrated. 5s. Most of us are already acquainted with Prof. Milne as the author of "Earthquakes and other Earth Movements"—a standard work in this department of observational science. The book before us is a companion volume, some of the chapters bearing the same title as those in its predecessor; but it will be found that the subject matter of the new volume contains observations more extensive in character, and more trustworthy than were formerly obtainable—conditions which admit of the formulation of precise conclusions, some of which encroach on new ground. It is, for example, interesting to note that the art of recording earth tremors has now been cultivated to such a degree that we in England may know an earthquake has occurred somewhere, say in Japan, before it is possible to transmit the information to us by telegraph from the place of disturbance. Earthquakes are transmitted with incredible velocity in all directions, so that the "movements of the earth's crust can be equally well recorded and studied in England and other non-volcanic countries as in the most frequently earthquake-shaken districts in the world." Considering that at present the number of observers working in this interesting field of research may be counted on one's fingers, it is remarkable that such refinement in the modes of observation should have been attained before the scientific world has thoroughly awakened to the importance of the subject; for important it certainly is. In a chapter on "Movements of the Earth's Crust in Relation to Physical Research and Engineering," attention is directed to the errors and annoyances to astronomers and physicists caused by earth tremors; regarding engineering it is pointed out how by the use of seismographs along the coast of Japan submerged areas of seismic activity have been mapped through which it would be dangerous to lay a cable. In 1888 three cables connecting Australia with Java were fractured simultaneously by seismic disturbances, and Australia called out the naval and military reserves on the supposition that their sudden isolation indicated an operation of war; hence the importance of being able to say whether this was brought about by natural or artificial means cannot be over-estimated. The study of seismology will enable us to do this. Prof. Milne gives a very full bibliography of seismological literature at the end of the book, and numerous references are scattered throughout the text.

Michael Faraday: His Life and Work. Century Science Series. By Prof. Silvanus P. Thompson, F.R.S. (Cassell). Illustrated. 3s. 6d. In this volume, of about three hundred pages, Prof. Thompson gives us a most fascinating sketch of "the greatest scientific expositor of his time," embracing the domestic, scientific, and religious aspects of Michael Faraday's life—a sympathetic and appreciative account of the most striking scientific career of the nineteenth century. The son of a blacksmith, who had come from Yorkshire to Newington-Butts, Faraday was born there in 1791. From the age of five to thirteen he lived over a coach-house in Jacob's Well Mews, Manchester Square; he was apprenticed to a bookbinder, and read the scientific books which passed through his hands. When about the age of twenty-one years, he attended Davy's lectures at the Royal Institution, took careful notes, and submitted them to Davy, asking for scientific employment. "Early in 1813, the humble household in which Faraday lived with his widowed mother, in Weymouth Street, was startled by the apparition of Sir Humphry Davy's grand coach, from which a footman alighted and knocked at the door. . . . At that interview Davy asked him whether he was still desirous of changing his occupation, and offered him the post of assistant in the laboratory." By the following October, Davy and Faraday were touring through France, Switzerland, and Italy, and the young philosopher had to grin and bear the distinction or indignity of being sometimes treated as a sort of valet, although the chief scientific men of the Continent "admired Davy"—"loved Faraday." He was, in 1821, made superintendent of the house and laboratory of the Royal Institution, and married, living a happy life on one hundred a year. Fees for conducting chemical analyses and expert work in the law courts augmented his pecuniary resources, and "he might easily have earned £5000 a year had he chosen to cultivate the professional connection thus formed." But he never cared for money for its own sake, and, moreover, it was against his religious convictions to enrich himself. Faraday never took out patents for his discoveries; when they began to possess a marketable value from their application to industry he left them alone, preferring to pursue his pioneering in other branches. In 1835 he received a Government pension of £300 a year, and in 1858 a comfortable house for life on the green, near Hampton Court. He died, painlessly and peacefully, sitting in his chair in his study, on the 26th of August, 1867. Professor Thompson has shed many sidelights on the various phases of Faraday's life, and his book will help to deepen the interest in a character almost unique in the annals of science.

London University Guide and University Correspondence Calendar, 1898-9. (University Correspondence Press.) Gratis. A fund of information is given in this book relative to University examinations, and the means by which aspiring students may force their way to the coveted object—a University degree. Courses of study, and the books suitable for each, are sketched out in such a way that, whatever the needs of the scholar may be, the preliminary labour necessary to find out the means towards the end in view is reduced to a minimum. Degree hunters owe much to the publishers of this useful work, and the best thing we can do, seeing that the book is issued gratis, is to advise all students seeking University honours to avail themselves of the opportunity of securing its friendly guidance and help in their laudable aims.

The Last Link. By Ernest Haeckel. (Black.) 2s. 6d. Prof. Haeckel here goes over, critically, the evidence and the different conclusions which at present represent our scientific knowledge of the descent of man and of the various stages of "his animal pedigree." The book is a reprint of his address in August last at the Fourth International Congress of Zoology at Cambridge. A series of biographical sketches of Lamarck, Saint-Hilaire, Cuvier, Baer, Mueller, Virchow, Cope, Koelliker, Gegenbaur, and Haeckel, is added by Dr. Hans Gadow, as well as chapters on "Theory of Cells," "Factors of Evolution," "Geological Time," and so on. As we have long since learned to expect, there is no "beating about the bush" in Prof. Haeckel's manner—only one construction can be put upon his words. Evolution, as taught by Darwin, is his watchword. "Whence our race has come; what are the limits of our power over Nature, and of Nature's power over us; to what goal are we tending—these are the problems which present themselves anew and with undiminished interest to every man born into the world." On these matters the professor exercises his powerful reasoning faculties, and the result is full of interest, whether we are at one with him or not.

The Structure and Classification of Birds. By Frank E. Beddard, M.A., F.R.S. (Longmans.) Illustrated. Mr. Beddard's papers on the structure of birds are well known to those who attend the meetings, or read the Proceedings, of the Zoological Society. In this book Mr. Beddard has brought together the results of the researches into the anatomy of birds undertaken by himself and his two predecessors, Prof. Garrad and Mr. W. A. Forbes, in the office of Prosector to the Zoological Society. Some one hundred and fifty pages of the book are devoted to a general sketch of bird structure, in which the author has avoided "histological detail, and the elaborate description of anatomical facts, which are not, in the present state of our knowledge, of great use in classification." The main portion of the book consists of detailed accounts of the structure of different groups of birds. The author has a wide knowledge of his subject, and expresses himself with clearness and directness. The book contains a multitude of facts, elucidated in many cases by excellent illustrations. It should prove of great service to those who are working at the anatomy of birds, as well as to those who wish to use it merely as a work of reference.

It is refreshing to see such a well arranged, neatly printed, and tastefully illustrated catalogue of chemical, metallurgical, bacteriological apparatus, and pure chemicals, as that just issued by Messrs. Becker & Co. It has a very complete index, contains nearly seven hundred pages and three thousand five hundred illustrations. A pleasing feature is that the figures in nearly every case are placed opposite the number and the matter describing them. The catalogue includes many new pieces of apparatus which we have not previously seen in publications of this kind. The volume is well bound and has a very attractive appearance.

The Heavens at a Glance, a handy card calendar for 1899, by Mr. Arthur Mee, F.R.A.S., is this year printed in type, and in several other points is a great improvement on previous issues.

We have received from Mr. Wm. Harbutt, of Bath, a sample of his new modelling material, "Plasticine."

BOOKS RECEIVED.

Volcanoes. By Prof. T. G. Bonney, D.SC., F.R.S. (Murray.) Illustrated. 6s.

The Science of Life. By J. Arthur Thomson. (Blackie.) 2s. 6d.

Practical Zoology. By A. Milnes Marshall and C. Herbert Hurst. Fifth Edition. (Smith, Elder & Co.) Illustrated.

Landmarks in English Industrial History. By George Townsend Warner. (Blackie.) 5s.

Birds. By A. H. Evans, M.A. The Cambridge Natural History. (Macmillan.) Illustrated. 17s. net.

West African Travels. By Mary H. Kingsley. (Macmillan.) Illustrated. 21s. net.

In the Australian Bush. By Richard Semon. (Macmillan.) Illustrated. 21s.

Outlines of Industrial Chemistry. By Frank Hall Thorp, PH.D. (Macmillan.) Illustrated. 15s. net.

A Retrospect of Eight Decades. By Rev. Edward L. Berthon. (Bell.) 5s. net.

The Sound of a Voice that is Still. By Archie Campbell. (Redway.) 5s. net.

Wonders of the Bird World. By R. Bowdler Sharpe. (Wells, Gardner, Darton & Co.) Illustrated. 6s.

The Story of the Mind. By J. M. Baldwin. (Newnes.) Illustrated. 1s.

Kant on Education. Translated by Annette Churton. (Kegan Paul.) 2s. 6d. net.

A Course of Wood-Carving according to the Japanese Method. By Charles Holme. (Offices of the *Studio.*) Illustrated.

Whitaker's Naval and Military Directory, 1899. 5s.

Siddhânta-Darpana—a Treatise on Astronomy from the Chinese. Edited by Jogés Chandra Ráy, M.A. (Indian Repository: Calcutta.) Three Rupees.

Remarkable Comets. By W. T. Lynn. (Stanford.) 6d.

Calendar and History of the Science and Art Department. (Eyre & Spottiswoode.) 1s. 8d.

La Nouvelle Monadologie. Par Ch. Renouvier et Louis Pratt. (Armand Colin et Cie: Paris.) 12 fr. Vol. XVI.

The Auk: a Quarterly Journal of Ornithology. Vol. XVI. No. 1, Jan. (Foster: New York.) Illustrated. 75 cents.

Dynamics. By Wm. Briggs and G. H. Bryan. (Clive.) 3s. 6d.

Practical Work in Physics. By W. G. Woollcombe. (Clarendon Press.) Illustrated. 2s.

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Archives of the Röntgen Ray. November, 1898. (Rebman Publishing Co.)

SUNSET ON THE MARE CRISIUM.

By E. WALTER MAUNDER, F.R.A.S.

THE principal object in the accompanying plate is the Mare Crisium; one of the best studied of all of the lunar "grey plains." It is the most sharply defined and completely outlined of its class, and, so far as we can judge, it is the deepest, deeper even than the Mare Serenitatis, which lies in the same quadrant, and which it resembles in that the enclosed plain is divided into two regions at different levels; a broad marginal zone surrounding a central area which lies considerably lower. The frequency with which it has been observed is, no doubt, partly due to its being visible during the first half of the month. It will be noted that at the time when the photograph was taken the sunlight was already leaving the Mare, although the moon was but two and a half days past the full. It is thus an object for study in the evening hours, not the morning. If we add to this its small dimensions among the Maria, rendering it an object that may be easily studied as a whole, and its complete separation from other regions of its class—for it stands amongst lunar "Seas" as the Caspian amongst the waters of our own world—its attractiveness to selenographers is sufficiently explained.

Its very separateness, however, places the Sea of Crises in a somewhat different category to the Maria generally. The evidences, which are so abundant elsewhere of the destruction of ring-plains and crater-plains, by the material which forms the floor of the Mare, are scarcely to be noted here. On the other hand, though strongly resembling not a little in some of its characteristics the great walled plains like Clavius and Schickhardt, its far greater area forbids its being ranked with them, since even Clavius is but one-fifth the size.

Near the opposite limb of the moon, and practically on the same diameter, is another small Mare, smaller than the Crisium, and almost as completely isolated. These two "Seas" form the ends of a great arch composed of the greater Maria, which seem to follow one another like beads strung on a thread. It has often been pointed out that this arrangement seems to indicate that at one time they marked out the lunar equator, for they lie nearly on a

SOUTH.

ST.

EAST.

NORTH.

SUNSET ON THE MARE CRISIUM.

From a Photograph taken 1896, July 26d. 21h. 14m. 25s.—33s., Greenwich Mean Time, with the 36-inch Refractor of the Lick Observatory, great circle; whilst the tendency of the Maria to increase in size as we approach the centre seems to suggest that the influence of our earth was in some way or other the chief determining cause in their formation.

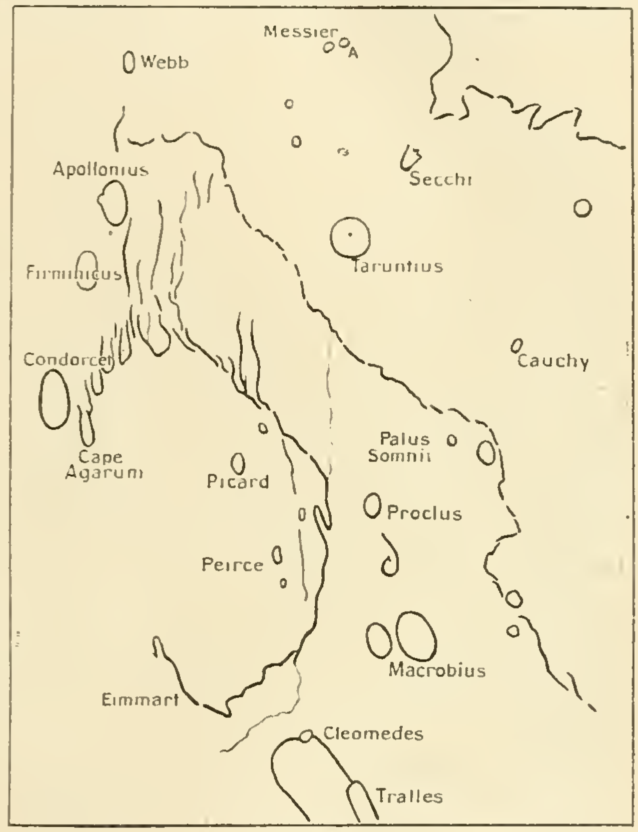
It is fully recognised now that the "Seas" are amongst the most recent of lunar formations. We cannot otherwise explain the traces of submerged ring-plains to be seen here and there in the Maria themselves, and the numerous instances of partially demolished rings which border them -the destroyed or injured rampart being always on the ... nearer the "Sea." Leaving altogether on one side the question of any change in the lunar axis as one too curious for our present information, this disposition of the Maria seems to point us backward with no uncertain finger to the time when the moon ceased to rotate as viewed from the earth. Up to that time the earth had of course an equal effect on every meridian; from that time it has been dominant over the centre of the apparent disc.

Mr. N. E. Green, truest of astronomical artists, and most experienced of selenographers, has suggested that it was the final set of the great lava tide which the earth produced on the moon which gave rise to the "Seas." The suggestion can hardly be far from the truth, and we are thus able to say that the time when the lunar rotation came into complete accord with the month was also the time when its crust was approaching solidification but had not reached it. It was also the time when our own earth was still emitting so much heat as to have a vast influence upon its satellite. For there is a very marked resemblance between the character of the polar regions of the moon and of the limb in general—a circumstance which has long been recognised, but to which MM. Loewy and Puiseux have given fresh importance by their studies of the photographs they have taken with the equatorial coudé of the Paris Observatory.

Whatever was the particular mode in which the final formation of the "Seas" was effected, and however it may differ from its greater brethren, the Mare Crisium evidently took its formation about the same time, and in the same way. This is indicated by the meridional ridges which mark its surface. Sunset, in our photograph, has advanced too far for most of these to be seen, but two can be made out pretty clearly.

Studying the Mare as it appears to-day, we find that its border differs much in its character in different parts. Our photograph brings out the character of these on the east and south in strong relief. On the east the cliffs are bold and precipitous, broken by only one important pass, which is near the centre, and is fully shown on the plate. On the south a number of valleys run up from the Mare into the Highlands, which form on the photograph a particularly bold and interesting region, full of striking detail. These Highlands curve round towards the north, and end in Cape Agarum, a bold promontory which is just receiving the last rays of the sun. Curving to meet this from the north is a similar, but less striking, promontory, which is all but lost in the darkness of approaching night. These two opposite points mark the opening of a deep bay, not seen in the photograph, as it has already passed into the lunar night. But for this bay the Mare Crisium would be roughly circular, its length and breadth being nearly equal. More accurately, it would be hexagonal, the tendency of the outlines of the great lunar formations being to take a polygonal rather than a circular shape. The bay, however, narrow as it looks to the eye through the effect of foreshortening, brings the greatest length east and west of the Mare up to three hundred and fifty-five miles, whilst its length north and south is but two hundred and eighty. The bay is further distinguished from the rest of the Mare, in that the greenish tint which can be seen over the greater portion of the floor under high illumination does not extend beyond Cape Agarum.

The region embraced by the plate is one that, more than most districts of the moon, supplies a considerable variety of colour. As already mentioned, the dark floor of the Mare has a certain greenish tinge, which is absent beyond Cape Agarum, and in the great ring-plain Condorcet, which lies just to the south of that promontory in the darkness. East of the Mare, on the other side of the great pass already referred to, lies the Palus Somnii, its further border strongly marked out by contrast with the dark Mare Tranquillitatis, which comes up so dark in the photograph. The Palus is described as of a peculiar yellow, almost amounting to a golden brown, whilst round the great



Sketch Map.

ring-plain Taruntius, which stands in the full sunshine due south of the Palus, Elger notes a very decided sepia colour under a low sun. Moving nearly due west from Taruntius, the ring-plain Firminicius lies in the darkness, beyond which is a curious mountain with triple peaks. Round this, on the surrounding plain, appear broad, dark grey streaks, which undergo apparent changes of a periodical character, and which Mädler suggested might be due to vegetation. The floor of Mare Crisium, too, has sometimes been noticed to be sprinkled with minute bright points, which Mathieu Williams ascribed to hoar-frost.

The region therefore is full of interest from the point of view of real or apparent periodic change. It includes also a pair of objects which supply us with perhaps the best attested example of intrinsic change. These are the two crater plains Messier and Messier A, at the extreme south of the plate. It will be seen that the more westerly Messier is distinctly the smaller of the two, and whilst Messier A, the larger and more easterly crater, is nearly circular, its companion is as distinctly elliptical and elongated in an east and west direction. Now Mädler drew and described the two as exactly alike in every respect, and Beer and Mädler examined this pair more than three hundred times between 1829 and 1837, without noticing any change. Schroeter, on the other hand, whose observations preceded those of Mädler by more than a quarter of a century, drew the western crater as the larger. Webb, in 1855, found this inequality had been reversed. Its appearance as he then recorded it corresponds with that which the photograph shows and which it retains to the present day.

THE PLANET EROS (D Q, 433).

A CAREFUL search has been made by Mrs. Fleming upon the Harvard plates for early photographs of Witt's Planet (433) D Q. Mr. S. C. Chandler has courteously furnished ephemerides based upon the best available material, and has devoted much time to correcting the elements and computing the positions corresponding to the times at which certain photographs were taken, as is more fully explained in the *Astronomical Journal*, No. 452.

In making this search the following method of procedure has been adopted. Mr. Chandler, by means of the elements published in the *Astronomical Journal*, No. 451, computed ephemerides for the oppositions of 1894 and 1896. It appeared that the observations then available were insufficient to determine the position in 1894. An error of one second in the mean daily motion in the orbit would change the right ascension of the object in 1894 by about half-an-hour. Moreover, the value of the daily motion differed by several seconds not only in the early ephemerides of this planet, but in those dependent on a large number of visual observations. Although plates were examined by Mrs. Fleming, covering a region of about one thousand three hundred square degrees, the planet was not found. Plates taken in 1896 were next examined, as it was thought that the smaller errors of the ephemeris would compensate for the extreme faintness of the planet. This examination proved to be especially laborious and fatiguing to the eyes. It was feared that the object might be too faint to appear upon the plates, and accordingly the faintest objects were carefully scrutinized.

Each plate was examined by superposing it upon another plate of the same region taken with the same instrument. Two adjacent images then appeared of each star, while the planet, if present, would appear only upon the upper plate. Numerous suspicious objects were thus found, including several images of the planets Flora (8) and Nysa (44), and two new variable stars, whose approximate positions for 1900 are in R. A. 8h. 33·9m., Dec. $+50° 29'$, and R. A. 18h. 38·7m., Dec. $-38° 52'$, were discovered. The star $+29°551$ fails to appear on ten plates which show other faint Durchmusterung stars, and two stars at R. A. 9h. 11·4m., Dec. $-10° 43'$, and R. A. 9h. 11·5m., Dec. $-10° 16'$, appear upon the Durchmusterung charts and upon the photographic plates, but are not given in the Durchmusterung catalogue.

At last a faint image was found on a plate taken on June 5th, 1896, and confirmed by other plates taken on June 4th and June 5th. A plate taken on April 6th covered the region of the planet, which was readily found by means of its computed position. Mr. Chandler, from positions of these images, was enabled to furnish a corrected ephemeris for 1894, by means of which the planet was readily detected on several plates.

The following elements have been computed by Mr. Chandler, by combining the observations of 1898 with those derived from the photographs taken December 19th and 27th, 1893, February 16th, 1894, April 6th, 1896, and June 4th and 5th, 1896:—

Elements.

Epoch 1898, Aug. 31·5, Gr. M. T. $\mu = 2015{\cdot}2326''$

$M = 221° 35' 45{\cdot}6''$ $\log a = 0{\cdot}1637876$

$$\left.\begin{aligned}\omega &= 177° 37' 56{\cdot}0''\\ \Omega &= 303° 31' 57{\cdot}1''\\ i &= 10° 50' 11{\cdot}8''\end{aligned}\right\} 1898{\cdot}0.$$

Period = 643·10d.

$\phi = 12° 52' 9{\cdot}8''$

December 26th, 1898.

The above method of search for Eros (433) has been continued. The ephemeris has been extended by Mr. Chandler, as required, and images of the planet have been found by the writer on thirteen plates, three plates being taken at Arequipa, the others at Cambridge.

The earliest of these photographs, taken October 28th, 1893, is important, since, with that taken on May 19th, 1894, the anomaly through which the planet was observed in 1893–1894 becomes 162°.

The orbit of the planet could be well determined from the observations in 1896 alone, using for the first place the position of April 6th, for the second the three positions on June 4th and June 5th, and for the third the photographs taken on June 29th and 30th.

Some important conclusions may be derived from this investigation. All the photographs on which the planet has been found were taken with doublets. If they had been taken with lenses of the usual form, with a field two degrees in diameter, all of the images would have fallen outside of the plates. In view of the difficulties found in photographing this object with an ordinary lens at Greenwich and Oxford (Observatory XXI., 429), it is doubtful whether we should have obtained many images of it here with such a lens, even if it had been in regions photographed. The number of plates on which the planet appears probably fairly represents the number we have of all other similar objects, whether already discovered or not. This planet is bright during only a small portion of time. During the last eleven years it has been brighter than the ninth magnitude, photographically, for only two months, or about a seventieth part of the entire time. There may be other similar objects, even brighter, as yet undiscovered. Nova Aurigæ was as bright as the fifth magnitude for six weeks before it was discovered. Had Eros attained the sixth magnitude instead of the eighth, it should have appeared on plates taken with the transit photometer. In this case, we should have had an image of it on every clear night on which it culminated after dark. Fairly good positions could have been obtained from these images, since the focal length of the telescope is about two feet, and the exposures are so short that the images are always circular. We have now a similar instrument in Arequipa, so that in general two images should be obtained every night.

January 16th, 1899. Edward C. Pickering.

Letter.

[The Editors do not hold themselves responsible for the opinions or statements of correspondents.]

LONGITUDE OF THE EARTH'S PERIHELION.

To the Editors of Knowledge.

Sirs,—I should esteem it a favour if one of your readers or contributors would be good enough to explain the apparent discrepancy between the longitude of the earth's perihelion, as given in the appendix to Sir R. Ball's

"Elements of Astronomy," viz., 100° 21′ 21·5″ in 1850, according to Leverrier, and the longitude required in order that it may take place on 31st December last at 10 p.m., according to the *Nautical Almanac*. If the longitude in 1850 was 100° 21′ 21·5″, and the annual increase is 61·72″ (50·238″ + 11·482″), the longitude in 1898 should have been 101° 10′ 44″, *i.e.*, 11° 10′ 44″ beyond the winter solstice, which angular distance it would take the earth, travelling at its *maximum* orbital velocity (61′ 9″ per diem), ten days twenty-three hours fifteen minutes to traverse, thus bringing us to 6h. 15m. p.m. on 1st January (taking winter solstice at 7 p.m. on 21st December), instead of the time given in the *Almanac*. The sun's apparent longitude at noon on 31st December, according to the *Almanac*, was 279° 53′ 31·9″, which would make the earth's 99° 53′ 31·9″, adding 23′ 28·75″ for the ten hours makes 100° 17′ 0″, which is 4′ 21·5″ less than Leverrier's figures for 1850. If those figures are wrong, why are they given in the last edition of Sir R. Ball's book above mentioned?

Perplexed.

[The discordance is due to the perturbation of short period which the moon and planets produce on the earth's motion. Perturbations are divided into two classes, secular and periodic. The advance of the perihelion through 11·48″ per annum (or through 61·72″ referred to the vernal equinox) is a secular perturbation. These secular perturbations have the effect of causing the earth's elliptical orbit to slowly vary, the variations being for long periods uniform both in direction and in amount. The periodic perturbations cause the earth to oscillate from one side to the other of this slowly varying ellipse. One of these perturbations is very easy to understand; it is due to the earth describing a small ellipse once a month about the centre of gravity of the earth and moon; owing to this motion the earth's centre is alternately inside and outside the mean orbit by an amount of some three thousand miles. The planets produce the waves in the earth's motion of large periods and of complicated forms. Hence it is clear that the position of the earth when nearest the sun is not the same as the perihelion point of the slowly-varying ellipse which is given in the table quoted by "Perplexed." If, however, he takes the values for several years from the *Nautical Almanac* he will find that they fall sometimes on one side, sometimes on the other, of the values given by the formula he uses. For example, take the following cases:—

Time of Perihelion.	D.	H.	Longitude of Earth. °	′	Value by Formula. °	′
1896. January	1	7	100	56	101	9
1896. December	30	22	100	18	101	10
1898. January	2	1	102	13	101	11
1898. December	31	10	100	19	101	12
1900. January	1	18	101	26	101	13

In three cases the actual longitude is below the tabular, and, in two cases, above it.]

British Ornithological Notes.

Conducted by Harry F. Witherby, F.Z.S., M.B.O.U.

On the Comparative Ages to which Birds live. By J. H. Gurney, F.Z.S. (*Ibis*, January, 1899, pp. 19-42).—In a very interesting article under the above title, Mr. Gurney, after deploring our want of knowledge on the subject, discusses a number of facts, collected from various books and papers, regarding the age to which birds live. Stories of birds having lived to enormous ages are, of course, plentiful. Of more or less authentic records, the greatest age, that of eighty-one years, seems to have been attained by a sulphur-crested Cockatoo. A domestic Goose was recorded by Willughby as having been killed on account of its destructiveness at the age of eighty. A Mute Swan, called "Old Jack," died at the age of seventy in St. James' Park in 1840. Mr. Dresser, in his "Birds of Europe," gives an instance of a Raven having lived sixty-nine years. Mr. Meade-Waldo has in captivity a pair of Eagle Owls (*Bubo maximus*), one of which is sixty-eight and the other fifty-three years old. Since 1864 these birds have bred regularly, and have now reared ninety-three young ones. A Bateleur Eagle and a Condor in the Zoological Gardens at Amsterdam are still alive at the respective ages of fifty-five and fifty-two. An Imperial Eagle of the age of fifty-six, a Golden Eagle of forty-six, and a Sea Eagle of forty-two, and many other birds of the age of forty downwards are also recorded. Mr. Gurney discusses the probability that some families or even allied genera of birds may attain a greater age than others, but owing to the want of information no satisfactory conclusion can be arrived at. The author suggests that wild birds might be marked with an aluminium or white metal ring, bearing date and name of place.

The Rufous Warbler, a bird new to Ireland (*Irish Naturalist*, February, 1899, p. 52).—Mr. R. J. Ussher announces that a supposed Nightingale, preserved for twenty years in the museum of Queen's College, Cork, and now faded, has been identified by Mr. Howard Saunders as a Rufous Warbler (*Aedon galactodes*), a southern species which has been obtained in England only three times, and has never before been recorded for Ireland. The bird was shot by Mr. F. R. Rohu, at the Old Head of Kinsale, in September, 1876.

Woodchat Shrike, a bird new to Ireland (*Ibis*, January, 1899, p. 158).—Mr. Richard M. Barrington writes to the *Ibis* that in 1893 he received from Mr. Patrick Cullen, master of the Blackwater Bank Lightship, County Wexford, the leg and wing of a bird killed by striking the lantern on August 16th. Mr. Barrington has lately sent the wing and leg to Mr. Howard Saunders, who recognized them at once as belonging to the Woodchat Shrike (*Lanius pomeranus*), a bird which has never before been known to occur in Ireland.

Nesting of the Goshawk in Yorkshire (*Zoologist*, January, 1899, p. 28).—An adult female Goshawk (*Astur palumbarius*), together with two of its eggs, have recently been presented to the Norwich Castle Museum. Mr. Thomas Southwell states that the bird was shot at its nest about May 13th, 1893, by Mr. W. M. Frank, a keeper on an estate at Westerdale, Grosmout, Yorkshire. The only question is: Was this a truly wild bird, or an escaped one? In commenting upon this question, Mr. Southwell says that the keeper is unable to state with certainty as to whether the bird had a mate or not; that the bird was very wild; aud that "the inner toe of the right foot is missing, evidently an old injury, as the stump is quite healed." Should anyone have lost a Goshawk in the early part of 1893, the loss of the toe may lead to its identification. Mr. Southwell remarks: "Since the instance reported by Colonel Thornton, who received a nestling from the forest of Rothiemurchus, 'prior to 1804,' I believe there is no authentic instance of its having bred in Great Britain, although it has been suspected of having done so."

Richard's Pipit in Cumberland (*Ibis*, January, 1899, p. 155).—The Rev. H. A. Macpherson has identified a specimen of *Anthus richardii*, which was shot by Mr. Tom Williamson, on October 10th, 1898, on Edderside Moss, near Allonby, Cumberland.

Barred Warbler in Oxfordshire (*Ibis*, January, 1899, p. 160).—Mr. O. V. Aplin obtained a specimen of *Sylvia nisoria* on November 28th, 1898, at Bloxham, Oxon. Mr. Aplin remarks that this specimen (the sixteenth procured in these Islands) "had wandered further inland than any of the other Barred Warblers which have straggled to our shores."

The Introduction of the Black Grouse and of some other Birds in Ireland. By G. E. H. Barrett-Hamilton, B.A., F.Z.S. (*Irish Naturalist*, February, 1899, pp. 37-43).—This is a careful paper, dealing chiefly with the many unsuccessful attempts which have been made from time to time to introduce the Black Grouse into Ireland.

All contributions to the column, either in the way of notes or photographs, should be forwarded to Harry F. Witherby, *at 1, Eliot Place, Blackheath, Kent.*

Science Notes.

A site has been secured at Kemp Town, overlooking Queen's Park, Brighton, for the Gardens of the recently founded Zoological Society for Brighton and Hove. Some sixty years ago Brighton possessed a small zoological garden situated north of The Level, on the Lewes Road. The institution did not flourish owing to the ignorance of its originators, who had no notion of the proper method of dealing with captive specimens. The consequence was a very high death-rate, and a brief career for the institution. The new garden will not be likely to fail from the causes which produced the collapse of its predecessor, for it will be managed by competent zoologists who have experience in the treatment of animals of all kinds. Moreover, the encouragement held out to the projectors by residents and persons of distinction in Brighton is such as to warrant us in believing that the undertaking will prove to be a success in all respects. A special feature in the new institution will be the regular delivery of courses of instructive popular lectures for the benefit of the numerous schools in Brighton and Hove. Among those who have enrolled their names as patrons of the Society are several of the foreign Ambassadors, the Duke of Fife, Sir John Lubbock, Sir Edward Sassoon, the Earl of Chichester, and the Hon. Walter Rothschild. The managing-directors are the Earl of Landaff and Mr. F. W. Frohawk.

Messrs. Taylor, Taylor, and Hobson have sent us an improved circular spirit level. The spirit chamber, made by squeezing from a flat sheet of German silver, being of white metal sharpens the contrast between the bubble and the surrounding spirit, and a compensating joint so effects the combination of the cover glass and spirit chamber that expansion of the metal does not cause leakage by rupture. Further security against leakage is effected by an elastic guard ring compressed into the angular space of the joint, and an outer jacket, separated from the spirit chamber, protects the cover glass from injury. The instrument is, indeed, a very compact, useful, and attractive bit of workmanship.

In our December number, 1898 (p. 275), we recorded the fact that Prof. Howes had received some eggs of the New Zealand lizard *Sphenodon*, and several of these which were carefully kept have now hatched out. The young lizards are in fine condition.

The Marine Biological Laboratory, founded in Brittany by M. de Lacaze-Duthiers, has been the scene of some interesting experiments on the artificial formation of pearls in Gastropods. The mollusc chosen by M. Louis Boutan, who conducted the experiments, was *Haliotis*, of which even the European species occurring in the English Channel has a fine pearly inside surface to its shell. After a series of unsuccessful attempts, some really fine pearls were obtained by trepanning a small part of the shell and introducing a foreign substance.

Our attention has been directed to a device for effecting a more complete combustion of coal or coke in the house. The patent "Automiser" involves in its construction a contrivance which is of great use in certain furnaces for metallurgical operations, namely, hot-air chambers, which augment in a remarkable degree the heating effect. The "Automiser" is equivalent to a hollow brick open at the bottom and having a tranverse slit across the front. When this is put in the grate, in place of an ordinary fire-brick, the air enters the chamber from below, and, becoming heated with the surrounding fire, is deflected from the curved surface above, the hot air emerging through the tranverse slit at such an angle as to impinge on the fuel in the grate.

Mr. Whymper has recently put the Watkin mountain aneroid to a severe test. Travellers or surveyors may be led to exaggerate their altitudes in climbing through the error caused by diminution of pressure; thus, Mr. E. A. Fitzgerald says, in the *Geographical Journal*, November, 1897, "Our aneroids played us some very curious tricks. One of them, on being taken to a height of nineteen thousand feet, registered twelve inches," that is to say, it indicated an altitude of twenty-five thousand feet, and was therefore about thirty per cent. in error as compared with the mercurial barometer. This loss in the aneroid depends (1) upon the duration of time it may be submitted to diminished pressure, and (2) upon the amount of the diminution in pressure. Colonel Watkin attacks the problem of correcting this error by relieving the strain on the mechanism of the aneroid and only permitting of its being put in action when a reading is required. This is effected by attaching to the lower portion of the vacuum-box a screw arrangement, actuated by a fly-nut on the outside of the case, which, when a reading is required, is screwed up as far as it will go, thus bringing the instrument into the normal condition in which it is graduated. An inspection of the accompanying table, showing comparisons of the aneroid with the mercurial barometer at different altitudes, ascent and descent, will indicate that the error has been practically eliminated:—

A Place of Observation.	B Date. 1898.	C Altitude.	D Merc.Bar. reduced to 32° F.	E Watkin Mountain Aneroid.	F Number of Observations.	G Mean error of Aneroid.
			Inches.	Inches.		Inch.
Zermatt ...	Sept. 3-8	5,315 ft.	25·006	25·096	21	+ 0·090
Top of Gugel ...	,, 9	8,882 ,,	21·963	22·020	1	+ 0·057
Top of Gornergrat	,, 9	10,289 ,,	20·872?	20·820	1	− 0·052?
Randa ...	,, 15-17	4,741 ,,	25·687	25·687	6	0·000
St. Nicholas ..	,, 17-22	3,678 ,,	26·443	26·424	5	− 0·019
Visp	,, 23-29	2,165 ,,	27·726	27·720	3	− 0·006
Sierre	Oct. 9-12	1,765 ,,	28·131	28·121	5	− 0·010
Geneva	,, 13-17	1,227 ,,	28·332	28·302	2	− 0·030

The instrument is made by Mr. Hicks, of Hatton Garden.

To the account of sanitary Bibles for witnesses to kiss, must be added the recent adoption by the Savings Bank in Brussels of a process for sterilizing the bank notes which pass through the establishment. This consists of exposing the paper money to the vapour of formalin for several hours. The *Révue Scientifique*, commenting on the fact, calls attention to the necessity which exists for disinfecting the books that are lent out from public libraries and institutions, and which often pass through various dangers of gathering harmful germs before being returned again.

ELECTRICITY AS AN EXACT SCIENCE.

By Howard B. Little.

II.—UNITS AND MEASUREMENTS.

It is no doubt tolerably safe to assume that a bargain of some kind was pending when primitive man attained to his first notion of measurement. Probably one of the high contracting parties (he of the keener commercial spirit) demanded, in pre-historic word and tone, "more than that." Arbitration, or trial by combat, may have ensued. But the important point for our consideration is this, we may again assume that the commodity of which more was first demanded was a foodstuff. Oliver Twist's demand was only novel in a relative sense, while that which we are considering is novel from hypothesis, but its meaning, we need not hesitate to say, was relative. More, or the synonymous expression was used.

Leaving for the moment this distinction between relative and absolute measurements, we come to another point of view, and ask, "What was the physical quantity which first became an article of barter?"

As regards the transaction alluded to, the answer would appear to be weight. But that is a popular error, if the purchase had to be conveyed any distance the weight would be a distinct nuisance. This graphic distinction between weight and mass is, I think, due to Prof. Olaus Henrici. A little reflection shows us that the physical quantity first purchased or bargained for is more than likely to have been muscular energy. The ability to wield a primitive spade must have been early in demand, likewise the power to manipulate a club.

Now let us contrast this state of things with that existing at present. The great distinction lies in that our measurements are absolute, or referred to some recognized system of units. Following out the same train of ideas, we find that the commodity perhaps most marketable now is energy, or the means of producing energy. There is, however, one marked difference. With the growth of mental energy, muscular energy is being largely superseded by mechanical and physical energy. Gas and coal are purchased, because heat, light, or energy, are required, while electrical energy is actually sold at so much per unit. As it is this latter commodity with which we are to concern ourselves, it may not be out of place to note the following facts.

The so-called electric current is never sold. It flows through the consumer's apparatus, and, under ordinary conditions, every milliampère is scrupulously returned by him, if unconsciously. Nor is electrical pressure sold. It may be regarded as potential energy.

To bring these points out more clearly, let us consider a parallel case. The owner of a large pond, situated on the top of a hill, could never find a purchaser for the pressure which that volume of water exercised on the sides and bottom of the pond. But, if he were to let the water flow down the hill, to drive mills, turbines, and so on, it would become a distinct source of income to him, while at the same time he would not be justified in charging anything for the water if it all flowed into a lake of his own at the bottom of the hill. It is then kinetic energy which appears to be the article in demand.

I am to some extent ashamed of having used the expression potential energy here, though it serves so well to illustrate the point under discussion. What I would imply is, that if we define potential energy as the energy which a body has on account of its position, and kinetic energy as the energy derived from its motion, it is quite obvious that the difference is only one of degree.* If the potential energy of a body, or system, be increased, it will, when that increase is sufficient, be converted, or partially converted, into kinetic energy.

Returning to the consideration of electrical energy, and its measurement, we find that the commercial measurement of electricity is on a far more reasonable basis than the commercial measurement of almost any other article of commerce. By reasonable I mean practical, and, in consequence, scientific.

But let us examine this claim which I have put forward. Bread is sold by weight. No one ever required heavy bread yet. The play upon words is inevitable, and like so much of the inevitable, unfortunate. Bread is purchased because it can support animal life. It by no means follows that four pounds of bread purchased to-day is so well capable of supporting animal life as that which may have been obtained last month. Yet, the weight being the same, the same price is in all probability paid. Here electrical dealings can claim to be on a far more scientific basis than those which refer to "The Staff of Life," because the purchaser pays for that attribute of electricity which he requires, while in the other case he pays for what he does not require. And "electricity is only in its infancy," precocious child!! Curiously enough, if the same contrast be made between the rational commercial measurement of electricity, and the existing stupid measurements of the very necessaries of life, it will still give us the same result, and be entirely favourable to electricity. It may be urged that it would be "unpractical" to endeavour to gauge the number of units of heat obtainable from a given ton of coals. On the other hand, the use of the word "unpractical" is a distinct misuse in this connection, added to which, one is led to ask, Has any effort been made to render such a system common? Arrived, then, at the bald statement that the measurement of electrical energy is the direct measurement of what the consumer actually requires, we are in a position to state that this style of measurement is going on *automatically* in millions of places day and night. By comparison with the treatment "meted out" to our infant, most commercial measurements, of the very commonest and most necessary articles, seem to be based on systems that are distinctly in their dotage. A pint of milk is by no means the same thing all the world over, neither is a cubic foot of gas. But a watt is. Let us just in passing define the watt, and next consider how it is measured. A current of one ampère (unit current), propelled by a pressure of one volt (unit pressure), is precisely equal to one watt of electrical energy. But to form a working basis for the charges to be made to consumers, time, of course, comes into the consideration. Hence, the "Board of Trade" unit is ten thousand watt-hours. That is, ten thousand watts supplied for one hour, one watt supplied for ten thousand hours, or any intermediate manner of making up the product, as for the sake of simplicity we confine ourselves to the consideration of whole numbers just now.

For highly accurate measurements of current strength a silver voltameter is generally made use of, and the calculation is based on the fact that one ampère, flowing for one second, deposits 1·118 milligrammes of silver per second. Fortunately, however, there is a far more rapid method of making current measurements, which, as a natural consequence, is adopted in practice.

We know that a magnetic needle hung or pivoted with its axis parallel to a conductor will be deflected by the current in that conductor, and this angular deflection is a distinct measure of the current strength, where the force tending to keep the needle in its original position is of uniform magnitude, and the position of the conductor remains unchanged. Instruments, therefore, are made on this principle, then calibrated by comparison of their readings with the results given by a silver voltameter, when the same currents were passing through the two. The

* I am well aware that many people, possessing knowledge and wisdom superior to my own, have no hesitation in accepting potential energy as energy differing in *quality* from kinetic energy. Yet I would ask them to reconsider this doctrine.—H. B. L.

instrument thus calibrated is known as a galvanometer when its scale is marked in degrees, or some trigonometrical function of degrees. But, to still further facilitate rapid commercial measurement, the scale is usually arranged so that it reads directly in ampères. in which case it is termed an ampèremeter, or an ammeter. It is not possible here to refer to the very many electrical and mechanical details which have to be considered, and to conditions which have to be fulfilled, that the readings of such an instrument may still be accurate although the magnetic field in which it is used may vary within wide limits, and any spring forming an essential part of its movement might be subject to great changes in its resilience, while it will as a whole undergo great changes of temperature. Further, errors introduced by "hysteresis" must be eliminated, or, to be more accurate, precautions should be taken to prevent their introduction. Hysteresis has been popularly defined as "the past history" of the instrument (Prof. W. E. Ayrton, if memory serve), an excellently bad pun, and an excellently good definition in this connection, for it will easily be realised that if an instrument, depending for its action on electro-magnetism, be used first for the measurement of a relatively large current, and immediately afterwards to measure one of low strength, the residual magnetism (a part of that magnetism previously induced by the much larger current) will, if it be allowed to work its wicked will, affect the second reading.

Speaking broadly, then, the ammeter of commerce is an instrument which depends for its action on the fact that a mass of steel or iron will always tend to set itself in the strongest part of a magnetic field.

The measurement of electrical pressure, electromotive force, or potential difference (as under varying circumstances the same "attribute" of electricity is called), is of course referred to the volt. The volt is a derived unit; its derivation is not, however, far to seek. In order that a current of one ampère may flow through a conductor having a resistance of one ohm, the difference of potential at the terminals of that conductor must be one volt. And the ohm may be defined as the resistance of a column of mercury, at the temperature of melting ice, 14·4521 grammes in mass, of a constant cross-sectional area, and of the length of 106·3 centimetres.

Since the volt is thus derived from the ampère and the ohm, it is not surprising to find that so-called voltmeters are really instruments to register the current strength flowing through a wire of definite resistance. And since we know that the potential difference at the terminals of any conductor is the product of the resistance, in ohms, and the current in ampères in that conductor (Ohm's law), the instrument can be so constructed as to indicate directly in volts.

In one well-known type of direct reading voltmeter, the increase in length of a stretched wire is actually taken as a measure of the voltage, because the passage of current causes heating, and the greater the current the greater the heat and expansion produced. The wire usually employed for "stringing" this instrument is of platinum-silver, and very fine. This instrument (due, by the way, to Major Cardew) has had a vast deal of thought expended upon it, to bring it to its present accuracy. The rods supporting, or forming part of, the frame upon which the wire is strung are compounded of iron and brass, so that their temperature co-efficient shall be equal to that of the platinum-silver, yet inexpensive. If this precaution were not taken the pointer would move through a certain angle on account of external change of temperature. If one of these instruments be used with the tube which encloses the wire placed vertically, a certain amount of error is introduced, especially on the higher parts of the scale, as, the wire being considerably heated when this is reached, air currents are set up in the instrument and the needle will vibrate instead of taking up a definite position. If the tube be horizontal this will not occur.

The Cardew voltmeter is not affected in the least by external magnetism, and of course no temperature correction need be made, unless extreme accuracy is required, in which case the constant will be negative, and of the order, 0·03 per cent. per degree Centigrade.

There are many forms of voltmeter which may be regarded as high resistance ammeters. In using all such instruments the temperature correction is a most important factor, because there must be very many turns of fine wire (otherwise the potential difference to be measured would be destroyed by the insertion of the instrument forming an easy path through which the pressure could send a current), and these many turns would, by the rise of temperature, have their aggregate resistance proportionally increased.

This difficulty has been recently overcome by the introduction of an alloy termed "Ja Ja," which has a negative temperature resistance co-efficient. By therefore arranging for a coil of a metal having a positive co-efficient and an added resistance (of proper proportion) of "Ja Ja"—that Gilbertian name!!—the temperature co-efficient of the instrument may be made absolutely nothing.

We have thus the essential parts of a direct current direct reading wattmeter, an ammeter, a voltmeter, and a clock. On alternating circuits, where the direction of the flow may vary very many times a second, the condition of things is different, and it must be remembered, in considering the wattmeter, that the product of mean current by mean potential difference throughout a definite time will not, as a rule, be equal to the mean value of the energy expended.

In practical forms of the wattmeter, the ammeter coil usually has the voltmeter coil suspended within it, or a small coil, connected up as a voltmeter, which, in order to make up the required resistance, is joined in series with a resistance; if the latter is to have no electro-magnetic effect, it is wound "back on itself," or double, so that the inductive effect of each half of this counterbalances, and is counterbalanced by that of the other.

As regards the addition of the clock, which converts the wattmeter into what is popularly termed an "electricity meter," this part of the apparatus is brought into gear in various ways. The pendulum bob may be replaced by a coil of wire, so that the electrical energy affects the regulation, or the time-counting arrangement may be motor driven.

The want of space does not permit of the discussion of any further forms of electric measuring instruments, though we may in passing point out that the public had no faith in the registrations of electricity meters until some genius was struck with the idea of making them look like gas meters externally.

It has been quite impossible here to refer to the entire system of electrical units—indeed the Coulomb, Farad, Joule, and Sechom are practically left out. Before leaving the consideration of units it may be well to add that the late Prof. Fleming Jenkin's "Report to the Royal Society on the New Unit of Electrical Resistance," which, in conjunction with British Association reports, 1862 and 1869, were issued in book form, shows very plainly how complete a system of mutually depending units has been arranged. In this connection the story of the Board of Trade standards would be well worth looking up.

TRIPLE ATMOSPHERIC CORONA.

By the Rev. SAMUEL BARBER.

ABOUT thirty years ago there was seen from the landing stage at Liverpool a solar halo and a corona at the same time. The writer hazarded the suggestion that a drift of sleet was the originating medium of both. This was confirmed, soon after, by a downfall of half-melted snow.

About the same time appeared a lunar corona of similar type to the one now figured and described, seen on

Christmas Day, 1898, about 8.30 p.m. The first-mentioned had the blue ring of a very intense colour, and appeared more steady, and was probably formed in a higher drift of particles. In this recent instance, the moon, two days off "full," was pretty bright, and a drift of broken cirro-cumulus, or "alto-cumulus" was rapidly passing from about west-north-west. The corona was very variable, and did not appear in perfection for more than a minute or two at a time, recurring again and again.

There was the usual small pale disc close to the moon,* with diameter equal to about three times that of the moon's disc. Then a larger disc of yellowish-grey edged by reddish-orange, and rounded off so as to give it a semi-spherical effect.† The diameter of this was seven or eight times as great as that of the inner disc. Outside the orange, again, was the beautifully coloured blue ring which makes this kind of corona so attractive in form. Then a ring of grey light as narrow or narrower than a rainbow. The blue ring was slightly wider than this outer grey one, and not so well defined on its inner edge.

The barometer was falling, and the temperature had risen before this appearance.

The weather for several weeks after was exceedingly stormy and changeable. A high wind was almost continuous for a long period.

For the explanation of these coronæ the reader is referred to Kaemptz, and any good treatise on optics, or Ganot's Physics. Not long ago the writer saw the corona illustrated beautifully in a Cornish field, where an immense deposit of gossamer had taken place during the night. Upon the fine lines myriads of drops from the autumnal hoar-frost produced exquisitely coloured concentric rings, the result of diffraction and interference of the declining solar rays.

In concluding this notice I may chronicle a curious observation made upon the effect of *steam*, when intercepting the view of a lunar corona. I was in a train near the engine from which the steam burst in large volumes right across the *double* corona which I had been watching in the bright moonlight. Every time the steam intervened it cut off completely in a moment the outer ring which again burst into view the moment the steam was dissipated. The large inner disc remained entirely unaffected, being seen as plainly through the steam as before, so that the corona was alternately single and double. It is understood that the *size* of these rings is related to that of the drops or vesicles, and that where their magnitude greatly varies, the overlapping and interference originate, not concentric rings, but a disc only, or "luminous aureola."

[It seems a pity that the term "corona" should be used in the above connection. "Corona" has so definite and special a significance, that to apply it, not only to the outer appendages of the sun, but also to phenomena quite unlike it, and due entirely to influences within our own atmosphere, is distinctly to be deprecated.—E. WALTER MAUNDER.]

* This small disc was seen several times of a pale green colour during the drought, 1898.

† The size of this disc is contracted in the sketch.

MAMMOTH IVORY.

By R. LYDEKKER.

IN spite of all their ingenuity and skill, there are two animal products of high commercial value which our manufacturers have not hitherto imitated with such success as to make the substitutes equivalent in utility and beauty to the originals. These products are elephant ivory and whalebone, and although the imitations in the former case make a much nearer approach to the true article than has been found practicable in the latter, they still leave much to be desired. Consequently, the demand for natural ivory is not only likely to be maintained on the same level as heretofore, but would undoubtedly increase if an adequate supply were forthcoming.

True ivory, to which the name should properly be restricted, is the constituent of the tusks of elephants of different species, and is found in no other animals. In making this statement it must not be assumed that its presence in mastodons is denied, since those extinct animals are nothing more than elephants in a wider sense of the term. From other so-called ivory, such as that of hippopotamus tusks, sperm-whale teeth, and narwhal "horns," elephant ivory is readily distinguished at a glance by the "engine-turned" pattern—similar to that on the back of a watch case—which it displays in cross-section, as may be seen by looking at the butt-end of the handle of a table knife. And it is probably due to this peculiarity of internal structure that elephant ivory displays the elasticity which forms one of its most valuable properties.

As all the readers of this journal are doubtless aware, there are only two living species of elephants at the present day, namely the Indian, or, as it might with more propriety be called, Asiatic, and the African. As regards the production of ivory, the latter is, or, perhaps, was, much the more valuable animal of the two. In the first place, till within the last few years, it existed in almost incredible numbers in many parts of its habitat; and in the second place, it produced more ivory, animal for animal, this being due to the circumstance that whereas in the African species both sexes are furnished with tusks of large size, in its Asiatic cousin they are generally restricted to the male sex, and even then in certain cases may be but very poorly developed.

Again, it appears that in modern times, at all events, much of the ivory yielded by the Asiatic elephant is worked up in the land of its birth, comparatively little reaching Europe in the raw state. Consequently, for recent ivory, the European market is very largely dependent upon the product of the African species, for which the great commercial emporia are London and Antwerp. Now, although, a few years ago, elephant hunting was a profitable trade in the remoter districts of south-east Africa, the herds have been so reduced in number, that comparatively little ivory is obtained at the present day. Moreover, the great stocks of ivory formerly possessed by the native chiefs have been largely reduced or exhausted over the greater portion of the country. It is true, indeed, that in the Congo district elephants are still locally abundant, while the opening up of the Egyptian Sudan may very probably introduce to the market a supply of tusks from Kordofan, Dafur, and the Bahr-el-Gazal districts. But if these regions prove productive in ivory, it is only too likely, unless proper precautions are taken, that they will comparatively soon be shot out. And if the production be not placed under restriction it is evident that the annual supply will be relatively small.

It is clear, therefore, that African ivory is likely to become gradually scarcer and scarcer; and if there were no other source of supply this beautiful substance would apparently soon reach a prohibitive price.

As a matter of fact there exists, however, in the frozen tundras of Siberia a supply of ivory which will probably suffice for the world's consumption for many years to come.

This ivory is the product of the mammoth (*Elephas primigenius*), a species nearly allied to the Indian elephant, but protected from the cold of the Arctic regions by a coat of long, coarse hair, with a finer woolly underfur at the base. The tusks, too, of the mammoth, were larger and more curved than those of its living Asiatic relative, being sometimes twisted into a spiral almost recalling that formed by the horns of the African kudu. From the abundance of these tusks it is further probable that they were developed in both sexes.

In addition to dwelling on the Arctic tundras of the Lena, Yenisei, and Obi Valleys, as well as extending to the New Siberian Islands (which in past times evidently formed a portion of the Asiatic mainland), and Alaska, the mammoth roamed over a large portion of Europe in Pleistocene times. And in the gravels and brick-earths of our English river-valleys its tusks, teeth, and bones are of comparatively common occurrence; while quantities of similar remains are dredged from the Dogger-bank by the North Sea trawlers. If, however, the ivory-turner expected to find a workable commodity in British mammoth tusks he would be grievously disappointed. All those found in the gravels and brick-earths, as well as the specimens hauled up from the Dogger-bank, have lost the greater part of their animal matter, in consequence of which they crumble more or less completely to pieces when exposed to the influence of the atmosphere, and for the purpose of preservation and exhibition have to be copiously treated with size or gelatine.

Not so the mammoth ivory of the Siberian tundras, which, in the best preserved specimens, retains the whole of the original animal matter, and, except when stained by earthy infiltrations, is as suitable for the purposes of the turner as the best product of the African elephant. This remarkable state of preservation has been produced by entombment in the frozen soil of the tundras. In many instances, as is well known, entire carcases of the mammoth have been found thus buried, with the hair, skin, and flesh as fresh as in frozen New Zealand sheep in the hold of a steamer. And sleigh-dogs, as well as Yakuts themselves, have often made a hearty meal on mammoth flesh thousands of years old. In instances like these it is evident that the mammoths must have been buried and frozen almost immediately after death, but as the majority of the tusks appear to be met with in an isolated condition, often heaped one atop of another, it would seem that the carcasses were often broken up by being carried down the rivers before their final entombment. Even then, however, the burial, or at least the freezing, must have taken place comparatively quickly, as exposure in their ordinary condition would speedily deteriorate the quality of the ivory.

The retention of their animal matter and their unaltered condition have led some writers to object to the application of the term fossil to the Siberian mammoth tusks, and to restrict its use to the altered and partially petrified specimens met in the superficial deposits of warmer countries. This, however, is quite illogical, seeing that a fossil must be defined as including the remains or traces of any animal or vegetable buried in the earth by natural causes. And we may, therefore, with perfect propriety speak of the Siberian mammoth tusks as fossil, in contradistinction to petrified, ivory.

How the mammoths were enabled to exist in a region where their remains became so speedily frozen, and how such vast quantities of these became accumulated in certain spots, are questions which do not at present seem capable of being satisfactorily answered; and their discussion would accordingly be useless, not to say out of place, on the present occasion. It will suffice to say that such accumulations do exist, and that the soil of certain portions of the tundras seems to be almost crammed with such remains.

It may, however, be remarked that the contents of the stomachs of the frozen mammoths, as also those of the two species of rhinoceroses which were their fellow inhabitants of the tundras, contain remains of pine needles and other vegetable substances. And from this it may be inferred that the tundras themselves were clothed with forest during the mammoth epoch; since the theory that the carcases were carried down by the rivers flowing from warmer southern regions into the Arctic Ocean can scarcely merit serious attention. Possibly some light may be thrown upon the subject by the great accumulations of bones of large recent mammals, which have been met with in certain districts of East Africa.

Although, outside scientific and commercial circles comparatively little is known with regard to the subject in England, mammoth ivory, in place of being a modern discovery, was known to the ancients, and has for centuries been an article of trade and manufacture. It is, however, only recently that the history of the subject has been worked out; and for this we are largely indebted to the labours of Sir H. H. Howorth,* and Dr. Trouessart,† of Paris. Baron Nordenskiöld has likewise contributed important information on the subject in the "Voyage of the Vega." And it is from these sources that the following paragraphs are mainly compiled.

If we may take the "buried ivory" mentioned by Pliny on the authority of Theophrastus, a disciple of Aristotle, to be the same as mammoth ivory, we may regard this substance as known to the western world in the time of Alexander. But apart from this, mammoth ivory was evidently familiar at a very remote time to the Chinese,

* "The Mammoth and the Flood," Chap. III. (1887.)

† "Le Mammoth et l'Ivroire de Sibérie," *Bull. Soc. Acclim. Paris*, 1898.

who spoke of the animal by which it was yielded as "thien-shu," the mouse that hides. This mythical creature, which was compared in size to an elephant, was reported to lead a subterranean existence like a mole, with bones as white as ivory, and the flesh cold, but pure and wholesome. This reference to the coldness of the flesh apparently pointing to their acquaintance with frozen mammoth carcases.

In Europe, Eginhard, the historian of Charlemagne, states that among the presents sent to the Emperor of the West by the Kalif Haroun-al-Raschid in the year 807 were the horn of a "licorne" and the claw of a griffon. These rarities were long preserved in the royal treasury at St. Denis; and, from a description given in a work dated 1646, it appears that while the former was a mammoth tusk, the latter was the horn of the woolly Siberian rhinoceros.

During the ninth or tenth century* Arab traders appear to have established a trade-route from Northern Russia or Siberia to Persia or Syria; and their records refer to the occurrence of buried ivory near the city of Bolghari, on the Volga, which was probably situated on or near the site of the modern Nijni-Novogorod. The first Siberian mammoth tusk imported into Western Europe in modern times was brought to London in the year 1611 by one Josias Logan, by whom it had been purchased from the Samoyedes of the Pechora district. Concerning this specimen, Baron Nordenskiöld writes that as Englishmen at that time visited Moscow frequently, and for long periods, a remark occurring in Purchas's history appears to indicate that fossil ivory first became known in the capital of Russia sometime after the conquest of Siberia.

Be this as it may, it is in evidence from the account of Avril, who travelled in Russia during 1685, that fossil ivory was at that time imported into China and other Asiatic countries, where it was highly esteemed; and it is stated that it was largely employed by Turks and Persians for ornamenting sword and dagger hilts, being preferred to Indian ivory on account of its whiter colour and finer grain. And here it may be incidentally mentioned that, according to the same author, the Russian term *mammout* is a corruption of the Hebrew *behemot*, or *behemoth*, which the Arabs make *mehemot*. Canon Tristram is, however, of opinion that in the Bible behemoth often refers to the hippopotamus; and, if this be correct, a transference of the name would appear to have been made by the Arabs, this being the less improbable since it is stated in Hebrew to be applicable to any large beast.

Apart from this there is a record that about 1722 Peter the Great ordered the collection of tusks and other remains of the mammoth for the museum at St. Petersburg. And between 1750 and 1770 a Russian trader, named Liakhoff, established an extensive importation of mammoth ivory from the districts lying between the Khotanga and Anadyr rivers, and likewise from one of the southernmost islands of the New Siberian group, which still bears his own name. Surveys subsequently made by the Government in those islands indicated that the soil is teeming with the bones, tusks, and teeth of mammoths; while the adjacent mud-banks exposed at low tide are equally prolific. Some idea of their abundance may be gathered from the account given by Dr. Bunge, who visited Liakhoff Island from 1882 to 1884, and in the course of three short summers collected no less than two thousand five hundred selected specimens. In the New Siberian Islands the thermometer now often falls to fifty degrees Centigrade below freezing point, so that collecting is an impossibility during the winter.

* Dr. Trouessart gives the former, and Sir H. Howorth the latter.

With regard to the amount of mammoth ivory that comes into the market, accounts are by no means so numerous nor so accurate as might be desired. It is stated, however, that in 1821 a Yakut brought back five hundred puds (forty pounds to the pud) from the New Siberian Islands; and between the years 1825 and 1831 the amount annually sold in Yakutsk ranged between one thousand five hundred and two thousand pud, in addition to that disposed of at other towns. Many writers speak of seeing boat-loads of tusks on the Lena and Yenisei—a steamer which carried Baron Nordenskiöld in 1875 having a cargo of over one hundred. About the year 1840, Dr. Middendorff, who visited the country, estimated that the annual output of Siberian ivory reached one hundred and ten thousand pounds, representing at least a hundred individual mammoths; so that the total number of animals whose remains have been exported since the conquest of Siberia must be between twenty thousand and thirty thousand. And since Middendorff's estimate probably errs on the side of being too low, the numbers may have been considerably in excess of this.

In the London market, according to Mr. Westendarp, one thousand six hundred and thirty fine mammoth tusks were sold during the year 1872, and one thousand one hundred and forty in the following year; the weight of these varying from one hundred and forty to one hundred and sixty pounds each. Only a small percentage of these were, however, fit for the turner of ivory of high quality; about fourteen per cent. being of the best description, seventeen per cent. of inferior quality but still useful, while fifty-four per cent. were bad, and the remaining fifteen per cent. rotten and worthless.

According to Dr. Trouessart the price of mammoth ivory in the market at Yakutsk is twenty-five francs per pud for the highest quality, seventeen and a half francs for the second, and from five to seven francs for the third quality. A small quantity is worked up locally into ornamental and fancy articles of various kinds; but this industry seems to be a waning one, and more and more of the raw material goes direct to the foreign market. Yakutsk, which is situated on the Lena about midway between its mouth and the frontier of China, and has about five thousand inhabitants, has long been the acknowledged centre of the trade; but it is considered probable that at present the great bulk of the ivory goes to China, and that only a comparatively small portion finds its way into the more distant markets of Europe. The opening up of the country by the Siberian railway may, however, lead to a revolution in this respect, and also inaugurate a new era of prosperity for Yakutsk and the other Siberian towns.

With regard to the future development of the trade and the persistence of the supply, it may be remarked that only a small portion of Siberia has hitherto been explored at all, and that other deposits remain to be discovered. Of those already worked, Dr. Trouessart writes as follows:—"It is difficult to believe that the enormous quantity of tusks indicated by the masses of bones spoken of by travellers who have visited the archipelagos of Northern Siberia can have been accumulated in the course of only a few centuries. It is most probable that only the surface of these vast bone deposits has hitherto been exploited, and that by excavating the soil to a greater depth, and, if necessary, employing the aid of dynamite to break up the frozen strata, good results will be obtained.

"If this idea be well founded, and if, as is unfortunately only too probable, the supply of African ivory comes practically to an end at no very distant date, there is every hope of finding a precious reserve in the fossil ivory of Siberia."

Microscopy.

By John H. Cooke, f.l.s., f.g.s.

A tough cement, suitable for use with the thinnest of rock-sections, may be made by heating together for some time sixteen parts by weight of Canada balsam and fifty parts of shellac.

Distilled water should be used in the treatment of microscopic objects on all occasions, as, on the evaporation of ordinary water, crystalline salts may be deposited on the object.

To remove an excess of balsam from around a cover-glass, allow the balsam to become hard and then chip it away with the edge of a blunt knife, taking care to avoid touching the cover-glass during the operation. A tooth brush dipped in methylated spirits will then readily remove what is left. Finally, dry and polish the slide with Japanese filter paper.

Specimens of plasmodia, for the study of the myxomycetes, may be obtained from the sclerotia which is to be found attached to rotten wood or on the ground beneath old logs. To prepare these, Mr. M. Barber, of Kansas University, suggests that pieces of the material should be placed in a warm moist place. After a few hours the plasmodia will develop, and they may then be fed with rotten wood or fleshy fungi. Small plasmodia, for the demonstration of protoplasmic currents, may be obtained by putting pieces of sclerotia in a hanging drop of water, or by placing in a large cover-glass on a plasmodium and transferring it to a moist cell after the plasmodium has run over it.

Kleinberg's picro-sulphuric acid is recommended for fixing zoophytes and polyzoa with their tentacles extended. The specimens should be placed in water, and as soon as they extend themselves they should quickly be covered with the solution. Fixation follows rapidly, when, after immersion in the usual grades of alcohol, they may be stained with any ordinary stain. Picro-carmine gives the most satisfactory results.

Formalin is now largely used in most laboratories as a preservative and fixative re-agent. It does not interfere with the processes of staining to any appreciable extent, nor does it cause much shrinkage of the structures operated on. Both as regards ease of manipulation and expense, it is decidedly superior to osmic acid.

A novel method of illumination, for the investigation of the structure of diatoms, is suggested by Mr. Allan Dick in his "Notes on the Polarizing Microscope." A thin platinum wire is twisted into a loop of just sufficient size to allow of the passage of a darning needle. This wire is rendered incandescent by a spirit lamp or a Bunsen burner, and it is placed at a distance of eight inches from a condenser in such a manner that the loop may be at right angles to the axis of the microscope tube. The most favourable condition for using this source of illumination is when the image of the loop may be seen in the field of view just surrounding the object. In some cases it is better to use a triangular rather than a circular loop, so as to minimize the risk of mistaking circular effects.

To preserve for an indefinite period such fluid mounts as fish embryos, ova, and the like, it is necessary to use a cement having exceptional strength and fluid-resisting properties. The following cement is admirably adapted for this purpose. Take two parts of carbonate of lead, two parts of red oxide of lead, and three parts of litharge. Grind these very finely, mix them dry and keep in a wide-mouthed bottle. When required for use a little of the powder should be mixed with old gold size on a watch glass. It is necessary that there should be no trace of grit or unground matter in the mixture. A cell made with this cement may be filed off the glass slip without the cell breaking away.

In a paper recently read before the Manchester Microscopical Society, Mr. J. V. Wolstenholme, f.r.m.s., gives details of the methods that were employed in his investigations on the micro-cocci (Botriomyces), which produce tumours in domesticated animals. He removed from the groin of a horse a pear-shaped tumour, the mass of which was dense, firm, and resistant, and of a pale pink colour. In the centre was an abscess cavity, two and a half by one and a half inches, which communicated by narrow channels with a large sore or ulcer at the base of the tumour. For microscopical examination, portions of this tumour were hardened in (α) Müller's fluid, (β) picric acid, (γ) alcohol, after which they were easily cut with the freezing microtome, and stained readily. In some cases it was found to be an advantage to embed the portion of tissue in celloidin before cutting. The stains used were (α) picro-carmine, (β) hæmatin followed by picro-carmine, (γ) hæmatin, and then rubin and orange combined, (δ) the Plantz method. Of these, the hæmatin with rubin and orange gave the most perfect differentiation. The fibrous tissue was thus stained pink, and the nuclei purple. It was in the nuclei, which appeared as minute specks in a delicate fibrous growth, that the colonies appeared. Under the one-sixth objective a colony was seen to be made up of grape-like bodies, some of a pale orange, and others of a pale green colour, but under the one-twelfth inch oil immersion the grape-like bodies were seen to be filled with cocci—small round elements—which were about 3 μ diameter.

NOTES ON COMETS AND METEORS.

By W. F. Denning, f.r.a.s.

Chase's Comet.—This comet, which is remarkable as having been discovered by photography in the position of the radiant point of the Leonids on the very night when a shower of these meteors was expected, is receding from the earth and becoming perceptibly fainter. On March 4th its apparent brightness will be 0·75, or three-fourths the amount it exhibited at the time of discovery. The comet is moving slowly westwards in the region between Leo Minor and the southern limits of Ursa Major, and its position on March 4th will be R.A. 10h. 54m. 31·4s., Dec. + 38° 10′ 40″. It will be distant from the earth about one hundred and ninety millions of miles. The latest computations of the orbit show that the observations are satisfied by parabolic elements, and that there is no probability that the comet is identical with Comet 1867 I., as has been suggested.

Wolf's Comet.—This object remains faintly visible in large instruments, and is situated in the south-west part of Monoceros. On March 4th it will be separated from the earth by an interval of two hundred and seven millions of miles, and its apparent place will be R.A. 6h. 19m. 24s., Dec. −8° 8′. The comet is moving slowly to the N.E., and is not likely to be visible much longer even in the best telescopes.

The Recent Shower of Leonids.—Reports of this display continue to come in, and show the very widespread interest manifested in the phenomenon. That this interest will be further accentuated next November is certain, seeing that the outlook is more promising as regards a really fine display. The moon, it is true, will be nearly full, and must, in any case, rob the event of much of the imposing effect it would have presented on a dark sky; but if the shower returns in its full strength it will, even in the presence of unfavourable circumstances, prove a striking spectacle. Many of the Leonids are bright meteors, quite equal to first magnitude stars, and will be distinctly visible in moonlight. The observations in 1898 have been of decided value in several connections. The photographs, taken in combination with the naked eye observations, prove that the radiant is in about R.A. 151°, Dec. 22·3°. The results also prove that the earth did not really encounter the main body of meteors, but only a tenuous region of the stream far in the van of the parent comet. The estimates of the time of maximum seem to have differed at various places, as though locality affected the visible numbers in some degree. In the case of a comparatively feeble shower such discordances are sure to occur, as the methods of observers, the number employed, the suitability of their positions, and other circumstances affect the results. In any case, the recent shower of Leonids was certainly most numerously presented after sunrise in England, so that even had favourable weather backed up the efforts of observers in this country, the phenomenon would have been one of decidedly minor importance.

Meteors and the Spring Season.—Very few meteors are usually observed in the spring season; in fact, as regards these objects, it may be considered as the most unproductive time of the year. Fireballs, however, occasionally appear, and provide valuable materials for discussion. On January 26th a very fine meteor was seen at 8h. 56m. p.m., by Mr. Sheppard at Bishop

Stortford, Herts, travelling from centrally between the two stars in the tail of Ursa Major towards ι Draconis. This object was also seen by Mr. A. King at Leicester, and he noted the path as being from 178½° + 60° to 171½° + 54°, but the observation was not a very good one. On February 12th, at 8h. 45m., a large meteor was seen in a cloudy sky by Mr. T. Harries, at Llanelly, who states it fell almost vertically in azimuth 70° west of south altitude 35° to 15°. On February 13th, at 8h. 37m., Mr. H. Corder, at Bridgwater, noted a slow-moving second magnitude meteor, travelling from *f* Tauri eastwards from the direction of α Arietis. Meteors of the latter type are interesting from the fact that their radiants lie in the western sky.

THE FACE OF THE SKY FOR MARCH.

By A. Fowler, F.R.A.S.

The Sun.—On the 1st the Sun rises at 6.48, and sets at 5.38; on the 31st he rises at 5.39, and sets at 6.29. The Sun enters Aries, and Spring commences on the 20th at 8 P.M. A well marked decline in the number and size of sunspots has lately been noted.

The zodiacal light may be looked for in the west during two or three hours after sunset.

The Moon.—The Moon will enter her last quarter on the 5th, at 4.7 A.M.; will be new on the 11th, at 7.53 P.M.; enter her first quarter on the 19th, at 3.24 A.M.; and will be full on the 27th, at 6.19 A.M. Occultations of 56 and 61 Geminorum (mags. 5·0 and 5·7) will occur on the 20th. The disappearance of the former takes place before sunset, at 5.32 P.M., at an angle of 124° from the north point (152° from vertex), and the reappearance at 6.50 P.M., 265° from the north point (275° from the vertex). 61 Geminorum disappears at 8.50 P.M., at 83° from the north point (60° from the vertex); and reappears at 9.59 P.M., 320° from the north point (286° from the vertex).

The Planets.—Mercury is an evening star throughout the month, and will be favourably situated in the west for observation, after sunset, for some days before and after the 24th, when he will be at his greatest easterly elongation of 18° 36′. We may note that the angular distance from the sun is small at this elongation, for the reason that the planet is near perihelion, the actual perihelion passage occurring on the 17th, at 2 P.M. The elongation, however, is favourable, because when the sun is setting near the vernal equinox, the ecliptic is greatly inclined to the horizon. The apparent diameter of the planet on the 24th will be 7·4″, and on that date he will set about an hour and fifty minutes after the sun. During the time of his visibility his path lies in Pisces, and there will be no bright star in his immediate neighbourhood. At 7 P.M. on the 24th he will be about 10° above the horizon, his amplitude then being only two or three degrees north of west.

Venus remains a morning star throughout the month. Her declination ranges from 19° south to 12° south, but at the beginning of the month she rises about two hours, and at the end a little more than one hour, before the Sun. The path of the planet is a little south of the ecliptic, through the most easterly part of Sagittarius until the 10th, then through Capricornus, crossing the ecliptic on the 27th, and passing into Aquarius. At the middle of the month, 0·84 of the disc will be illuminated.

Mars will still be a conspicuous object in Gemini. Passing from his recent stationary point a little south-west of Pollux, he will traverse a short easterly path to a point almost in a line with Castor and Pollux. At the middle of the month he will have an apparent diameter of 9·8″, as compared with 14·4″ at the opposition, on January 18th. On the 1st he will be on the meridian at 8.49 P.M., and on the 31st at 7.14 P.M., setting on these dates at 5.20 A.M. and 3.27 A.M. respectively. On the 15th, 0·922 of the disc will be illuminated.

Jupiter is rapidly coming into a position for observation at convenient hours. On the 1st he rises about 11 P.M., and on the 31st shortly before 9 P.M. During the month he describes a short retrograde or westerly path, not far to the west, and a little north of α Libræ. The polar diameter increases from 37·4″ to 40·2″. When on the meridian at London the planet will be about 25° above the horizon.

Saturn is a morning star, and continues his eastward path through the most southerly part of Ophiuchus. On the 1st he rises shortly before 3 A.M., and on the 31st a little before 1 A.M. He will be in quadrature with the Sun on the 14th.

Uranus rises on the 1st about 1.40 A.M., and on the 31st about 11.40 P.M. He describes an eastward path until the 13th, when he will be stationary, after which his path will be westerly near ω Ophiuchi. The southern declination of the planet is 21½°, and the apparent diameter 3·6″.

Neptune is stationary on the 3rd, and in quadrature on the 12th. He remains in the neighbourhood of ζ Tauri, preceding this star by about 6m., and lying about 50′ to the north.

The Stars.—About the middle of the month, at 9 P.M., Aries will be nearly setting a little north of west, Taurus will be nearly due west, Orion in the south-west, Capella high up in the west, Sirius low down about 30° west of south, Procyon and Gemini higher and a little nearer the meridian, Cancer on the meridian, Leo pretty high up in the south-east, Arcturus in the east, Hercules and Vega low down in the north-east.

Minima of Algol will occur on the 4th at 12.21 A.M., on the 6th at 9.10 P.M., on the 26th at 10.53 P.M., and on the 29th at 7·41 P.M.

Chess Column.

By C. D. Locock, B.A.

Communications for this column should be addressed to C. D. Locock, Netherfield, Camberley, and posted on or before the 10th of each month.

Solutions of February Problems.

(J. Nield.)

No. 1.

1. Q to Q3, and mates next move.

No. 2.

1. Q to Rsq, and mates next move.

Correct Solutions of both problems received from G. A. Forde (Capt.), K. W., Alpha, J. M. K. Lupton, G. C. (Teddington), G. Reed Makeham, C. T. Kershaw, H. H. Thomas, W. H. Stead, F. V. Louis, W. de P. Crousaz, W. Clugston, W. Hughes, D. R. Fotheringham.

Of No. 1 only, from Miss J. G. Theakston, H. S. Brandreth.

Of No. 2 only, from Sunnyside, G. G. Beazley.

[The dual in No. 1 (after K to Q4) appears to have escaped general notice; also the clever "try" by 1. Q to Bsq. F. V. Louis alone mentions them.]

G. G. Beazley and Sunnyside.—1. Q to R5 is met by B to Kt2.

H. S. Brandreth.—In No. 2, if Q to R7, P to K6.

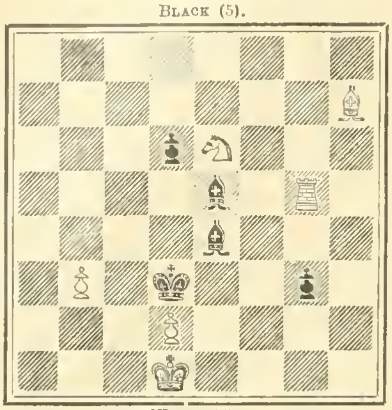
H. Bristow.—Thanks for your problem. Is there not a second solution by 1. R to R5? From an economical point of view this Rook is also an offender. Personally we object to the Black Queen and its attendants, which provide only one defence.

PROBLEMS.

No. 1.

By V. H. M.

BLACK (5).



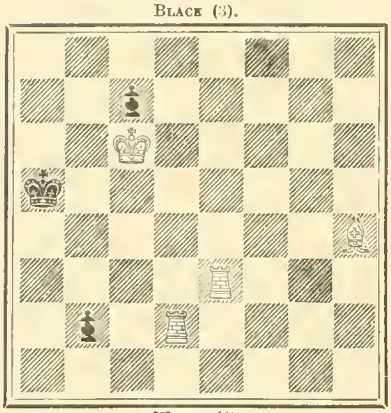
WHITE (6).

White mates in two moves.

No. 2.

By W. I. M.

BLACK (3).



WHITE (4).

White mates in two moves.

CHESS INTELLIGENCE.

Surrey has defeated Sussex, by $11\frac{1}{2}$ games to $8\frac{1}{2}$, in the Southern Counties Chess Union Competition. A Northern Chess Union has recently been formed, Mr. I. M. Brown being the secretary.

The correspondence match of two games between the Vienna and St. Petersburg Chess Clubs has resulted in a victory for the former club, who won one game and drew the other. The Janowski-Showalter match has also been brought to a conclusion, the final score being Janowski 7, Showalter 2, drawn 4. Since Mr. Showalter's first match against Pillsbury he has never shown any form approaching his performance in that encounter.

The brilliancy prizes in the recent Vienna Tournament have at length been awarded. Mr. Pillsbury takes the first, the two others going to Herren Lipke and Marco.

The London International Tournament is arranged to begin on May 30th. Play will take place in St. Stephen's Hall, Westminster. The principal event will be a two-round tournament, limited, probably, to sixteen players. There will also be an unlimited one-round competition. The whole tournament is expected to last six or seven weeks.

The annual match by cable between the British Isles and the United States is fixed for March 10th and 11th. The British team will play, as last year, at the Hotel Cecil, play beginning at 3 p.m. on the 10th. The following team has been selected:—Messrs. H. E. Atkins, G. E. H. Bellingham, J. H. Blackburne, A. Burn, E. M. Jackson, Herbert Jacobs, T. F. Lawrence, C. D. Locock, D. Y. Mills, and G. E. Wainwright. Reserves: H. W. Trenchard, G. Walker, and W. Ward. The American Committee are said to be making strenuous exertions to strengthen their team at the last three boards, at which the British team have hitherto scored heavily; for should their representatives fail to turn the tables this year, the cup will be held permanently by their opponents. In the British team the only player new to the match is Mr. Wainwright, who has been scoring very heavily in the level and handicap tournaments at the British Chess Club. Mr. Lawrence played in 1897, when he had the misfortune to lose. He was omitted from the 1898 team owing to his disastrous start in the City of London Championship; nevertheless, he won that tournament in spite of his disastrous start, and as he has the best score again this year, he could hardly be left out of any representative team. It must have been an invidious task to decide on the two members of the 1898 team to be left out; the choice ultimately fell on Mr. H. Caro, who lost at board No. 3, and Mr. Trenchard, who won at board No. 10.

KNOWLEDGE, PUBLISHED MONTHLY.

Contents of No. 159 (January).

The Mycetozoa, and some Questions which they Suggest. By the Right Hon. Sir Edward Fry, D.C.L., LL.D., F.R.S., and Agnes Fry. (*Illustrated.*)

Ozone and its Uses.

Two Months on the Guadalquiver.—I. The River. By Harry F. Witherby. (*Illustrated.*)

Witt's Planet DQ.

Considerations on the Planet Saturn. By E. M. Antoniadi. (*Illustrated.*)

Science Notes.

British Ornithological Notes.

Notices of Books.

Letters.

The Ovipositor of a Beetle (*Baptolinus alternans*) and the Teeth of the Dung Fly. By Walter Wesché. (*Illustrated.*)

Electricity as an Exact Science. By Howard B. Little.

Notes on Comets and Meteors. By W. F. Denning, F.R.A.S.

Microscopy. By John H. Cooke, F.L.S., F.G.S.

The Face of the Sky for January. By A. Fowler, F.R.A.S.

Chess Column. By C. D. Locock, B.A.

PLATE.—Saturn.

Contents of No. 160 (February).

On the Treatment and Utilization of Anthropological Data.—I. Colour. By Arthur Thomson, M.A., M.D. (*Illustrated.*)

The Bad Language of Wild Birds. By Charles A. Witchell.

The Karkinokosm, or World of Crustacea.—VII. The Box Crustacea. By the Rev. Thomas R. R. Stebbing, M.A., F.R.S., F.L.S., F.Z.S. (*Illustrated.*)

Secrets of the Earth's Crust.—I. The Unseen Core. By Grenville A. J. Cole, M.R.I.A., F.G.S. (*Illustrated.*)

Notices of Books.

Science Notes.

Obituary.

Letters.

The November Meteors in 1898.

Photograph of the Nebula N. G. C. No. 1499 Persei. By Isaac Roberts, D.SC., F.R.S. (*Plate.*)

Comparative Photographic Spectra of the Brighter Stars.

British Ornithological Notes. Conducted by Harry F. Witherby, F.Z.S., M.B.O.U.

The Nervous System of our Empire. By John Mills.

The Icknield Way in Norfolk and Suffolk. By W. G. Clarke. (*Illustrated.*)

Microscopy. By John H. Cooke, F.L.S., F.G.S.

Notes on Comets and Meteors. By W. F. Denning, F.R.A.S.

The Face of the Sky for February. By A. Fowler, F.R.A.S. Illustrated.)

Chess Column. By C. D. Locock, B.A.

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CONTENTS.

ON THE TREATMENT AND UTILIZATION OF ANTHROPOLOGICAL DATA.

By Arthur Thomson, M.A., M.B.

II.—THE HAIR.

In a previous article we dealt with the question of colour. We propose in the present chapter to take up the consideration of hair. It is a matter of difficulty to explain how man came to lose the covering of body hair with which he seems at one time to have been clothed. Most of us fail to recognize the fact that, covering almost the entire surface of the face and body, there is a scanty "down," so slightly developed, however, that it escapes our notice unless our attention be particularly directed to it. Yet it is remarkable that this hairy covering is better seen, and more uniformly distributed over the surface of our bodies at the time of our birth than in after years. The significance of this "lanugo," as it is called, is important, as it serves to indicate that during his development man passes through a stage in which his hairy covering is relatively better developed than at a later period of his growth. After birth we find that the hair covering the scalp continues to grow, whilst that covering the body undergoes regressive changes, and is represented in the adult by the "down" above referred to, the survival doubtless of a state in which our bodies were better protected in this respect. Much may be learned from a study of this fœtal hair. The manner in which the hair is implanted in the skin serves to indicate the habitual position in which the part so covered is exposed. To render this clear, it may be necessary to remind the reader that hair is a protective covering, which shields the animal from the inclemency of the weather, acting in some respects like thatch to carry off moisture falling on the surface of the body. We find, therefore, that in the more exposed situations the hair is directed downwards. Now, by a comparison of the manner in which the hair is implanted in man as contrasted with animals, we may obtain some hints as to differences in the habitual posture of the body and the disposition of the limbs.

What, perhaps, strikes us as most remarkable, is that in man the body hair is more scantily developed over the back of the body than over the front of the trunk. We see this particularly in those who, in adult life, develop a strong growth of body hair. The anterior surface of the trunk, thigh, and legs is usually covered with a stronger growth than the posterior surface of these same regions. Now this is in striking contrast with what we see in mammals as a rule; in them the growth of fur over the under surface of the trunk and the inner sides of the limbs is much more sparse than over the more exposed surfaces of the back and the outer aspects of the limbs. From this we may infer that man retained his hairy covering for some time after he assumed the erect posture, and that that growth was thickest over the most exposed surface of the body. We might, perhaps, explain our meaning better by saying that his weather side (*i.e.*, the front of his body) had a better covering to protect it than his lee side (*i.e.*, his back), in contradistinction to what maintains in quadrupedal mammals, where the dorsal surface of the trunk is more exposed to the inclemency of the weather. We will not here concern ourselves with those remarkable growths of body hair which appear after the age of puberty other than to observe that we know of no comparable growth in mammals—indeed the contrary seems the more general rule for those regions, *i.e.*, the axillæ and pubis, which in man are the most thickly coated are in lower forms the most thinly covered. At the same time we may add that the theory advanced by Dr. Louis Robinson—viz., that the axillary tufts were useful as affording the offspring a means whereby to get a good grip when, during flight, they sought the protection of the parent—appears to us more ingenious than convincing.

Before leaving the question of the general distribution of hair over the surface of the body, it may be of interest to note that, exceptionally, remarkable instances are met with of a pronounced development of this body hair. The most striking example hitherto met with is that of a family in Burmah, the members of which all displayed to an unusual extent this exceptional growth of hair. Doubtless many of our readers may remember the exhibition of some members of this family, and the photographs of them may still be obtained by those who seek for the curious. Among the races of man, the Ainu, who inhabit the islands north of Japan, are accredited with a stronger growth of head, face, and body hair than usually falls to the lot of most. In consequence these people are often spoken of as the hairy Ainus, though it may be candidly admitted that they are credited with a hairiness which facts do not seem to justify.

Whilst the foregoing considerations are interesting in view of man's descent, what more immediately concerns us are the variations met with in the texture and appearance of his head hair, for advantage is taken of these differences to help to classify the various races of man. We have already referred to the importance of hair as an index of colour, and we took occasion in a previous article to point out that, under ordinary conditions, there was a limit to its use in this respect, for what appeared to us as black hair might contain a much less amount of pigment than another sample, which appeared no blacker, if one may use such an expression. We then stated that the only satisfactory way of estimating the "blackness" of the hair was to extract the pigment from samples of equal weight.

But apart altogether from the question of pigment, we have the texture of the hair to consider. We are all familiar with what we term coarse and fine hair. Coarseness here implies that the individual hair is thick as compared with the fine variety. This thickness imparts to the hair a wiriness, which causes it in bulk to be less amenable to the use of the brush and comb than the thin or sleek variety. Furthermore, a thick hair may contain proportionately less pigment than a fine hair, weight for weight; the pigment is, as it were, present in more dilute form, so that the colour is not so pronounced, an explanation why the hair of the beard and moustache usually appears lighter in tint than the finer head hair. Again, some hair is straight, some wavy, and some curly. We find, as a rule, that thick hair is the straightest, whilst the finest hair is that which constitutes the "woolly" hair of the negro and negrito. Wavy hair is usually a hair of intermediate thickness. But hitherto we have assumed that all hair is of the same shape, that is, cylindrical on section. This we shall find presently is not the case. It is now many years since Pruner Bey drew attention to this difference in the hair of man. By making sections of different head hairs, he demonstrated that every variety between that displaying a circular form on section and that showing an oval or flattened section was met with. The

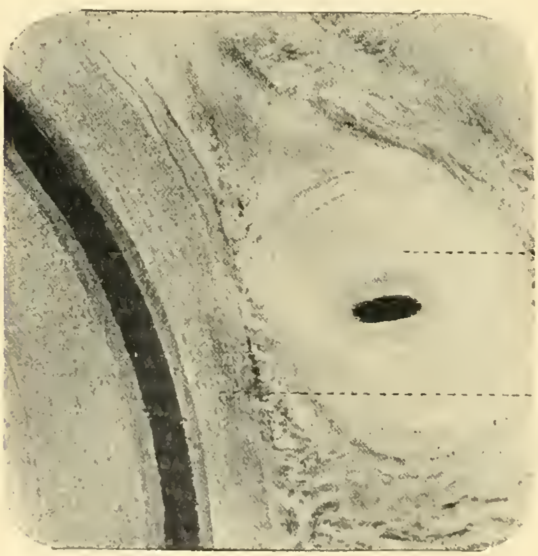


Fig. 1.—Section through scalp of a Bushman, showing curved hair follicles cut transversely (*a*), and longitudinally (*b*). In the centre of the hair follicle *a*, the flattened form of the section of the hair is seen.

circular section is characteristic of straight hair, either fine or coarse; the flattened form of curly or "woolly" hair; whilst the wavy variety displays intermediate forms. At that time this difference in the form of the hair was considered a sufficient explanation of its straightness, curliness or waviness, and it was not till some years later that Prof. Charles Stewart, of the Royal College of Surgeons Museum, pointed out that not only was the hair of the negro curly, but the follicle within which it grew was also curved (Fig. 1). This naturally leads us to a consideration of the structure of a hair follicle.

In a previous article,* some account was given of the structure of the skin, which consists of the dermis, or true skin, and the epidermis, scarf skin, or cuticle, which overlies it; the latter is further sub-divided into two strata, a superficial horny layer, and a deeper juicy layer, the *rete mucosum;* between these there is an intermediate folium, comprising the *stratum granulosum* and *stratum lucidum*. If the reader can conceive these superficial layers as pushed downwards around some solid cylinder into the substance of the true skin, or even onward, into the subjacent tissue, he will be able to form some idea of the manner in which the sheath of the hair is formed. The bottom of the recess so produced has projected into it from the vascular dermis or true skin a papilla-like growth. Around this the layers of the in-

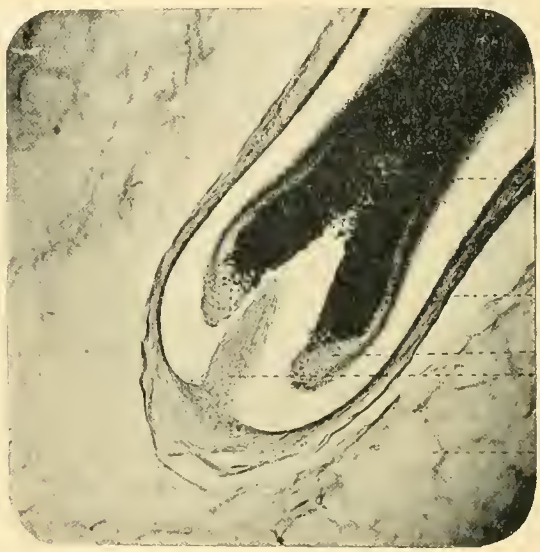


Fig. 2.—Photomicrograph of section through hair follicle. The root of the hair is displaced so as to show more distinctly the dermic covering and papilla, and the epidermic sheathes. *a*, Hair shaft; *b*, epidermic lining of sheath; *c*, dermic sheath of follicle; *d* marks the point where the eversion of the epidermic layers takes place over the surface of the papilla; *e*, papilla of the dermic sheath; *f*, subcutaneous tissue.

vaginated sheath are reflected, and as at this point, owing to its greater vascularity, the cell growth is most active, it follows that the cells of the *mucosum* which are proliferating most freely are thrown on to the surface of the papilla, and having no room to accumulate within the sheath, are gradually pushed along it so as to appear ultimately at its orifice on the surface of the body. Now, the evagination of the layers at the bottom of the sheath, dependent on the presence of the papilla, naturally leads to the eversion of the horny layer as well, so that we have a hair formed, the outer cells of which are horny, whilst the inner are soft, and form the core or medulla. The softer cells of the *mucosum*, as they advance over the surface of the papilla, naturally absorb the pigment which is brought to them by the blood and lymph streams, but as they advance

* Knowledge, February, p. 25.

they retain their pigment, and thus cause the hair to be coloured. In this respect these lower cells of the *mucosum* differ in their behaviour from what we have seen in the

Fig. 3.—The same as Fig. 2, more highly magnified. *a*, The deeper cells of the epidermic layers, loaded with pigment; *b*, shows where the epidermic layers are everted over the surface of the papilla; *c*, the papilla, an upgrowth from the dermic sheath; *d*, the dermic sheath.

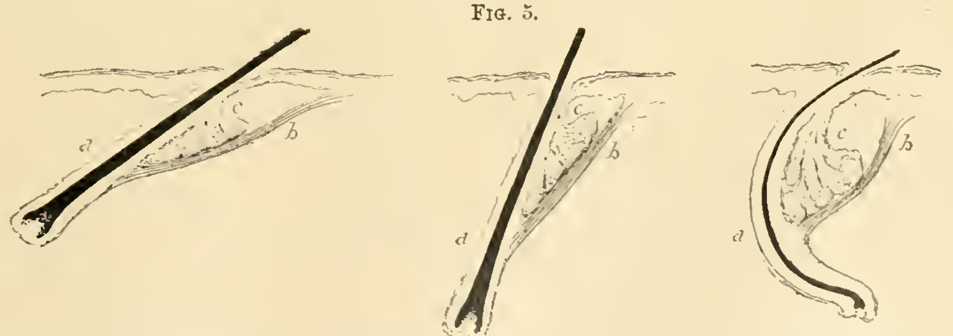
integument, for there they remain pigmented only in the deeper layers. As was stated in the previous article, if we adopt the accepted view with regard to the regeneration of the more superficial cells of the epidermis, we have to account for the disappearance of the pigment within these cells of the *mucosum* as they advance to the surface, but as was pointed out in the same article, the accepted view appears to us untenable, and necessitates the explanation of the disappearance of the pigment in the superficial layer of cells, which disappearance curiously does not occur in the hair, although it is probably subjected to similar influences. The view we suggested, viz., that the intermediate layers of the epidermis, *i.e.*, the *stratum granulosum* and *stratum corneum*, were the active layers, and that growth occurred in two directions, *i.e.*, towards the surface and towards the true skin, would at once overcome all difficulties—difficulties which are still further emphasized when we come to deal with the coloured races. If the reader has followed the description given above, he will recognize that the evagination of the layers of the sheath over the papilla at the base of the follicle leads to an eversion of these layers, so that the deep layers of the *mucosum*, no longer imprisoned by contact with the superficial aspect of the *cutis vera*, are now thrown outwards over the surface of the papilla and pushed onward into the sheath. So long as there is pigment to absorb these cells will retain it; but as the deeper layers of the *mucosum*, which rest on the surface of the *cutis vera*, cannot be displaced, the pigment remains there permanently; whereas over the surface of the papilla, the cells, constantly shifting, carry with them the pigment, they have absorbed, into the body of the hair; when, however, that supply of pigment ceases, there is no longer any for the moving cells to absorb, the consequence being that the cells forming the hair are now colourless, and so the hair appears on the surface as grey at the root. In this way we have a simple explanation why a negro may have grey hair and yet retain the blackness of his skin; in the former situation the pigment-loaded cells are shed, and

Fig. 4.—Longitudinal section through hair follicle, showing sebaceous gland and hair muscle. *a*, Hair shaft; *b*, sebaceous gland; *c*, muscle of hair.

cease to be coloured when there is no more pigment to be absorbed; in the latter situation the cells constitute a permanent layer, which never advances to the surface, and therefore retain for indefinite periods the pigment which has been taken up.

The question of the manner of production of the straight and curly varieties of the hair has long been a matter of conjecture, and hitherto no satisfactory explanation has been forthcoming. There are a number

Fig. 5.



Straight Hair. *a*, Hair follicle, with hair shaft inside; *b*, hair muscle; *c*, sebaceous gland.

Straight Hair erected by action of Muscle. *a*, Hair follicle, with hair inside; *b*, hair muscle; *c*, sebaceous gland.

Curved Hair (Bushman). *a*, Curved follicle, with hair inside; *b*, hair muscle; *c*, sebaceous glands.

of facts which it appears to us are of importance in the consideration of this question. Each hair follicle is provided with a sebaceous gland opening into it, together with a muscle connected with it; these are well represented in the photomicrograph (Fig. 4). The size of the gland varies considerably in different individuals, and from our own observations appears larger and better developed in the negro races. The muscle called the *erector pili*, from its attachments, has long been recognized as having an influence on the position of the hair, causing its erection by pulling forward the root of the hair, thus converting

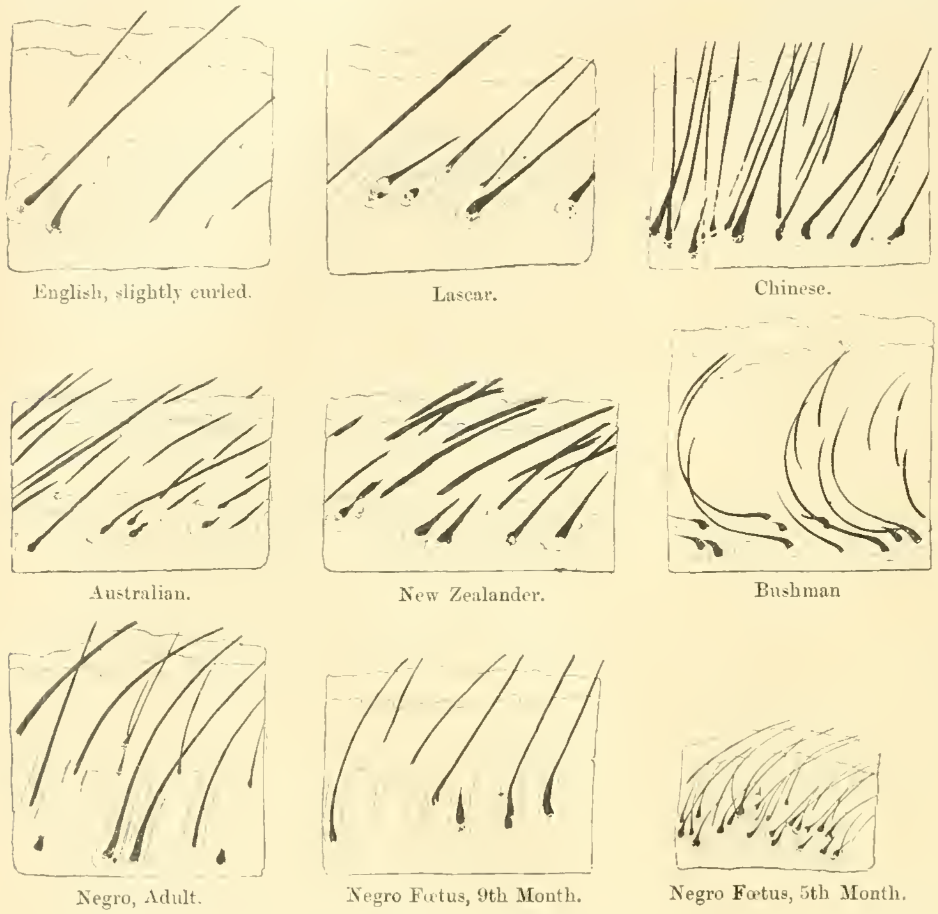


Fig. 6.—Sections showing appearance of the hair follicles in the scalps of races with straight, wavy, and curly hair.

the shaft into a lever, the fulcrum of which corresponds to the dense *stratum corneum* through which it passes to appear on the surface. Such action of these little muscles is displayed when a cat in rage erects the hair of its tail, or a straight-haired dog causes the hair of its back to rise in a median crest (Fig. 5). Their influence in man is commonly observed in the condition known as "goose skin." Further, it is to be noticed that the gland is always placed between the muscle and the hair shaft, thus occupying the triangular interval between them, so that during the action of the muscle the gland must necessarily be subjected to pressure, aiding thereby the expulsion of its contents.

As has been already stated, straight hair is always circular in section, and is usually thicker than curly hair, which is ribbon-like and fine, the finest human hair being that met with in the Bush and Andaman races. Now it appears to us that these facts have a most important bearing on the question under consideration. In order that the muscle afore-mentioned may act as an erector of the hair, it is necessary that the hair must be sufficiently strong to resist the tendency to bend; unless this be so, the lever action is at once destroyed. On the other hand, when the hair is fine and ribbon-like, the shaft, no longer sufficiently stout to resist the strain of the muscle, naturally assumes a curve, and this, we think, is the explanation why the follicle assumes the form so well displayed in the section of Bush scalp represented in Figs. 1 and 6. The influence of the sebaceous gland on this curvature must not be overlooked. If a scalp, in which the follicles are curved, be examined, the gland is seen to be placed on the concave surface of the curve, and the muscle is attached to the same side of the follicle just below the gland; the gland, therefore, forms a mass of greater resistance around which the follicle may be curved by the traction of the muscle, thus leading to the characteristic form of the follicle met with in races with curly hair. At the same time it may be noticed that the base of the follicle is often hooked backwards, as may be seen in the Bush scalp (Fig. 6), and this, presumably, must be accounted for by its vascular connections, which are here best developed, and which will tend to withstand the strain exercised by the muscle. The follicle thus becoming more or less permanently curved, it naturally follows that the softer cells at the root of the hair will accommodate themselves to the curve, and becoming more horny in their consistence as they advance to the surface, will retain the form of the follicle in which they are moulded, the cells on the concave side of the hair being more compressed than those on the convex side. In this way we have, in all probability, a more reasonable explanation of how curliness in the hair is produced than any hitherto offered.

There are other considerations which might be mentioned in this connection, but these are beyond the scope of the present article.

THE LOVE-GIFTS OF BIRDS.

By Charles A. Witchell.

April and May are the chief months in which wild birds are nesting; and in these months the birds' small property is most heavily taxed by collectors. All but a minute fraction of this waste of egg-life is useless. But this is an old theme. The remark might be permitted, however, that in the treatment of wild birds the country should learn from the city, where public ornithology rises above the use of the gun, and knows how to tame as well as how to kill. It might be of benefit to the sportsman who goes to the seaside armed with a gun if he were to stand for five minutes on the Embankment, or on the bridge in Regent's Park, to see the gulls fed.

In some earlier articles in Knowledge I have endeavoured to prove to the person who is developing an interest in bird-life (with the usual results), that if he does but sit down under a hedge instead of searching it, and looks and listens, he may gather a richer store than ever filled a collecting-box, though it be but a store of changing pictures in memory's cinematograph.

It is now proposed to approach another theme—the restraint of a wild bird's impetuous voracity when it offers food to a courted companion or a brooding mate. The incident proves the bird to be akin to man in sense and feeling; and even the possession of ulna, radius, and metacarpals, will never prove that. It is not every animal that rises to so high a level as to share dinner with a mate; not all dogs, nor even all human beings attain to it.

Of course, if adult birds of any species habitually fed each other on ordinary occasions, the same behaviour in the breeding season would be no evidence that it had anything to do with love. But the converse is the case. I have never heard of a wild bird which habitually shares its food with a mate. In times of scarcity, however, a bird has sometimes been observed to feed a companion. In the severe winter of 1879-80 there was a good deal of snow in the western counties, and the rooks had a bad time, finding a diet of mangold insufficient. Several of them came to a garden in which the birds were fed. Another rook, whose flight betrayed its lightness and weakness, perched in a tree there, and one of the usual two or three took up a piece of bread directly to the newcomer, and gave it up to him without any show of resistance or anger. I saw this from a distance of about twenty-five yards. Quite possibly the birds were mates; but the incident is only mentioned for its rarity.

In the nesting season the males of many species feed their mates on or "off" the nest, as is well known. The rook, for instance, brings food to his mate, who, when receiving it, flutters her wings (a frequent habit at this time), and also utters a hoarse cry similar to the cries of the young. The adult rook utters this note on no other occasion. In several species of finches, also, the male feeds his sitting mate. I have seen this done by the chaffinch, greenfinch, linnet, and lesser redpole. The recipients shook their wings and uttered call-notes. The food thus bestowed could hardly be termed a "love-gift"; but when, before birds have a nest, and apparently before they have paired, the male gives the female morsels of food, it is fair to assume that this courtesy is intended as an earnest of passion—that it is, in fact, a love-gift.

I do not know of any book to which the student can refer for information on this fascinating theme. He should, therefore, refer to the book of nature; and if he will use a small telescope, and be silent, he should easily obtain information from this source.

Among the raptores, it is probable that the brooding female obtains food chiefly by the agency of her mate. Major C. Hawkins Fisher (the well-known falconer) informs me that the male peregrine hunts all day to supply the domestic larder, which is in the charge of his mate.

Among domestic birds, the common fowl affords a conspicuous instance of gallantry when the male calls the females to some choice morsel. He obviously intends the tid-bit only for the hens, and any rival attempting to partake of it is at once attacked.

In regard to domestic pigeons, I have obtained information from my brother, Mr. E. N. Witchell, who has been for many years a successful flier of homing pigeons, and has from childhood kept this and other varieties. One of the indications of pairing by pigeons is the insertion of the beak of the male into that of the female, and this is accompanied by a shuffling of the wings exactly as occurs when the young are fed. It does not appear, however, that any considerable amount of food (if any at all) passes from the male. Homers never omit this performance before pairing. The male homer is passionately fond of his home, his mate, and his young. But though his mate is a model wife, he is not a model husband, and often, especially if a strong flier, he is likely to bring domestic troubles into the life of any unmated young female bird in the loft. But it is a general rule for the cock to "feed" only his own hen, though there are exceptions to this rule. This very curious fact has often been noticed by my brother. It indicates that to the wife of the nest this courtesy of the pigeon is reserved, and that the other birds are deemed unworthy of it. These observations do not apply to pouters, runts, and trumpeters, which are "very immoral." It should be remembered that homers live the most naturally of any except farmhouse pigeons, and they may, therefore, be supposed to possess the natural instincts of their race in greater vigour than any other fancy breed.

Returning to wild birds, my opportunities have been too limited to enable me to generalize; but the following observations may be not without value to those who try to see in the bird a sentient and tender being.

A few days after the arrival of the spotted flycatcher, a pair of them were in a near tree. The male often attempted a song, and was evidently following the female. He suddenly went forth on a longer journey than usual, as though for a larger insect, turned and went to the female, and in the gentlest manner presented to her the captured insect (which appeared to be of the size of a bee). She took it sedately. Shortly after, she received another gift of the same kind. A second pair of flycatchers behaved in precisely the same manner. Last April a male robin gave some food in the same way to its mate. Both birds often uttered their call note.

Several male chaffinches, before nesting time, gave captured insects to their intended mates. All these insects were captured in flight. The chaffinches were full of ardour, the males, all a-flutter with excitement, following the females, and with the cuckoo-like flight, which is one of the bird's surest signs of love, and repeating the soft love-note almost incessantly.

On one of the first days of May, two willow wrens were busy in a hedge. The male often sang, but was mainly intent on keeping near his companion, who appeared to be a female bird. She was seemingly indifferent to his presence, and hunted for insects with all the graceful activity of her species. But she remained in the same spot. The male was greatly excited, his wings lowered and pulsating, and his call-note prolonged to a scream rather than a chirp. Through the telescope it was evident that she also was trembling a little. Suddenly the male darted forth, returned and alighted near the other. He then without haste went to her, and her beak met his. The incident was so brief that the telescope could not be used; but it was, perhaps, fair to assume that he had found and bestowed a love-gift. She accepted it with the same sedateness that the female flycatchers, chaffinches, and robin had exhibited in the like circumstances.

THE ACETYLENE INDUSTRY.

By George T. Holloway, assoc.r.coll.sc., f.i.c.

ACETYLENE or "ethine" has been known for about sixty years, yet it is only within the last four years that it has been proved possible to produce it at a cost which renders it of commercial importance. Even now, it must be considered to be merely on trial, although the industry which embraces the manufacture of calcium carbide, and the production from it of acetylene, is already an important one, and is represented by over half-a-dozen journals in various languages specially devoted to its interests. This gas has always occupied a peculiar position among organic bodies, from the fact that it is the lowest member of the important group of compounds known as hydrocarbons; and, further, that it is the only hydrocarbon which can be produced synthetically, and that it thus forms the starting point from which other organic bodies have been built up. Its singular properties and the manner of its decomposition, under certain conditions, have also contributed to placing it in a unique position.

Acetylene was first prepared in an impure state by Edmund Davy, by the action of water on the mass obtained by heating cream of tartar in an attempt to manufacture metallic potassium. He called it "klumene," but, as he made no investigation of its properties, it attracted no interest until its re-discovery by Berthelot, who obtained it in a state of purity. It may be prepared synthetically by the action of hydrogen on carbon heated to whiteness by the electric arc. It is also produced by strongly heating or sparking marsh gas—many other bodies, including benzene, being also produced; or by the incomplete combustion of hydrocarbons, such as those in coal gas, as is noticed when a Bunsen burner "burns back."

These processes, however, are of scientific interest only, as the amount of gas produced is but small in any case, and the method of production which has given rise to the acetylene "boom" consists in the action of calcium carbide upon water. The carbide is now always produced electrically, as described later on.

Acetylene is a colourless gas about nine-tenths the weight of air. It is stated to have a pleasant ethereal odour when pure, but, as ordinarily prepared, it has a strong unpleasant smell resembling that noticed when ordinary iron filings are dissolved in dilute hydrochloric or sulphuric acid.

At eighteen degrees Centigrade it can be liquefied by a pressure of eighty-three atmospheres, while at one degree Centigrade only a pressure of forty-eight atmospheres is required. It forms a mobile liquid, having a specific gravity of 0·451 at zero Centigrade, and it has the lowest refrangibility of any known liquid or solid, also the greatest co-efficient of expansion. At eighteen degrees Centigrade, water dissolves its own volume of acetylene gas, carbon tetrachloride or turpentine dissolves twice its volume, amyl alcohol three and a-half, benzene four, and glacial acetic acid six times its volume, while acetone, which has been proposed as a convenient means of storing the gas in solution, dissolves no less than twenty-five volumes at fifteen degrees Centigrade, at the ordinary pressure, and three hundred volumes at twelve atmospheres pressure, but the solubility is much less at higher temperatures, and is only half as much at fifty degrees Centigrade. Commercial acetylene is poisonous, though not so injurious as carbon monoxide. The gas affects the respiration and weakens the heart and lungs. The pure gas is said to be harmless when inhaled in small quantities, and Dr. Weyle states that air containing nine per cent. of ordinary acetylene may be breathed for a "long period" without serious results.

Among its other peculiarities, acetylene has the power of combining with many metals with the production of highly characteristic compounds, which are of importance as bearing upon the dangers attending its use, and also as affording a convenient means of purifying it or of ascertaining its presence in admixture with other gases. The most interesting of these compounds is the acetylide of copper, which is formed as a red precipitate when acetylene is passed through an ammoniacal solution of cuprous chloride. When dry, it explodes if struck or if heated to one hundred to one hundred and twenty degrees Centigrade, leaving a black velvety mass containing carbon and metallic copper. This acetylide is so characteristic that its production forms the most delicate test for acetylene, as little as 0·005 of a milligramme being thus capable of detection according to Berthelot. The well-known danger of explosion, often from unascertained causes, may be largely attributed to the fact that acetylene is an endothermic compound—*i.e.*, that the combination of carbon with hydrogen to produce acetylene absorbs heat to the extent of sixty-one thousand one hundred heat units. Hence, any cause which gives rise to a sudden decomposition of acetylene results in the evolution of great heat. The decomposition of the gas by the induction spark at the ordinary atmospheric pressure is not, however, rapid, and takes place only where the spark acts. Liquid acetylene appears to explode *en masse* under certain conditions, and, as these are not clearly defined, it must be regarded as highly dangerous. The explosions which have occurred were so destructive as to prevent the possibility of determining the cause.

Messrs. Berthelot and Vielle find that, under a pressure of two atmospheres or more, even a platinum wire heated by the electric current produces complete and explosive decomposition of acetylene gas. The intensity of the explosion increases with the initial pressure, and this increase is very rapid as the pressure approaches the liquefying point of the gas. Liquid acetylene may be similarly exploded by a hot wire, but not by blows or shocks, although the breakage of a cylinder of the liquid by a blow is usually followed by an explosion, probably induced by sparks from the friction of the broken metal. These investigators are, however, of opinion that the properties referred to need not prevent the domestic use of acetylene if proper care is taken in the preparation and manipulation of the gas, and it appears evident that the purer the acetylene is the less danger exists of explosion from friction and other causes.

According to Prof. Clowes, air containing any proportion of acetylene between three and eighty-two per cent. is explosive, and, as this is a far wider range than is shown by any other combustible gas, there is little doubt that it is in part due to the endothermic nature of acetylene. It is stated by Gréhau that the most explosive mixture contains one volume of acetylene to nine volumes of air.

Before considering the manufacture of calcium carbide and acetylene on a large scale, it is of interest to note that although many other metallic carbides exist, that of calcium is at present the only one known which yields acetylene in sufficient quantities to stand any chance of competing with coal gas, electricity, etc., as a source of illuminating power. In the case of aluminium carbide, for instance, the action of water yields practically pure methane (marsh gas), while the carbide of manganese, under similar conditions, yields methane and hydrogen, and that of uranium gives off not only gaseous but also liquid and solid products, mainly of the ethylene group.

The best calcium carbide in the market is that produced by the Acetylene Illuminating Company at Foyers, in Scotland, but the Willson Company at Spray and Niagara Falls, in America, the Neuhausen Aluminium Company, in Switzerland, and many other companies, are also large producers. The principle of manufacture is the same in all cases, and consists in passing a powerful electric current, by means of large carbon electrodes, through a mixture of carbon and lime. The best form of carbon has been found to be coke, and unslaked lime is preferred to slaked lime.

The following account refers to the method of production employed at the Willson Aluminium Company's Works. The coke, containing from seven to ten per cent. of ash, is pulverised and mixed with ground lime, containing about one and-a-half per cent. of magnesia, and not more than one per cent. of other impurities, sixty-four to sixty-five parts of coke to one hundred parts of lime being used. The mixture is charged into an iron car, the bottom of which is covered with a layer of carbon, which forms one of the electrodes, and is connected with the dynamo conductor by a clamp, fixed to a projection on the car by a screw.

The other electrode consists of twelve carbon pencils, each four inches square and thirty-six inches long, dovetailing into a holder, and surrounded by an iron jacket to minimise waste by oxidation. This electrode is connected with the dynamo by a copper bar enclosed by iron slabs, and its height is adjusted by means of a chain operated by a screw, as the current is found to vary from the amount required.

The charge is run into the car through shoots, aided by four-bladed feed rods. The car is automatically moved to and fro about two inches, twenty times a minute, by means of a rod, to keep the mass compact. The gases evolved during the reaction escape at a chimney, and a cold-air jacket is also provided. Doors are fitted to the furnace. The charge covers the pencils to a height of about twelve inches.

The best yield has been found to be produced by a one hundred volt current and one thousand seven hundred to two thousand ampères. The carbide is obtained in the form of an ingot, the inner portion of which is almost pure. Around it is a less pure carbide, containing fifty to seventy per cent. of carbide, while this, again, is surrounded by the unaffected charge which is used again. The pure and second rate carbide are usually broken up together so as to yield a mixture which gives five cubic feet of acetylene per pound of carbide, instead of 5·89, the theoretical amount under ordinary atmospheric conditions.

At the extensive Swiss works, where the cheap water power has given rise to the erection of several large carbide plants, the method of production is somewhat different, the reduction being performed in crucibles and the product usually drawn off while liquid. The selling price of the Swiss carbide is now about forty centimes per kilogramme (2·2 lb.), say £16 per ton, for quantities of over a ton. According to Korda, the cost of production at present never falls below £10 per ton.

SECRETS OF THE EARTH'S CRUST.

By Grenville A. J. Cole, M.R.I.A., F.G.S., *Professor of Geology in the Royal College of Science for Ireland.*

II.—THE OLDEST FAUNA OF THE GLOBE.

PRIOR to the publication of Darwin's "Origin of Species," most geologists would have been content to regard the oldest known fossil fauna as truly that which was first formed upon the globe. The Cambrian strata, investigated by Prof. Sedgwick about 1840, were seen to contain a considerable number of organic remains; but these were obviously more obscure and "primordial" in type than those found, in such wealth of variety, in the overlying Silurian beds of Murchison. Even when, in 1846, Barrande had revealed the beauty of preservation of the Cambrian fossils of Bohemia, the absence of any evidence of previous organisms made it natural to suppose that life itself sprang into existence at this horizon. The arguments that were fully justified only sixty years ago are well expressed in the words of Mr. Joshua Trimmer :—*

"The rocks of the Cambrian group . . . . occur at but few points, and in small quantities, amidst a great thickness of sedimentary rocks, extending over a wide area, and this circumstance, connected with the paucity of species where the fossils are in the greatest abundance, appears favourable to the presumption that the absence of organic remains from the older stratified rocks of the mica slate and gneiss systems is not the effect of any process by which they have been destroyed, and that in the Cambrian rocks we behold the first appearance of organic life upon the surface of our planet."

Prof. John Phillips, in devising the terms Palæozoic, Mesozoic, and Cainozoic, recognised that we must divide up geological time by the succession of faunas, as established by William Smith in 1815. The base of the Palæozoic or "old life" group has long been fixed at the bottom of the Cambrian system. Any strata earlier than that horizon became styled Azoic (devoid of life) or Eozoic (dawn of life), according to the philosophy of the writer. Nowadays, the terms Archæan and Precambrian, which commit us to no opinion, are employed for this most ancient group. It is obvious that one of the profoundest secrets of the earth's crust has been entrusted to the Precambrian strata.

Mr. Trimmer, as above quoted, and his contemporaries, commented on the absence of organic remains from the "mica slate and gneiss systems," the fundamental rocks on which so many of our Cambrian beds repose. Even if these old rocks result from the metamorphism of sedimentary masses, it is extremely improbable that fossils could remain in them unharmed. In recent years, moreover, it has been made clear that the banded structures of schist and gneiss, so long relied on as indications of a sedimentary origin, are commonly due to flow of the mass, or, in some cases, to the penetration of one rock by another in thin parallel sheets. Scrope and Darwin† long ago ascribed these foliated structures to flow in a non-homogeneous body; but the truth of their observations was overlooked for half a century. The result, however, of the acceptance of their views is that few are likely to look for fossils on the foliation-planes of an Archæan schist. It chances that here and there, among Palæozoic schists, some remains of organisms have survived; but their broken and distorted condition offers little hope to the student of more fundamental masses.

In many parts of the globe, however, we find unmetamorphosed and clearly stratified rocks, underlying the lowest Cambrian, and resting unconformably on the ancient metamorphic series. Thus the normal types of sediment by no means begin with the fauna studied by Sedgwick and Barrande. It has become, indeed, necessary to set a limit to the Cambrian deposits, a limit which shall at the same time mark the close of the mysterious Archæan era.

Such a limit has been found in what is called the *Olenellus* zone, or, better, the *Olenellus* series. Just as it is convenient to classify the Cretaceous beds by their prevalent sea-urchins, or the Jurassic beds by their ammonites, or the Ordovician and Silurian by those obscure

* "Practical Geology and Mineralogy," 1841, p. 199.

† See, for instance, G. P. Scrope, "Geology of the Ponza Isles," *Trans. Geol. Soc.*, 1824, p. 228; and Darwin, "Geol. Observations on Volcanic Islands," end of chapter iii., and "Geol. Obs. on S. America," end of chapter vi.

but useful organisms, the graptolites, so the trilobites have been selected for the division of the Cambrian system. *Olenus*, *Paradoxides*, and *Olenellus*, mark respectively the Upper, Middle, and Lower Cambrian; and the fauna associated with *Olenellus* has naturally assumed considerable importance.

In America, where the first forms of this trilobite were described, the succession of the strata was obscured by the thrusting up of the Lower Cambrian locally upon higher beds, and even on the Ordovician. The fauna was carefully worked out, but its importance was not at first fully realised. Dr. Brogger,* however, compared it with that of the *Olenellus* beds of Europe, which were clearly at the bottom of the series; and he urged that further examination of the succession in America would lead to some re-arrangement of ideas. Mr. Walcott† undertook this work by visiting Newfoundland, where the beds were less disturbed; and in 1888 he triumphantly reported that *Olenellus* and its associates must be placed as the fundamental fauna. Since then the name of this trilobite has become familiar, and the search for organic remains below the *Olenellus* beds has been undertaken in every quarter of the globe.

In our own islands, inroads have been made on the accepted dicta of our text-books. Prof. Lapworth‡ announced, in 1888, the discovery of *Olenellus* near the base of the Comley or Hollybush Sandstone in Shropshire. This same Hollybush Sandstone was formerly regarded as Middle Cambrian. A far more important change is the consequent reference of the Longmynd mass to the Precambrian systems. Though its boundaries are in part faulted and obscure, there is little doubt as to its antiquity, especially as the series following upwards from the *Olenellus* beds are represented by fossiliferous strata in the same locality, quite different in character from the barren slates and sandstones of the Longmynd.

In 1891, Sir A. Geikie§ recorded *Olenellus* from the North-west Highlands of Scotland. The trilobite, and its associated fauna, occur in the base of the Durness series, which was long supposed to be Ordovician. This series reposes unconformably on the famous Torridon Sandstone. The latter thus becomes Precambrian.

Here, then, we have in Britain two fine masses of deposits in which to search for an earlier fauna than the Cambrian. As yet, unfortunately, only obscure traces have been discovered.‖ While ripple-marks and rain-prints show that the conditions of deposition resembled those of modern strata near a shore, the Longmynd beds for many years yielded nothing except worm-borings and worm castings. Imperfect brachiopods (*Lingulæ*) are now recorded by Prof. Blake. The Torridon Sandstone, with its gritty and conglomeratic strata, is even less likely to have retained traces of organisms.

The prize may, however, ultimately fall to some unprofessional but keen-eyed visitor to either of these interesting regions. The Longmynd—the "long mountain"—forms a picturesque highland, rising to seventeen hundred feet, west of Church Stretton in Shropshire. Its moorland slopes, cleft by steep ravines, its heather-clad crests and sparkling streamlets, attract the eye by contrast with the cultivated lands. Grouse still call across these wilder summits; and the geologist, cycling, it may be, from London, finds in the Longmynd his first contact with the mountains.

The Torridon Sandstone offers a far wider field. It forms a sort of bulwark, a chain of fastnesses, on the northwest coast of Scotland, stretching for seventy miles from Loch Carron to beyond Lochinver. The total thickness is estimated at from eight thousand to ten thousand feet; and Sir A. Geikie has pointed to occasional shaly bands as possible preservers of the fauna. The material of the sandstone is derived from the crystalline Archæan masses; and in places, as on the coast of Lewis, the conglomerate between the sandstone and the gneiss provides a fine picture of the ancient shore. But the great secret will hardly be revealed in these sandstone beds themselves. Such rocks are proverbially barren; and shells that may have lain upon a pebbly beach become broken up during entombment, or are dissolved away later by permeating waters. The Torridon beds, moreover, may be lacustrine, like the Old Red Sandstone to the east; this would still further limit their fauna, in comparison with that which may be found in other areas.

In Charnwood Forest, a rough upland rising unexpectedly through the industrial lowlands of Nottingham and Leicester, another Precambrian area has been recognised. But the slates and sandstones, associated with volcanic tuffs, have here given no sign of fossils.

In almost every region of Archæan rocks, whether we select North America, Scandinavia, or Bohemia, we find similar stratified Precambrian systems resting on the highly metamorphosed or igneous series. These systems are not likely to prove of the same geological age throughout the world. If the "fundamental gneisses" represent in any area the primitive crust of our cooling planet, an enormous interval of time must separate the period of their consolidation from that in which *Olenellus* flourished. In the intervening deposits, the succession of which is yet unknown, lies entombed the oldest fauna of the globe. The earlier of these deposits must have been laid down in water of high temperature; but it is just possible that a more uniform distribution of heat, and an absence of the chilly depths that now prevail in our oceans, may have favoured the spread of primordial life across the globe.

Lowly forms of life, in a suitable environment, multiply with extreme rapidity. Their comparative immunity from disease, their simple and easily satisfied needs, the convenient interchange of their protoplasm from one individual to another, give them, indeed, the semblance of immortality. But it is only when such forms became provided with a skeleton or a shell—when, in fact, their needs had grown far more complex—that their remains had a chance of being preserved.

If, further, we hold with Prof. Judd* that "no good reasons have been adduced for asserting that any of the highly crystalline rocks—whether foliated or not—were originally part of the globe as it first consolidated from a state of fusion," we may well despair of finding any fauna of such vast antiquity as that now under discussion. The mutual interpenetration of members of the old gneissic series certainly suggests that much valuable evidence has been altogether swallowed up in cauldrons of re-melted fundamental rocks.

But this fascinating secret is not to be disposed of or set

* "Om alderen af Olenelluszonen," *Geol. För. Stockholm Förhandlingar*, Bt. VIII. (1886), p. 182.

† "Succession of Cambrian faunas in N. America," *Nature*, Vol. XXXVIII., p. 551.

‡ *Geol. Mag.*, 1888, p. 484; *ibid.*, 1891, p. 532.

§ *Geol. Mag.*, 1891, p. 498. See also Peach and Horne, *Quart. Journ. Geol. Soc.*, Vol. XLVIII., p. 227, and Peach, *ibid.*, Vol. L., p. 661.

‖ *See* J. F. Blake, "Monian Rocks of Shropshire," *Quart. Journ. Geol. Soc.*, Vol. XLVI. (1890), p. 391; Geikie, *Geol. Mag.*, 1891, p. 499.

* "The Student's Lyell" (1896), p. 563.

aside, because it may never come entirely within our grasp. The real problem at the present day lies in the amazing completeness of the Lower Cambrian fauna, and in the trivial nature of the discoveries that have been made in underlying strata. Setting aside the once famous *Eozoön*, which is itself a crystalline metamorphic rock, we know of possible radiolaria in Brittany, obscure brachiopods from the Longmynd, and a slightly more hopeful series of remains from Arizona.* These last include, to quote Mr. Walcott, "a small Patelloid or Discinoid shell, a fragment of what appears to be the pleural lobe of a segment of a Trilobite, and an obscure, small Hyolithes." Lower down, "an obscure Stromatoporoid form occurs in abundance." The caution of the above sentences is noteworthy. If the suggested determinations become fully verified, we have here a brachiopod, a trilobite, a pteropod, and a hydrozoan. Similarly uncertain remains have been found in Canada and Newfoundland. North-west India, however, now seems to offer a better field.

The one thing positive about Precambrian life is the prevalence and antiquity of annelids. Traces of worms have been everywhere recorded; and other soft-bodied animals have left tracks, which are difficult enough to decipher.† On zoological grounds, worms occupy an august position in the long chain of animal life. Mr. H. M. Bernard‡ derives such highly organised creatures as the trilobites from a "browsing annelid, with first segment bent round, and lateral projections." The argument connecting the existing crustacean *Apus* with *Olenellus*, and both with their "richly segmented annelidan ancestor," forms a highly instructive chapter in palæontology. In his later paper, Mr. Bernard even affirms that "the crustacea can now be linked, step by step, with the chætopod annelids." To him, looking far back into undiscovered faunas, the trilobites themselves appear as "browsing armoured annelids," their ancestors behind them having possessed sixty to seventy segments, and having been genuinely worm-like. But what of the ancestry of these worms themselves? The pages of the vast Precambrian history must be turned with hesitating slowness.

The stimulus for research is found at once when we consider the Lower Cambrian fauna. We have there so much to account for—so much that cannot have sprung, full armed, from mother earth. Walcott's review of this fauna,§ with his fine series of plates, shows how complete our knowledge has become. To begin with, we have sponges, including the spicular mesh of the well-known *Protospongia* of Wales; early types of corals, which were formerly classed as sponges; hydrozoa, represented by graptolites, and by strange dark markings and siliceous bodies, which are believed to be internal casts of jelly fish.‖ A few plates of a cystidean, one of the primitive sea-lilies, have been discovered in America. The brachiopods have long been known, including *Kutorgina* in our Hollybush Sandstone, and *Lingulella*, an ancestor of the still surviving *Lingula*. In Britain, the oldest lamellibranchs are in the Upper Cambrian; but bivalve molluscs actually occur in the *Olenellus*-zone of North America, and form one of the more surprising features of the fauna. If the lamellibranchs are regarded as degenerate molluscs, their degeneration must have taken place during the Precambrian ages.

Then we have gastropods, including even *Pleurotomaria*, which attained its full development in Jurassic times, and which is still represented by four species in the warm seas of the present day. *Hyolithes*, a common Palæozoic fossil, is generally treated as a pteropod, but brings us to the verge of the cephalopods, and caps this molluscan series. Higher animals are represented by the trilobites.

Of these we already know some fourteen genera, including the zone-fossil, *Olenellus*. Species of *Olenellus* have been multiplied of late, and have been named after workers in this difficult Cambrian field. The species here figured (Fig. 1), *Olenellus Thompsoni*, was described from Parker's Quarry, Vermont, by James Hall in 1859, and was made by him,* in 1862, the type of the genus *Olenellus*.

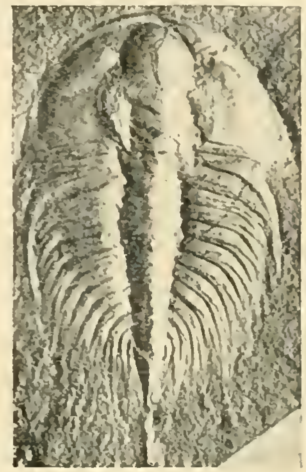


Fig. 1.—*Olenellus Thompsoni.* Lower Cambrian. From Parker's Quarry, Georgia, Vermont, U.S.A. From a specimen presented by the U.S. Geol. Survey to the Royal College of Science for Ireland. (The head-shield has become pushed back slightly, the large body-segment being in reality the third.)

We have, then, in the lowest Cambrian a rich invertebrate fauna, primitive in some respects, but still far from being primordial. A sea in which fishes had not yet arisen, a world which was dominated by quaint crustaceans some four or five inches long, seems very far removed from the conditions of the present day. But when, on the other hand, we consider the time required to differentiate the groups of the mollusca, to encase the cystidean in his plated calyx, to define the genera of the trilobites, so that *Olenellus*, "richly segmented," lies side by side with the dwarfed and specialized *Agnostus*, then we may see in the *Olenellus*-zone the beginnings of our modern fauna. The secret beyond that zone spreads out through immeasurable ages. It is written, as it were, on a torn papyrus, the fragments of which lie scattered round about the globe. At length some skilful worker may fit two lines together, though their position in the whole document may still remain unknown. Yet such a couplet would be for him the triumph of a life-time.

Notices of Books.

The Native Tribes of Central Australia. By Professor Baldwin Spencer and F. I. Gillen. (Macmillan & Co., Ltd.) 21s. net. Whoever takes up this book with the hope of finding within its pages a thrilling narrative of life and adventure among the blacks of Central Australia will be grievously disappointed. Not so the serious student of anthropology, who will discover in it a veritable storehouse of information regarding the manners and customs of the aborigines. It is not often that we meet with so happy a combination of authors: Mr. F. I. Gillen, the special magistrate and sub-inspector of the aborigines at Alice Springs, S. Australia, has had, through his knowledge of the language, and the confidence he has inspired among the natives, unrivalled opportunities of making himself familiar with their most secret ceremonies and traditions, whilst Professor

* C. D. Walcott, "The Fauna of the Lower Cambrian or Olenellus Zone," *Tenth Ann. Report U.S. Geol. Survey (1890)*, p. 552.

† Photographic representations of similar markings in Palæozoic rocks are well given in Sir W. Dawson's paper in *Quart. Journ. Geol. Soc.*, Vol. XLVI., p. 595.

‡ "On the Systematic Position of the Trilobites," *Quart. Journ. Geol. Soc.*, Vol. L., p. 430; also *ibid*, Vol. LI. (1895), p. 358.

§ *Tenth Rep. U. S. Geol. Survey*, pp. 515—658.

‖ Walcott, *Monographs U.S. Geol. Survey*, Vol. XXX. (1898).

* *Fifteenth Report, N. York Cabinet of Nat. History*, p. 114.

Spencer, the distinguished teacher of biology at the University of Melbourne, has brought to bear upon the many problems considered the influence of his scientific training, thereby sifting the evidence and setting aside as untrustworthy much that is mere hearsay. The result of this co-operation is a remarkable book, noteworthy for the painstaking care displayed in every chapter as well as the guarded conclusions therein expressed. In the description of the various ceremonials, no details, however trivial, have been omitted, and we have in consequence a much fuller and more accurate account of what takes place at these "functions" than has hitherto been presented to us. This, together with the remarkable series of photographs with which the work is illustrated, serves to place the book in the forefront of the literature relative to the ethnology of Australia. In various chapters the authors treat of the social organization of the tribes, the totems, the various ceremonial proceedings, the myths concerning the origin of the tribes, and the customs relating to marriage, burial, mourning, etc. The general reader will find the description of the social organization of the tribes a very stiff chapter to digest; it may well be left to the experts in these matters. More interesting, from a general standpoint, is the account of the totems; our authors incline to the view that in regard to the particular tribes with which they are dealing, this peculiar custom is in some way related to the food supply. "It is quite possible," say they, "that the curious ceremony in which the members of any local group bring into the men's camp stores of the totemic animal or plant, and place them before the members of the totem, thus clearly recognizing that it is these men that have the first right of eating it, as well as the remarkable custom, according to which one man will actually assist another to catch his, *i.e.*, the former's, totemic animal, may be surviving relics of a custom, according to which in past times the members of a totem not only theoretically had, but actually practised the right of eating their totem." Concerning their "Medicine men," the natives seem to be in advance of the times, for women as well as men are eligible for the "profession," having to undergo the same initiation ceremonies and become subject to the same restrictions. Startling, too, are the remarkable instances recorded by the authors in which the mind seems to exercise an all powerful influence over the body. Three cases are quoted in which men were so slightly wounded that there was absolutely no reason why they should not speedily recover; so convinced were they, however, that the weapons they had been wounded by were "sung" to, or subjected to the influence of magic, that they all made up their minds to die, and this, in the words of the authors, they "accordingly did." On the other hand, a man, even though severely wounded, would make a rapid recovery provided he was satisfied that no magic had been practised on him. The various methods of obtaining wives by magic, as also the instances of what appears remarkably like thought transference, are no less curious, but those interested in this and other subjects must be referred to the book itself. A valuable addition to the volume is the series of measurements given of twenty males and ten females. We congratulate the authors on the completion of a work which has been undertaken and carried through under many difficulties, and it is with pleasure that we accord to them our hearty thanks for this trustworthy addition to our knowledge of the ethnology of the Australian tribes.

Skertchley's Elements of Geology. 9th Edition. Revised by Dr. James Monckman. (Murby.) Illustrated. 1s. 6d. As a class-book, Skertchley's Geology has sustained a good place among many competitors, and we are glad to see it revised by so able a man as Dr. Monckman. The science is so progressive, and, what is more to the point in this case, the syllabus of the Science and Art Department is so ephemeral, that radical changes in the text are often required to keep pace with the modifications thus rendered inevitable. The new matter comprises chapters on Rock-forming Minerals; Crystallography; Volcanic and Plutonic Rocks; and the Microscopic Examination of Rocks. Also many new illustrations have been interpolated in the text, but as far as circumstances would permit, the original author's impress on the work has been left undisturbed.

The Farmer and the Birds. By Edith Carrington. (Bell.) The author's aim in this book has been to show, by bringing together a considerable amount of evidence regarding the food of birds, that apparently all birds do infinitely more good than harm. While agreeing with a great deal that Miss Carrington says, we do not consider that she has struck a just balance with regard to several of the birds with which she deals. It is very likely the case that all birds, provided their numbers are kept within due proportion, do more good than harm, but in this book the good is positively pronounced as great, while the harm is minimised or considered uncertain. The destruction of game by birds has not been considered an offence, because "game is a luxury," but in a book appealing to farmers, to whom game is often a source of income, this exclusion is absurd, and will do the author's case no good. Of the number of "authorities" which are quoted some have been inadvisedly chosen. We have no wish to throw cold water upon Miss Carrington's endeavours, which are deserving of all praise and support, but she herself wishes the question to be faced fairly, and this, we think, has hardly been done in the little book before us.

The Science of Life. By J. Arthur Thomson, M.A. (Blackie.) 2s. 6d. As Mr. Thomson remarks in his preface, "this little book bears a big title," but the author does not attempt to solve the stupendous riddle of existence. The book is intended simply as a historical sketch of the growth and development of biological science, and as such it is a very valuable production. All students of biology should possess a work of this kind, which gives, so to speak, genealogical trees of every branch of the science—classification, morphology, physiology, embryology, heredity, bionomics, psychology of animals, evolution, and so on; shows us who has taken part in bringing our knowledge of these subjects to its present condition, from Aristotle's time to our own day; brings before us contemporaries in all ages who have formed the scientific senate, as it were, and evolved for us laws, theories and beliefs which, like the acts of our Legislature, have undergone many transformations in conformity with the progress of advancing civilization and the amplification of knowledge.

Quæro. By James H. Keeling, M.D., F.R.C.S. (Taylor and Francis.) For private circulation. An essay in which certain questions relating to matter, energy, intelligence and evolution are discussed, the purpose being to ascertain whether recent advances in physical and biologic science can be held to have shaken the grounds for the old faith in the existence and rule of a Supreme and Intelligent Power." It is written in popular form, and thoughtful, educated people, though not deeply versed in science, will probably be able to gauge the value of the arguments advanced. The author exhibits a profound knowledge of scientific questions, and the reader, whether he accepts his views or not, will be repaid for time spent in the perusal.

The Principles of Stratigraphical Geology. By J. E. Marr, F.R.S. (Cambridge University Press.) Illustrated. 6s. A correct chronology is of paramount importance to the student of earth-lore, for the history of our planet, like other histories, is a connected one in which one period is linked on to the next, and it is the aim of the stratigraphical geologist to record the events which have occurred during the existence of the earth in the order in which they have taken place. In order that the student may not be confused with the multifarious details usually accompanying descriptions of the stratified rocks, the author has given very concise accounts of the strata of the different systems, showing the skeleton only—if we may use the expression—of the solid crust. This is as it should be for the beginner in such a subject, which demands the exercise of imagination as well as common sense, and too much explanation, like too much salt, may blunt the edge of one's appetite.

Through Arctic Lapland. By Cutcliffe Hyne. (A. and C. Black.) Illustrated. In his preface to this book the author claims to have "stumbled across the one bit of Europe which has not been pilloried on paper at one time or another." We wish there were such a place in Europe, but we are afraid there is not. Mr. F. L. H. Morrice, in the "Nightless North," published in 1881, deals with a journey undertaken by himself and a friend from Vadsö to Torneo at the head of the Gulf of Bothnia. Mr. Hyne, accompanied by Mr. C. J. C. Hayter have traversed Lapland between the same points, but they have taken a route some few miles to eastward of Mr. Morrice's route. Mr. Hyne writes in a most graphic, emphatic style, and it is a great pleasure to read his epigrammatic and often very humorous pages. We have some shrewd remarks on the characters of both Lapps and Finns, and a good description of their country. Like

Mr. Morrice, and everyone else who has written of Lapland, our author devotes many pages throughout the book to mosquitoes. Mosquitoes, bogs, want of food, the laziness of the Lapps, and scarcity of carriers seem the chief evils of this country, and Mr. Hyne does full justice to them. The book is well worth reading, but it tells us little that is fresh. The illustrations, which are the work of Mr. Hayter, are for the most part excellent.

Diet and Food. By Alex. Haig, M.A., M.D. (Churchill.) Illustrated. 2s. A rational system of supplying the human machine with food, although of the utmost importance, is for some unaccountable reason entirely ignored by the great majority of the British public. Even among the more enlightened, far too little attention is devoted to the advantages which follow in the wake of a course of dieting suited to the varying needs of the body at different periods of life. Dr. Haig endeavours to impress on the minds of his readers the necessity for varying the diet at different stages of life. The food required for youth, he contends, will not answer equally well in old age, neither will the diet adhered to by persons in active outdoor life suit persons of sedentary habits. In this way the doctor goes into the subject thoroughly, touching upon many phases of human life, and projecting the light of science thereon in a manner which is decidedly instructive and agreeable reading at the same time. Careful perusal of such books as this will help to minimise the evils arising from ill-regulated gastronomic operations—disease in many forms, the agony of a deranged digestive system, and premature death.

We learn from Mr. Davies, of Brecon, that he is publishing by subscription a volume on "The Birds of Breconshire," by Mr. E. Cambridge Phillips. The price of the book to subscribers will be 7s. 6d.

BOOKS RECEIVED.

Primitive Constellations. Vol. I. By Robert Brown. (Williams and Norgate.) Maps. 10s. 6d.

The Story of the British Race. By John Munro. (Newnes.) 1s.

Laboratory Manual in Astronomy. By Mary E. Byrd. (Ginn and Co.) $1·35.

Truth and Error. By J. W. Powell. (Kegan Paul.) 9s.

On Centenarians. By T. E. Young, B.A. (Chas. and Edwin Layton.)

An Introduction to Stellar Astronomy. By W. H. S. Monck, M.A., F.R.A.S. (Hutchinson.) Illustrated. 3s. 6d.

Haunts and Hobbies of an Indian Official. By Mark Thornhill. (Murray.) 6s.

Chemistry for Photographers. 2nd Edition. By Charles F. Townsend. (Dawbarn and Ward.) Illustrated. 1s. net.

The Practical Electrician's Pocket Book and Diary—1899. (Rentell & Co.) 1s. net.

The Naturalist's Directory, 1899. (Upcott Gill.) 1s. net.

Chapters on Human Love. By Geoffrey Mortimer. (University Press, Limited.) 10s.

The Life Story of Sir Charles Tilston Bright. By Edward and Charles Bright. 2 Vols. (Constable.) Illustrated.

Funafuti, or Three Months on a Remote Coral Island. By Mrs. Edgeworth David. (Murray.) Illustrated. 12s.

The Resources of the Sea. By W. C. McIntosh, F.R.S. (Cambridge University Press.) Illustrated. 15s. net.

History of Physics. By Florian Cajori, PH.D. (Macmillan.) 7s. 6d.

Eclipse Observations taken at Dumraon, 22nd January, 1898. By Rev. V. de Campigneulles, S.J. (Longmans.) Plates. 10s. 6d. net.

The Internal Wiring of Buildings. By H. M. Leaf. (Constable.) Illustrated. 3s. 6d.

Early Chapters in Science. By Mrs. W. Awdrey. (Murray.) 6s.

Report of the Australasian Association for the Advancement of Science, 1898.

Harold Hardy. By F. C. Huddle. (University Press, Limited.) 6s.

The Scientific Roll. A Magazine conducted by A. Ramsay. (O'Driscoll, Lennox & Co.) 1s.

Science Notes.

Most observers are agreed that before a great storm birds which sing are more restless than usual. During one of the nights of August, last year, there was a very severe storm, accompanied by wind, rain, thunder, and lightning, which prevailed over a considerable part of Illinois. For forty-eight hours before the storm broke, Mr. W. Warner, of Henry County, U.S.A., records that not a sound was heard from a single one of the numerous song birds in the district. Other observers declare, however, in letters written to Mr. C. E. Linney, that birds sing more loudly and more persistently in such circumstances. But all were agreed about the restlessness of song birds before a storm. That there is some connection between the conditions of the atmosphere and the behaviour of birds is borne out by some of the proverbs Mr. Linney has collected in his paper on this subject in the *United States Monthly Weather Review*. The following will help to exemplify this connection :—When birds cease to sing, rain and thunder will probably occur.—Robins will perch on the topmost branches of trees and whistle when a storm is approaching. —Parrots and canaries dress their feathers, and are wakeful the evening before a storm.

An ingenious generator of acetylene gas has been patented by Sir Howard Grubb, particularly useful for domestic purposes, or where unskilled labour is employed. The generator, provided with baskets or compartments for the carbide, may be inside or outside of an enclosed tank, but connected therewith in such manner that, as the volume of gas in the container increases, water is displaced and forced up through a pipe to the water supply tank, or, water may flow from a separate tank on to the carbide in such manner that as the gas accumulates the generator is left comparatively dry. The generator, if outside the gas container, is conveniently provided with a water jacket, a precaution which minimises the chances of explosion, and the various valves for shutting off the water inlet, the gas outlet, and the pipe to the waste tank may be automatically operated by springs or other equivalent means by the removal of the cover of the generator when it is necessary to recharge.

The Frena pneumatic release is a new auxiliary to the hand camera. Among other advantages it overcomes the risk of shaking the camera in the act of setting off the shutter; enables an exposure to be made in many positions where it is otherwise most inconvenient; and, with the aid of a long tube and ball, enables the operator to retire to a distance and make the exposure unobserved. It consists of a spring plunger attached to the ordinary tube and ball, and can be clipped on or taken off the camera as required without removing the screws which hold it in position.

Just now, when the Bill relating to the sale of food and drugs is engaging the attention of the Legislature, it is opportune to mention a most useful journal, *The British Food and Analytical Review*, the official organ of the Commission, the object of which is to disseminate authoritative information upon the thousand-and-one ways in which unprincipled tradesmen tamper with commercial products. Public authorities and officials, by consulting its pages, may receive valuable assistance in the administration of the existing laws for the suppression of the malpractices in question, and so give the public proper guidance in regard to food and other useful products.

There is every reason to believe that the proposed National Antarctic Expedition will start in 1900. Grants of one thousand pounds each, it is confidently expected, will be received from the Government Grant Committee of the Royal Society, and from the Council of the British Association for this object. Sir Clements Markham has received a letter from Baron von Richthofen, President of the Berlin Geographical Society, in which he refers to a great and enthusiastic meeting in connection with the German Antarctic Expedition, and in very explicit terms to the expected co-operation of England in the great work of a thorough exploration of the unknown Antarctic area. At present the total amount available, including the two grants referred to above, is about fifteen thousand pounds, but to equip a satisfactory expedition, with two ships, would require one hundred thousand pounds. It is understood that if twenty-five thousand pounds can be obtained steps will at once be taken to organise a modest expedition with one ship, and so comply to some extent with the desire for co-operation on the part of Germany. With a view to help, the scientific societies in Australia are moving in the matter, with the object of influencing the premiers of the different colonies.

Prof. Pickering has announced by telegram, within the last few days, the discovery of a new satellite of Saturn. An approximate computation indicates that the satellite, a small body of the fifteenth magnitude, revolves in an orbit outside the other eight satellites of the planet, and completes its circuit round the primary in a period of seventeen months. It was by means of photography that this discovery was effected.

The next congress of the South Eastern Union of Scientific Societies will be held at Rochester on May 25th, 26th, and 27th.

British Ornithological Notes.

Conducted by Harry F. Witherby, f.z.s., m.b.o.u.

Fire-crested Wren in Breconshire.—On 27th February, hearing a Crested Wren in my garden with a somewhat different note from the ordinary Gold-crest, my son shot it with a catapult for the purpose of identification, and I found it to be an undoubted Fire-crested Wren. The stripe through the eye, the sort of black moustache from the corners of the mouth, and the black stripe under the crest, with the white between, left no doubt of the bird's identity. I have always thought this bird occurred occasionally with us, and on that account included it in my list of birds of the county, but it was and is much rarer than I at first supposed. I omitted to say that the above bird was a cock, with all his colours of the very brightest, also that when he flew he darted out from the tree and back, something after the manner of the Whitethroat; he also appeared slightly larger than the Goldcrest. He had another with him, which we secured a few days after, very near the same place where we secured the cock. This was the hen bird, and she was much smaller than the cock, and less bright in all her markings, but they both had the beautiful gold sort of mantle on the sides of the neck. I dare say I shall be blamed for killing this pair of birds, but I have been looking out for the Firecrest for the last eighteen years and this is the first time I have been able to positively identify it in the flesh as occurring here, as from the incessant movements of both this bird and the Gold-crest one is unable to distinguish the stripes on the head which almost alone marks the difference in the two birds. Mr. Marsden, of Clifton, is preserving them both.—E. Cambridge Phillips, The Rock, Bwlch, Breconshire.

Linota Exilipes (Coues) in Holderness.—On December 30th, 1898, two Mealy Redpoles were shot by a farmer at Skeffling, in Holderness. Both birds were killed at a shot, and the only two seen. They had attracted the man by their light colour and the bright carmine on the breast of the male. These two subsequently came to me through Mr. Philip Loten, of Easington, who set them up. I find they are distinctly referable to the Arctic and circumpolar Redpole, the *Linota exilipes* of Dr. Coues, and are identical with one from the same district which was sent by me to Mr. H. E. Dresser in 1894. There are altogether three species, or, perhaps, only races, of the northern Redpole which have occurred in the Spurn district—the typical *Linota linaria*, which in some years is fairly common; the subject of this notice; and a still larger and lighter coloured bird which inhabits Greenland, *Linota hornemanni, Hölboll.* This latter is figured in Lord Lilford's "Coloured Figures of the Birds of the British Islands" (Vol IV., plate 29), from an example obtained near Spurn in 1883. This, however, is not the only occurrence. On February 25th, in 1892, Mr. Hewetson and I watched for some minutes a most beautiful example (showing more white even than in Lord Lilford's plate) which was clinging to the top of a thistle on Kilnsea Common, close to the sea shore. When first observed it was in company with Snow Buntings, which flew away leaving it clinging to the thistle head, and permitting us a very close approach. Another was obtained near Kilnsea in 1893, and also sent to Lord Lilford.—John Cordeaux, Great Cotes House, R.S.O. Lincoln.

Correction.—Macqueen's Bustard (*Otis Macqueeni*) in Aberdeenshire.—The Bustard shot by Mr. J. G. Walker on October 24th, 1898, at St. Fergus, and unfortunately recorded in the *Annals of Scottish Natural History* (see Knowledge, February, 1899, page 42) as a Little Bustard, now proves to be a specimen of Macqueen's Bustard. This bird, which is a female, is only the fourth example of the species which has occurred in Great Britain. The first was obtained in Lincolnshire in 1847, another was shot near Redcar, in 1892, and the third, which I had the pleasure of seeing alive, was shot in Holderness, Yorkshire, in 1896 (see Knowledge, November, 1896, p. 251). All four specimens of this wanderer from Asia appeared on our east coast in the month of October. —H. F. W.

King-Eider in Shetland (*The Field*, March 11th, 1899, p. 356).—Mr. J. E. Harting has examined a specimen of *Somateria spectabilis* which was shot near Lerwick, on February 25th, and sent to Mr. Rowland Ward for preservation. Mr. Harting remarks that in this specimen the bill was rose-pink, the cere bright lemon, the toes orange, with the interdigital membranes dusky. The King-Eider, which is a very beautiful bird, inhabits the Arctic Regions, and its visits to our coasts are rare.

Mallard and Pintail Hybrid.—At a meeting of the British Ornithologists' Club, held on February 15th, the Rev. H. A. Macpherson exhibited a nestling Duck, which was the offspring of a female *Anas boscas* and a male *Dafila acuta*.

Red Grouse and Bantam Hybrid.—At a meeting of the British Ornithologists' Club, held on February 15th, Mr. J. G. Millais exhibited an extraordinary hybrid between a male Red Grouse (*Lagopus scoticus*) and a female bantam fowl.

Barred Warbler in Lancashire (The Naturalist, March, 1899, p. 75).—Mr. W. Ruskin Butterfield records that a male example of *Sylvia nisoria* was shot by Mr. A. P. Page, near Fleetwood, on August 20th, 1898.

All contributions to the column, either in the way of notes or photographs, should be forwarded to Harry F. Witherby, *at 1, Eliot Place, Blackheath, Kent.*

Letter.

[The Editors do not hold themselves responsible for the opinions or statements of correspondents.]

LOCUSTS IN ENGLAND.

To the Editors of Knowledge.

Sirs,—During the last week three live locusts have been taken in imported vegetables.

The first at Hampstead, on the 11th inst., by a greengrocer. This insect is now at the Zoological Gardens, Regent's Park, and is doing well.

The second at Blackheath, on the 13th inst., by a greengrocer, in cauliflowers that had come from Italy. I sent it to the Zoological Gardens, where it unfortunately died. Mr. Thomson, the Assistant Superintendent, writes me that he believes it is the migratory locust *(Pachytylus migratorius)* of south-east Europe.

The third at Highgate, on the 15th inst., by a greengrocer, in a case of Algerian bananas. It is now in the school museum of the Highgate Board School.

From the descriptions I conclude all three are of the same species. Jos. F. Green.

West Lodge, Blackheath,
18th March, 1899.

Obituary.

We greatly regret to note the death, on March 5th, of Miss Elizabeth Brown, of Further Barton, Cirencester. Miss Brown has been well known in astronomical circles for many years as a most careful and industrious amateur astronomer. Her favourite subject of work was the sun, and she became Director of the Solar Section in the Liverpool Astronomical Society in 1883, and on the formation of the British Astronomical Association she was at once invited to fill the same post. In this Association she was a most indefatigable worker and a most generous contributor to its funds. The problems offered by solar eclipses also attracted her attention, and she made three long journeys to Russia, to the West Indies, and to Lapland, in order to take part in their observation. On only one of these three occasions, however, was she favoured by a sight of the phenomenon. Two charming little books, written by her sister and herself, and entitled respectively "In Pursuit of a Shadow," and "Caught in the Tropics," narrate the experiences of the first two of these expeditions. She contributed many papers, chiefly on solar matters, to the Liverpool Society and the British Astronomical Association, beside the preparation in seven successive years of annual reports on the daily state of the sun's surface. These latter were illustrated by drawings of sunspots largely from her own hand, which are of extreme beauty and truth. Her sudden death is an irreparable loss to the Association, in which she had made a large number of personal friends.

By the death of Sir Douglas Galton, science loses from its front ranks a gentleman whose name is intimately associated with the sanitary advancement of our time. Born in 1822, he entered the Royal Military Academy, at Woolwich, at the age of fifteen, and there distinguished himself by taking the first prize in every subject. In 1847 he became secretary to the Railway Commission that investigated the application of iron to railway structures, and subsequently became an inspector of railways and secretary of the Railway Department of the Board of Trade. When, in 1857, Metropolitan drainage was under consideration, Captain Galton was one of the referees. In 1859 he was appointed Assistant Inspector-General of Fortifications, and, in 1862, Assistant Under-Secretary for War. Sir Douglas was elected a Fellow of the Royal Society in 1863, and, in 1870, General Secretary of the British Association. Oxford conferred on Sir Douglas its honorary degree, D.C.L., and Durham its LL.D. Few men have sat on so many commissions, or been oftener connected with the great public exhibitions as judge of awards or member of executive council. He was an authority on hospital construction, on the drainage of towns, on all subjects which are open to arbitration as between railway companies, who often chose him for arbitrator. His services to the British Association were recognized in his election to the Presidency in 1895. Foreign orders were lavishly bestowed upon him.

A NEW FORM OF PHOTOGRAPHIC TELESCOPE.

A GREAT number of very large telescopes of nearly the same form have been given to observatories during the last few years. Although such instruments are indispensable, in a limited number of investigations, yet when the latter are divided among so many telescopes the results obtained by each are often disappointing to the donors. These instruments have been erected, with two or three exceptions, in places selected from local or political motives, and without regard to meteorological or astronomical conditions. For this reason the great observatories of the world are near large cities or universities where the very conditions that have rendered the countries great have rendered them unfit for the most delicate astronomical research. Nine-tenths of these instruments are in the temperate zone in Europe and the United States, while the southern hemisphere has been entirely neglected, and many of the most interesting parts of the southern sky have not yet been examined by a modern telescope of the largest size.

This duplication of expensive instruments in unsuitable localities is rendered still more objectionable by another condition. All the telescopes are similar in form, their focal length being from fifteen to eighteen times the aperture, and therefore all are best adapted to the same kind of work. In view of these numerous precedents it was a bold step to deviate from it; but this step was taken, and taken by a woman, Miss Catherine W. Bruce, of New York, who gave fifty thousand dollars to the Harvard College Observatory to construct a telescope of twenty-four inches aperture, in which the focal length should be only six times the length of the aperture. Fortunately, this experiment succeeded, and the Bruce Photographic Telescope is mounted in Arequipa, Peru, in a climate unsurpassed, so far as is now known, for astronomical work. Its immediate results are charts, each covering a large part of the sky and showing such faint stars that four hundred thousand appear upon a single plate. By its aid many new stars of the peculiar fifth type have been found in the Large Magellanic Cloud, showing an additional connection of this object with the Milky Way. A group of forty nebulæ, hitherto unknown, has been found in another part of the sky. The most important work of the Bruce telescope, however, is that every year it sends hundreds of photographs to the great storehouse at Cambridge. Besides the immediate discoveries made from these plates, they doubtless carry with them many secrets as yet unrevealed, and many images of objects of the greatest interest yet to be discovered. A striking example of this kind is found in the recent discovery of the planet Eros, which, next to the Moon, is sometimes our nearest neighbour in the heavens. Calculation showed that this planet must have been near the Earth, and therefore bright, in 1894. An examination showed that this object, although not discovered until 1898, had not escaped the Harvard telescopes. Two images of it were found upon the Bruce plates, fifteen upon the Draper plates, and three upon the Bache plates. It can thus be followed through nearly half a revolution. Six images were also obtained in 1896, when it was more distant and much fainter.

These examples show the advantages of trying new forms of telescopes instead of duplicating those now existing. The Bruce telescope is well adapted to investigations in which the focal length is small; it will therefore be interesting to try the effect of a great focal length. It is proposed to build a telescope with an aperture of twelve to fourteen inches, and a focal length of one hundred and thirty-five or one hundred and sixty-two feet. This telescope would probably be placed horizontally, and the star reflected into it by means of a mirror, and the motion of the Earth would be counteracted by moving the photographic plate by clockwork. It would thus become a large horizontal photo-heliograph. This method of mounting a telescope for use on the stars was advocated by the writer in 1881, and has been used here since then with successive telescopes of two, four, and twelve inches aperture. The instrument here proposed would be adapted to investigations for which a great focal length would be needed, as the latter would be more than a hundred times the aperture. Several such investigations may be suggested, any one of which, if successful, would amply justify the construction of such an instrument.

1. The Sun. The best instrument now in use for photographing the Sun—the horizontal photo-heliograph—is a small instrument of this form. It is possible that, under favourable atmospheric conditions, finer details on the Sun's surface could be obtained with a large instrument than have yet been photographed. It would be equally useful in photographing the protuberances. Preparations must soon be made for observing the solar eclipse of May 28th, 1900. This instrument might be useful in photographing the spectrum of the reversing layer, and in showing the details of the inner corona.

2. The Moon. The images of the Moon obtained with such a telescope would be more than a foot in diameter, and even if printed without enlargement would probably surpass the best photographs yet taken. The use of a telescope of this form for photographing the Moon was advocated by Prof. W. H. Pickering in 1894 ("Harvard Observ. Ann." XXXII., p. 110). It is possible that good results could also be obtained with Jupiter, Saturn, and perhaps Mars.

3. Eros. This planet approaches the Earth so closely that its parallax sometimes amounts to a minute of arc. The next approach, in 1900, will be more favourable than any other until 1927. Careful preparations should, therefore, be made for observing Eros when east and west of the meridian, since the distance of the Sun can probably be determined with more accuracy in this way than by any method of observation yet attempted. As the distance of the Sun is the unit to which all astronomical distances are referred, the importance of its accurate determination cannot be overstated. It is one of the great problems of astronomy, which, though supposed in the eighteenth century to have been solved, must probably be left to the twentieth century for satisfactory solution. To determine the parallax from the Transit of Venus in 1874, the principal nations of the world sent expeditions to the most remote regions. In all about eighty stations were occupied at an expense of more than a million of dollars.

4. The Fixed Stars. It is expected that the positions of adjacent stars could be determined with this instrument with an accuracy approaching that of the heliometer. If so, it would have an important and permanent field of work in charting the coarser clusters, the double stars, and determining stellar parallax; also in locating the major planets, and the relative positions of the satellites of Jupiter and Saturn with an accuracy as yet unattained.

The very moderate expenditure of five thousand dollars to ten thousand dollars would permit this experiment to be tried here, since we already have a portion of the apparatus required. If successful, the name of the donor would always be honourably associated with a new departure in one of the most important branches of astronomy.

February 11th, 1899. Edward C. Pickering.

WIDE ANGLE PHOTOGRAPHY IN ASTRONOMY.

By E. Walter Maunder, F.R.A.S.

One of the first results of the great scheme of an international photographic survey of the entire sky was a rather curious one. There was a sensible diminution in astronomical activity, at any rate in England, apart from the more or less routine work carried on by the great public observatories. This would seem to have resulted from a vague, unspoken, yet powerful impression that the great photographic revolution which was in progress had rendered the older methods of observation more or less obsolete, and in particular had doomed the amateur astronomer to uselessness and extinction.

In all probability, no one man ever formulated this impression into a categorical statement, but for a time it certainly had its effect. Nor was it without some plausibility, for it was a new thing to see an astronomical enterprise set on foot of so gigantic a nature that no single observatory, however fully equipped and richly endowed, could hope to deal with it. Nothing less than the association of something like a score of the largest observatories in the world could cope with it.

The discouragement did not last long, and there were some who never felt it. Dr. Isaac Roberts, for instance, was very quick to realize that the international scheme had by no means annexed the whole of the photographic universe, and he promptly carved out a territory for himself, which he has developed with a thoroughness and a success which requires no setting forth to the readers of Knowledge, who have had the privilege of studying so many of his wonderful revelations of world systems in the making.

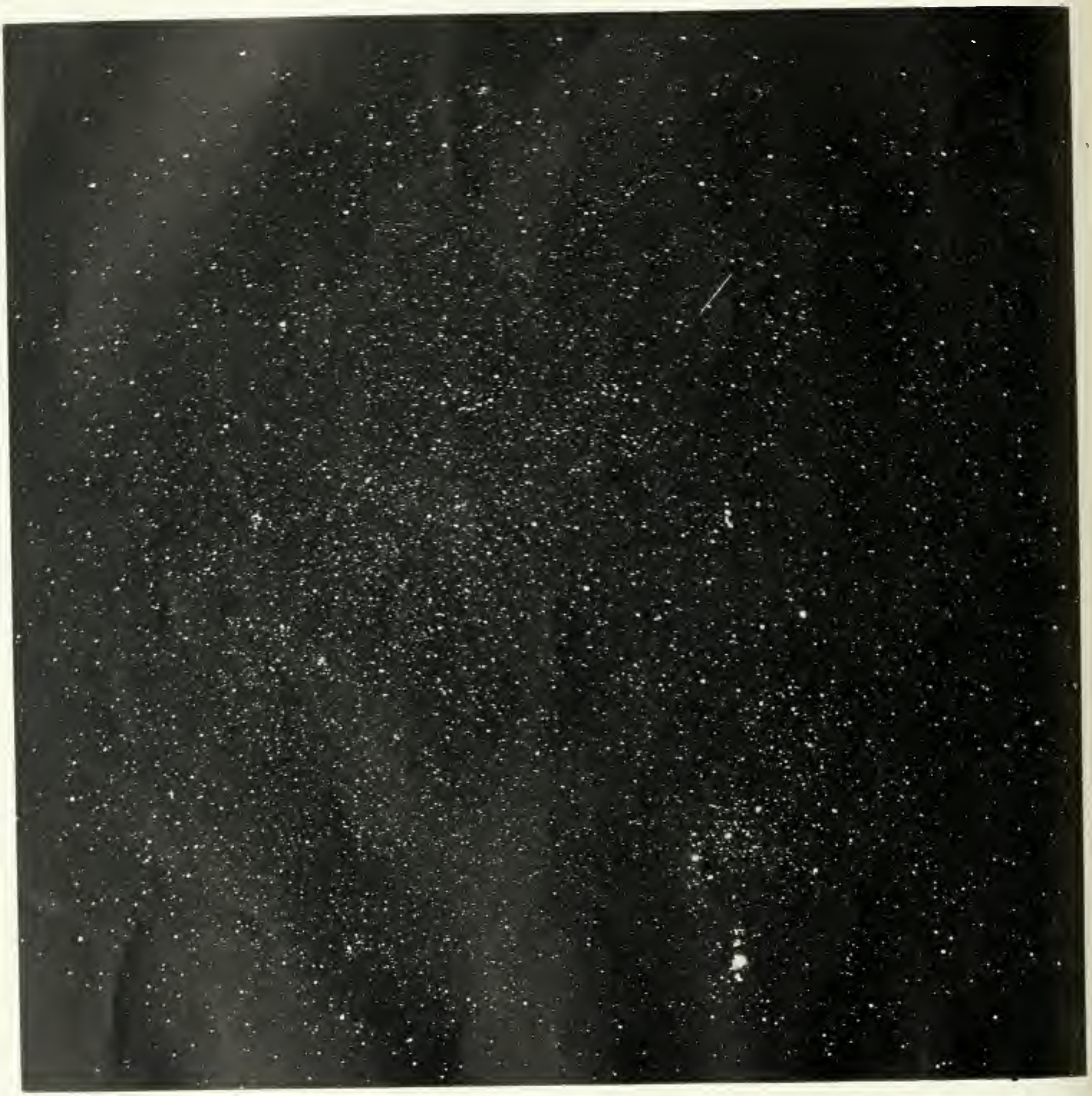
Here, then, are two great photographic surveys with entirely different objects, carried out by very dissimilar instruments, but both carried out so effectively as to render any thought of competition quite out of the question, save to extend Dr. Roberts' cluster and nebular studies to the Southern Pole.

Do these two great schemes cover the whole of possible photographic research? It might almost appear that with some astronomers there had been a feeling that this was indeed the case. If so, others have not been wanting who have been most active in opening out new lines of work.

Amongst the pioneers of new photographic enterprise two names are pre-eminent, those of Prof. Barnard and Prof. Pickering. The impetus which the former has given to the use of the portrait lens in astronomical photography is well known, whilst the latter has been especially fertile in devising new departments of work and new forms of telescopes to carry them out. The present number of Knowledge, for instance, has an article from him on the use of photographic telescopes of extremely long focus. But we would now specially refer to the recognition by Prof. Pickering of the necessity, not only for one great survey of the sky, carried out once, and once for all, but

NORTH.

EAST.



WEST.

SOUTH.

ONE-THIRTIETH OF THE SKY.

From a Photograph taken by Mrs. WALTER MAUNDER with a Dallmeyer Stigmatic Lens of one and a half inches aperture.

for surveys made in a short time and repeated at frequent intervals. Such surveys are useful for several purposes. The detection of new planets, of variable stars and Novæ, can only be satisfactorily carried out by schemes of which such frequent surveys form an integral part. Prof. Pickering, therefore, early devised an ingenious method by which the same plate might be exposed to many different parts of the sky and record the stars in each region in so distinctive a manner that no confusion need take place between the different images from each.

There are two fields of work in which the necessity for embracing a large area of the sky upon a single plate is even greater than in that of the search for variables or Novæ, and yet in which the device of repeated exposures would be absolutely useless. These are the two departments of the study of general stellar distribution and of meteor observation.

The former subject was one in which Mrs. Maunder took a great interest. It was apparent to her that fields of five or ten degrees in breadth were insufficient for the purpose of dealing with some of the problems of sidereal architecture. Regions much wider must be brought together upon a single plate, and that, too, without serious distortion, if the work was to be carried out in the most effective manner. There did not seem to be any lens in the market meeting this requirement until Mr. Dallmeyer, whose work as a photographic optician is so well known, brought out his stigmatic lens, covering an unusually wide field. Consequently she applied to Mr. Dallmeyer for one of his lenses immediately upon their details being published, that is to say, early in 1897. It was with this lens—one and a half inches aperture and nine inches focal length—that the photographs were taken of the solar eclipse of January last year, which appeared in KNOWLEDGE for May, 1898. The lens was, however, not procured for eclipse work, but for the charting of wide sky areas; its employment in eclipse work was incidental only, and a portrait lens would probably have been more effective, since a considerably higher ratio of aperture to focus might have been obtained.

The accompanying plate may serve to illustrate two of the uses to which a lens of this kind might be put. The field shown is thirty-seven degrees in side, fifty degrees in diagonal, and includes one-thirtieth of the area of the entire sphere. The plate was chosen for reproduction quite at random, and is far from being the best available. Nevertheless it cannot, I think, be in the least contested that it shows the largest field, by much the largest field, of stars defined throughout that has ever yet been published.

The part of the sky depicted is at once apparent, being that which has its centre about 5h. 55m. of R.A. and $8\frac{1}{2}°$ N. Dec., and which includes nearly the whole of the constellation of Orion. Stars are seen down to the 10th magnitude, and the nebula round θ Orionis is, of course strongly marked; the much fainter nebula *nf.* ξ Orionis is also very distinctly seen. Two meteors of sufficient brightness to leave a trace fell during the exposure of the plate. One is at the extreme north-west corner of the plate, and only part of the trace is seen. The other is very distinct, and crosses the 17th parallel of N. Dec. about R.A. 5h. 30m.

Considerably more than a year later than Mrs. Maunder's first employment of this wide-angle lens, Prof. Pickering used a similar lens, as described in KNOWLEDGE for September, 1898, for the purpose of the detection of short period variables. Circular No. 40, from the Harvard College Observatory, suggests the use of such lenses for meteor observation, and the photograph at once demonstrates its suitability for such work. The mode of operation suggested by Prof. Pickering, and which will shortly be in operation at Blue Hill and at Cambridge, is as follows:—At each station a camera will be exposed to the zenith, each being provided with caps which will close automatically shortly before dawn. About one-third of all the meteors having long paths pass within thirty degrees of the zenith, and all of these, if bright, can thus be photographed. Bright meteor tracks often show points of increased brightness due to small explosions, such as are very noticeable in the meteor in the plate. Such a trail, if photographed at two stations, would give the height of the meteor at the moment of explosion. If the cameras were mounted equatorially, their radiant point could be fixed with great precision. Prof. Pickering goes on to suggest that the use of a prism in front of the lens would secure the spectra of bright meteors, and adds that by the expenditure of three plates a night it seems possible to determine the altitude, radiant point, velocity, and spectrum of one-third of all the bright meteors visible in a given locality. It is probable that several meteors bright enough to be photographed in this way appear every month.

To sum up, then, this new departure in stellar photography offers the following advantages:—Considered merely as photographs of the heavens, a set of forty plates of the same angular field as the one here shown, but of larger scale, would provide a more complete map of the heavens than any we yet possess, in exceedingly small compass, and at very little trouble or expense. The scrutiny of such a set of plates would give us the fullest possible development of that method of attack of the great sidereal problem which Herschel first attempted in his gauges. Indeed, a vast amount of information as to sidereal structure would result from the mere inspection of such plates. Their value in the work of discovery is most obvious. The systematic employment of wide field plates at a number of observatories would ensure the record of all asteroids, comets and Novæ within the limits of magnitude recorded; whilst the ingenious methods which Prof. Pickering has devised will bring about nothing short of a revolution in the discovery of short period variables and the observation of meteors. Much of this work, too, can be done with lenses of small size and therefore little cost, and so lies quite within the powers of many owners of small observatories. For instance, two friends situated north and south of the equator respectively, might easily and at a trifling expense, bring out not only a complete chart of the heavens, embracing over a million stars, but might bring out a new edition every year.

THE KARKINOKOSM, OR WORLD OF CRUSTACEA.—VIII.

By the Rev. THOMAS R. R. STEBBING, M.A., F.R.S., F.L.S., F.Z.S., *Author of "A History of Crustacea," "The Naturalist of Cumbrae," "Report on the Amphipoda collected by H.M.S. 'Challenger,'" etc.*

THE DOOR-SHELL CRUSTACEA, OR RINGLET-FEET.

THE sailors who moored their boat to a whale's back, mistaking it for an island, were abruptly undeceived when they proceeded to light a fire upon it. Cirripedes of sorts treat the massive beast with no more ceremony than the sailors did, and take liberties with better success. They land upon it and embed themselves either at the surface or within the whole thickness of its hide in a way that takes no denial. It might be thought that the whale would find some opportunity of rubbing off these troublesome intruders and excrescences, but even museum specimens will show the futility of any such expectation. The deeply burrowing kinds are quite sheltered from any friction short of that which would scarify their host, in which case the mighty Samson would pay dearly for the ruin of his tormentors. The *Coronula diadema* has a superficial foothold. But examine the base of a specimen. Its numerous radiating compartments are occupied by a sort of black putty. That putty is whale-skin, which the rightful owner would have to part with in rubbing off the Cirripede. Here, too, the remedy would be worse than the disease, and we have striking proof that recourse is not taken to this mode of relief. For on the *Coronula* there is sometimes quietly seated a stalked Cirripede of large size, which would fall like a ripe fig at the least concussion, but which has obtained a practical assurance that, wherever else the rubs of life may be arranged by or for a whale, they are not likely to be at the point occupied by a *Coronula*.

Securely embedded in the skin of a Manatee, the *Platylepas bissexlobata* may for ages have been exploring the rivers of West Africa, but, apart from such rare exceptions, it is singular that hitherto this varied and extensive group of crustacea should have neglected to occupy the fresh waters of the world, for to the utmost limits of maritime dominion it spreads its colonies with a supreme indifference to the character of the supporting basis. Deep down on the floor of the ocean, high up on rocks which only the spray of a spring-tide can reach, on bathing machines, on floating bottles or logs of wood, or in masses of seaweed, on the smooth iron sheathing of a ship, in rocks, in corals, in sponges, in narrow tunnels burrowed into shells, attached to the spines of sea-urchins, clinging to the feathers of sea-fowl, on the backs of sea-snakes, of turtles, of crabs, fringing the very jaws of crawfish and other crustaceans, sometimes conspicuous, sometimes concealed, sometimes solitary, sometimes crowded and multitudinous, coating vast surfaces of the wave-beaten shore, they assert themselves as citizens of the world, of which they occupy a far more extensive tract than man does. The human organism, with its incomparable superiority of brain, is, on the other hand, excessively hampered by a fastidious conservatism in regard to outward form. As Darwin said of the goose, so may it be said of man—that his organization is very inflexible. That is where the Cirripede has had the advantage of us, as a little reflection will suffice to prove.

Tubicinella trachealis Shaw, in skin of Right Whale. (Two-thirds nat. size.)

The Crown Cirripede (*Coronula diadema*) is, as its name implies, a stately form, proper for the pageantry of life, not needing to hide its light under a bushel. But supposing that by the exigencies of existence it were reduced to burrowing into an oyster shell, its massive walls and spreading plumes would be simply a nuisance. Æsop might then have used it—instead of the antlered stag in a thicket—to point the moral of his fable against conceit. But, untaught by Æsop, some of our Thyrostraca (door-shells) or Cirripedia (ringlet-feet) have learned to cast off everything that their alternative names suggest—shells and valves, and feet and ringlets; everything that may be regarded as specially characteristic—in order to live, as if it were better to live without a character than not to live at all. They come down, as it were, from the castle to the cottage, from the cottage to multifarious lodgings, often of the humblest kind, and end in a degraded pauperism, wherein, from their shape and habits, they may, without libel or slander, be described as blood-sucking sausages. The division to which these last belong is known as that of the Rhizocephala, meaning that their heads have been turned into roots, the so-called roots being narrow processes which penetrate the soft part of their host, such as a common shore crab, and derive nourishment from it.

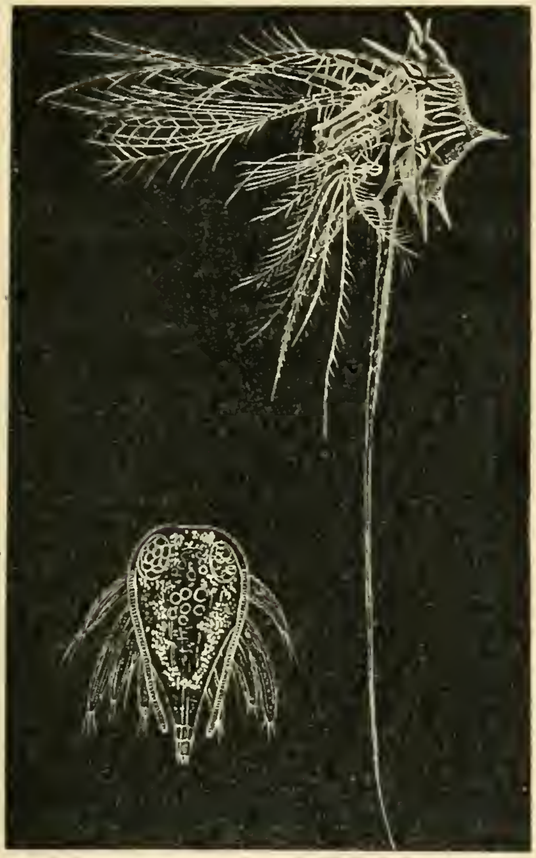
For many of the genera and species, the attachment to an endless variety of moving objects sufficiently explains their extensive dispersion. But many of those which love a settled life are also widely spread. This is due to the fact that the young are born free to move, and not averse to travel.

As for Cirripede and Thyrostracan, the giddy world still knows as little about such names as fifty years ago it knew about the centre of Africa. Barnacle seems to be the only name to conjure with. Johnson's Dictionary, a hundred years ago, defined it as "a kind of shell-fish that grows upon timber that lies in the sea," and secondly as "a bird, like a goose, fabulously supposed to grow on trees." As is well known, earlier writers thought the bernicie or barnacle goose from the tree no fable. Sir Robert Moray, for instance (*Phil. Trans. R. S.*, Vol. XI., p. 925), in every shell that he opened found the bird "curiously and completely formed, that there appeared nothing wanting as to the external parts for making up a perfect sea-fowl." "The little bill, like that of a goose, the eyes marked, the head, neck, breast, and wings, tail and feet formed, the feathers everywhere perfectly shaped and blackish coloured, and the feet like those of other water-fowl, to the best of my remembrance." Seeing is believing, and we easily see what we believe. But in natural history it is dangerous to trust to the best of one's remembrance. Also it is not good to trust too much to dried specimens. "All being dead and dry," Moray continues, "I did not look after the inward parts of them." The pleasing hallucination conveyed in this and many similar records is embalmed for the history of science in the names of two species, *Lepas anatifera*, the duck-bearing, and *Lepas anserifera*, the goose-bearing barnacle. Probably the fable did more to awaken and keep alive a popular interest in Cirripedes than any account would have done based on the real wonders of their life-history.

Lepas anatifera Linn.

Lepas anatifera, with tergum and scutum removed.

Though the barnacle never turns into a bird, its free-swimming larva is scarcely more like its adult form than a caterpillar is like a butterfly. At first emergence from the egg-membrane the baby Cirripede is simple in structure and appearance. It has three pairs of appendages, a mouth, and an eye. It is left to its own resources. There are no breasts for it to suck. There is no fostering nurse. There is no education, primary or secondary. It becomes at once a citizen of the ocean. Its business is to moult as quickly and as often as its growing forces will allow. By successive moultings it comes to assume such a form as that shown in the Nauplius figured by Prof. Chun.* Though the animal at this stage is not awe-inspiring by its size, being only about a quarter of an inch long all told, still its lanceolate armour may make it formidable in some social circles, and the glassy transparence of its caparison invests it with beauty.



Nauplius of *Lepas anatifera*, shortly before hatching. From Groom.

Nauplius of *Lepas*, sp., just prior to the Cypris stage. From Chun.

Mr. Theodore Groom† considers that the movements of the Nauplius are brought about exclusively by the activity of the three pairs of appendages, propelling it by a series of jerks. These follow one another with great rapidity in the newly hatched Nauplii, but more slowly afterwards. Nature in some way teaches them to husband their resources, and that the business of life should be conducted *ohne Rast ohne Hast*. By this policy, some of them, it is calculated, after the first moult can swim something over two inches in a minute, about a hundred times their own length, equivalent to a mile in eight minutes for a man six feet long. Whether swift or slow, their movements are probably not for any swimming competition nor for the mere fun of the thing. Their throat is said to undergo continuous contraction and dilatation by means of the muscles with which it is furnished, and to constitute a suction pump which causes an intermittent stream of water to enter the mouth. At the same time "the powerful strokes of the three pairs of appendages sweep backwards and inwards any small organisms or particles entangled between the network of hairs and bristles." Mr. Groom seems to have taken a mean advantage of their innocent rapacity, to judge by the following paragraph of his essay :—

"Though the Nauplii of *Balanus*, *Chthamalus*, and *Lepas* refused to eat starch, they greedily took up water containing carmine, indigo-carmine, methyl-blue, litmus, etc. In the case of the first three substances, considerable accumulations were formed after a short time in the stomach and intestine, but the greater part of the carmine was passed out unabsorbed."

The young that are born must be inconceivably numerous. The dangers of their childhood are also innumerable. By dint, however, of energetic feeding and refusing to eat starch, a vast remnant of the Nauplii pass into the Cypris stage. This transformation derives its name from the surface resemblance which the Cirripede undergoing it assumes to the genus *Cypris*, among the Ostracóda or Box-Crustacea, discussed in the last chapter. The soft parts and appendages of the organism are now almost entirely enclosed in a pair of valves comparable to those of a minute mussel, with the insignificant appearance of a little brown ovate seed. But if we look after the inward parts of them, we shall find them not at all like those of a mollusc. They are now approaching the character of the adult form. The animal will before long settle down in life, and form a permanent attachment. There is no romantic love-making concerned in this; the attachment in question is a local affixing. By means of cement-glands the head is attached to any suitable object, and the legs thrown upward, or, if not upward, at least in a direction opposite to the foothold which is monopolized by the head. There is no clownishness or dramatic vulgarity in this eccentric behaviour of the legs, since these many-jointed and beautifully plumose limbs (the cirri-peds or ringlet-feet) are encased within a variety of plates or valves, from which they only protrude when occasion demands, with coy reserve.

Cypris-stage of *Lepas australis*.* From Darwin.

In *Lepas*, and various other genera of the pedunculate or stalked barnacles, the valves are reduced to five, a manageable number for purposes of explanation. The narrow curved valve on the left, in the figure given above of an adult *Lepas anatifera*, is called the carina, or keel, from its shape. It is unpaired. At the top of the figure is seen one of a pair of valves called terga or back-plates, and below this on the right, one of a pair called scuta or shields. In *Scalpellum* there are from twelve to fifteen valves, and the peduncle is covered with scales. Nevertheless, the five primary valves above mentioned maintain a predominance. In the old genus *Pollicipes*, which was already flourishing in the Lower

* *Die Nauplien der Lepaden.* Carl Chun. *Bibliotheca Zoologica*, 1895.

† "On the Early Development of Cirripedia." By Theodore T. Groom, B.SC. *Phil. Trans. R. S.*, 1894.

* The specimen having been treated with caustic potash, and so rendered transparent.

Oolite, the valves range from eighteen to the rather bewildering number of over a hundred. On the other hand there are genera, such as *Dichelaspis*, in which the five plates, so far from requiring to be supplemented, themselves dwindle away to more or less feeble strips, and lead the way to groups which have no valves at all.

Scalpellum tritonis Hoek. From Hoek.

In the Balanidæ, or Acorn Barnacles, the peduncle, which in *Lepas* is sometimes more than a foot long, does not put in an appearance. Hence these are sometimes called sessile cirripedes, as being seated fairly and squarely on their bases, that is on their heads, without the intervention of a stalk. Sometimes, on the other hand, they are distinguished from the pedunculates as the operculate. The reason of this is that the shields and back-plates no longer form the main walls, but give place to a more or less cylindrical, shelly circumvallation, in compartments four to eight in number, often very firmly consolidated, and having a sort of roof, usually somewhat sunk in, compactly closing the summit. This roof, or operculum, is formed by the neatly fitting and movable scuta and terga. As in the pedunculate Thyrostraca, these valves can open or shut for the protrusion or shelter of the feathered limbs. When the living animals are placed in a bowl of sea-water, as soon as all seems to be safe and quiet, the valves will slowly open, and the plumes will be displayed. In one respect the Cirripede is like the vulgar criminal who, in response to his sentence, informs the worshipful magistrate that he can "do it on his head"; but the criminal is loose in an involuntary prison, while the Thyrostracan is fastened to a fortress of its own construction. From this it waves its arms for food, summoning any minute marine animals that happen to find life not worth living to come to its embrace.

Among the Cirripedes there can as a rule be no rivalry in love, no heartless desertions, no inequality of the sexes, because in almost all of the group both sexes are united in one body, and such interchange of affection as may, notwithstanding this, take place between different individuals, must in these fixed animals be determined much more by the accidents of proximity than by choice or inclination. But in the genera *Ibla* and *Scalpellum*, Darwin found that there were, besides the usual combined forms, some independent females. Upon each kind, in some instances, he observed curious little parasites, and proceeded to make the strange discovery that these seeming parasites were independent males of the species on which they were found. Those of them which he found attached to animals of double sex he named "complemental males." Anyone who wishes to pursue this difficult branch of investigation must not fail to study what the original discoverer has written upon it, and what has since been added by Dr. Hoek in 1884, and Dr. Aurivillius in 1894. In another branch of the subject, Dr. H. J. Hansen has marked the opening of the present year by giving reasons for cancelling that group or division of the Cirripedes which bore the uncouth name of the Abdominalia. Darwin himself gave eight years of steady work to the study of this great sub-class of the Crustacea. Alluding to the published results, in his autobiographical chapter, he says, "I do not doubt that Sir E. Lytton-Bulwer had me in his mind when he introduced in one of his novels a Professor Long, who had written two huge volumes on limpets." As to the complemental males, he says, "This latter discovery has at last been fully confirmed; though at one time a German writer was pleased to attribute the whole account to my fertile imagination." In the opinion of Dr. Hoek, and of most competent naturalists, Darwin's monographs, though with such errors as all foundation works contain, mark the dividing line between the dark ages and civilization in respect to the science of Cirripedes. One very anomalous form dates back even to the Wenlock limestone, so that they are not creatures of yesterday. But, though the group may thus claim to be coeval with the trilobites, instead of following the trilobitic example of passing into decay and extinction, it appears to have been continuously expanding. We may regard ourselves, with the vanity natural to man, as living in the era of Shakespere and Galileo, but from a geological point of view, we are rather, according to Darwin, living in the Age of Cirripedes.

CUSTOMS OF SHAKESPEARE'S GREENWOOD.

By George Morley.

[While correctly representing the existing customs of Shakespeare's greenwood, the subjoined examples are not confined exclusively to Warwickshire.]

THOUGH the influence of modern civilization has had a depreciating effect upon the customs of the country in certain places, the sequestered position of Shakespeare's greenwood has, in a great measure, rendered it impervious to the revolutions of change; and in many of the out-of-the-way hidden villages there may still be seen the quaint and often picturesque customs in which "the rude forefathers of the hamlet" were wont to take delight.

And not only in the immediate greenwood of Warwickshire are customs practised to-day which date so far back as to render their origin obscure, but in centres of the county which are now busy with the hum and bustle of industry, and the gathering place of toiling thousands, customs of quaintness and antiquity are still prosecuted with a vigour which at present shows no sign of abating, in spite of legal attempts to crush them.

One of these erstwhile village customs is that of the Shrove Tuesday festival of football which is played annually in the streets of Nuneaton—the "Milby" of George Eliot's "Scenes of Clerical Life"—and also at Atherstone. On the morning of the day the towns present quite a holiday appearance. The shops are closed and shuttered, and the young men turn out in hundreds to play their balls through the streets from one end of the town to the other, and win cheers and bright smiles from the faces of their bonnie lasses. In the observance of this custom Warwickshire enjoys an almost unique position, for there seems to be only one other place in England (the town of Dorking) where the practice is carried out.

The Shrove Tuesday festival is the first custom of the year in Warwickshire. The next custom is that of the mothering. It is the tie which binds the hearts of the family together, making every member of it one—in feelings, aspirations, thoughts, and sympathies akin; and bringing them all together at least once a year, after the manner of the rhyme used for the occasion.

"The lad and lass on Mothering Day
Hie home to their mother so dear;
'Tis a kiss for she and a kiss for they,
A chine of pork and a sprig of bay,
A song and dance—but never a tear."

The favourite joint for the mothering is a chine of pork, with the stuffing flavoured with a few leaves of the aromatic bay; and the after-dish consists of the famous fig pudding alluded to by Shakespeare. In many an isolated cottage the preparation of these well-known and ancient dishes for the table and the palates of the children returning home once more, is a labour of love and great ceremony to the homely cottage woman. Both married and single children observe the custom of the mothering, and the fourth Sunday in Lent is, indeed, a day of rejoicing under many a thatched roof in "leafy Warwickshire."

No more picturesque or mirth-moving custom could well be imagined than the Eastertide practice of "lifting," which used to be largely in vogue on the village greens of this neighbourhood, and was, until recently (and may be so even yet), still extant in some of the more secluded places. It may be that the so-called refining influences of modern civilization have been the means of causing this purely Arcadian custom to fall somewhat into disuse. In any case, what was an annual event looked forward to with pleasure at the beginning of the century, is, at the end of it, a custom "more honour'd in the breach than the observance"—a picturesque and merry scene being thus lost to English country life.

The custom in the villages of Warwickshire was to hold two "liftings"—one on Easter Monday and the other on the following day. On the first day of the junketing the rustic youths "lifted" the lasses—that is, took them up lengthwise in their arms and kissed them. All were served alike—the buxom, the slender, the comely, the plain, the saucy, the shy—so that there should be no complaining of more favour shown to one than to another. On the second day the girls returned the compliment and lifted the young men. There seems to have been even more merriment at the second performance of the custom than at the first.

Certainly one of the prettiest customs still in active practice in the shady lanes and on the village greens of Warwickshire is the Maying custom. The method is probably much the same in all the counties of rural England in which the festival is still observed; the only difference may be in the wording of the carols which are sung upon the occasion.

In Shakespeare's greenwood the general rule is to hold the festival upon the twelfth of the month—old May Day. The earlier hours of the previous day are occupied by the children in a perambulation of the parish, calling upon the farm folk and other residents for gifts of flowers and finery with which to decorate their maypoles. In the evening the large maypole is hoisted on the village green, or in some paddock or orchard lent for the purpose, and the election of the queen takes place. Some villages have a king and queen, but the majority elect a queen only.

On the morrow the queen and her attendants, as richly bedizened as flowers, ground ivy, may blossom, and patchwork can make them, again parade the bounds of the parish, singing their May songs (first at the doors of the squire and the parson, and then at the houses of the lesser people) round a portable maypole, finally returning to their ground or play mead, where the songs are sung over again.

After the songs dancing begins, and in some villages in the immediate vicinity of Shakespeare's birthplace the festival of the day is concluded in the rectory, where children of a larger growth keep up the dance with unflagging energy until the small hours of the next morning.

In the little border village of Welford (just below the "Hungry Grafton" and adjoining the "Drunken Bidford" of the well-known verse erroneously attributed to Shakespeare) there stands in the centre of a raised mound, encircled by a hedge, a maypole which is regarded as the successor to one around which Shakespeare himself must often have danced with his Shottery lass. The existing maypole stands seventy-five feet in height, and bears upon the shaft the faded colours of the red, white, and blue "ribbons" which it was the custom to paint upon the pole in the poet's days.

Shakespeare alludes to the practice of painting the maypole in "A Midsummer Night's Dream" (Act III., Scene 2), where Hermia thus addresses Helena—

> "And are you grown so high in his esteem
> Because I am so dwarfish and so low?
> How low am I, thou painted maypole?"

The ancient custom of ringing the curfew at eight o'clock every evening is still practised with unfailing regularity in many villages, and without which many of the rustics would not know the time for bed, for "there is no clock in the forest."

As there are customs that make for joy in lifetime in active use in this historic county, so there are customs of a pathetic and sympathetic nature observed at the close of a person's life.

For example, there is a well-established custom among the peasant folk of attending their village church on the Sunday morning following the interment of a relative, the female mourners remaining seated and deeply veiled during the singing of the hymns. This emulation of the custom observed at the singing of the *Dies Iræ* is strictly conformed to upon frequent occasions.

Among the dwellers in this poetic neighbourhood the custom of using sprigs of rosemary, both at weddings and burials, is still observed, much in the same way as mentioned in "Romeo and Juliet." Rosemary, indeed, is "for remembrance" in many ways. A maiden will give her lover a sprig when the time comes for them to part, and she will receive one from him. The shrub is largely grown in the cottage gardens, and from Shakespeare's days down to the present time it has played an important part in the floral and other customs of this county.

The festival of the ingathering or harvest home is not restricted to the occupants and workers of the farm, but is extended, by means of an outdoor demonstration, to all the dwellers in the village—so far, at least, as the first portion of the ceremony is concerned. A case I have in mind, which occurred at a village in the historic Vale of the Red Horse (the property of Lord Willoughby de Broke), no longer since than the autumn of 1892, may be regarded as typical of the manner in which it is now customary to observe the celebration in honour of a bountiful harvest.

On a beautifully fine October day, the celebrants met at four o'clock in the afternoon, at the sign of the Swan. There a procession was formed. Farmer Trab and Master Scoles were mounted on stout horses, representing the farmer of 1792 and 1892. Flags and banners with harvest mottoes; the village drum and fife band; serving-man carrying sheaves of wheat, barley and beans; a gay farm waggon (drawn by the farmer's dandiest team), laden with vegetables; a rustic bearing a huge loaf of bread upon a pole; a pony-carriage in which was seated the wife of "Farmer Trab," in quaint costume of the end of last century, attended by a cockaded flunkey; these and other items followed behind the farmers of two centuries.

Having gone a tour of the village the procession halted in front of the house of the lord of the manor, where Farmer Trab doled out bread and cheese to the farm servants from a basket in front of his saddle, and some wine from a wooden bottle slung at his side, much to the amusement of Lord and Lady Willoughby de Broke, who viewed the proceedings from the steps of the Manor. This done the company returned to the sign of the Swan, to feast at the generous table furnished by the host, and to perpetuate the harvest custom in "potations pottle deep" after the usage of Shakespeare's time.

There is, perhaps, no more curious custom extant in England than that known as "the Candle-light Auction" for the Warton grazing rights, which occurs in the month of October immediately subsequent to the commemoration of the harvest home.

Between the Warwickshire villages of Polesworth and Atherstone there is a small hamlet called Warton. At the sign of the Boot, or the Hatter's Arms of this village (the two inns which the village boasts) this quaint custom, dating from the time of George the Third, is annually celebrated. It relates to the letting of certain grazing rights upon the herbage growing at the roadside and upon the common lands in the parish. The rights are let by auction and the custom is that the whole of the grass has to be sold by candle-light, and the last bidder, when the flame burns out, is declared the purchaser.

The road surveyor of the day performs the duties of auctioneer, and is present with candle and book. The latter, doubtless, would be highly entertaining to the antiquary, inasmuch as it contains the records of these yearly auctions by candle-light from October 1st, 1815, to the present time, with the prices realized at each sale. At one time, soon after the institution of the custom, the sales used to realize about fifty pounds, but a quarter of that amount is now considered a satisfactory result.

All being ready, the tallow candle is cut into five lengths, half an inch high, there being five lots of herbage to be sold—each half inch of candle being for one lot. Then the road-surveyor auctioneer proceeds to describe the lots.

But the eyes of the company are, for the moment, attracted only by the flame of the candle. It is something to watch; something to make jests upon. The company show not the slightest disposition to bid for the herbage until the candle-light is dying out. Then the competition is remarkably brisk, and at the last flicker of flame each lot is knocked down by the road surveyor amid roars of laughter.

The custom of the payment of "wroth silver" to the stewards of the Dukes of Buccleuch, Lords of the Manor of Knightlow Hundreds, so far as is known is now practised in no other county of rural England. There was a similar custom in vogue in the New Forest in Hampshire in 1670, where "rother money" and "cattle money" appears to have been paid by the inhabitants to the owners of different manors for rights of herbage; but to-day, Shakespeare's greenwood seems to be the only place in England where this relic of early Saxon times is still practised with almost the same curious formalities as those observed at the wroth silver payment of eight centuries ago.

The custom dates from the days of King Canute (about the year 1018), who appointed a verderer or chief woodsman —represented by the land steward of to-day—over the forest districts, with powers to act as judge, and to see that no encroachments were made, or Royal Forest destroyed; to seize robbers frequenting the woods, to cause the destruction of wild animals, to see to the stalling of beasts of venery, and to prevent cattle straying.

The dwellers in the forests had certain privileges granted to them in regard to the grazing of the vast unenclosed lands, and these, in course of time, they obtained as their rights—often paying acknowledgments to the king, or to the lord of the manor, either in labour or remuneration, in money, or in cattle; and to these rights and charges are due the ceremonies of "wroth silver," "warth moneth," "hoctive moneth," "turf-dale moneth," and other similar customs, none of which now exist in Shakespeare's greenwood but that chief and most ancient of them all—"the payment of the wroth silver."

On Knightlow Hill (a slight eminence on the old London coach road between Coventry and Dunchurch, within the parish of Ryton-on-Dunsmore) the observance of this Saxon custom is annually carried out "before sunrise on Martinmas Day," the 11th of November.

The steward of the Duke of Buccleuch, woodlanders attracted by the prospect of rum and milk, representatives of the parishes upon which the toll is levied, and a few other persons (mostly antiquarians) interested in the practice of this curious ceremony of feudal times, assemble round the base of an old roadside cross which stands upon the brow of an ancient British tumulus or barrow, and in which there is a hollow formed for the reception of the wroth silver. Tolls ranging from one penny half-penny to two shillings and three half-pence are "called" from twenty-eight parishes in the Hundred of Knightlow; and for non-payment of these fees there is a fine of twenty shillings for every penny not forthcoming, or else the forfeiture of a white bull with a red nose, and ears of the same colour.

The ceremony in its chief points is as follows:—The steward, as the emblem of authority, takes his stand facing the east, and invites those present to form a ring round the broken cross, whereupon he recites "The Charter of Assembly," commencing "Wroth silver collected at Knightlow Cross by the Duke of Buccleuch, as Lord of the Manor of the Hundreds of Knightlow." The parishes liable to pay the fees are then cited to appear, each representative (on the calling of the name by the steward) casting the required sum into the hollow of the cross.

The ancient mode of payment was that the person paying must walk thrice round the stone and say, "the wroth silver," and then lay the money in the hole before good witness; for if not duly performed the parishes were in danger of the fine. These formalities have but slightly changed through the eight centuries of their observance, the custom of to-day being that the person does not walk thrice round the stone as in the original practice, but simply throws the money into the hollow of the stone, calling out "wroth silver" as each separate amount falls in, the money being afterwards gathered (in single payments) into the hand of the modern representative of the ancient verderer. Subsequently a breakfast is partaken of at the Shoulder of Mutton Inn at Stretton-on-Dunsmore, where the health of the Duke of Buccleuch, "the Lord of Knightlow Hundreds," is drunk in the time-honoured glasses of rum and milk.

Once only during the present century has the fine for non-payment of "the wroth silver" been exacted, and then the animal was rejected as not answering to the description prescribed by the charter—namely, "a white bull with a red nose, and ears of the same colour."

Microscopy.

By John H. Cooke, F.L.S., F.G.S.

Mr. Robertson, M.A., B.SC., of St. Andrew's University, finds that there are many plants which do not allow of the use of the filter pump for injection-staining or of treatment by the well-known method of Von Höhnel. For such specimens he suggests an alternative method, which he thinks will be found useful, both to private workers and for classes. A piece of india-rubber tubing, eight or more feet in length, is securely wired to the end of a large glass funnel. The apparatus is fixed at a convenient height, and a compressor clip is affixed to the free end of the tubing. A section of the stem to be injected is cut smooth and round, and is securely wired in the lower free end of the tube. A weak aqueous solution of fuschin is poured into the funnel, the compressor clip is removed, and a beaker is placed below to receive the drippings. After a few hours it will be found that much of the solution has passed through the conducting elements, staining them *en route*. The stem is then affixed to a second apparatus and treated in a similar manner with a weak solution of picric acid. This second treatment darkens the stained elements and fixes the tissue. If the specimen is intended for sectioning, it should finally be placed in ninety per cent. alcohol for a few days, after which it will be ready for the microtome.

The following method of making a culture cell whereby the various stages in the propagation of the diatomaceæ may be directly observed under the microscope is both simple and effective. It was first suggested by Dr. P. Miquel, and has since been used by him in his laboratory with considerable success. To a glass slip cement a glass ring out of the side of which a small piece has been cut. Cover this with a cover-glass. Through the orifice introduce the cultivating media containing a small quantity of a culture of, say, *Nityschia longissima*, and expose to the light. In the course of time the interior of the cover-glass will be covered with a beautiful growth of the frustules of the diatoms. This cell must, of course, be stood upright on its side. Cells may also be prepared by making the orifice in the cover-glass.

To clean cover-glasses and slides, immerse for one hour in a mixture made by adding to a saturated aqueous solution of potassium bichromate about one-eighth of its bulk of strong sulphuric acid. This will also be found useful for cleaning glasses that are intended for use as coloured screens.

Herr K. Koninski suggests a new gelatin-formalin method for fixing paraffin sections to the slide. The plate is first covered with a film of gelatin by the usual method, and, when this has set, the ribands of sections are arranged on it. The plate is then gently warmed until the gelatin has liquefied. Remove the superfluous gelatin with bibulous paper and allow the preparation to set. To render the gelatin firm and insoluble, the plates are immersed in pure formalin for ten minutes. Thus prepared, the mounts are sufficiently hard to resist the action of boiling water.

The following will be found to be a useful cement for making live-cells and zoophyte troughs, and for cementing the glass of aquaria. Dissolve gum elastic and thoroughly rub in with it a sufficiency of white lead and linseed oil varnish to form a paste.

The last number of the *Journal* of the Quekett Microscopical Society contains a *résumé* by F. Rousslet, on "Micro-Cements for Fluid Mounts." The author has obtained his best results by first giving a coat of pure damar in benzole, then a coat of a mixture of damar and gold-size, then three or four thin coats of pure gold-size at intervals of twenty-four hours, and finally a thin coat of Ward's brown cement.

The high refractive index of oil of cassia, and the fact that it dries hard enough to make permanent mounts, renders this reagent particularly useful to microscopists. It has an index of 1·6016, and clears from eighty per cent. alcohol.

To determine the character of a residue, place a small portion on a glass slip and saturate it with a drop of water. Note the general characters of the particles with the aid of a one-inch or a half-inch objective. At the end of the glass slip, place a drop of a ten per cent. solution of sulphuric acid, and at the opposite end a small piece of blotting paper. Diffusion will take place, and if any particles of carbonates be present, they will reveal themselves by effervescing. Quartz grains, clay, and carbonaceous matter will remain unaffected.

Coloured screens, for the purpose either of increasing the contrast between different coloured objects in a specimen, or of reducing it, are useful adjuncts to the equipment of the microscopist and the photo-micrographer. To obtain perfection of definition and of contrast either for visual or micro-photographic work, the use of partial monochromatic light is essential when working on bacteria and similar subjects; and the following plan for making reliable screens may, therefore, be of assistance to those who are engaged on this branch of study. It was first suggested by Mr. Wall to Dr. Spitta, the author of "Photo-micrography." Coat a patent plate with a two and a half per cent. solution of albumen; and, when dry, pour over it one hundred and seventy minims of an eight per cent. solution of gelatine, level and allow to dry. To make red, orange, green, or violet screens, soak the prepared plates in a one per cent. solution of crysoidine, aurantia, napthal green, and methyl violet respectively. For yellow screens, soak the plate in a solution of twenty grains of picric acid, dissolved to saturation in absolute alcohol, two ounces of water and a little ammonia.

Dr. Caspar O. Miller has developed an elaborate method of studying the mycetozoa by means of which he expects to ultimately obtain pure cultures. Bacteria are present in all cultures, and he is, therefore, now giving his attention to the influence that these have on the growth of mycetozoa. The plan of working that he most favours is as follows:—Well wash a handful of hay until the water is colourless, and then leave it to soak for about twenty-four hours. Pour off this water, filter it and dilute with fresh water until it is of a white wine colour, after which add two per cent. of milk to the infusion. Filter again and sterilize for future use. The hay is then cut up and placed in Erlenmeyer flasks, sufficient to fill them two-thirds full. Just cover the hay with water and sterilize for fifteen minutes, and repeat this process the following day with fresh water. This water is then poured off, and sufficient of the previously prepared infusion of hay and milk is added to cover it to a depth of one centimetre, after which the flasks are sterilized in a steam sterilizer for ten minutes on three successive days. They are then ready for use. The cultures were transplanted by means of a sterilized pipette. The results of the experiments were communicated to the *Journal of the Microscopical Society*, Vol. XLI., and all who are interested in the aseptic cultivation of mycetozoa would do well, therefore, to refer to that journal for the detailed description which it contains.

The following method for embedding small bodies, such as spores and pollen grains for sectioning in large quantities for class purposes, has been successfully adopted in the botanical laboratory of the University of Ohio. The spores are placed in a small test-tube and treated as for paraffin embedding. When the material is ready the tube is filled with paraffin, and after the spores have sunk to the bottom the whole is quickly cooled. The paraffin soon hardens. The tube is then broken, leaving the paraffin cast, which, with a little trimming, is at once ready for the microtome.

NOTES ON COMETS AND METEORS.

By W. F. Denning, F.R.A.S.

Present Comets.—The telescopic observer is now virtually without cometary objects, as Wolf's, Chase's, and other comets recently visible have become exceedingly faint, and may not be suitably observed unless in very powerful instruments. No discoveries of new comets have yet been effected this year. There are, however, several periodical comets near their perihelion passages, viz., Barnard's (1892 II.), Denning's (1881 V.), Tempel's (1866 I.), Tuttle's (1858 I.), and Holmes's (1892 III.). The three former are likely to elude observation owing to their unfavourable positions. It is particularly unfortunate that Tempel's comet of 1866 is situated at a disadvantage, as many observers would like to see the comet which is closely associated with the Leonid meteoric shower. But it can only be well seen on occasions when it reaches perihelion in about November or December, and if we assume that the comet has the same periodic time as its affiliated group of meteors, then this will happen only once in a century, and the object will not be seen again until the close of 1965 and opening of 1966, when it is likely to be presented under the best circumstances. Tuttle's comet was rediscovered by Wolf at Heidelberg on March 5th, when it was very faint, and estimated of the 11½ magnitude. It is moving to E.S.E. about 1° per day, and on April 1st will be placed in R.A. 44° 49′, Dec. + 24° 11′.

Holmes's Comet, which exhibited such a novel and rapidly changing aspect in the autumn of 1892, has a period of 2521·2 days according to Zwiers, and may be expected at perihelion (after allowing for perturbations by Jupiter and Saturn) on April 27th, 1899, but it will be invisible until later months, and will, at the best period, be placed at a considerable distance from the earth. Its conspicuous appearance in 1892 favours the view that it will be re-observed, notwithstanding the unfavourable conditions which will affect its visibility.

Tempel's Comet (1867 II.).—This comet was seen at its returns in 1873 and 1879, but escaped notice in 1885 and 1892. Gautier pointed out, some time ago, that under the powerful influence of Jupiter's attraction the time of revolution had been lengthened, and announced that a perihelion passage of the comet would occur in September, 1898. It evaded detection, however, though Perrine, at the Lick Observatory, made a careful search for it with the 36-inch refractor and other instruments.

Meteors of March 1–4.—Fireballs have often been observed to be unusually numerous at this period, and it is probable that a tolerably rich shower of slow bright meteors is occasionally, if not annually visible, though it appears to have previously escaped observation. From an investigation of the meteor-paths registered at Bristol, on the first few nights of March, the writer obtains radiants at 140° + 51°, 166° + 5°, 176° + 9°, and 201° + 67°, but the materials are not sufficiently numerous to indicate satisfactorily the positions of the best showers. A fine meteor equal to Venus was seen by Mr. G. T. Davis, of Reading, on March 1st, 1899, at about 8h. 45m., moving from 187½° + 40½° to 205° + 35° in 1½ secs. The same object was observed by Mr. T. H. Astbury, of Wallingford, traversing a path from 168° + 33° to 191° + 25° in 4 secs. A comparison of the two observations shows that the meteor passed over Essex, descending from a height of fifty-eight to twenty-two miles along a path of forty miles, with a velocity of about ten miles per second. The radiant point was at 119° + 33°. Earlier on the same night, at 7h. 1m., Mr. Astbury had observed a meteor brighter than Sirius, falling from 340° + 63° to 323° + 44° in 2½ secs., clearly belonging to the same radiant in Gemini as that which furnished the large meteor at 8h. 45m.

The April Lyrids.—The Moon will reach her first quarter on April 17th at 10h. 43m., and will therefore greatly interfere with observations of this periodical shower in the present year. Something of the early part of it may, however, possibly be witnessed on the mornings of the 18th and 19th before sunrise. It will also be worth while looking for it on the night following, April 20th, for if the sky is very clear and the shower returns with unusual intensity, it may be well seen in spite of the presence of a gibbous moon. The shower is, however, often very feeble and always brief in its visible duration. There is one important point to settle in regard to its radiant at 270° + 32°, and that is whether it exhibits an easterly motion similarly to the Perseids of August. There is very little doubt that the radiant varies in its position from night to night, but the thorough investigation of this feature must be relegated to one of the April periods when moonlight is absent and when several very clear nights occur successively.

The May Aquarids.—These should be looked for before sunrise, during the first week of that month. The radiant does not rise until about 1h. 45m. a.m., so that there is only a short time, in the morning twilight, available for observation. It is important that this shower should be well observed, as it has rarely been seen, and presents some orbital resemblance to the path of Halley's comet.

[*Addendum, March 15th.*—Since the above notes were written, Prof. Lewis Swift, of California, U.S.A., discovered a comet on March 4th, which he describes as just visible to the naked eye. The comet has been too far south and too near the sun to be favourably visible in England. At the beginning of April it will be about twenty degrees east of the sun, and will be placed to advantage in the mornings of May, when it will rise several hours before the sun.]

THE FACE OF THE SKY FOR APRIL.

By A. Fowler, f.r.a.s.

The Sun.—On the **1st** the Sun rises at 5.37, and sets at 6.31; on the **30th** he rises at 4.35, and sets at 7.19. He will be at his mean distance from the Earth on the **1st**. Sunspots have not been either conspicuous or numerous of late.

The Moon.—On the **3rd**, at 11.56 a.m., the Moon will enter her last quarter; she will be new on the **10th**, at 6.21 a.m.; will enter her first quarter on the **17th**, at 10.43 p.m.; and will be full on the **25th**, at 7.22 p.m.

The two most notable occultations of the present year will take place during this month. On the **15th**, μ Geminorum, magnitude 3·2, will be occulted. The star will disappear at 11.26 p.m., at an angle of 65° from the north point (26° from vertex), and will reappear at 12·8 at 319° from north point (283° from vertex). The Moon will be six days old, and the disappearance will take place at the dark limb. On the **28th** there will be an occultation of θ Ophiuchi, magnitude 3·4. The disappearance will take place at 11.56 p.m., at 89° from north point (114° from vertex), and the reappearance 1h. 6m. after midnight at 280° from north point (296° from vertex). The Moon will be nineteen days old, so that the disappearance will take place at the bright limb.

The Planets.—Mercury is too near the Sun for observation in this month. He will be in inferior conjunction on the **12th**, and will afterwards be a morning star.

Venus is a morning star, but is not well placed for observation. Her path lies very near the ecliptic through Aquarius and Pisces. On the **1st** she rises at 4.28 a.m., a little more than an hour before the Sun; on the **30th** at 3.37 a.m., about an hour before the Sun. At the middle of the month, three-quarters of the disc will be illuminated, and the apparent diameter will be 14·6″.

Mars is still well placed for observation, but his distance from the earth is rapidly increasing, and his apparent diameter diminishing. On the **1st** he crosses the meridian at 7.11 p.m., and sets at 3.30 a.m.; on the **30th** the meridian passage is at 6.4 p.m., and he sets at 2 a.m. The planet will be at aphelion on the **8th**, and in eastern quadrature on the **23rd**. During the month the semi-diameter of the planet diminishes from 8·4″ to 6·8″. The path of the planet is from Gemini, being almost in line with Castor and Pollux, at the beginning of the month, into Cancer, reaching a point not far from the Praesepe cluster about the end of the month. At the middle of the month nine-tenths of the disc will be illuminated.

Jupiter is very favourably situated for observation this month, being in opposition on the **25th**. On that date he will have a south declination of 12°, and an apparent polar diameter of 41·2″. During the month he describes a short westerly path in Libra, towards Spica Virginis. On the **1st** he will cross the meridian at 1.4 a.m., and on the **30th**, at 11.37 p.m., his altitude on the meridian being about 26°.

Saturn is not well placed for observation at convenient hours during this month. On the **1st** he rises about 12.50 a.m., crossing the meridian at 4.52 a.m., and on the **30th** at 10.52, crossing the meridian at 2.55 a.m. He will be stationary on the **2nd**, at a point in the most southerly part of Ophiuchus, and will afterwards traverse a short westerly path. His south declination is 22°, so that even when on the meridian his altitude in London will only be about 16°.

Uranus remains in the south-western part of Ophiuchus, not far south-west of the star ω. He rises shortly before midnight on the **1st**, and soon after 9.30 on the **30th**. The planet has a south declination of 21½ degrees, and will accordingly be very low in the sky.

Neptune may still be observed up to midnight in the early part of the month. He describes an easterly path, nearly a degree north of ζ Tauri, and preceding that star by an amount which diminishes from 5m. 12s. to 2m. 21s. during the month.

The Stars.—About 9 p.m. at the middle of the month, Leo will be on the meridian; Gemini in the south-west; Orion in the west; Virgo in the south-east; Hercules in the north-east; and Ursa Major almost overhead.

Algol may be conveniently observed at minimum on the **18th**, at 9.24 p.m.

Chess Column.

By C. D. Locock, b.a.

Communications for this column should be addressed to C. D. Locock, Netherfield, Camberley, and posted on or before the 10th of each month.

Solutions of March Problems.

No. 1.
(By V. H. M.)
1. R to B5, and mates next move.

No. 2.
(By W. I. M.)
1. B to Ksq, and mates next move.

[Several of our correspondents have attempted to solve No. 2 by 1. R to Q4, or 1. B to K7, overlooking Black's ingeniously provided defence 1 . . . P becomes a Knight.]

Correct Solutions of both problems received from Capt. Forde, G. G. Beazley, D. R. Fotheringham, Alpha, H. S. Brandreth, K. W., J. G. Parker, J. M. K. Lupton, W. Clugston, W. H. Stead, G. S. Hardy, F. V. Louis, one unsigned from Leeds, C. S. Kershaw.

Of No. 1 only, from Sunnyside, Miss Theakston, G. C. (Teddington), W. Hughes, W. de P. Crousaz, B. C. Tillett, H. B. Soper.

H. Bristow.—Revised problem will appear shortly. There is no harm in using a Black Queen to prevent a second solution, in default of a better way.

H. B. Soper.—R to R3 will not solve No. 2.

W. Hughes.—There is no dual in No. 1. Your definition of a "try" is correct, with the addition perhaps of the condition that the defence should not be immediately obvious.

A. Goldwater.—No. 1. If R to Kt4, B × B. No. 2. If R to Q4, P to Kt8, becoming a Knight.

G. A. Forde (*Capt.*).—Yes, there is a solution to the 3-mover which you send. The key is B to QB5.

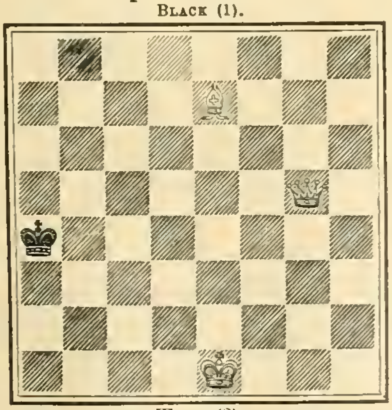
E. Reed Makeham.—There is a solution. As the problem is rather remarkable, we print it below. You may perhaps like to try it again.

Several correspondents are thanked for their good wishes for the cable match.

PROBLEMS.

No. 1.
Composer unknown.

Black (1).



White (3).

White mates in three moves.

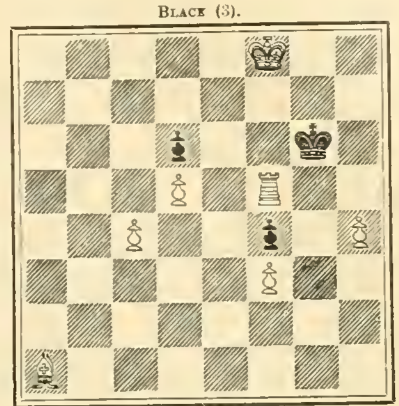
[This must be quite one of the best four-piece problems extant.]

No. 2.

By Jan Dobrusky.

(From the *Manchester Weekly Times.*)

Black (3).



White (7).

White mates in three moves.

[An ancient but always pleasing device.]

CHESS INTELLIGENCE.

Two club championships have recently been decided. At the British Chess Club Mr. Wainwright carried all before him. He won the handicap with a clean score of 11, and in the level tournament took first prize with a score of 8. The next in order were E. O. Jones, 6½; P. Hart-Dyke, 5; W. Ward-Higgs, 4½; E. Young, 4.

In the City of London Level Tournament the prize-winners were—

Section A.—T. F. Lawrence, 10½; F. Leye, 9; R. Loman, 9.

Section B.—Herbert Jacobs, 9½; L. Zangwill, 8½; P. Howell, 8.

Mr. Ward-Higgs tied with Mr. Howell for the third place in B, but lost in playing off the tie. In the final pool between the six prize-winners, Mr. Jacobs came out first with a score of 3½ out of 5, Mr. Lawrence failing to rise to the occasion. These short final contests are scarcely a fair test: in the final pool each competitor should play two games with every other.

The Anglo-American Cable Match took place on March 10th and 11th, the British team playing at the Hotel Cecil. Mr. Burn declined to play, his place being taken by Mr. Trenchard. The British team was evidently weaker than last year, while the Americans were evidently stronger than usual if they could afford to put Mr. D. G. Baird at No. 10. The victory for the United States by six games to four was accordingly not unexpected, though as the games went the English players should nearly have saved the match.

It is noteworthy that no less than seven out of the ten games were Ruy Lopez openings, and that the four English players of that opening were unanimous in castling on the fourth move. The score is subjoined, with a brief account of the games.

America.		Great Britain.	
1. H. N. Pillsbury	0	J. H. Blackburne	1
2. J. W. Showalter	1	H. E. Atkins	0
3. J. H. Barry	1	T. F. Lawrence	0
4. A. B. Hodges	1	E. M. Jackson	0
5. E. Hymes	½	D. Y. Mills	½
6. H. C. Voight	½	Herbert Jacobs	½
7. S. P. Johnston	½	C. D. Locock	½
8. F. J. Marshall	½	G. E. Wainwright	½
9. C. J. Newman	½	G. E. H. Bellingham	½
10. D. G. Baird	½	H. W. Trenchard	½
Total	6	Total	4

Board No. 1.—Mr. Blackburne, after converting his opponent's Two Knights' Defence into a Guioco Piano, took advantage of the open KB file presented to him, and obtained a slight advantage in position, in spite of an apparently useless manœuvre with his Queen. After the exchange of Rooks, Mr. Pillsbury, by a weak advance in the centre, allowed his opponent to establish a Knight at KB5, afterwards losing a clear Pawn by exchanging Queens. Mr. Blackburne does not appear to have selected the quickest way of winning, and Mr. Pillsbury, defending himself with great tenacity, was enabled to prolong the game and almost to save it.

Board No. 2.—Mr. Atkins selected an unfavourable defence to the Ruy Lopez, and Mr. Showalter found himself with two passed Pawns in the centre. Mr. Atkins might have pressed forward on the Queen's side, but confined himself too strictly to defensive manœuvres, and had to resign on the forty-fifth move. This is Mr. Showalter's fourth consecutive victory in these matches.

Board No. 3.—Mr. Lawrence played a variation of the Lopez at one time favoured by Steinitz, and more recently by Janowski. He lost a move with his Queen, and soon found himself with a defensive end-game, his opponent having two Bishops against Bishop and Knight. In the end he fell into a neat trap, the offer of a Pawn, and the Black King promptly marched in to QKt7, winning the QRP and the game. This is Mr. Barry's fourth consecutive victory.

Board No. 4.—Mr. Jackson defended the Lopez with the now discredited King's Fianchetto. He emerged, nevertheless, with two Bishops against Bishop and Knight, and a nearly even game. Mr. Hodges pressed the attack in the centre, and a Rook and Pawn ending in which Mr. Jackson wasted a move, resulted eventually in favour of his opponent.

Board No 5.—Mr. Mills played a weak move in the Lopez in order to avoid the exchange of Queens, but ingeniously forced the exchange of Rooks, and was left with Bishop and Knight against two Bishops. Mr. Hymes manœuvred his Bishops with superb confidence in apparently dangerous positions, and sacrificed a Pawn in order to Queen a Rook's Pawn. Mr. Mills, by an ingenious resource, obtained a passed Pawn in the centre, but overlooked a win, and though he eventually won a piece, this proved to be insufficient, and he had to be content with a draw.

Board No. 6.—Mr. Jacobs obtained a bad game through playing the centre Counter Gambit. His opponent unnecessarily gave up one of his Bishops for a Knight, and after an uphill struggle with Rooks and Pawns, Mr. Jacobs eventually obtained equality.

Board No. 7.—Mr. Locock took advantage of his opponent's defence to the Lopez, and obtained a strong attack which led to the win of a Pawn. He unnecessarily gave his opponent an opportunity for counter attack, and in trying to avoid a drawish position, obtained instead a difficult one. Eventually he found a difficult mode of saving the game instead of a simpler way of winning it. This was the first game finished.

Board No. 8.—Mr. Wainwright, defending the "stonewall" attack, overlooked a manœuvre which let his opponent's Bishops right into his game. Becoming eventually tired of the Bishops, he gave up his Queen, remaining with Rook and Knight against Queen and two passed Pawns. His opponent's neglect of one simple precautionary move allowed Mr. Wainwright to win the Queen's side Pawns with his Rook. After this the draw was easy.

Board No. 9.—Mr. Bellingham, playing the same variation as Mr. Mills, exchanged Queens and continued correctly with the Queen's Fianchetto. His opponent spent all his time in trying to preserve his two Bishops, and Mr. Bellingham obtained an attack which resulted in the gain of a Pawn. He remained, however, with Bishops of opposite colours, and overlooked his opponent's scheme for forcing the draw.

Board No. 10.—Mr. Trenchard defended the Lopez with his favourite P to KB4, and succeeded in isolating a Pawn. The players were left with two Rooks and a Bishop each, and eventually with Bishops and Pawns only. Mr. Trenchard tried hard for a win, but his opponent's King arrived just in time to stop the last Pawn.

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CONTENTS.

MOTHER-OF-PEARL AND ITS SOURCES.

By R. LYDEKKER.

OF the various descriptions of shells employed in European manufactures and arts, by far the most important position is held by those yielding the beautiful substance known as mother-of-pearl, so largely used for buttons, knife-handles, inlaying, etc. Forming the inner or "nacreous" layer of the shells of many kinds of molluscs, mother-of-pearl is characterized by its more or less marked iridescent play of colours and its "pearly" nature, being, in fact, in all respects identical in substance with pearls themselves. Unlike the colouring of the outer surfaces of shells, which is due to the deposition of pigment in their substance, the iridescence of mother-of-pearl is caused by the mechanical arrangement of the particles of the shell itself, which form a number of extremely minute and delicate ridges and grooves, thus breaking up the light falling upon them into its constituent elements. Pearly lustre is, indeed, precisely analogous to the colours of thin plates or films, and that it is really due solely to mechanical structure is rendered evident by the fact that impressions taken from mother-of-pearl in gum or fusible metal exhibit the same play of colours.

Although the shells of several kinds of molluscs are employed as sources of mother-of-pearl, those of the pearl-oyster form the staple of the trade. This is due to the fact that in no other shell does the pearly substance form such a thick and flat layer as it does in the pearl-oyster of commerce. As regards intensity and variety in the play of colours, the mother-of-pearl of the pearl-oyster is, in reality, much inferior to that yielded by the ear-shells (mentioned in the sequel); but for intrinsic beauty the former is perhaps unrivalled. Strictly speaking, the commercial pearl-oyster is not an oyster at all—that is to say, it is not included in the same family with the edible oyster. It belongs, however, to the same group of bivalve molluscs as the latter—the true oysters (*Ostreidæ*), scallops (*Pectinidæ*), thorny oysters (*Spondylidæ*), file-shells (*Limidæ*), and pearl-oysters and their allies (*Aviculidæ*) forming a closely-related assemblage of families. In all the members of this group the gills are folded, the edges of the two flaps of the mantle are quite distinct from one another, and the foot is comparatively small, or even rudimentary. The *Aviculidæ*, or pearl-oyster family, presents the following distinctive features:—The two valves of the shell are more or less unequal, and the vertical or central axis of each is placed very obliquely to the practically toothless and straight hinge-line, the extremities of which are often produced into long wing-like processes. Accordingly, the whole shell is very unsymmetrical, and the attachment of the two valves is formed entirely by the horny ligament. Externally, the shells are more or less rough and scaly, with the annual lines of growth marked by concentric ridges, while internally they are smooth and pearly. A notch beneath the anterior wing marks the position of the byssus, or mooring-rope, secreted by the small foot. In the more typical members of the family, or those properly belonging to the genus *Avicula*, the shell is comparatively thin, and the wings of the hinge-line, especially the hinder one, are very long and slender. On the other hand, in the true pearl-oysters, the shell often becomes much thickened, and the wings, with the exception of a rudiment of the anterior one, are not developed. Unfortunately, there is a difference of opinion among naturalists how much importance should be attached to these points of distinction, and we consequently find the true pearl-oysters sometimes described as *Avicula*, and at others as a distinct genus—*Meleagrina*. It is a matter of comparatively little importance which course is adopted, and they will here be alluded to under the latter title, as being the one in most general use.

Of pearl-oysters there are two distinct types. One is represented by the Ceylon pearl-oyster (*Meleagrina fucata*), in which the shell is comparatively small, and so thin as to be reckoned of no value in the mother-of-pearl trade, this species being fished only for the sake of its valuable pearls. The commercial pearl-oyster (*M. margaritifera*) (Fig. 1), which likewise produces pearls, has, on the other hand, a much larger and more massive shell, the two valves of which will not unfrequently weigh as much as two and a half pounds. And it is these shells which yield the great supply of commercial mother-of-pearl.

Pearl-oysters occur in vast banks in many parts of the Indian Ocean, Red Sea, Persian Gulf, and the warmer portions of the South Pacific, generally at about twelve fathoms depth. Formerly they were fished by divers, especially women, who worked without any special apparatus, and brought up a mollusc under each arm; but of late years the diving-dress has come largely into use.

According to the trade-reports of Messrs. Lewis and Peat,* of Mincing Lane, mother-of-pearl oysters are classified commercially into the following chief descriptions: (1) Australian, (2) black-edged Tahiti, etc., (3) Fiji and Sydney, (4) Egyptian, (5) Bombay, (6) Zanzibar, (7) Manila, (8) Mergui, (9) Banda black-edged, (10) Panama, and (11) Shark's Bay. All these different descriptions can be easily recognised by commercial experts; but, from the mixture of localities and the observations which follow, it is evident that many of them do not indicate distinct local races

FIG. 1.—Inner Surface of One Valve of Commercial Pearl Oyster. One-third natural size.

of the species, although others may probably be regarded as such. All descriptions are further subdivided, according to size, quality and condition, into "bold," "medium," "small medium," "chicken," "pickings," "broken pieces," and "stale and dead," which, in each description, diminish in price from the first two or three to the last. Furthermore, the shells, irrespective of origin, vary in value according as the margin of the interior is pure silvery-white, yellow, as in Manilla and Queensland samples, or black, as in those from Tahiti and Panama; the white, or silver-lipped, being the most, and the smoky, or black-edged, the least valuable, although there is some amount of variation in this respect according to fashion.

Pearl-oysters being sold in London by the hundredweight, it might seem an easy matter to obtain from the trade-reports the amount of the annual imports. Unfortunately this is not the case, since the consignments are reckoned by "packages," so that only the price per hundredweight can be ascertained; but it may be taken as certain that the imports are to be reckoned by hundreds of tons. As regards price, it would appear that, in spite of very heavy fluctuations that have taken place according to supply and demand during the last half-century, at the present day the value is much higher than the former average, and this, too, when the supply, owing to steam communication, may be presumed to be fairly constant. We read, for instance, in the first edition of Woodward's "Mollusca," published in 1851, that the price per hundredweight then ranged from two pounds to four pounds, and that the annual import of silver-lipped shells from the Society Islands to Liverpool was only about four hundred hundredweights, and that of the black-edged from Manila six hundred hundredweights in the year mentioned. Of the smaller Panama shells, however, the average annual import was at that time four thousand hundredweights, and in 1851 a single vessel brought upwards of six thousand eight hundred hundredweights (three hundred and forty tons).

About 1853, from which date till 1870 annual returns were issued by the Board of Trade, the mother-of-pearl imports seem to have received a new impetus, the following being the seven maximum years during that period:—

1856 = 42,032	hundredweights,	valued at	£76,544.
1859 = 40,003	,,	,,	67,859.
1869 = 37,662	,,	,,	94,015.
1854 = 36,644	,,	,,	88,305.
1867 = 36,175	,,	,,	70,426.
1857 = 34,324	,,	,,	57,819.
1868 = 32,002	,,	,,	64,869.

From this it appears that in the last year mentioned the average price was almost exactly two pounds per hundredweight, while in 1869 it was somewhat above, and in 1856 rather below that sum.

Turning now to Messrs. Lewis & Peat's trade-report for January, 1898, a single glance will show the enormous advance on these prices. Among the various descriptions of Australian shell the highest price was obtained for best Australian samples, in which "chicken" yielded eleven pounds twelve shillings and sixpence per hundredweight, "small medium" ten pounds seventeen shillings and sixpence, and "stale and dead" a minimum of three pounds two shillings and sixpence. Of other Australian shell, "Sydney and Queensland" showed a maximum of ten pounds twelve shillings and sixpence for "chicken," and a minimum of two pounds ten shillings for "dead and stale," while the descriptions respectively known as "Colonial sorted" and "Port Darwin" yielded very similar returns. On the other hand, the Australian shell known as "New Guinea character" ranged somewhat lower in value—"bold and medium" realizing eight pounds seventeen shillings and sixpence, and "stale and dead" two pounds. In shell coming under the description of black-edged, the maximum and minimum in "Tahiti" were nine pounds five shillings and three pounds, respectively. Cheaper still was that variety of black-edged described as "Gambia"—the maximum price being five pounds fifteen shillings per hundredweight. Here it should be mentioned that the word "Gambia" would naturally lead the uninitiated to believe that the shells came from the West Coast of Africa, where, so far as we are aware, pearl-oysters are totally unknown. The explanation of the mystery seems to be that "Gambia" is a trade corruption for "Gambier," which is the name for a small group of islands in the Low Archipelago, not very far from Tahiti, where there is an extensive pearl-fishery.

Another, although less glaring, misnomer occurs in the case of the so-called Egyptian shell, which is really obtained from the Red Sea, and was formerly shipped from Alexandria. About 1870 the annual shipment of shell from that port to Liverpool averaged about twelve thousand hundredweights; but some years later it fell to half that amount. The maximum price for this class realized in the January sale, 1898, was six pounds two shillings and sixpence per hundredweight. "Bombay" shell, again, which at the same sale reached a maximum of six pounds twelve shillings and sixpence, instead of being dredged off the city from which it takes its name, really comes from the Persian Gulf. Most of these shells are small, with dark edges; and although they used to realize more than the

* The writer takes this opportunity of expressing his thanks to that firm for much valuable information on this and kindred subjects.

Tahiti black-edged, they are now somewhat cheaper. A large quantity go to Birmingham for manufacture into buttons and counters, as well as for inlaying—the annual imports, some years ago, oscillating between about three thousand and five thousand hundredweights.

Of other descriptions of pearl-oyster, Manila shell, which is fished from the great banks of these molluscs stretching between the Sulu Islands, through the Strait of Macassar, to Basilan, fetches prices not greatly inferior to some of the Australian descriptions; while Mergui shell, from the archipelago of that name near the Tenasserim coast, is somewhat cheaper, realizing from about five pounds to eight pounds per hundredweight. Cheaper still are the Banda, Panama, and Shark's Bay shell; good samples of the former varying from three pounds fifteen shillings to four pounds five shillings, while similar qualities of the latter range between one pound fifteen shillings and two pounds six shillings and sixpence. Panama shells, which are small and black-edged, each valve weighing only about half-a-pound, are obtained from the Margarita, or Pearl Islands, in the Gulf of Panama. Fair to good qualities sell at prices ranging from three pounds to three pounds seven shillings and sixpence per hundredweight, those from the Island of St. Joseph being the best in quality. About 1855 the trade from these islands began to be of importance, the annual import for some years after that date ranging between sixteen thousand and twenty thousand hundredweights.

The foregoing are the chief descriptions of large pearl-oysters employed in the mother-of-pearl trade; and although these constitute the great bulk of the industry, they by no means include all the commercial sources of that material. Among several other kinds of shells, an important position is held by a small species of pearl-oyster apparently indistinguishable from the Ceylon *M. fucata*, and commercially known as "lingah." These shells measure less than three inches in diameter, and each valve averages only about one ounce in weight. The great bulk of the supply comes from the Persian Gulf, but a certain amount is shipped from New Guinea. As it is imported and sold in packages, the weight is not detailed, but as more than twenty thousand packages were offered at a single sale in 1898, the total amount must be considerable. The price of best quality varies from about twenty shillings to thirty-five shillings per hundredweight, according to the supply and demand. It is somewhat curious that this shell should be valued, while the Ceylon pearl-oyster is rejected.

In the "M. O. P." trade the term "mussel" has a signification different from that in ordinary use, being applied to a species of true *Avicula*, or those forms in which the "wings" are conspicuously developed, and the axis of the shell is very oblique. The particular species used is the common *A. heteroptera*: usually the variety in which the development of the hinder wing is comparatively small. "Bold and medium" shells may measure between five and six inches in diameter, whereas "chicken" shell is only between two and three inches. The number of packages offered at one of Messrs. Lewis and Peat's sales generally ranges between one hundred and one thousand, the price per hundredweight varying from two pounds thirteen shillings to three pounds ten shillings, or even four pounds, for the best quality.

In addition to the foregoing, certain kinds of freshwater mussels (*Unionidæ*) are used in the "M. O. P." trade. These are quoted as American sweet-water mussels, and belong to the genera *Paxyodon* and *Mutela*. When polished, they present a pinkish-white surface, with but little pearly lustre. Both the supply and the demand seem to be limited; and no prices were quoted in 1898. Some are worked up entire, while others are cut up. In the United States there is a considerable manufacture of ordinary pearl-buttons from freshwater mussel shells.

Turning to univalve shells, we find numerous quotations of "Japan ear" in the trade-reports. This shell belongs to the same genus (*Haliotis*) as the much smaller ormer, or ear-shell, found at low tide clinging to the rocks of the shores of the Channel Islands, much after the manner of a large flattened limpet. Indeed, the ear-shells are near relatives of the keyhole-limpets (*Fissurellidæ*), both showing one or more perforations in the shell connected with an excretory duct from the mantle. In the *Haliotidæ* these perforations form a curved line near the margin furthest away from the short spire. Internally the whole of the shell consists of a thick pearly layer, exhibiting a beautifully iridescent play of colours. Some of the tropical species measure from eight to ten inches across the shell. Several of these, like the one from the South Seas, have the shell so convex as to be of little or no commercial value; while in others, like the large Californian species, although the shell is flatter, it is spoiled by the great ridges and grooves on its outer surface. The Japan ear-shell of commerce (*Haliotis gigantea*) (Fig. 2), on the other hand, has a fairly flat and smooth shell, characterised by the large size of the marginal perforations, which are raised into crater-like elevations. As the portion of the shell external to the line of perforations is useless, it is always broken away in commercial specimens. Good samples of Japan ear in this condition realize from about five pounds five shillings to six pounds five shillings per hundredweight; but inferior descriptions sell as low as one pound five shillings. Mother-of-pearl from ear-shells was formerly largely employed at Birmingham for inlaying papier-mâchè ornaments and fancy goods, as it still is in America; but in this country it is now mainly used for studs, buttons, links, buckles, etc., its opalescent green tints rendering it more appreciated for some descriptions than the mother-of-pearl from oysters. Occasionally pounded ear-shell is used to ornament the lettering of shop-fronts. "Abalones" is a commercial name for the mother-of-pearl from ear-shells.

Fig. 2.—Outer surface of "Japan Ear."

Another shell of some importance in the trade is known commercially as "green snail," although it really belongs to a marine mollusc of the genus *Turbo*, its full title being *T. olearius*. These shells, which, when polished, display a mixture of green, yellow, and pinkish pearly tints, are of so large a size that they were formerly mounted as goblets for the Scandinavian kings. They are imported from Penang, Manila, and Japan; specimens from the former locality which weigh from one and three-quarter to two and a-quarter pounds selling at from sevenpence to sevenpence farthing each, while small samples varying between one-half and three-quarters of a pound fetch prices from twopence to threepence each. A second and smaller species of the same genus (*T. sarmaticus*), commercially termed "turbo" (Fig. 3), is also employed

Fig. 3.—The "turbo" of the mother-of-pearl trade.

in the mother-of-pearl trade, although it does not appear to find a very ready sale. Externally this shell is covered with a black epidermis, beneath which the whole structure is pearly, with a greenish tinge. Commercial samples are generally dead shells, more or less coated internally with a calcareous deposit overlying the pearly layer. These shells, which come from West Africa, are cut into sections, and used for small fancy articles, such as baskets, trays, boxes, etc.; but they are also worked up into buttons, brooches, and earrings, while they are occasionally employed as pipe-bowls.

Although seldom quoted in the sales, it may be mentioned that a beautiful little top-shell, *Trochus* (*Elenchus*) *iris*, used, when polished, by the Maories as an ear-drop, is sometimes employed in the mother-of-pearl trade.

This completes the list of shells quoted in English trade circulars as mother-of-pearl producers. Nevertheless, as already said, the full amount and value of the imports at the present day are difficult or impossible to obtain, the figures quoted above afford a fair idea of the great importance of this branch of commerce. In 1878 Mr. P. L. Simmonds estimated the average annual imports at between thirty thousand and forty thousand hundredweights (fifteen hundred to two thousand tons), at an approximate value of one hundred thousand pounds. And if the imports are maintained at anything like that level, present prices would indicate a largely enhanced total value. But to the English trade must be added that of other countries, among which America, Austria, and France figure largely, the latter country being reported in 1878 to work up annually about thirty thousand hundredweights (one thousand five hundred tons) of mother-of-pearl. In 1876 the French imports were given as one million three hundred and seventy-six thousand one hundred and thirty-two kilogrammes, of the value of three million one hundred and fifty-nine thousand nine hundred and forty-three francs; this being apparently exclusive of an annual average import of ear-shells to the extent of one hundred and thirty-four thousand five hundred and fifty kilogrammes.

Some of the uses of mother-of-pearl have been already mentioned, but a few details may be added. Papier-mâché inlaying seems to be a decadent art in this country; nor is this to be regretted, seeing that, from a modern standpoint, it was far from an artistic production. Handles to dessert knives and forks account for a considerable amount of mother-of-pearl, while it is also used to coat card-cases, for fan-handles and the hafts of pocket-knives, as well as for book-covers and countless other fancy articles. Mother-of-pearl, in some instances beautifully carved, was formerly much employed for the tops of snuff-boxes, being sometimes inlaid with tortoiseshell. It is also extensively used by cabinet and piano-makers, and is likewise worked up into boxes, carved brooches and pen-holders. Pearl buttons form a very important item in the trade—the large ones selling at as much as half-a-crown each, while the smaller kinds descend as low as eighteenpence the gross. Whereas in one season pure white may be the fashion for the large buttons, in another the "smoked pearl" of the black-edged oysters or the green pearl of the Japan ear may be solely in demand.

From its extreme density and hardness, the tools suitable for the worker in mother-of-pearl must be of the finest temper, and acids are often employed to aid in its manufacture, while it is polished with calcined iron-sulphate. Chinese and Japanese workmen are adepts in carving this refractory material, and the beauty and finish of some of their work almost, if not completely, defies imitation by the British artizan. In olden days, too, the inhabitants of Polynesia and Melanesia manufactured most beautifully-finished fish-hooks from mother-of-pearl, fine specimens of which are exhibited in the Ethnological Gallery of the British Museum at Bloomsbury. Some of these, from their opalescent green tints, appear to have been cut out of ear-shells, and probably served not only as a weapon to capture fish, but likewise as a bait to lure them to destruction.

ELECTRICITY AS AN EXACT SCIENCE.

By Howard B. Little.

III.—Arbitrary Assumptions and Expressions. Scientific Speculation as opposed to Hysteria.

When one is asked, "What is Electricity?" the wisest course of all is to confess ignorance. The sweeping statement of our old friend Democritus certainly holds good here. Many efforts have been made to formulate a scientific definition, and all have been failures. Of these, one of the best I ever heard was a statement to the effect that "Electricity is a particular state of matter." But here there are two unfortunate points—what particular state is not specified, and matter is still, so far as we are concerned, undefined. So that the suggested definition is no definition at all.

Yet electricity is by no means the only science placed in this position, or remaining in it. We do know that certain causes will always produce definable effects. And, when we are confronted by some specific phenomena we can say without hesitation, "This body is electrified," or "There is a current flowing in this wire." These expressions convey to us very definite meanings, yet they only tell us what we may expect from the body, or wire, under the circumstances. We have no information concerning the first cause. And it may not be too much to assert that this condition of things exists with reference to all natural sciences. Absolutely no moral application is intended here.

We can then easily recognize the presence of electricity, control it, deal with the effects produced by it, reason mathematically concerning it, and design apparatus, or machinery so accurately as to be able to assert, without hesitation, what amount of electrical energy can be obtained from it under given mechanical conditions.

Facing the fact, then, that we can recognise electrical effects but not electricity, we find ourselves compelled to adopt certain arbitrary forms of expression, otherwise we should frequently be at a loss as to how to follow up trains of reasoning and to give utterance to our ideas.

We speak of the flow of the current, yet it is by no means certain that anything does flow. The point is that we require some terse expression; it would not be convenient to say, "From the phenomena observed in the neighbourhood of the wire we know that the wire is in a high state of electrification with reference to the bodies surrounding it." The adoption of the word "flow" has another advantage. In the elementary consideration of current and pressure (both arbitrary expressions) it is of great assistance to regard the conductor which is electrified as being a pipe through which water is flowing, though this analogy must be carefully dealt with, even at first, and ultimately abandoned.

Again, we take it upon ourselves to actually define the direction of the flow, without being aware that there is a flow. But this is done with good reason. In the winding or connecting up of electro-magnets, and in electro-chemical operations, it is almost invariably the essential thing to know beforehand in what direction certain phenomena will occur. In the case of an electro-magnet, if we look at the north-seeking pole, when it actually points to us, we may assert (since we have the useful convention as regards flow) that the current is flowing contra-clockwise round the coil. If there were no other reason for the convention, the convenience here would be sufficient to justify its adoption. We see then that the one assumption that something does flow leads at once to the use of certain arbitrary expressions.

There is another assumption made with reference to the comparison of potentials—*i.e.*, static potentials. One sees the necessity for this by considering that positive and negative potentials are to be spoken of, and since these two expressions are not to be regarded as having their exact mathematical meaning (any more than negative as opposed to affirmative has), it becomes essential that there should be some universally accepted body considered as being without potential. The earth has been chosen, for the obvious reason that it is accessible all the world over, and may be regarded as a good conductor if proper contact be made to it.

Conventions which are based on reasonable and convenient principles, that are well understood, and generally adopted, are just as necessary in scientific as in social circles. But in the former case it is imperative that the fact of their being conventions adopted for the sake of the general convenience must never be lost sight of. For example, when stating that the earth's potential is nought, it must be borne in mind this does not imply that the earth is not an electrified body; any such assertion would be ridiculous, and liable to lead to very grave errors.

The nomenclature of electrical units is based upon an excellent system. Such names as volt, ampère, ohm, joule, farad, and so on, keep before the student the more important branch of some great predecessor's life work, and serve to remind him to what heights human intelligence and industry may attain.

With the rapid growth of electrical undertakings (due to the strides which the science has made) there have not been wanting growths which may be termed parasitical, and growths which may be relegated to the general class termed fungi. This was, perhaps, inevitable, and it must ever be of interest to consider (as dispassionately as may be) the causes which have tended to bring these unpleasant excrescences into existence. Lust of fraudulent gain will in all probability be the dominating influence of a section of the community so long as that community shall last. But of the frauds we would prefer to say little here. Indeed, some suggestions made in the first paper of this series might be considered sufficient, only that reference to a certain wonderful motor was omitted there. This motor crops up frequently; its claim to public attention seems to be based upon two facts, it is reported to get an enormous percentage of its energy from nowhere,* and it seems to have been designed with a view to relieving the public of their superfluous wealth. Alas for the frailty of human nature! The machine in question came into existence at about the time that the first electrical undertaking was "quoted on Change." It is not one month since, reckoning from the actual date of the writing of these lines, that a report was printed in a well-known and high-class paper here of the exposure of an American fraud based upon "The extraction of gold from sea water." It seems that the majority of American frauds find their way over here. To be charitable, we must assume that the little schemes of this nature which have their birth here find their way to America.

But there is another, and a still more widespread source of error. Even in the minds of intelligent men and women there is, as a rule, a deep-rooted love of the marvellous. And this foible is unfortunately pandered to by people who should know better. The result is, all too often, that a section of the community works itself up into a wild frenzy of admiration for some individual whose name becomes a household word. It goes so far at times that the unfortunate recipient of this attention, who may actually have been a really honest worker in the paths of science, is driven into a mental condition which had better perhaps be described as hysterical, and he arrogates to himself the gift of prophecy. It must be trying to the most level-headed of men to find that his name is, in all seriousness, coupled with such titles as wizard, and magician, particularly if the effusions of this sort are circulated throughout the entire world, and in the nineteenth century, by papers of good repute, which in the main employ only responsible contributors.

And there is a case, unique, I think, of a lady novelist who lets her wonderful imagination run amuck in the realms of electrical science, and actually adds, by way of preface, or note, to her remarkable work, that she has the highest scientific authority for the assertions she makes. I have often tried to understand just some little point in connection with the marvels described, but, being only an electrician, have invariably failed.

* Since this was written the inventor of the motor has died. An examination of the building in which the machine was shown has revealed the presence of tubes in its walls. And these tubes conveyed compressed air to the machine.—H. B. L.

A nation which spends annually enormous sums upon education might well spend an adequate fraction on the suppression of this style of thing.

A certain "Mother Shipton" is credited with the "prophecy" that "one day carriages should run without horses," or something to that effect. Should that Delphic utterance have entitled her, in her own time, to any credit as a discoverer, as an inventor, or as a scientist? Emphatically, no! Yet, not to deprive her of all credit, one may say, without reserve, that she made a shrewd remark.

But there is such a thing as scientific speculation, which may be indulged in with great benefit, both to the actual speculator and those to whom he communicates his ideas. Workers in every branch of science can multiply instances of such rational speculation which have indicated most profitable lines for investigation. In this connection, the chemist might possibly refer to Mendelejeff, the astronomer to Gallileo, and the electrician to Grey or Cromwell Varley.

It will be noted that, so far as electrical workers are concerned, two names are mentioned. Apart from the fact that this is perhaps natural in a paper under the above heading, there is a specific point which I would bring out here. Stephen Grey expressed a hope—to which reference has already been made—while Varley uttered a warning, concerning the speed of signalling which could be attained through a submarine cable. Thus while both indulged in well-founded scientific speculation, and both had the ultimate advancement of science in view, the one encouraged, and the other strove to damp the ardour of his contemporaries.

Many other instances might be quoted, but surely these names will more than serve.

Another form of hysteria, perhaps as pernicious as that already mentioned, has recently led certain really intelligent scientists to announce (with what one can only allude to as a flourish of trumpets) what they are about to do. On the other hand, if it is not they themselves who have made such statements, they have the option of either contradicting them, or stating that they are made without authority. It is in a great measure due to this hysterical tendency that we hear of the internal troubles of scientific societies. A painful controversy is raging now, and the long established constitution of the society appears to be threatened.

But perhaps too much has already been said on this subject. Finally, it may be urged that electricity can add to the foundation of its claim to be an exact science the plain statement that, even when arbitrary assumptions are made and arbitrary expressions are used, a distinctly scientific convention is always adopted, and, the position being so well understood, there is absolutely no danger of serious error being allowed to creep in on account of either such expressions or such assumptions.

As regards scientific speculation which can be justified, electricians can point to their share; but, alas! it must be admitted that we suffer to far too great an extent from hysteria, both internally and externally. The internal suffering is by far the most acute. We can only hope that the external trouble, thrust upon us and the public, is not to be allowed to become chronic.

THE ACETYLENE INDUSTRY.—II.

By GEORGE T. HOLLOWAY, ASSOC.R.COLL.SC., F.I.C.

IT would be impossible within the limits of this article to describe the various generators which have been used or patented for the production of acetylene from calcium carbide, but the general types may be briefly referred to. Those shown at the Exhibition of the Imperial Institute during last summer were divided into three groups—(1) those in which the gas is generated by the action of water dripping or flowing in a small stream upon the carbide; (2) those in which water rises around the carbide; and (3) those in which the carbide falls into water.

In Class 1, the water commonly falls upon the carbide from perforations in a metal pipe, while in Class 2 the water is usually allowed to pass on to or through the carbide, which is contained in perforated trays. This latter arrangement is frequently made automatic, by the carbide being contained in a receptacle fixed to an inner vessel which rises and falls as the gas is generated and used up, as in the case of a gasometer, so that the carbide is raised out of the water or lowered into it, as the gas is produced or consumed. A common form for Class 3 consists of a generator having a side shoot through which the carbide is dropped into the water as required.

A lengthy series of experiments made by Prof. Vivian B. Lewes as to the temperatures developed by the reaction between the carbide and the water under these various conditions, and as to the amount of gas produced, and other matters connected with the application of acetylene, especially for small lighting installations, has resulted in some interesting conclusions. In each of the first two forms there is a considerable liability to such a rise of temperature as leads to polymerization, and also to the partial decomposition of the gas, with production of tar, benzene, and other bodies, which not only reduce the volume of acetylene generated, but also tend to choke up the burner, as described later on. The second class of generator, which constitutes the bulk of those on the market, is found to be less objectionable than the first form, but those of the third class, of which very few are in use, appear to be the most scientific, and give rise to less over-heating, although it has been stated that their yield of gas is below that of the other forms.

After the rapid evolution of gas which occurs on the first admixture of the carbide with water, a slow evolution continues for some time, and for this reason, in apparatus having an automatic "cut-off," the arrangements should be such that the cut-off acts when the gas-holder is not more than three-fourths charged. Finally, a large excess of water must be used to minimize overheating of the carbide, and a cock should be fitted at the base of the generator to draw off the lime sludge formed during the reaction.

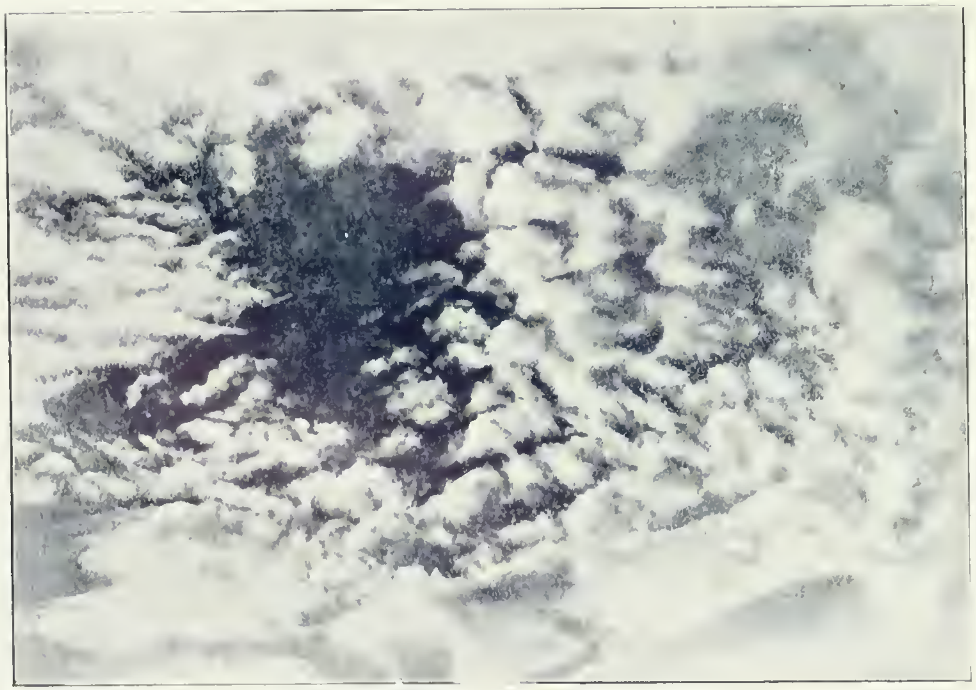
The danger of explosion from acetylene gas may be attributed to (1) the action of the acetylene on the metal used in the construction of the gas-holder and its fittings, with production of explosive acetylides; (2) to the presence of phosphoretted and siliciuretted hydrogen and, perhaps, other impurities, and (3) to the endothermic nature of acetylene. Other and unknown causes appear also to form factors in this problem.

The presence of phosphoretted and siliciuretted hydrogen in acetylene is due to impurities in the carbide. Prof. Lewes has found from a trace to 2·3 per cent. of the former gas (an average of 0·65 per cent. on twelve samples) in acetylene, but not more than very small traces of siliciuretted hydrogen were detected, and his experiments tend to show that in carbide of English manufacture there is no danger of explosion from the presence of either of these gases, provided the generator is so constructed as to prevent overheating of the carbide. It appears, however, according to Dr. Grainger, that friction, even such as may be produced by opening a valve, is sufficient in the case of the liquefied gas to sometimes induce an explosion.

Other impurities, such as ammonia, sulphuretted hydrogen, arseniuretted hydrogen, marsh gas, oxygen, nitrogen,

No. 1.—STRATUS.

No. 2.—CUMULO-NIMBUS.



No. 3.—ALTO-CUMULUS.

No. 4. CIRRUS.

hydrogen, carbon monoxide, benzene, certain cyanogen compounds and tarry products, are also present, and various methods of washing out the most objectionable of these have been used and proposed, such as bubbling the gas through water, sulphuric acid, calcium chloride solution, and solutions of lead salts.

It is stated that M. Pictet prepares absolutely dry and pure acetylene possessing a distinct, but not unpleasant, odour, having no action on metals, and capable of being compressed without any danger of explosion.

Although it is not impossible that acetylene may be ultimately applicable for heating purposes, it is at present only in use as an illuminating agent, either in its natural state or after admixture with other gases.

Prof. Lewes recommends the use of acetylene mixed to the extent of ten volumes of acetylene with ninety volumes of a mixture of thirty volumes of methane (marsh gas) with seventy of hydrogen, carbon monoxide or water gas. On the Prussian State Railways, a mixture of one volume of acetylene with three volumes of oil gas is in use, and has been found to pass the tests imposed by the Prussian Government. Acetylene has also been used on trains in Ontario and elsewhere with success, and the United States Lighthouse Board propose to employ it for lighting buoys at sea. The danger of explosion already referred to has, however, given rise to various regulations, which much restrict the use of the gas. The employment of compressed and liquefied acetylene, for instance, comes under the Explosives Act in England, while on the Continent and elsewhere more or less stringent rules are enforced. The action of the English and Continental insurance companies has also much restricted its domestic use.

The value of acetylene for illuminating purposes lies in the intense lighting power it possesses, the burner which replaces the ordinary domestic gas burner only consuming about half a cubic foot per hour. The luminosity of the ordinary coal gas flame has, indeed, been attributed by Prof. Lewes to the partial decomposition of the gas into acetylene in the inner region of the flame, and the subsequent combustion of the acetylene; while, according to M. Pictet, the intense light of the acetylene flame is due to the decomposition of the gas into its elements. This decomposition, which occurs near the base of the flame, is accompanied by the evolution of so much heat as raises the separated particles of carbon to incandescence.

Apart from any dangers attending the use of acetylene, it has hitherto been found impossible to produce a burner which is entirely satisfactory. Probably, mainly on account of the dissociation of the gas, the nozzle of the burner soon becomes carbonized, and, especially when exposed to draught, growths of carbon soon appear round the nozzle and render the flame so irregular as to make it practically useless. This difficulty, which is particularly noticeable where no chimney or draught preventer is used, makes it necessary to frequently clean the burner, an objection which very seriously militates against the domestic use of the gas. The burners in use resemble the ordinary coal-gas burners, but have much smaller outlets, some being only the one-hundredth of an inch in diameter.

Many burners have been introduced to prevent the carbonization referred to, but none have proved entirely satisfactory. The burner of Naphey, of New York, is, however, said to be the best. It consists of two nozzles arranged at such an angle that the thin round pencils of light which they emit meet at an angle of about ninety degrees, where they impinge, and produce an ordinary batswing flame. The nozzles are so perforated that small currents of air impinge on the base of each flame, and thus ensure the maximum of oxidation without impairing the light, so that carbonization is minimized.

Finally, it should be stated that, although much capital has been invested in the acetylene industry, and there is a reasonable prospect of its somewhat extended use where the conditions are not favourable for the employment of other illuminants, this new handmaiden of science is still only on trial, and has many difficulties to overcome before taking the important place among our lighting agents which has been predicted for her.

CLOUDS.

By James Quick.

To the occasional observer the different types of cloud formed above us appear almost endless. The difficulty he experiences, however, in not being able to assign definite names to them is not surprising when one considers the universal attention clouds have claimed throughout the present century.

Since Luke Howard put forward his classification in 1803, there have been proposed up to the present time something like fourteen systems of nomenclature, and fifty or sixty names to designate different cloud types. These, moreover, emanating from most of the principal observatories and meteorologists throughout the world, have demanded their proper consideration and discussion.

Howard's system, as will probably be well known, comprised three different types of clouds. These were described as follow:—(1) *Stratus.*—" A widely extended, continuous, horizontal sheet, increasing from below." (2) *Cumulus.*—" Convex or conical heaps, increasing upwards from a horizontal base." (3) *Cirrus.*—" Parallel, flexuous, or diverging fibres, extensible in any or all directions." Together with these three fundamental ones, Howard recognized four intermediate forms, compounds of the above.

Notwithstanding the numerous systems of nomenclature proposed later, none has to any extent displaced that of Howard, which gradually came into general use, and continued so, down to recent years.

The classification put forward by the late Clement Ley has many points of interest. It claims attention not only as a new system, but also on account of the physical nature of its definitions presenting a clear idea of the several causes of cloud formation.

Four primary types are here recognized, corresponding to a certain extent to Howard's three fundamentals. The first two, viz., clouds of radiation and interfret, are similar to the original stratus; the third type—those of inversion—comprise the cumulus; and the final division, consisting of inclination clouds, correspond to the cirrus variety. These four primary types are split up, making, in all, twenty-six sub-divisions.

The generally accepted classification of the present day is the International system formed from the nomenclature of Hildebrandsson and Abercromby. It is composed of the following ten types and sub-divisions:—

Low Clouds.	Middle Clouds.	High Clouds.
1. Stratus.	6. Alto-Stratus.	8. Cirro-Cumulus.
2. Nimbus.	7. Alto-Cumulus.	9. Cirro-Stratus.
3. Cumulo-Nimbus.		10. Cirrus.
4. Cumulus.		
5. Strato-Cumulus.		

Examples of some of these types of clouds are given in the plate. The first photograph is a typical example of the stratus variety, which is defined in the International system as a lifted fog in a horizontal stratum. The second picture shows the cumulo-nimbus, or thunder-cloud type.

These heavy masses of cloud, rising up like mountains, towers, or anvils, suggest the terms "anvil," and "turret," which have been applied to them. They are generally surrounded at the top by a veil or screen of fibrous texture, known as false cirrus, and below by nimbus-like masses of cloud.

The next is of the alto-cumulus type; a dense, fleecy cloud, composed of large whitish or greyish balls, with shaded portions grouped in flocks or rows. Finally come those isolated, feathery clouds—sometimes like thin veils—belonging to the cirrus variety, as depicted in the fourth photograph.

Reproductions of original photographs of both cumulus and stratus varieties appeared in Knowledge for August, 1894, from Mr. H. C. Russell, of the Sydney Observatory. Particularly fine and interesting are the two alto-cumulus or "mackerel" sky pictures, while the shades upon the other compounds are exceedingly characteristic.

In the main, as will be seen from the preceding classification, the system of Howard has remained unchanged except by natural growth. Even the International system is professedly only an adaptation, for general use, of the cloud names which had already come into use in different places. It must, moreover, be remembered that a general classification of clouds becomes possible only in view of the fact that cloud-forms are identical in all parts of the world; in other words, that condensation processes take place everywhere in the same way. Nevertheless, it must not be inferred from this that the same cloud-forms are everywhere associated with the same kind of weather. The conditions producing any one particular weather phenomenon vary greatly in different parts of the globe.

It will be seen from the International list above that the lower and middle clouds comprise the first three types and sub-divisions of Ley's system, viz., radiation, interfret, and inversion, and the higher clouds the fourth of these, viz., cirrus. They are sub-divided according to the altitudes at which they occur, thus presenting a more uniform and convenient method for classification.

Considering now, more in detail, the actual mode of formation of clouds and the physical changes involved, radiation clouds are produced by the radiation of the heat from any particular locality and by the consequent cooling and precipitation of the water particles. These clouds, only dependent upon radiation and not upon the motion of the air, are reduced as a matter of fact to one only—fog. Speaking generally, however, of the two terms, fog and cloud, there is no real physical difference between them. A cloud may be defined as a fog viewed from the outside, and a fog as a cloud viewed from the inside.

This formation of fog is, of course, in accordance with the general physical law, that if a mass of air containing water vapour is cooled below its saturation or dew-point, condensation of the vapour will set in. This can easily be shown experimentally by means of the apparatus depicted in Fig. 1. A is an air-pump connected to one of the vessels, C, D, which are large, round bottom, glass globes—the larger the better. C and D are connected together with a stop-cock, B, inserted. The bore of this connecting tube, as well as the orifice of B, should be as large as possible. G is a screw-clamp cutting off communication with the outside air. A little water is poured into D to saturate the air, and the stop-cock B turned off. C is then exhausted by means of the air-pump, and B again turned on. Air immediately rushes from D to C, and in doing so expands and takes up the necessary heat from the remainder, thus cooling the latter below saturation point. A thick fog is produced in D, and may be shown in a more striking manner by arranging a lime-light jet behind D, when brilliantly coloured halos will be seen, varying according to the number and size of the water particles.

Under certain circumstances, two currents, the one colder than the other, may be formed up in the air, moving more or less horizontally and in opposite directions. The one rubbing over the other will produce ripples in the air, such as does a wind blowing over the surface of a lake, but ripples of greater magnitude. In the hollows of these waves the vapour will be condensed and other forms of the stratus type of clouds are thus produced. One variety of these is the well-recognized stratus maculosus or sky, which, compared by some to a flock of sheep lying down, always claims an observer's attention by its quiet beauty.

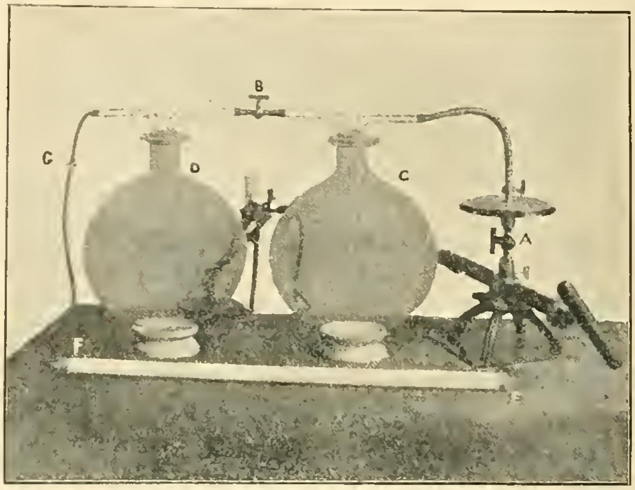


Fig. 1.—Fog-producing apparatus.

The next type of clouds are those produced by the ascent of heated columns of water-laden air, which expand and become colder, as has just been explained. Condensation of the vapour takes place, therefore, as it rises into higher and colder regions. In this division occur those massive, woolpack, or heap clouds, the cumuli, together with their compound forms, such as cumulo-stratus or the "anvil" cloud; cumulo-nimbus or the shower cloud; and, finally, the easily recognized and generally disagreeable form of nimbus or rain cloud.

These flat-bottom, extensive, cumulus-clouds, sometimes measuring twenty-five thousand feet from base to summit, present different aspects according to their positions when looked at. Seen, when fairly low down, by the reflected light of the sun, they give to an observer a beautifully brilliant picture to gaze at. When, however, the sun is not shining on the lower portion of the cloud, the bright picture changes generally to one of approaching gloom, and one thinks sometimes of a coming storm. As a matter of fact, however, simple cumulus is by no means a usual cloud of unsettled weather. It is when it commences to unite to form one of its compound forms—say cumulo-nimbus, that rain may be looked for.

The final principal type of clouds, the cirrus, presents a different appearance to the preceding varieties, and offers a somewhat different consideration. When from any cause a layer of air containing water vapour has been carried to a high altitude into layers of rarefied air, which, moreover, are at a very low temperature, condensation will commence as soon as this layer has been sufficiently cooled. The minute water particles thus formed are immediately frozen into ice-dust, producing those vague, thin, lofty clouds resembling tufts or branches of curled hair, so characteristic of the true cirrus type.

Cirrus clouds and their compounds seem to play an important part in the production of thunderstorms, although the exact action taking place in the formation of the latter is not, perhaps, clearly understood. The cirrus clouds, bristling all over with pointed ice spicules, if brought into the neighbourhood of a cumulo-nimbus cloud highly charged with electricity, would tend to lower the electrical potential of such a cloud considerably by the numerous point discharges. Now the experiments of Lord Rayleigh in connection with this brought out some interesting results. Experimenting with a water jet, he found that by electrifying it feebly, the separate water drops coalesced instead of rebounding from one another as they did before electrification. If, however, the jet was strongly charged—say, with a Leyden jar—the effect was just the opposite. The colliding drops no longer coalesced, but were scattered even more widely than when the jet was unelectrified.

Assuming, then, that the reverse of this action is true—that the separate particles of a cloud when highly charged rebound from one another to a greater degree than when less charged—the action of a cirrus cloud invading the territory of a cumulo-nimbus, or *vice versa*, will perhaps be more clearly understood. The drops will coalesce more when the electrical potential is lowered, and the large-size rain drops accompanying a thunder shower will result.

Coming now to the conditions affecting cloud formation, many circumstances determine when and where the water vapour is condensed. It may rise only a comparatively short height above sea level before the change takes place, or circumstances may require its ascension to high altitudes. For instance, suppose a cold north-east wind, or a south-east wind already laden with moisture, or a lowering of the barometric pressure to set in; all these will tend towards an early formation of cloud. Upon a dry, calm day, however, the vapour will generally have to travel up a long way before it will change its condition. In fact, sometimes, under these circumstances, it only changes into water drops to be directly transformed again into ice particles, resulting in the delicate, fleecy, cirrus variety.

Again, water vapour possesses a good heat absorbing power. A cloudy sky, therefore, or an atmosphere already charged with vapour will, in one respect, check condensation by preventing free radiation of the heat out into space.

But there is yet another and most important item in the programme, the presence or absence of which materially aids or prevents any cloud being formed at all. This essential factor in the atmosphere is—dust. Dust, or minute particles of matter of some description in the air to act as nuclei, is apparently as necessary to the formation of a cloud as the water vapour itself. It is quite possible that a minute water drop *can* be formed without the agency of such a nucleus, but, as has been shown by Clerk Maxwell and J. J. Thomson, unless the water vapour finds something to act as a nucleus around which to form a water drop, it will evaporate away again before it has had time to grow.

Most exhaustive has been the work by Mr. John Aitken, F.R.S., upon the importance, both qualitatively and quantitatively, of dust particles or other nuclei in cloud formation. One of Aitken's experiments illustrating the part played by dust is so striking that, although it will doubtless be familiar to some, it will bear repetition. Referring to the experiment illustrated in Fig. 1, it will be remembered that with ordinary dust-contained air a thick fog was formed in the vessel D when the air contained in the latter was expanded into C. The long tube E F in Fig. 1 is packed with cotton wool, and one end, F, connected to the vessel D by means of a thick walled india-rubber tube. The pinchcock G is now screwed up tight to prevent air flowing in through E F, the stopcock B opened, and the vessels C D then exhausted of air by means of the pump A. B is then shut and G opened slightly to let the outside air flow slowly in at E and get filtered of its dust in traversing the tube. By going through the whole process two or three times, the final air in D will be quite dustless. The pinchcock is then again screwed up and the air in D expanded by opening the stopcock. No fog or cloud will be observed, and the brilliantly coloured halos obtained before will be conspicuous by their absence. Large drops of water will trickle down the sides of the vessel because the latter will offer a surface upon which the vapour can deposit its burden.

In view of the above result it can be seen why the well-known Scotch mists are so different to many others; why the drops are so big and at the same time few. The atmosphere in some parts of Scotland being so pure, so comparatively free from dust and dirt, there are very few particles of the latter round which the vapour can condense.

Illustrative also of this point, but in the other extreme, the dense, thick fogs of our cities tell their own tale of manufactories and fires and of the products of combustion in the air. With nuclei in abundance and other conditions satisfied, the water vapour has no difficulty in finding rocks upon which to build its numerous water-drop castles.

Although it is conclusive that water vapour must have nuclei around which, as centres, it can condense; and, notwithstanding, owing to the immense number of solid dust particles present in the air condensation takes place upon them, yet they are not absolutely essential. It has been shown by Aitken, R. von Hemholtz and others, that in the absence of dust cloudy condensation occurs, but the solid nuclei are replaced by other foreign substances. These may be the molecules of the vapour of sulphuric acid, or the particles given off by anhydrous sulphuric acid, or even from metal surfaces when heated or electrified.

There is yet one further point to be considered, and one which Tyndall first described in his heat lectures. This is the direct influence of sunshine in producing condensation. Tyndall illustrated this by showing the beautiful clouds that result when a beam of light is allowed to pass through a long tube full of dustless, saturated vapour. Furthermore, Aitken has recently found, from similar experiments, that many of the vapours which are called impurities in the atmosphere, such as ammonia, chlorine and several acids, give rise to nuclei of condensation when acted upon by sunshine. Indeed, sulphurous acid and chlorine are thus active, even in the dark, but to a much less extent than in sunshine.

Thus the great wheel of Nature turns—from the sea to the sky, from the sky to the earth, and back to the sea again; this interchange, this complete cycle, working for our good and for the good of everything in general, is ever in action.

A NEW STAR IN SAGITTARIUS.

A NEW star appeared in the constellation Sagittarius early in the year 1898, or possibly in the latter part of the year 1897. It was found from the peculiarities of its spectrum, by Mrs. Fleming, during the examination of the Draper Memorial photographs. The approximate position for 1900, derived from a photographic chart, using the Durchmusterung positions of adjacent stars, is R.A. = $18^h\ 56^m{\cdot}2$, Dec. = —13° 18′. It was too faint to be photographed on eighty-seven plates, from September 5, 1888, to October 23, 1897, including three plates in 1888, one in 1889, three in 1890, eleven in 1891, three in 1892, twelve in 1893, ten in 1894, twenty-one in 1895, eight in 1896, and fifteen in 1897. On the last of these plates, A 2845, taken at Arequipa with the Bruce telescope, stars of the fifteenth magnitude are shown, but the Nova is invisible. The Nova appears on eight photographs taken in March and April, 1898. In the description of them given below the designation of the plate is followed by the date and the exposure. The letter B indicates that the photograph was taken at Arequipa with the eight-inch Bache telescope, and I, that it was taken at Cambridge with the eight-inch Draper telescope. Both of these instruments are doublets. The magnitudes are estimated by comparison with adjacent stars, and are approximate only, especially since the image was near the centre of the plate only on B 21251, B 21258, and B 21319.

I 20428. March 8, 1898. Ex. 13^m. Mag. 4·7. Estimated 0·1 fainter than — 16°5283, photometric magn. 4·6.

I 20500. March 14, 1898. Ex. 13^m. Magn. 5·0. Estimated 0·5 fainter than — 16°5283, and 0·4 brighter than — 14°5476, photometric magn. 5·6.

I 20612. April 3, 1898. Ex. 16^m. Magn. 8·2.

B 21251. April 19, 1898. Ex. 60^m. Magn. 8·2. An excellent photograph of the spectrum, 3 mm. in length, and showing the lines $H\beta$, $H\gamma$, $H\delta$, $H\epsilon$, $H\zeta$, $H\eta$, and probably $H\theta$, bright. A broad band, wave length 4643, is also bright, and narrow bright lines are seen at about 4029, 4179, 4238, 4276, 4459, and 4536. These lines appear to be identical with the corresponding lines found in the spectrum of Nova Aurigæ. A well-marked dark line appears at 4060. It will be noticed that in this star, as in Nova Persei, Nova Aurigæ, Nova Normæ and Nova Carinæ, the line $H\epsilon$ is bright, while in variable stars of long period this line is always dark, being probably obscured by the broad calcium line H. This alone may serve to distinguish between a Nova and a variable. The accompanying dark lines on the edge of shorter wave length of the bright lines in Nova Aurigæ, Nova Normæ, and Nova Carinæ are not visible. The line K. also, is not shown.

I 20738. April 21, 1898. Ex. 9^m. Magn. 8·6.

B 21258. April 21, 1898. Ex. 62^m. Magn. 8·2. The spectrum closely resembles that on B 21251 taken two days earlier, but shows certain marked differences. The broad dark line at 4060 has disappeared, and a narrow bright line appears at 5005, doubtless identical with the principal nebular line, 5007. The hydrogen lines appear to be somewhat narrower and more intense than in the earlier photograph, although the lines in the adjacent stars are nearly the same in both.

B 21290. April 26, 1898. Ex. 10^m. Magn. 8·2.

B 21319. April 29, 1898. Ex. 10^m. Magn. 8·4.

The region of the Nova is included on two, and perhaps three, plates taken at Arequipa on October 7 and 8, 1898, but not yet received in Cambridge. They will later furnish important information regarding the rate of diminution of the light. On March 9, 1899, the morning after the discovery of the Nova, a faint image of it was obtained through passing clouds, which showed that its photographic image was about half a magnitude fainter than that of — 13°5193, magn. 9·5. On the morning of March 13, 1899, the Nova was examined visually by Prof. O. C. Wendell. He found, first, that its position for 1900 is R.A. = $18^h\ 56^m\ 12^s{\cdot}2$, Dec. = — 13° 18′ 16″. Secondly, that it was 1·52 magn. fainter than — 13°5200, and therefore 11·37 on the photometric scale. Thirdly, that its light was nearly monochromatic with a faint continuous spectrum. This Nova, therefore, like several that have preceded it, appears to have changed into a gaseous nebula. This is also indicated by the faint bright line at 5005, which, as stated above, appeared in the photograph of its spectrum taken April 21, 1898.

During the last four centuries fifteen stars have appeared, which are commonly regarded as Novæ. These stars are, in general, near the central line of the Milky Way. Their average galactic latitude is 11°·2, while if uniformly distributed in the sky it would be 30°. The region whose galactic latitude is less than 30° has an area equal to one-half of that of the whole sky. Fourteen of these stars appeared in this region, and only one (Nova Coronæ) outside of it. Nova Andromedæ and Nova Centauri had spectra without bright lines, and unlike other Novæ. Omitting them, the average galactic latitude of the others is 9°·0. The galactic latitude of Nova Coronæ is 46°·8, and this seems to be the only known exception to the rule that all Novæ having bright lines in their spectra have appeared near the central line of the Milky Way. Omitting this star, the average galactic latitude of the other twelve is 5°·8. The only Novæ known to have bright lines in their spectra are those which appeared in Corona, Cygnus, Perseus, Auriga, Norma, Carina and Sagittarius. Omitting the first of these, the mean galactic latitude is 4°·6. The probability that such a distribution is due to accident is extremely small. Edward C. Pickering.

March 14th, 1899.

AN ANGLO-SAXON "STORY OF THE HEAVENS."

By E. Walter Maunder, F.R.A.S.

I CHANCED on one occasion to be present at a debate in a literary society on the subject of "Education." The gentleman who opened the debate spent most of his time in expatiating at great length, and with many repetitions, on the profound ignorance of our forefathers. We were reminded that up tc comparatively recent times even the nobility could neither read nor write, and that education scarcely had an existence in this country until the institution of School Boards rather late in the Victorian era. I was the only person who ventured in any way to call in question this sombre picture of the past, and my statements on the other side were received with marked incredulity.

This little experience has suggested to me that perhaps it might not be unwelcome to some readers of Knowledge to have some short account of a little popular manual in astronomy—popular in a two-fold sense, as being written for "the unlearned," and as enjoying a wide circulation—which was current in this country very nearly a thousand years ago. I take astronomy as an example, partly because it is the oldest of the physical sciences, and because a widespread attention to it is clear evidence of a state of education fairly advanced in several directions as well as of an attachment to knowledge for its own sake.

The little manual in question appears to have been written during the reign of Ethelred the "Unready" (*i.e.*, the uncounselled or ill-advised), a time of violence and disturbance, which can have been by no means favourable for a general cultivation of science. The book is an abstract in the vernacular of a Latin treatise by the Venerable Bede, "De Natura Rerum." The author of the abstract is not known, but it has been ascribed with some probability to Ælfric, the "grammarian," and translator of a large portion of the

Old Testament Scriptures, and, indeed, its style is not unlike in its clearness and simplicity the "Homilies" for which he is famous.

As was necessarily the case in a book intended for wide circulation before the invention of printing, the treatment is exceedingly concise, and the whole book does not exceed in amount five pages of Knowledge. In this short space we have the creation of the world treated of, the nature and typical significance of sun, moon, and stars, of the first day of the world and of the vernal equinox, of night and its divisions, of the year and the zodiac, of the relations of the sun and moon, and of their movements, of the time of the equinoxes and the solstices, of leap year, of meteors and comets, of wind, rain, hail, snow, and thunder.

The book bears the name, when complete, of "De Compoto," but occasionally it is found without its first chapter. The second chapter is entitled "De primo Die Sæculi."

The first point which would, I think, strike most modern readers is the clearness with which the writer has grasped the fact of the rotundity of the earth. It is clear to him that the earth stands in empty space, having the heavens as far below it as they are high above it. This, he teaches again and again, sometimes directly, sometimes incidentally.

> "Seo heofon belycth on hyre bosme ealne middan-eard, and heo æfre tyrnth on butan us, swiftre thonne ænig mylnn-hweol, eall swa deop under thyssre eor'dan swa heo is bufan."

"The heaven envelopes in its bosom all the middle-world, and it always turneth about us, swifter than any mill-wheel, all as deep under this earth as it is above." Similarly, he describes how our "earthly night soothly comes through the earth's shadow, when the sun goeth in the evening under this earth, then is the earth's broadness betwixt us and the sun so that we have nothing of her lightiog till she is at the other side uprisen." "Assuredly it is a wonderful thing that this worldly night is nothing but the earth's shadow betwixt the sun and mankind." Again, "the earth stands in the very middle through God's might, so fastened that it never moves higher or lower than the Almighty Shaper, who holds all things without effort, has established it."

He gives a proof of the form of the earth incidentally by remarking "truly the day of equinox is one for all the world, and equally long, and all other days in the twelve-month have different lengths. In some lands they are longer, in some shorter, through the earth's shadowing and the sun's going about. The earth stands in the likeness of a pine-nut, and the sun glides about it by God's setting, and on the end where she shines it is day through her lighting, and the end that she leaves is overcast with darkness till she is thither returned again. Now, it is the earth's roundness and the sun's going about that prevents the day from being in each land equally long."

I think we may pause here to note how greatly in advance our author was of those who in recent times have been bitten by the stupid "flat-earth" opinion. He clearly had a sufficient grasp of spherical geometry to see that the variation in the length of the longest day in different latitudes was explicable only on the theory of the rotundity of the earth.

It may be pointed out, on the other hand, that he places the earth in the centre of the solar system, and makes the sun and the stars revolve round it. This and another error to which we shall allude presently are the only two of any consequence in the entire manual, which on the whole is written in a strictly scientific spirit, that is to say, it is based upon actual observation and on strict and careful reasoning therefrom. Nor is his following of the Ptolemaic theory a departure from this. For it is clear that he had no sufficient means of disproving it, and it amply sufficed to explain such observations as he could make.

The geographical information which had reached him varies in accuracy. He correctly speaks of India as lying partly within the tropics. "In the land of India turn their shadows in summer southward and in winter northward." But he is mistaken when he places Alexandria actually on the Tropic of Cancer. "In Alexandria goeth the sun right up on the summer solstice at midday, and there is no shadow on any side." But a line or two further he states quite correctly, "In the land that is called Alexandria the longest day has fourteen hours," which is exactly correct. For Italy he gives the longest day fifteen hours—correct for Campania; and for England seventeen, which is its duration in Northumbria, the land of Bede, the author of the work he is popularizing.

He is quite clear as to the division of the earth into the five zones; although of course no report had reached him of any hardy voyager who had penetrated south of the equator. "Then there are," he writes, "on two sides of the torrid zone, two parts that are well meted, neither too hot nor too cold. In the northern part dwell all mankind." Nor does he seem to have known of any exploration within the Arctic circle, for his description of "Thile" is that it is an island where there is no night for six days at the summer solstice, as the sun then sets and immediately rises again.

As this little manual was clearly intended not for the learned—that is to say not for the monks and clergy—but simply for the common people who could speak and read no language but their own, and to whom Latin, then the universal language of the cultured, was a sealed book, its author has thought it well to add a little caution here and there where he thought there was a danger of his descriptions being misunderstood. He therefore supplements his description of the long summer days of Thile by the emphatic caution that "there is always in a day and night, four-and-twenty hours," neither more nor less.

His description of the stars though very brief might, we have much reason to fear, put to shame the ignorance of many thousands of dwellers in English towns and cities of to-day. He describes clearly how certain constellations, as, for example, the Great Bear, never set in England, whilst other constellations round the South Pole never rise here, and we, consequently, know nothing of them. He points out, too, that there is not only a North Pole star, round which the whole heavens appear to revolve but which itself moves not, but there is also a southern one, "for on these two stars the firmament turns as a wheel turns on the axle." Other stars, again, both rise and set, going from east to west, and are visible at different times in the year. Thus, the Pleiades "through all the summer go at night time under this earth and in the day above; in the winter time they are up at night and down by day."

With regard to meteors, our writer cautions his readers that they must not suppose that they are real stars falling from their places. "Truly there are yet as many stars in heaven as there were at the first when God shaped them." He then mentions the seven planets "which are not fast in the firmament, but have their own going severally," but he considers this too deep a matter to enlarge upon for "unlearned men." Of comets he simply says that they appear suddenly and unaccountably, "and have long rays like a sunbeam. As oft as they appear they betoken something new towards the people that they overshine." This seems the only indication in the little treatise of any leaning towards astrology. Indeed, the writer says expressly that the Christian man who takes to divination by the moon has forfeited his faith.

He equally repudiates a delusion which is very widely current even at the present time, namely that the position of the moon's horns when crescent betokens the kind of weather that is to come. "If the sun lights him from above then will he stoop, if she light him right through then he will be equally horned." (The sun, of course, in Anglo-Saxon is always feminine, the moon masculine.) "Now argue some men who do not know this reason that the moon turns him as the weather shall be in that month; but never from his nature will weather or unweather turn him." On the other hand he fully believes "that trees hewn down at the full moon are both harder against worm-eating and longer lasting than those hewn at the new moon."

Similarly he evidently regards eclipses, whether of the sun or moon, as perfectly regular instances in the order of the universe and not in the least as portents to alarm men. He carefully explains the causes of both kinds of eclipse, and mentions that the moon's orbit does not coincide with the ecliptic, but that he goes both to the north of it and to the south, and that it is when he is new and when his track coincides with that of the sun, that he is able to eclipse her. Then comes the remark so common in all the ancient notices of eclipses, "and the stars appear as at night." It should be remembered that total eclipses of the sun were by no means so unknown in England in the Saxon period as they have been for the last seven hundred and fifty years. There were no fewer than five which had occurred in the four hundred years preceding the publication of this little manual. One, indeed, had taken place during the lifetime of our author, but seems to have been total only for Cornwall, which was not then part of England. It is very curious that in all these ancient records, whilst we find absolutely no notice of that which strikes our attention so forcibly in eclipses nowadays—namely, the shining out of the corona—we are told of the appearing of stars, a phenomenon which by no means forces itself on the attention, unless perchance, as in the eclipse of last year, Venus or Jupiter happen to be near the sun. Can it be that the corona was less conspicuous then?

There are several other points of interest in our treatise. For instance, his explanation of leap year is a model of brevity and clearness, and he is careful to explain that it has nothing whatsoever to do with Joshua's miracle. He fixes the day of the vernal equinox as St. Benedict's Day, March 21st, and not Lady Day as some considered it to be. One little bit of traditional superstition shows itself, when he says that "the equinoctial day was the fourth day from the shaping of this world. On the fourth day from the shaping of this world, the Almighty Shaper made the Sun and set her in early morning in the mid east, where is told the equinoctial circle. The same day He set the moon full in the evening in the east, together with shining stars in the course of the harvest equinox." Of course he overlooked the fact that if the sun was suddenly called into existence at any moment of time, it would be rising in the east only to places on one particular meridian. But the oversight was a very venial one in the Saxon, who wrote at a time when the known inhabited world was not only confined in latitude to the north temperate zone, but also in longitude to no more than six hours at the very outside. Then, again, though they might have reasoned it out that local time must differ from meridian to meridian, yet they had absolutely no means of determining it. Nor have we any reason to exalt ourselves against our forefathers when we see in our own day—a day of chronometers and watches, of standard and railway time, and of telegraphs—that precisely the same superstition, with the solitary substitution of the autumnal equinox for the vernal, has attained an immense circulation in the writings of sundry quack *soi-disant* chronologists.

We cannot give equal space to the other points that are still worthy remark. Ælfric—if Ælfric it was—explains exceedingly clearly the cause of the moon's phases, and points out that no matter how little or how much of her surface is illuminated she always in truth remains a perfect orb. Here, however, analogy leads him into a serious mistake. For recognizing that the moon and planets shine by reflected sunlight, he generalizes hastily that the stars owe their light to the same cause.

This mistake is partly the reason why he attains to what, under all the circumstances, we must consider a very advanced view of the size and distance of the sun. Seeing that the stars shine at night, and believing that they receive their light from the sun, he is compelled to think "that her light ascends by the side of the earth, and lights up the stars above us." He infers, therefore, that "the sun is exceeding great; all as broad she is as all the whole compass of the earth, but she seems to us very narrow because she is very far from our sight." "Also the stars that seem little to us are very broad, for they might not send any light to earth from the high heaven if they were so small as they seem to our eyes." Then he argues that the moon must also be very great, inasmuch as in a total eclipse he hides the sun. It is, however, far less distant from us than the sun, for "soothly the moon's year has seven and twenty days and eight hours. In that time he underruns all the twelve signs that the sun goes under in twelve months. The sun's running is very wide because she is very high up; the moon's running is very narrow, for of all the planets he runs the nethermost and to the earth the nearest." The brevity of his treatise does not allow him much indulgence in analogy or illustration, but on this one occasion, to make his point quite clear, he continues, "now that thou mightest understand, that a lesser going around hath the man who goes about one house than he who goes round all the burgh, so also the moon hath his running quicker run out on the lesser circuit than the sun hath on the greater." May we not see in this little analogy the germ of that wealth of illustration, metaphor and anecdote with which the Lowndean Professor makes the science of astronomy so vivid and delightful to his audiences to-day?

Letters.

[The Editors do not hold themselves responsible for the opinions or statements of correspondents.]

THE NEED FOR A BETTER INTERCHANGE OF SCIENTIFIC THOUGHT.

To the Editors of Knowledge.

Sirs,—Startling as it may appear, it is yet a fact that the term "specialist" implies ignorance — ignorance of many things. There are but twenty-four hours in a day, throughout some of which "No man can work."

Further, since the modern tendency is for us all to become specialists, one is led to fear that there must be a growth of ignorance. Better so perhaps than that we should find ourselves contented to jog along as "Jacks of all trades." Let us, however, look the possibilities of danger in the face. Is it conceivable that a time will come when our mere dabbler in various sciences must be regarded as a man of great importance? It seems so, for a time will surely come when we and our descendants will have specialized to so great an extent that there will be no common ground upon which we, or they, can meet.

If, then, we are all to become specific parts, or volumes, of one great book, there must ultimately be an outcry for the index, or, at best, the synopsis of chapters. Where will it be found?

Both sciences and arts have been lost in the years which have gone before!

Our case is by no means fully stated here, but the effort has been made to indicate the lines upon which it should be argued.

A time may come when there will be a need of authoritative advice upon some question of pure or applied science, and there will be difficulty in finding the Oracle amongst the number of temples which will have arisen.

For this reason it seems imperative that some scheme for the better interchange of thought should be set on foot.

Any deliberative body attempting to set forth the propaganda of such an institution must carefully avoid the introduction of that social aspect which would, from the outset, discount the success of such a scheme (even to damnation) more assuredly than has been the case already, in some instances, which must here be taken as excellent examples of what to avoid. Admitting that social functions are pleasant, yet we must specialize just so far as to leave them severely alone.

If an instance should be required to make clear the dangerous shoals upon which we seem to be going, full speed ahead, let us suggest a simple one, which should appeal to all. If a dental operation is to be undergone, well, the *general practitioner* is the man who saves the situation—from at least much of its possible pain, by the kindly administration of the anæsthetic.

Trusting that enough has been said to indicate a want, and regretting that space does not permit of suggestions as to how it may be met, it seems incumbent upon us, for the moment at least, to leave the matter.

23, Pembroke Road, W. HOWARD LITTLE.

MIRA CETI.

To the Editors of KNOWLEDGE.

SIRS,—Continuing my observations of o Ceti (Mira), during the passing apparition, my estimates of its light are as follows:—

1898.	Mag.	1899.	Mag.
Novem. 24-26 ...	3·90	January 1 ...	5·75
,, 29 ...	4·00	,, 2 ...	5·70
,, 30 ...	4·07	,, 6 ...	5·95
Decem. 1-2 ...	4·30	,, 7 ...	5·90
,, 4 ...	4·40	,, 8 ...	6·00
,, 5 ...	4·50	,, 14 ...	6·55
,, 6 ...	4·55	,, 16 ...	6·40
,, 10 ...	4·77	,, 22 ...	7·00
12 ...	4·70	,, 24 ...	7·2
,, 13 ...	4·80	,, 28 ...	7·1
,, 14 ...	4·85	,, 29 ...	7·2
,, 19 ...	5·10	,, 31 ...	7·1
,, 20 ...	5·15	February 1 ...	7·05
,, 21 ...	5·45	,, 22 ...	7·7
,, 24 ...	5·50	,, 27-28 ...	8·1
,, 25 ...	5·40	March 2-3 ...	8·10
,, 27 ...	5·50	,, 9 ...	8·00
,, 28 ...	5·40		
,, 29 ...	5·55		
,, 31 ...	5·65		

The star is now too low in the city smoke for further useful observations. The gaps in the observations are due to bad weather, as no opportunity for an observation was missed.

Putting the maximum at October 4th, Mira was then thirty-five days late, as that phase, following the terms of the second catalogue, and the data of previous years, as given in "The Companion," was due August 31st (not in July, as stated in my last note).

The approaching minimum will be watched for.

Memphis, Tenn., U.S.A., DAVID FLANERY.
16th March, 1899.

THE LOVE-GIFTS OF BIRDS.

To the Editors of KNOWLEDGE.

SIRS,—With reference to the love-signs of pigeons, I find I was guilty of a mis-quotation in the April number of KNOWLEDGE in stating that the male pigeon inserts his bill into that of the female. The contrary is the case. Also, the strongest males (independently of their being the best fliers) are the most likely to offend against the exemplary moral law of the genus.

CHARLES A. WITCHELL.

Science Notes.

A new way of preserving milk has been tried, after which it retains all the properties of the fresh article. New milk is cooled down directly, and treated to pure carbonic acid gas under a pressure of five or six atmospheres for four or five hours. This kills all germs which require oxygen or äerobic bacteria. Then the milk is subjected to a pressure of five atmospheres in the presence of oxygen for five hours, after which all germs that will not flourish in contact with oxygen, but obtain their supply from the substances they live upon, or anäerobic bacteria, are found to be destroyed. In transit the milk is carried in vessels containing oxygen under two atmospheres' pressure, which may be in the form of syphons.

To distinguish unpasteurized milk, Professor Storch has elaborated a useful test, and this in connection with the Danish law which does not allow skim milk or buttermilk to be sold that has not been heated to eighty-five degrees Centigrade, in order to limit the spread of tuberculosis. Babcock found that hydrogen peroxide is decomposed by the fibrin of milk, cream is more active than whole milk, while skim milk has less effect, and milk heated to one hundred degrees Centigrade has none. The limit as determined by Storch is seventy-nine degrees Centigrade, milk heated up to that temperature still being able to reduce hydrogen peroxide. To perform the test a teaspoonful of the material, be it cream, milk, or whey, is shaken in a test tube with a drop of peroxide of hydrogen, some strong sulphuric acid, and two drops of an indicator (*paraphenylendiamin*). Milk or cream immediately colours indigo blue, and whey violet red brown, if not it has been raised to seventy-eight degrees Centigrade. If raised to seventy-nine or eighty degrees, the milk or cream becomes greyish-blue, while if it has been subjected to a temperatnre of more than this it remains white or has only a slight violet tinge.

Now that out-door experiment by the amateur photographer may be carried on under the best conditions as regards duration of light and variety of scenery, a good and handy camera is a desideratum. In this connection, possibly no better instrument can be obtained than the "Gambier Bolton" Camera, made by Messrs. W. Watson & Sons. It is moderate in price, can be used as a hand-camera, or on a tripod stand, requires one lens only, has the advantage of a reversing back, square shutter and finder, and that most ingenious contrivance, the automatic release.

What promises to be one of the most valuable geographical works ever published will shortly be issued by Messrs. George Newnes, Limited, under the title of "The International Geography." The volume will be international in authorship as well as in scope, no less than seventy leading geographers, each the highest authority on the section with which he deals, having taken part in its preparation. Among the authors on general geographical principles are Dr. A. M. W. Downing, F.R.S., who writes on mathematical geography; Sir John Murray, F.R.S., on the oceans; Prof. J. Arthur Thomson on the distribution of living creatures; and Dr. J. Scott Keltie on political and applied geography. Various parts of Europe are described by such distinguished geographers as Prof. A. de Lapparent, Prof. A. Penck, Dr. Thoroddsen, Prof. A. Phillipson, and Prof. A. Kirchhoff. Among the authors dealing with different parts of Asia are Sir G. S. Robertson, Sir C. W. Wilson, F.R.S., Mrs. Bishop, Dr. H. O. Forbes, and Captain E. de Vasconcellos. The Hon. D. W. Carnegie, the Hon. J. W. Reeves, and Sir William Macgregor occur among the authors on parts of Australasia and Polynesia; Profs. W. M. Davis and A. Heilprin on North America; Sir Clements Markham, F.R.S., Dr. W. Sievers, and Mr. J. Rodway on Central and South America; Dr. J. W. Gregory, Sir H. H. Johnston, the late Sir R. Lambert Playfair, and the Right Hon. James Bryce, M.P., on Africa; and Dr. Nansen and Sir W. Martin Conway on the Polar regions. The whole work is edited by Dr. H. R. Mill, who has devoted the best part of two years to its preparation. Judging from the prospectus and the names it contains, the volume will be an indispensable handbook of geography.

The "Biokam," an instrument for amateurs interested in the production of *living pictures*, is a novelty put on the market by the Warwick Trading Company, and strikes us as being eminently adapted for bottling up, so to speak, those animated scenes, incidents and phenomena, when for reasons, general or special, their reproduction may serve some useful purpose. The "Biokam" is so compact, portable, moderate in price, and easy of manipulation, that it bids fair to attain the same degree of popularity as the ordinary camera. Indeed, the film, twenty-five feet in length, and containing as many as seven hundred pictures, can be wound on a sort of creel and developed as easily as an ordinary plate. The exposure, by means of a train of wheels, can be effected at such a speed that each separate impression is practically instantaneous, and thus an unlimited number of midget portraits or photographs of scenery may be taken with a minimum of trouble. The instrument is provided with two lenses—one for negatives, the other for projection purposes, by which means living pictures taken by the amateur himself may be thrown upon the screen for his own delectation and that of his friends.

We have received many letters in reference to a communication addressed to the *Times* early in April, and signed "Knowledge." The letter in question did not emanate from us.

British Ornithological Notes.—These Notes are unavoidably held over until next month.

Notices of Books.

Recent Advances in Astronomy. By A. H. Fison, D.SC.(LOND.). The Victorian Era Series. (Blackie & Son.) "Under the general editorship of Mr. J. Holland Rose, M.A., late scholar of Christ's College, Cambridge, the individual volumes are contributed by *leading specialists* in the various branches of knowledge which fall to be treated in the series." It is therefore passing strange that Mr. Rose should have selected for his author one whose work lies outside the domain of astronomy. It is especially evident in the last three chapters, dealing with the analyses of sunlight and starlight, and with the red flames of the sun, that Dr. Fison is an "outsider" in astronomy, and that his own work has been in the terrestrial laboratory, not in the celestial. He treats very well of the fundamental laws of light and chemistry, and shows how they are adaptable to astronomical research; but these adaptations were made a quarter of a century ago, and Dr. Fison has scarcely attempted to follow them in their application in the regions of pure astronomy. He goes fully into any laboratory experiments in chemistry that may bear on astronomical results. He touches lightly on the stellar velocities in the line of sight. He just mentions the Harvard spectral surveys; but we look in vain for any discussion of the spectra of sunspots and faculæ, for any mention even of the broadening or "reversal" of lines over them. Above all, he does not touch at all on the knowledge that we have obtained in the later Victorian age through eclipses, of the sun's chemistry or the sun's surroundings—without which surely the analysis of sunlight is scarcely even begun. To his readers the "corona" is something that no two people see alike—like the rainbow. In his study of Mars, Dr. Fison's limitations are less noticeable, seeing that his treatment is based on purely theoretical considerations. In the first two chapters also, bearing on the life-history and distribution of the stars, he does excellently, in so far as he deals with mathematical or theoretical conditions. We would like to protest, however, against the introduction into a work that deals with the facts not the fictions of astronomy, of Mädler's absolutely baseless suggestion of a great central influence in the Pleiades. In his ingenious simile also of the distribution of stars to the conditions of things imagined in the kinetic theory of gases, he suggests that the stellar system will eventually disintegrate through the escape of members acquiring high velocities (like Groombridge, 1830), forgetting that increase of velocity attained by one star means the decrease by another, and that the process tends rather to aggregation. Had Dr. Fison had a practical training in astronomy, and had he still further confined the departments of this science of which he treats (for the volumes of this series are quite small), his book would be an admirable one, for he is careful in his work, his style is good, and his judgment clear and critical.

Landmarks in English Industrial History. By George Townsend Warner, M.A. (Blackie.) 5s. As regards matter, the author makes no claim to originality in these pages; but, as each historical event in England's industrial and commercial progress in the past is important, not only by itself but also in its bearing on other events, the grouping of events round chief landmarks or epochs is intended to bring out these connections more fully; it is in this co-ordination of agricultural, mechanical and economic historical information that the novelty of the book consists. Chronological order is thus, to some considerable extent, traversed; indeed, the book really consists of a number of essays, in which certain topics are selected, such as the rise of banking, machinery and power, trade and the flag, trading companies and colonial expansion, towns and gilds; and thus the author seeks to convey broad, general notions of the great factors in our civilization. The plan is very good. Instead of the history of kings and queens we get the broader and larger history of the people and their institutions. In place, however, of one slight volume for so gigantic a task, very many would be required to give anything like an adequate account on the same lines as here carried out; it is but fragmentary at best—an amputated appendage of a great idea, and taken as such it is a book which will be read with interest.

Outlines of Industrial Chemistry. By Dr. Frank Hall Thorp. (Macmillan.) Illustrated. 15s. net. Apparently, at the outset, the author, or rather the compiler, of this book, intended to cover the whole range of industrial chemistry—a very laudable ambition, but it failed, as all like attempts must fail in dealing with the colossal subject of applied chemistry in all its branches within the narrow limits of a comparatively small volume. One might as well try to cram a hundredweight of coal into a quart pot. The book before us is an American production, the object of which is "to furnish an elementary course in industrial chemistry." Acids, alkalies, glass, pigments, coal-gas, mineral oils, soap, candles, explosives, dyeing, paper, leather, glue, and a multitude of other products and processes are included in this so-called technical course. No student ever requires such a miscellaneous collection of expert knowledge. A student who has gone through courses of inorganic and organic chemistry, with the usual analytical work in the laboratory, can readily adapt himself to any *special* line of work, but if he devotes himself, say, to the *ceramic industries*, he will certainly not glean his information from a book of this kind, in which the subject is despatched in a few pages. Analytical processes are omitted as being foreign to the scope and purpose of the book; metallurgy does not find a place because there are many good books on the subject; the coal-tar colours have been condensed into the briefest possible outline because usually included in courses in organic chemistry. By a similar process of reasoning, quite as legitimate, the author might have eliminated all the rest of the book. Candles and paraffin, for example, are organic as well as the coal-tar colours; on metallurgy there are certainly many books, and so there are on soap-making, glass manufacture, etc., and it is absurd to exclude analysis from such a work because the substances treated of, in many cases, require special methods. The author himself says that a chemical library will be necessary to supplement what he advances. The book is good enough, as far as it goes, but we in England, who have plenty of chemical dictionaries, and special works on all, or nearly all, the subjects here included, do not require such a work, the importation of which from America is very much like "carrying coals to Newcastle." In these days of cheap printing, 15s. net is a prohibitive price for so slim a volume.

Birds of the British Islands. Drawn and described by John Duncan. (Walter Scott, Limited.) 5s. This book forms nothing more than a collection of pen and ink drawings of British birds, with a short description of each bird, and a very brief and not always accurate account of its distribution. Nothing, therefore, of an original nature can be claimed for the letterpress. If there is any value attached to the book it lies in the author's drawings, which have appeared from week to week for the last ten years in the *Newcastle Weekly Chronicle.* Some of the drawings are very fair and accurate pen and ink sketches, but the majority appear to us as stiff and formal—as though the author had taken stuffed specimens as his models.

The Discharge of Electricity through Gases. By J. J. Thomson, D.SC. (Constable.) Illustrated. 4s. 6d. net. Consists of an expansion of four lectures on Discharge of Electricity through Gases, given at the University of Princeton, New Jersey, 1896. The relation between matter and electricity is best studied by matter in the gaseous state, because the properties of a gas and the laws it obeys are simpler than for either a solid or a liquid, and the kinetic theory of gases supplies us with the means of forming a mental picture of the processes going on in a gas which is lacking for matter in its other states. Professor Thomson here deals with this subject in a most profound manner—profound, let us explain, in frigid contrast with that sort of popular, scientific literature which is intelligible to the meanest capacity. To some, though well equipped in general scientific knowledge, many of the ideas advanced will appear as through a glass darkly. In the purely experimental portions, such as the deflection of rays by a magnet, and the thermal effects of rays; electrification of gases by the splashing of liquids, or by chemical means; and the conduction of gases and so on, it is easy to follow the clear delivery of the Professor; but when theories in explanation of the many and diversified phenomena involved are under consideration, then the mists descend and envelope the reader. Still, for a work of this kind, we could hardly expect a more intelligible presentation of the results obtained in the new field opened up by the advent of the so-called Röntgen rays.

A History of Astronomy. By Arthur Berry, M.A. (John Murray.) We must confess to a strong feeling of disappointment with Mr. Berry's book. Though entitling it "A History of Astronomy," and designing it as a text-book for study and reference for University Extension students, it contains little of value that has not been often given before, and given better and far more brightly by books that are now half-a-century old. Thus, though Mr. Berry professes to give "an outline of the history of astronomy from the earliest historical times to the present day," in his chapter on "Primitive Astronomy," he devotes but eleven lines to the "Progress due to early civilized peoples—Egyptians, Chinese, Indian, and Chaldæans"—and euphemistically characterises this little paragraph as not being a "*connected account.*" The rest of the chapter is given over to the definitions of the celestial sphere, and of its circles and poles, of direct and retrograde motions and stationary points, of occultations, of the measurement of time and of the lunar month of eclipses, and the saros. Chapter II. deals with Greek Astronomy, and Chapters III. to XII. tell of the slow progress of astronomy, and of the lives of the astronomers or mathematicians during the long centuries of the Middle Ages until the great Astronomical Renaissance at the very end of the eighteenth century. This occupies pages 76 to 353. But to astronomy in the nineteenth century but one chapter is given. The chapter contains just fifty-five pages, and considering the scope of the subjects it deals with, its style somewhat resembles an auctioneer's valuation list. Is this because Mr. Berry wishes to give a slap to the dying century's conceit in the works it has wrought and the progress it has made in its hard spent life? Or, is it that Mr. Berry was too indolent to attempt a subject which it would have cost him time and research to master? Judging from the preface, we should say that the latter was the true explanation. Mr. Berry congratulates himself on saving "a good deal of space" by these omissions. His principle carried out to its logical conclusion would have resulted in the "saving" of the entire volume, nor do we think that the intellectual life of the end of the nineteenth century would have been materially injured thereby.

The Way the World went Then. By Isabella Barclay. (Stanford.) Illustrated. 4s. A very useful reading book for the higher standards of elementary schools. The authoress infuses into the story of the earth's history a little of the romantic element, not too much, but just sufficient to impart a proper relish for the intellectual nourishment she has to offer. Written with the object of instructing a child of the deceased author's friend, the present editors express a hope that the book may appeal to other young people, and we think they will not be disappointed. The illustrations are vivid and the style easy. If the authoress has sometimes soared into the realm of imagination at the expense of slight perversions of the truth, the warm colouring of her images perhaps more than compensate for this liberty, and we trust that many of the rising generation may profit by this little history of our forefathers—men of the stone age, the bronze age, the lake dwellers, and the sea-kings. The price is rather high for so slight a production.

An Intermediate Text Book of Geology. By Charles Lapworth, F.R.S. (Blackwood.) Illustrated. 5s. Founded on the text of the late Professor Page's Elementary Geology, this work, in its extended form, is "no longer wholly elementary in its character." Most of the chapters have been recast; the sequence of subjects is that adopted in its prototype, but, with the exception of occasional paragraphs, the letterpress has been re-written, and the free interpolation of new matter has swollen the size of the volume more than a hundred pages. The care which the author, aided by many experts in different branches of the science, has bestowed on the work in bringing it up to the present state of knowledge invests it with the character of a new production, and students, we think, may rely on it as a safe guide in systematic work.

Annual Report of the Board of Regents of the Smithsonian Institution, 1896. (Government Printing Office: Washington.) Illustrated. This extremely useful volume contains the proceedings of the Board of Regents, report of the Executive Committee, exhibiting the financial affairs of the Institution, and the report of the Secretary, giving an account of the affairs of the Institution, accompanied with statistics of exchanges, and so on. A general appendix contains a selection of memoirs of the highest interest to those engaged in the promotion of knowledge: thus, Professor Dewar's researches on liquid air; Cornu's investigations of the physical phenomena of the upper regions of the atmosphere; Martin's utilization of the Falls of Niagara; Le Conte's earth-crust movements and their causes; Michael Foster's recent advances in science and their bearing on medicine and surgery; and Schweinitz's war with the microbes, are all here reprinted from various sources. These papers, and many others, beautifully illustrated, form a miscellaneous collection, embracing a considerable range of scientific investigation and discussion; they depict the more remarkable and important developments in physical and biological discovery, and follow concisely the prominent features of recent progress in astronomy, geology, mineralogy, anthropology, and, indeed, every branch of science.

Chemical Analysis, Qualitative and Quantitative. By William Briggs, M.A., and R. W. Stewart, D.SC. (London: W. B. Clive.) 3s. 6d. The addition of a single chapter of thirteen pages on volumetric analysis is hardly sufficient justification for referring to this little book as one on quantitative analysis. The first six chapters, of one hundred and fourteen pages, deal with ordinary test-tubing, which it would appear is still required in some of the examinations for which Mr. Clive specially caters. As a guide to the analysis of a simple substance the book is as good as many others which have been published, but it is in no sense an educational introduction to practical chemistry.

Cressy and Poictiers, or the Story of the Black Prince's Page. By J. G. Edgar. Illustrated. (London: Ward, Lock & Co., Ld.) 3s. 6d. The publishers are to be congratulated upon this handsome re-issue of the late J. G. Edgar's splendid story of the conqueror of Cressy and Poictiers.

Practical Work in Physics. Part 4.—*Magnetism and Electricity.* By W. C. Woollcombe, M.A., B.SC. (Oxford University Press.) Illustrated. 2s. If the art of criticism be the art of praise we cannot criticise this book. The initial statement is inaccurate, or at best incomplete. The first experiment contains a reference to the sixth, and the sixth page contains a reference (*via* a foot-note) to the twelfth. The arrangement throughout is bad. On p. 7 it is stated that if a compass needle lie along the magnetic meridian it is unaffected by the earth's field. The author appears unable to differentiate between the exact meanings of the expressions "at right angles to," "perpendicular to," and "normal to." The second portion of the book is slightly better, though it contains such errors as (p. 54) "indirectly proportional" for "directly proportional," etc. There are too many notes, and too many references, both to them, to the diagrams, and to the appendices. A list of the E.M.Fs. of primary cells is given, matters being in this connection taken to the second place of decimals. If ever a note or a caution were needed, surely it is here. But the illustrations are good, and we find some ingenious suggestion as to the putting together of simple apparatus.

The Renaissance of Girls' Education in England: A Record of Fifty Years' Progress. By Alice Zimmern. (Innes & Co.) 5s. There is no more interesting legacy which the nineteenth century can bequeath to its successor than the present position of women in all fields of human activity, and in no direction have they achieved more than in the department of education. The subjection of women, which John Stuart Mill so brilliantly resisted with tongue and pen thirty or forty years ago, has given place to their emancipation, and they stand upon the threshold of the new era—free. For this emancipation they are in nowise indebted to the lords of creation, but just to their own patience, skill, and perseverance, and the well conceived and admirably written volume before us traces the history of the movement during a fifty years' progress. That movement has effected a peaceful revolution of the highest import for the future, and we do not know a more encouraging story. Miss Zimmern has done her work thoroughly well, and we heartily commend the volume.

The Practical Electrician's Pocket Book and Diary, 1899. Edited by H. T. Crewe, M.I.MECH.E. (London: S. Rentell & Co.) Illustrated, 1s. nett. This little book contains a vast deal of really useful information. There are 130 pp. of just such hints, tables and diagrams, as men engaged on practical work frequently require. The information conveyed is sound, but we trust that in future editions more attention will be paid to the arrangement. And Mr. Crewe must refrain from the building up of sentences which contain two hundred words each! We believe that an edition *de luxe*, say at half-a-crown, would find a ready sale, for while the matter is good, the manner is bad, albeit good at the price. Besides the text and the diary there are other useful features—as, for instance, detachable estimate and requisition forms, and small sheets of squared paper. On the whole an excellent shillingsworth.

West African Studies. By Mary H. Kingsley. With illustrations and maps. (London: Macmillan.) 21s. As the authoress of "Travels in West Africa," Miss Kingsley acquired a reputation for smart and vivacious writing, and the present volume not only maintains her character in this respect, but shows her competency to deal with problems of a graver character connected both with politics and ethnology. Miss Kingsley holds a brief on behalf of English traders and the native population. She has strong views against the present system of governing Crown colonies in which she hopes to make the public participate. She has an alternative method of administration to advance; but her views would probably receive more attention from high authorities if she gave less play to her vein of humour. We can have little to do here with political questions and the fittest form of colonial government, but Miss Kingsley's enquiries into forms of nature, religion, and belief, are within our province. In this portion of the book the author is at her best. There is evidence of wide reading of recognized authorities, and of acute and painstaking observation. The district throughout which enquiries were prosecuted, extended from Sierra Leone to Loanda on the West Coast with occasional visits to the interior, where the Oil Rivers, the Ogowe and the Lower Congo, offered facilities. It is evidence of the care with which the question was studied, that Miss Kingsley was able to recognize four main schools of West African Fetish. The Tshi and Ewe school, which Ellis has described, the Calabar school, and those of Mpongwe and the Fjort schools. Classification necessarily implies discriminating and careful work. We have, of course, not space to enter into the details of Fetish, which the author defines as the religion of the natives of the West Coast, where they have not been influenced either by Christianity or Mohammedanism. Growing out of this subject we have the questions of witchcraft and of native medicine in relation to West African religious thought. These chapters will well repay careful study. Two appendices are added to the book, which should by no means be skipped. These are written by M. le Comte C. de Cardi, and Mr. John Harford, of Bristol, authorities on the subjects of which they treat. The illustrations are good; the index might have been more complete.

First Lessons in Modern Geology. By the late A. H. Green, F.R.S., edited by J. F. Blake, M.A. (Clarendon Press.) Illustrated. 3s. 6d. This book is practically a primer, as one might infer from the title. It has been prepared from manuscript left by the late Professor Green. There is nothing in the style or arrangement to differentiate it from other books of the same kind so far as we are able to discover. From beginning to end the book lacks individuality; it bears a striking likeness to other well-known primers of good reputation.

BOOKS RECEIVED.

The Art of Writing English. By J. M. D. Meiklejohn, M.A. (A. M. Holden, London.)

True Tales of the Insects. By L. N. Badenoch. (Chapman & Hall.) Illustrated.

My Tour in Palestine. By F. H. Deverell. (Eyre & Spottiswoode.) Illustrated.

On Buds and Stipules. By the Rt. Hon. Sir John Lubbock, Bart., F.R.S. (Kegan Paul.) Illustrated. 5s.

The Journal of the Society of Comparative Legislation. New Series. No. 1, March, 1899. (Murray.) 5s. net.

Society for the Protection of Birds. Eighth Annual Report, January to December, 1898.

Rousdon Observatory: Variable Star Notes, No. 4—R Cygni and χ Cygni. By Sir C. E. Peek.

Journal of the Essex Field Club. Edited by Wm. Cole. Nos. 1-24. 6s. per annum.

The Studio: An Illustrated Magazine of Fine and Applied Art. No. 72. 1s. monthly.

"48 Hours" Dispute—July, 1897, to January, 1898. (The Engineering Employers' Federation.)

Report of S. P. Langley, Smithsonian Institution, for the Year ending June 30th, 1898.

China, Anglo-America, and Corn. A Lecture. By Granville Sharp. (*Hong Kong Daily Press* Office.)

Table-Talk with Young Men. By W. J. Dawson. (Hodder & Stoughton.) 3s. 6d.

The Hunterian Oration, 1899. By Sir William MacCormac, Bart. (Smith, Elder & Co.) 2s. 6d.

Notes upon the Romano-British Settlement at Chigwell, Essex. By J. Chalkley Gould. (Epping Forest Museum, Chingford.) Illustrated. 6d.

A Select Bibliography of Chemistry—1492–1897. By Henry Carrington Bolton. (Smithsonian Publications.)

The Photo-Miniature: A Monthly Magazine of Photographic Information. (Dawbarn & Ward.) 25 cents.

Bulletin de la Société Neuchateloise de Geographie. Tome XI., 1899. (Paul Attinger.)

Results of Meteorological and Magnetical Observations, 1898. (Stonyhurst College Observatory.)

Report of the U. S. National Museum for the Year ending June 30th, 1896.

WHAT IS A GEOLOGICAL CATASTROPHE?

By N. A. Graydon.

MOST geologists of the present day take the uniformitarian point of view, according to which the general features of the earth's surface are the product of, not sudden catastrophes, but gradual and uniform changes, such as are now more or less perceptibly in progress. There are, however, some special features, the explanation of which seems to demand changes so great and rapid or violent as to make them hardly distinguishable from catastrophes.

Generally speaking, disturbance of conformable strata, such as upheaval, subsidence, tilting, folding, faulting, erosion, etc., may well be conceived as a slow and uniform process, but formation of conformable strata, especially if of different nature, like, for instance, sandstone and limestone, is not easily representable as such; for the sudden transition from the last deposit of the one kind of sediment to the first deposit of the other kind seems inexplicable, without a correspondingly sudden change of level within or without the affected area.

So long as there is no evidence in favour of great and rapid changes of level, it may be right to assume their non-occurrence; but it is, in any case, advisable to reconsider the available evidence on the subject in all its bearings, for some data, such as the preservation, more or less intact, of submerged river valleys in the so-called continental platform, seem to indicate immersion so rapid as to leave no time for the action of the sea's levelling agency.

Under the title of "Sub-Oceanic Terraces and River Valleys of the Bay of Biscay," Prof. Hull, F.R.S., gave in *Nature*, of April 21st, 1898, some details of a typical case. He says: "The Adour passes out to the deep ocean through a continuous deep cañon or gorge one hundred miles long as 'Fosse de Cap Breton.' At thirty miles from the coast the bed of the cañon is three thousand one hundred and seventy-four feet below the general level of the continental shelf. At sixty-two miles it is about five thousand four hundred and forty-two feet below the same level. The cañon can be distinctly traced to the depth of nine thousand feet where it opens out on the oceanic floor."

Accepting this account as correct, the question suggests itself: How is it that this narrow submarine channel has not long ago been filled up with river deposits or other sediments travelling to and fro along the coast under the influence of waves and currents, the action of which is pretty well known and may be briefly summarized as follows:—

I. Motion of the sea caused by the winds does not extend far down. At a depth of thirty to fifty fathoms, wave action is almost imperceptible and current scour ceases.

II. Motion of the sea caused by tidal action is, in deep water, chiefly vertical; it is only converted into horizontal motion in shallow water; tidal currents are, therefore, essentially surface phenomena and their scouring action generally ceases at less depth than wave action.

III. The only deep-water currents of sufficient strength to scour away or prevent deposits are those about submarine ridges impeding the circulation of polar and equatorial waters.

IV. The material of shore deposits has a tendency to travel to and fro along the coast with waves and currents, the maximum action of which is between low and high-water mark, and every hollow in the sea-bed, near the shore, acts as silt-trap for travelling sediments.

Applying these principles to the case under review, assuming, in the absence of evidence to the contrary, that every part of the small Adour basin was subjected to the same total amount of subsidence, which, measured at the old river mouth at the foot of the continental escarpment, appears to be about nine thousand feet, and dividing the period of subsidence into two:—

(A.) Period before submergence of the edge of the continental platform—here, apparently, indicated by the two hundred fathom line—and with it of the terminal headlands of the Adour valley.

(B.) Period after it.

It follows that, at the beginning of period (A), the seashore was at the base level of erosion or the foot of the continental escarpment, and the whole region drained by the Adour was some nine thousand feet higher above sea-level than it now is. It was therefore, better able to intercept moisture-laden air-currents. Precipitation was accordingly, heavier, and the drainage area including, as it did, a region now submerged, was considerably larger than now. The stream's volume must, therefore, have been much greater than at the present time.

The submerged part of the channel presents the very steep fall of from sixty to seventy feet per mile, so the Adour was, then, more a torrent than a river. Its erosive power must have been very great and the amount of sediment borne along very large. The narrowness of the submerged valley—a mere gorge—shows that the rate of erosion of the bed was much more rapid than that of weathering of the sides.

As subsidence progressed the gorge must have assumed the aspect of a long fiord, which, under conditions of slow subsidence, would have soon been filled up with the river's own deposits to the level at which scouring action of tidal currents obtained the mastery—that is, up to, say, the fifty-fathom line. As nothing of the kind seems to have happened, it must be inferred that either the scouring action of the tidal currents extended, here, to a depth far greater than it is known to do anywhere else on the earth, or the rapidity of submergence was such that the amount of sediment brought down by the river during the process was insignificant.

Further, it has been observed that the depth of the sea within a fiord often far exceeds that just without it—this being due to the filling in of the trough, up to scour limit, by the sediments ever travelling up and down the coast. As the process does not extend far into the fiord, the result is a kind of deep bar at the mouth. As there is apparently no such bar in the case of the submerged mouth of the Adcur valley, it must be inferred that either there was no shore deposit going on at the time, or the rapidity of submergence was such that the amount of travelling coast sediment trapped by the deep trough during the process was insignificant.

At the close of period (A), the Adour fiord had, at the mouth, a depth of about seven thousand eight hundred feet, or apparently many times that of the deepest known of Norwegian fiords.

With the advent of period (B) and submergence of the edge of the continental platform, conditions changed to some extent. As the shore line retreated up the gentle slope of the continental platform, every part of the submerged gorge became, in turn, silt trap for the travelling coast sediments, and under conditions of slow subsidence the channel would have been gradually filled up and obliterated from the mouth upwards if not from both ends. As this did not happen it must be again inferred that either there was no shore deposit going on at the time, or the rapidity of submergence was such that the amount of travelling coast sediment trapped by the deep trough during the process was insignificant.

In each case it seems more natural to adopt the second alternative mentioned—that is, great rapidity of submergence—especially as to adopt the other involves a series of implications which have the character of gratuitous assumptions. The question then imposes itself: "What rate of subsidence—and if of subsidence why not of upheaval—constitutes a catastrophe?"

THE MYCETOZOA, AND SOME QUESTIONS WHICH THEY SUGGEST.—III.

By the Right Hon. Sir Edward Fry, D.C.L., LL.D., F.R.S., and Agnes Fry.

Species.—That true species exist in the myxies is doubted by no one who has studied them, and the constancy of many forms from distant places strongly supports this view. But it may be permitted to doubt whether the range of variation possible to one and the same species is yet sufficiently known to enable us to rely with security upon the whole of the present classification. In the progeny of a common parent when under cultivation, great diversities have been observed in the character of the calcareous walls of the sporangium, in the thickness of the capillitium, and even in its presence or absence, in the colour of the sporangium walls, the capillitium, and even of the plasmodium. Until, therefore, more species have been subjected to observations under culture, or more life-histories have been exactly traced, we must be prepared to regard the specific distinctions as open to revision. Mr. Massie considers that he has found cases of hybridism in myxies; but this, perhaps, requires confirmation.

Whatever be the limits of variation within a species, the great fact of specific distinction seems to admit of no doubt, and one of the most interesting faculties of these pieces of naked protoplasm is the power of knowing other pieces of protoplasm of their own species from the apparently similar protoplasm of other species. According to the concurrent testimony of three of the chief observers of these organisms, Cienkowski, De Bary, and Lister, "union never takes place between plasmodia of different species." "Branches of different plasmodia," says Cienkowski, "crawl near one another, and mutually embrace one another, without showing the least trace of any fusion."

The merging of two protoplasms has been seen under the microscope. "There appeared to be no mutual attraction until the two plasmodia were only separated by a distance of 40 μ. When a lobe from one was pushed out towards its companion, the intervening swarm cells were thrust aside, and they came into contact; the hyaloplasm (ectoplasm) of each blended at a single point, and then a stream of granular matter was seen to pass, then with a return flow of the streaming in the layer of the two, the channel was widened, and a gush of its contents poured into the smaller one, when union was complete and the system of circulation became common to both."

It may be permissible to adduce another instance of organisms of a very simple character to illustrate at once the attractive force of members of one species on their fellows, and of the capacity for selection which makes them reject the members of other, though very similar species. The case we are about to mention relates to two species of the genus *Cutleria*, algæ of a low type.

To the receptive ova of *Cutleria adspersa*, Falkenburg added actively mobile spermatozoids of the nearly allied species *Cutleria multifida*; so like the other species *adspersa* that they can only be distinguished by small external differences. "In this case the spermatozoids, as seen by the microscope, wandered aimlessly about, and finally died without having fertilized the ova of the allied species of algæ. . . . A very different result was obtained as soon as a single fertilizable ovum of the same species was introduced into the vessel containing the spermatozoids. After a few moments, all the spermatozoids from all sides gathered around this ovum, even when the latter was several centimetres distant from the place at which the latter were chiefly collected."

These instances impress the mind with the fundamental character of the fact of species; whether it has arisen from variation and selection or not, it is a fact that goes down to the very foundations and rudiments of organic life, and even there influences the life and habits of the organism. As we see it in the myxies, it precedes the origination of the sexual distinction, it precedes any differentiation of parts or organs, it precedes the development of the cellular tissue. It may, perhaps, be said to precede the division into the animal and vegetable kingdoms. The distinction can exist in small naked bits of protoplasm, and each of these, indistinguishable in structure as the protoplasts of some of the species are to any organs or instruments which we possess, has the power of distinguishing between these indistinguishable masses, of attracting and being attracted by those of its own kind, and of remaining indifferent and neutral towards those of other kinds.

That the pollen of an oak should not act on a daisy seems to us natural; that the naked protoplasm of these minute organisms should be endowed with this selective capacity does seem very remarkable, and may well make one pause and think. Is it possible, one inclines to ask, to feel sure that all the various species of myxies have been produced from one original form by the force of a natural selection? How can the doctrine of the fittest be applied as between two naked protoplasts, and if applied only to the later stages of growth, how has it reacted on the earlier stages?

Classification.—We now propose to deal with the classification of these organisms, and this will afford us an opportunity of describing more in detail some parts of their structure.

The value of characters for the purposes of generic and specific distinctions is a subject well worth consideration, for it often reveals unexpected facts in the correlation of parts, startling one by dividing organisms which, at first sight, seem nearly akin. Colour is for the most part of little value as a distinction in flowering plants, for we know how widely colour will vary in the same species. "Color," says Linnæus, "in eadem specie mire ludit: hinc in differentia nil valet;" and yet in the pimpernel, the blue and red forms differing in scarcely any other character are true and not interchangeable species; in the algæ the presence of colours other than green is found a fundamental character in their classification, and in like manner we shall find in the myxies that the colour of the spores has been found a character of real value.

What is the meaning, some one may ask, of the value of a character for classificatory purposes? It means that the presence of that character affords a safe line of cleavage; that those plants or animals which are on one side of the line will be found to agree in other characters—will have a likeness in many points of that kind which creates what we call in human beings a family likeness; whilst those organisms which stand on the other side of the line will be found dissimilar from the first family group. For instance, if we gather the common white dead nettle and observe its stalk, we shall find that it is four-sided, so that a section across it is a square. Now this characteristic might easily be supposed to be one of little consequence, and yet, in fact, it will be found to be a true and valuable one, and that all plants with a square stalk and lipped flowers will be found to have a four-lobed ovary and four nuts on the bottom of the calyx, and these belong to the family of the Labiatæ. If now, on the other hand, we count the number of the stamens in plants, and use this character as the foundation of our classes, we shall break up this natural family with its square stems, and shall relegate some genera, such as Salvia, to one class, while the great mass of the family go to another, and, what is perhaps worse, these exiled genera find themselves put into a class together with plants with which they have no real connection or sympathy—with the Enchanter's Nightshade and the Duck-weed. This form of the stem then has a high value as co-existent with a general likeness of structure; the number of the stamens may vary in plants closely akin, and agree in plants widely different, and therefore has a low systematic value.

The variations of form of our domesticated dogs are generally held to be of no value even as specific distinctions; but the difference of the markings in the spores of myxies is held by those who have most studied their classification to be often a safe difference as between two species. It is only by experience that we can tell the systematic value

Fig. 5.—*Cribraria aurantiaca* × about sixty diameters.

of a difference—*i.e.*, by observing how far it is correlated with other differences of structure or life-history, and whether the difference does, or does not, lose itself in a series of easy gradations between the two extreme forms. And yet there are some minds whose thoughts so run along the lines of creative thought that, as if by a happy intuition, they are able to seize these crucial points which are of real value, and to reject those that are useless. Such is the mind of the true naturalist.

Some slight difference exists amongst naturalists as to the extent to which the group of the Myxomycetes is to be carried—viz., whether they shall include or exclude a small group of organisms about to be mentioned, and as to the way in which the two terms Mycetozoa and Myxomycetes shall be used in classification. The following table may be useful as indicating the primary and secondary divisions of the group, which we shall accept in its widest signification:—

			Example.
(*a*) Mycetozoa	With an aggregate plasmodium, *Acrasieæ*		*Dictyostelium.*
	With a fused plasmodium, *Myxomycetes*	Exosporeæ, spores borne externally.	*Ceratomyxa.*
		Endosporeæ spores borne internally.	*Arcyria.*

Of these classes, it may at once be observed that the endosporous Myxomycetes are by far the largest, and that the species at present known of the other groups are very few in number, and, accordingly, in the sketch which we have given of the life-history of a myxie we have dealt only with the changes in an endosporous myxie.

It now becomes needful to call attention to the points in which the smaller classes differ from the dominant one.

In the ordinary myxie, as we have seen, the swarm spores effect a true fusion and build up one mass of protoplasm. In the Acrasieæ, on the contrary, the swarm spores do not fuse or coalesce together, but only aggregate together, retaining a power of separating from and moving on one another. This is the first and broadest division of the group of organisms.

The next characteristic which has been used for the classification of the group is the position of the spores in the organism. Hitherto we have only mentioned spores as contained within the sporangium; but there are one or perhaps two species very different in many ways from the rest of the group, in which the spores are carried on the outside of the organism. From this character the whole myxomycetes have been divided into two classes: the Exosporeæ, in which the spores are developed on the outside of the *sporophore*—*i.e.*, the part of the organism which bears the spores; and the Endosporeæ, in which the spores are generated within the sporangium.

Fig. 6.—*Arcyria punicea* (*cap* = *capillitium*; *c* = *cup*; *p* = *pedicel*) × about ten diameters.

(*a*) Note.—To avoid confusion, it may be well to state that in the foregoing table we have followed the classification of De Bary—that Van Tieghem would write "Myxomycetes" as the name of the whole class where we have written "Mycetozoa," and would write "Myxomycetes proprement dits" where we simply write "Myxomycetes"; and that Mr. Lister uses "Mycetozoa" for what we have called "Myxomycetes," and so excludes the *Acrasieæ* from the Mycetozoa.

We propose hereafter to consider somewhat more in detail the peculiarities of these two sets of aberrant forms; but they will be better appreciated after we have dealt with the larger group. We therefore now turn to the myxies which carry their spores within the sporangium, and we shall indicate some of the points of structure of which use has been made for the purposes of classification.

Fructification.—Perhaps the point of distinction which first arrests the eye of the student is the variety of form in which these organisms fructify and bear their spores.

These forms, to which different designations have been given, may be considered:—

a. The sporangium, a term which is sometimes applied to the spore-bearing organ in general, has been often applied in a narrower sense when that organ is well defined

Fig. 7.—*Stemonitis ferruginea.* Group of sporangia. × about eight diameters.

and symmetrical, such as the grape-like structures of *Badhamia* (Fig. 1), the baskets of *Cribraria* (Fig. 5), or the elongated forms of *Arcyria* or *Stemonitis* (Figs. 6 and 7).

β. Plasmodiocarp is a term applied to the spore-bearing part when it is sessile and irregular in form, sometimes like a cushion, sometimes like a creeping snake or a long tube. It may be said to represent the aggregated plasmodium which has stayed its onward course, gathered itself together, covered itself with a coat, and then produced spores. This form is shown at *a*, in Fig. 8.

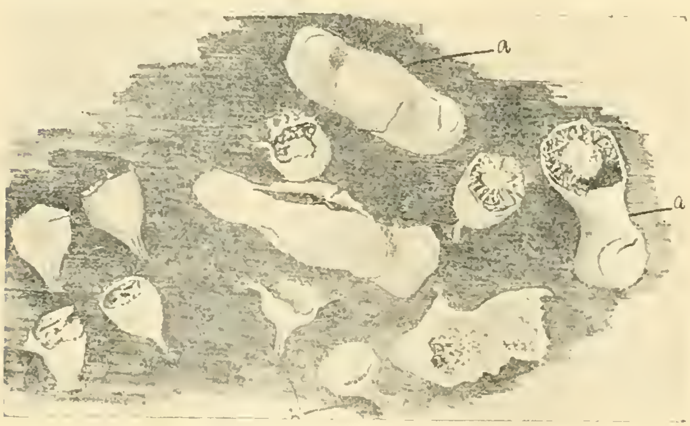


Fig. 8.—*Craterium pedunculatum.* Group of Sporangia and Plasmodiocarps. × about 10 diameters.

γ. Æthalium is the name given to that form of fructification in which a number of separate spore cases exist; but where they are so densely packed together, so intricately coiled, and so freely anastomosing that their individuality seems to disappear. The *Fuligo septica*, the myxie to which we have already often alluded as living on tan, and which is known as the flowers of tan (the only instance, we believe, in which any one of these organisms has the slightest claim to an English name), is an instance of this form of fructification. Fig. 9 exhibits a section of the mature æthalium of Fuligo.

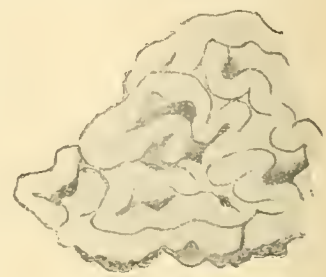


Fig. 9.—*Fuligo septica.* Section of mature æthalium. Somewhat enlarged.

Though it is both possible and convenient thus to classify the forms assumed by the fructification, it must not be supposed that the lines between them are hard and fast; on the contrary, there are abundant instances in which the plasmodiocarp and sporangium forms merge into one another; frequently the two forms will co-exist as the products of one and the same plasmodium.

Thus the beautiful little cups of *Craterium* will sometimes fail of complete separation, and part of the plasmodium is content to take the cruder form of a plasmodiocarp, as shown in Fig. 8. Again, sporangia, which are sometimes stalked, are at other times sessile, and thus differ but little from a plasmodiocarp. In the *Dictyostelium* (one of the Acrasieæ to be hereafter mentioned), a similar phenomenon has been observed; although in the normal form the production of spores occurs at the top of the pedicel, or column, in some cases the plasmodium turns into spores without ever developing the column at all.

There appears to be a considerable difference in the way in which the plasmodium turns into sporangia. In some cases the plasmodium first separates, and then each separate part forms a sporangium. In other cases the plasmodium begins its transformation as a whole, and breaks up into sporangia as the process advances.

Fig. 10.—*Stemonitis fusca.* Plasmodium turning into Sporangia. (After De Bary.) Enlarged.

Comatricha and *Craterium* appear to be cases of the former mode of procedure; *Stemonitis* of the second. Thus in *Comatricha* the plasmodium emerges in separate centres, like small conical hillocks on the wood. These grow upward, and as they approach maturity the upper part of the protoplasm draws all the lower part after it, except so much as goes to form the pedicel and *hypothallus*, or foot.

In *Stemonitis*, on the contrary, the plasmodium gathers itself together in a lump or mass, and first shows signs of dividing up by the appearance of papillæ on the surface; then at points corresponding with the papillæ, dark-coloured stems grow upwards in the gelatinous mass. Around these stems, portions of the adjoining protoplasm gather, and separate vertically from their neighbouring parts; and again, before maturity, the lower portion of the protoplasm around each column moves upwards, leaving only the delicate stalk which supports the arborescent sporangium. Fig. 10 will explain these steps in development.

It would seem as if the sporangium forms were the most highly developed, and the plasmodiocarp form the more rudimentary. We suppose that in the matter of advantage to the organism there must be something to be said for and against each form, for the plasmodiocarp must expend less material on perishable walls and stalks, and, on the other hand, be less open to the atmospheric influences; whereas the opposite in each respect must apply to sporangia. If one of these forms be better than the other, why does it not universally prevail? and why do some individuals of some species halt between the two opinions? We certainly do not know. This is one of the many cases in which it is at least very difficult to see any advantage gained by the variations of development of an organism.

Sporangium Walls.—The walls of the sporangium vary very greatly; sometimes they consist of a single membrane; sometimes of two or even three membranes; sometimes they continue till by rupture they let loose the spores; in other cases, the whole, or the upper part only, early falls away and discloses the system of hairs and the spores within; sometimes, as we shall see, they are furnished with lime, at other times they are without it.

In *Cribraria* (Fig. 5) we have a very beautiful form of sporangium, the wall of the lower half persists and forms a cup, whilst the upper half in its mature state consists of a network only of slender threads more or less thickened at the points where they cross one another.

In *Dictydium* we have again another very beautiful form of sporangium—it consists of rays of longitude gathered together at the pedicel and at the top as their two poles, with much slighter transverse lines of latitude. The intervening membrane falls away in whole or in part, and leaves for the sporangium a basket of most delicate network (*see* Fig. 11).

Fig. 11.—*Dictydium umbilicatum.* Empty Sporangia. × about 40 diameters.

In some cases the exterior of the sporangium has a most delicate surface, shining with iridescent colours. The *Lamproderma* is a genus with several species distinguished by this beautiful peculiarity. Our English species are very attractive, but they are excelled in brilliance by some tropical kinds. Of other genera, the *Physarum psittacinum* is another species with iridescent sporangia, and derives its name from its supposed resemblance to the colours of a parrot.

NOTES ON COMETS AND METEORS.

By W. F. Denning, F.R.A.S.

Swift's Comet (1899a).—This comet promises to be an interesting object for the telescope during May. Its approximate positions will be as follow:—

1899.	R.A. h.	m.	Dec.	Brightness.	Distance from Sun.
May 1	0	9	+ 22° 33′	1·8	35°
" 6	23	50	+ 27° 19′	1·7	44°
" 11	23	26	+ 33° 13′	1·7	53°
" 16	22	53	+ 40° 28′	1·7	63°
" 21	21	58	+ 48° 45′	1·8	75°
" 26	20	27	+ 55° 48′	1·7	87°
" 31	18	22	+ 56° 56′	1·5	98°
June 5	16	40	+ 51° 10′	1·2	106°
" 10	15	39	+ 43° 2	0·8	112°

On May 1st the comet will be nearly twice as bright as when discovered, so that it ought to be well visible to the naked eye. It will rise about three hours before the Sun, and will be placed six degrees S.S.E. from α Andromedæ. Moving rapidly to N.W., it will pass one and a-half degrees S. of o Andromedæ on May 16th, and on June 1st may be seen in the head of Draco, close to ξ. On June 16th the comet will be much fainter and a few degrees west of δ Herculis. Between about the middle of May and June 12th, it will be visible all night, as it will be placed within the circle of perpetual apparition.

Tuttle's Comet.—This comet may possibly be observed after sunset in the N.W. region of Orion, but the strong twilight will render it extremely faint.

Holmes's Comet (1892 III.) is now gradually approaching the earth, but its position in May will be such that it can only be observed a short time before sunrise. In later months it will be presented under more favourable conditions, as it is moving northwards. The re-discovery of this singular comet is awaited with special interest.

Tempel's Comet (1873 II.) is also expected, and will be favourably situated in the morning sky during ensuing months. On May 1st its position will be in R.A. 281°, Dec. 5° south, and close to the star 6 Aquilæ (magnitude 4½). The comet is travelling slowly to the east, and its brightness increasing.

Fireballs of March 1st.—In our notes for last month some details were given of two fireballs recorded at 7h. 1m. and 8h. 50m. on this date. The path of the former, as observed by Mr. Astbury at Wallingford, Berks, was from 340° + 63° to 323° + 44°, which it traversed in two-and a-half seconds, and the brilliancy of the object near the close of its visible career greatly exceeded that of Sirius. The meteor was seen by Sir W. J. Herschel, at Littlemore, near Oxford, and he describes it as the most brilliant which he had ever observed. The apparent path was from about seven degrees preceding β Cassiopeiæ, and descending almost vertically to within ten degrees of the horizon. Duration two-and-a-half seconds. Light about four times that of Venus. The same object was noticed by the Rev. A. T. Fryer, of Cardiff, while walking between Bridgend and Tondu, and his observation is described in the *Cambrian Natural Observer* for March, 1899. He says the meteor descended in a curve, roughly parallel with and to the north of the tail of Ursa Major. The colour was very remarkable—very light blue on the body but ending in brilliant red of a deep tone, like the red which the winter sun shows in setting. The meteor was fish shape.

From the above observations I have endeavoured to compute the real path. The meteor was a fine Geminid, and evidently belonged to the same system as that which supplied the fireball at about 8h. 50m. on the same night. The former was probably first seen when at a height of seventy miles over Stourbridge, and disappeared over a point five miles S.S.W. from Shrewsbury at a height of twenty-five miles. Its length of path was about fifty-five miles, and velocity twenty-two miles per second. This differs materially from the ten miles per second found for the fireball seen at a later hour, and it is probable that a mean of the two values—about sixteen miles per second—would more correctly represent the actual motion. The two fireballs are interesting as proving that the Geminid radiant continues active until the beginning of March.

Fireball of April 4th.—On April 4th, at 7h. 59m., Mr. C. Parker, of Handsworth, Birmingham, saw a brilliant meteor. It started from η Ursæ Majoris, and finished its course one degree beyond β Cassiopeiæ. When near the latter star, it broke up into three pieces. The meteor was brighter than Jupiter, and exhibited a marked variation in colour during its flight. The same object was observed by the Rev. R. Killip, of St. Anne's on-Sea, Lancaster, and he gives some details in *The English Mechanic* (April 14th). The time was 7h. 56·5m., and the meteor was estimated as fully twice as bright as Venus. It was first observed near α Cassiopeiæ, and travelled leisurely towards ϕ Andromedæ, dying out when eight or ten degrees from the W.N.W. horizon. This fireball appears to have been directed from a well-known April radiant of large meteors at about 205°–9° in Libra: but the above two observations appear to be somewhat discordant, and a satisfactory real path of the object cannot be computed from them.

Fireball Epochs.—There are many well-known fireball epochs during the year, and it is intended to make special observations with a view to discover the principal showers to which they belong. It is certain that at some of these periods a large number of streams are displayed, and that the paths of such fireballs as have been observed will not conform with any one radiant. They have exhibited considerable variety in their directions of flight, but it is hoped that further observation will reveal many of the chief systems of fireballs.

Microscopy.

By John H. Cooke, f.l.s., f.g.s.

The respiratory system, and other organs of many insects, may be clearly shown by bleaching with peroxide of hydrogen.

A saturated solution of neutral red in 0·8 per cent. sodium chloride is recommended for demonstrating the hæmoglobigenous granules in the erythrocytes of certain animals, such as the lamprey, frog, guinea-pig, and fowl embryos.

A solution consisting of pure glycerine and three per cent. formalin, in the proportion of three parts of the former to two parts of the latter, has been suggested as an effective preservative for fresh-water sponges. Unlike alcohol, it does not decolourize the specimens.

One of the principal difficulties hitherto experienced in the use of the electric arc lamp for microscopical purposes has been that of keeping the position of the arc constant and of securing a sufficiently small and uniform source of light. At a recent meeting of the Quekett Club, Mr. J. E. Barnard gave an account of the improvements he had made in this direction, whereby he had adapted an electric arc lamp for micrographic and photomicrographic purposes. He regulates both the position of the carbons and the distance between the carbon points by hand in such a way, that, by reference to cross wires on a glass screen, the source of light can always be kept in the same place, while "the oblique position in which the carbons were set enabled the small point of intense light from the incandescent crater of the positive carbon to be used as a source of unvarying and steady illumination of small area but very great intensity." This steadiness and intensity render the light specially suitable for photographing with high power objectives.

The last issue of the *Transactions of the South-Eastern Union of Scientific Societies*, contains *inter alia* a suggestive paper by Mr. E. M. Holmes, f.l.s., entitled "Botanical Work wanting Workers." The author refers briefly to work that may be done among the mosses, scale mosses, fungi, lichens, marine algæ and freshwater algæ, and indicates lines of work that might be followed and the localities in south-eastern England where the best results are likely to be obtained. He appeals specially to microscopists to take up the life-history of algæ, both freshwater and marine, but particularly the latter. Little is known of the changes that take place between the times when these plants disappear and reappear again; and it is not even known whether some of the algæ are not merely stages of growth of others. This is especially true of those plants in which only vegetative growth and reproduction are known, and in which sexual reproduction is unknown. It is suggested that the systematic observation during cultivation of such plants as Porphyridium, Chroococcus, Oscillaria, Tetraspora, and Schirogonium, might add considerably to our knowledge of their life-histories.

Students of marine algæ are likewise appealed to. We know very little of the life-cycles of the common Laminariæ. Mr. Holmes therefore suggests a careful study of these by cultivation from their spores. A microscopical examination once a fortnight throughout the year might result in finding the cystocarps of *Rhodymenia palmata*, the unknown tetraspores of some of the species of *Phyllophora*, *Ahnfeltia plicata*, and of *Gigartina mamillosa*, as well as the fructification of *Sphacelaria scoparia*, which, so far as is known, has never been found in this country. The paper is as practical as it is suggestive, and it is well worth the consideration of those who are desirous of taking up a line of research.

The following useful piece of apparatus for carrying material through the processes of fixing and hardening has been devised by Mr. W. C. Stevens, of Kansas University. It is specially suitable for very small objects, such as root-tips, sporanges, and young flower buds. Small glass buckets are made by cutting up glass tubing one centimetre in diameter into lengths of three centimetres. By means of heat, one end of each piece is turned out so as to form a rim; over this a piece of muslin is tied. The little bucket is provided with a suspender by means of a piece of thread fixed in the middle of the bottom; and the specimen is then placed in the bucket and suspended in the fixative fluid.

To obtain the most satisfactory definition with high power objectives, "critical" illumination is a *sine quâ non*. The microscope should be placed in a horizontal position, with its mirror turned on one side, and the lamp and microscope should be so arranged that the thin edge of the flame shall be projected along the optical axis of the condenser, and so that its image, when viewed with a one-inch objective shall be sharply defined in the same field of view as that occupied by the objects when under observation. The substitution of the one inch objective for either a $\frac{1}{15}$th, $\frac{1}{25}$th, or a $\frac{1}{50}$th, may now be made, and, after a slight readjustment of the achromatic condenser, it will be found that, the field of view will be so brilliantly illuminated, the most minute flagellate organisms are defined with an amount of sharpness rarely obtained under any other conditions.

Of late years considerable progress has been made in the methods adopted for the determination of the structural characteristics of steel by means of the microscope. In a paper, read before the American Microscopical Society, Mr. F. S. Rice briefly reviews the present state of our knowledge of the subject, and gives some very interesting details regarding the preparation and mode of examination of specimens. His experience has shown that specimens three-fourths of an inch in diameter, and mounted on ordinary slips, are the most convenient. He deprecates the use of emery and crocus papers, rouges, and wheels charged with polishing and cutting compounds, but suggests instead, that the best sections are obtained by carefully grinding off the surface to a plane, by hand, on an ordinary quick-cutting oil-stone, then on the finest Belgian oil-hone, and, finally, polishing on a piece of chamois leather tightly stretched over a block of wood charged with peroxide of tin. The specimen is finished by washing thoroughly with alcohol, followed by a little chloroform.

Professor E. Mead Wilcox, of Harvard University, advocates in the columns of the *Journal of Applied Microscopy* the use of soap for imbedding plant tissues. It is frequently found that it is not practicable to apply either the paraffin or the collodion methods on account of the time that they require. Fleming, Lee, and Pfitzer have each suggested the soap method, and have practised it at different times with more or less success. Prof. Wilcox now gives his experiences in this direction. He finds that glycerine and alcohol together as the solvent give the best results. A tablet of Pear's soap was cut into small pieces and dissolved in a mixture of equal parts of ninety-five per cent. alcohol and glycerine. The resulting liquid was then poured into a warm, shallow dish and allowed to harden, after which it was ready for use. Before imbedding the tissues it has been found desirable to immerse them in a diluted solution of the soap, in order that thorough penetration or infiltration may be secured. Final imbedding may then be accomplished in a watch glass.

THE FACE OF THE SKY FOR MAY.

By A. Fowler, F.R.A.S.

The Sun.—The Sun rises on the **1st** at 4.33, and sets at 7.21; on the **31st** he rises at 3.51, and sets at 8.3. A fine group of spots was visible during the latter part of March, so that the Sun may still be worth careful scrutiny.

The Moon.—The Moon will enter her last quarter on the **2nd** at 5.47 p.m.; will be new on the **9th**, at 5.39 p.m.; enter her first quarter on the **17th**, at 5.13 p.m.; will be full on the **25th**, at 5.49 a.m.; and enters her last quarter on the **31st** at 10.55 p.m.

On the **24th**, there will be an occultation of B.A.C., 5254, magnitude 5·4. Disappearance at 10.15 p.m., at 125° from north point (138° from vertex); reappearance at 11.25 at 261° from north point (264° from vertex).

On the **26th**, 7 Sagittarii (magnitude 5·4) will be occulted. Disappearance at 11.39, at 51° from north point (69° from vertex); reappearance at 0.39 at 302° from north point (312° from vertex).

The Planets.—Mercury is a morning star, reaching his greatest westerly elongation of 26° 4′ on the **10th** at 4 a.m. He rises, however, only about half-an-hour before the Sun, so that he will not be seen with the naked eye in our latitudes.

Venus is a morning star, but, like Mercury, does not rise early enough to be seen with the naked eye. On the **12th** she rises at 3.22 a.m., that is 53m. before the Sun, and crosses the meridian at 9.51 a.m.

Mars remains visible throughout the month, but as his apparent diameter is only 6·6″ at the beginning of the month and 5·6″ at the end, he is not very accessible to small telescopes. Still, about the end of March, when the apparent diameter was not more than 8·8″, the principal markings were readily perceived. He is a little east of the Praesepe, in Cancer, at the beginning of the month, and afterwards travels almost directly towards Regulus. On the **1st** he sets at 2 a.m., and on the **31st** at midnight. Nine-tenths of the disc will be illuminated.

Jupiter is a conspicuous object, though not far above the horizon. During the month he describes a westerly path, lying roughly midway between Spica and α Libræ. He will be due south at 11.32 p.m. on the **1st**, and at 9.22 p.m. on the **31st**, his altitude on the meridian at London being about 27°. The eclipse disappearances and reappearances take place on the eastern side of the planet; in the case of the first satellite (Io), only the reappearances are visible. The satellite phenomena are especially interesting at convenient hours on the **6th**, **7th**, **13th**, **14th**, **15th**, **22nd**, **23rd**, **29th**, **30th** and **31st**.

Saturn is a little more favourably placed for observation than last month. On the **1st** he rises at 10.48, crossing the meridian at 2.51 a.m., and on the **31st** at 8.40, crossing the meridian at 12.45. He is still in the southerly part of Ophiuchus, and traverses a short westerly path. When on the meridian at London, his altitude is only 16°. At the middle of the month the polar diameter of the planet is 16·8″; the major and minor axis of the outer part of the ring are respectively 42·2″ and 18·9″; the major and minor axis of the inner edge of the bright ring are respectively 26·8″ and 12·0″. It will be seen that the rings are very widely open. The northern surface of the rings is visible.

Uranus is in opposition on the **27th**. He is nearly 5° north of Antares, but with his south declination of 21½°, he only reaches an altitude of 17° when on the meridian at London. He rises on the **1st** at 9.36, and on the **31st** at 7.32, crossing the meridian on these dates at 1.46 a.m. and 11.39 p.m. respectively. His apparent diameter is 3·7″.

Neptune is practically not observable.

The Stars.—About 10 p.m. at the middle of the month, Spica Virginis will be due south, Arcturus a little east of south, Ursa Major nearly overhead, Scorpio rising in the south-east, Vega pretty high up in the east, Cygnus north-east, Leo in the south-west, and Gemini a little north of west.

Chess Column.

By C. D. Locock, B.A.

Communications for this column should be addressed to C. D. Locock, Netherfield, Camberley, and posted on or before the 10th of each month.

Solutions of April Problems.

No. 1.

1. K to K2, and 2. Q to Q2, etc.

No. 2.

1. B to R8, and 2. K to Kt7, etc.

[Other variations obvious.]

Correct Solutions of both problems received from Alpha, K. W., J. T. Blakemore, Capt. Forde, A. H. Doubleday, J. H. Jones, F. V. Louis, C. S. Kershaw J. M. K. Lupton, J. Herbert.

Of No. 1 only, from R. Inwards, W. de P. Crousaz, G. J. Newbegin, Gerald Todd, J. Baddeley.

W. de P. Crousaz.—After 1. R to Kt5ch, K to R2; 2. B to R8, Black need not take the Bishop. If two *keys* to a sound problem are received, the solution counts as incorrect. A *reductio ad absurdum* would show the necessity for this. In the case of duals on the second move it is different. We no longer have your card, but fancy that you sent more than one key to No. 2 (March).

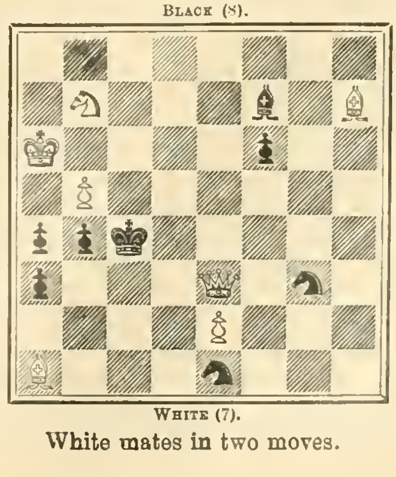
J. T. Blakemore.—Thanks for your contribution, which we publish with pleasure. Have you an original problem for publication?

PROBLEMS.

No. 1.

By H. Bristow.

Black (8).



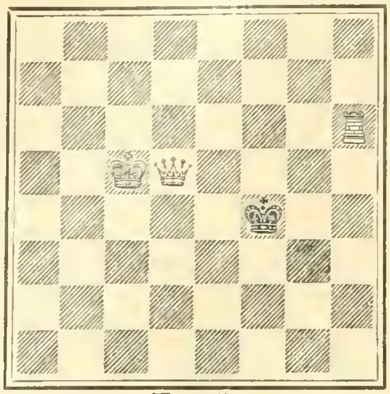
White (7).

White mates in two moves.

No. 2.

By T. Hane (Prague).

BLACK (1).



WHITE (3).

White mates in three moves.

CHESS INTELLIGENCE.

The Inter-University match was played at the British Chess Club, on the 24th ult., the Cambridge representatives winning easily with a score of 5½ to 1½. Some such result might have been expected from a casual review of the score made by the combined teams in their trial matches against the principal London clubs earlier in the week. In these matches the Cambridge men invariably contributed considerably more than half the combined score. Cambridge are now eight matches to the good. The score was as under :—

CAMBRIDGE.		OXFORD.	
C. E. C. Tattersall	1	A. H. W. George	0
L. MacLean	1	A. P. Lacy-Hulbert	0
H. G. Softlaw	1	G. E. H. Ellis	0
A. Fotheringham	1	F. Soddy	0
R. S. Mackower	½	F. A. Babcock	½
J. E. Wright	0	H. Hilton	1
C. C. Wiles	1	L. Giles	0
Total	5½	Total	1½

The combined Universities lost all four of the matches earlier in the week against very strong opponents. Against Hastings they scored 5½ to 8½, against the Metropolitan Club 7½ to 10½, against the British Chess Club 6 to 15, and against the City of London Club 8 to 14. Messrs. Tattersall and MacLean made very fine scores in all those matches, and are undoubtedly the two best players out of the fourteen.

Yorkshire defeated Lancashire on the day of the cable match by 20 games to 11. Mr. Burn elected to represent Lancashire in this match, rather than assist the British Isles against the United States.

Messrs. P. Howell, T. F. Lawrence, and L. Zangwill tied for second prize in the City of London Tournament, won by Mr. Jacobs, as stated last month ; Messrs. F. Leye and R. Loman were bracketed fifth. The handicap was won by Mr. E. O. Jones.

Mr. Mills has once more won the Scottish Championship. We fancy that he has never failed to accomplish this feat.

Messrs. Janowski and Showalter are engaged in a return match, the American native leading at present by 3½ games to 2½, a considerable improvement on his score in the first match, which he lost by seven games to two. The negotiations for a match between Janowski and Pillsbury have fallen through, at any rate until after the London International Tournament, which begins on May 30th.

A Midland Counties Chess Tournament was held at Birmingham during Easter week. The competitors, and the order of the prize-winners, remind one of the January Craigside Tourney. Mr. Burn took the first prize, Mr. Atkins the second, Messrs. Bellingham and Sherrard coming next.

The Annual Chess Festival at Hastings took place towards the end of March. In the consultation games, Messrs. Blackburne and Chapman (an invincible combination) defeated Messrs. Teichmann and Trenchard ; Messrs. Teichmann and Bullock beat Mr. Gunsberg and Dr. Colborne, while Messrs. Gunsberg and Guest drew against Messrs. Blackburne and Jenour. Mr. Gunsberg's simultaneous performance resulted in fourteen wins, three draws, and four losses to the single player. Mr. Blackburne, playing six games blindfold, won four and drew the other two. The interesting performance in which each master plays two simultaneous games against two sets of consultants, resulted in Mr. Teichmann's winning both his games ; Mr. Blackburne won one and drew the other, while Mr. Gunsberg drew one and lost one. The Championship of Sussex final round was played for at this meeting, and resulted in the victory of Mr. D. B. Kitchin. Mr. Shoosmith, last year's champion, did not compete.

KNOWLEDGE
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CONTENTS.

THE HEREFORD EARTHQUAKE OF 1896.*

By CHARLES DAVISON, SC.D., F.G.S.

THOUGH slight earthquakes are not at all uncommon in this country it is fortunately but seldom that we are visited by a shock so strong and so destructive to property as that which occurred near Hereford on the morning of December 17th, 1896. The Essex earthquake of 1884 was productive of greater damage within a limited district, but the area disturbed by it is estimated at not more than fifty thousand square miles.

The accompanying map will show at a glance how much greater was the area affected by the Hereford earthquake. It includes the whole of England and Wales, with perhaps the exception of the three northern counties of Northumberland, Durham and Cumberland, and extending across the channel, entrenches upon the south-eastern counties of Ireland. The outermost continuous line (called the "isoseismal 4") bounds the region within which the shock was strong enough to make doors, windows, etc., rattle, but if the earthquake had not occurred at so early an hour (5.32 A.M.) there can be little doubt that it would have been perceived far beyond these limits. However, it was observed at the point of Ayre lighthouse (in the north of the Isle of Man), at Middlesborough, and at Flamborough Head lighthouse. Records have also come from more distant places, but, as these are somewhat isolated, it is not quite certain that they refer to the earthquake. The furthest from the bounding line just mentioned are Acklington, in Northumberland (fifty-nine miles distant), and Killeshandra, in County Cavan (sixty-five miles), and it is worthy of notice that the times at which the disturbances were observed at these places do not differ greatly from what they should have been, taking into account the velocity with which the earth-wave radiated from the origin.

It will be seen that the outermost line is very nearly circular in form, its dimensions being three hundred and fifty-six miles from north-west to south-east, and three hundred and fifty-seven miles from north-east to south-west. The area included within it is ninety-eight thousand square miles. If, however, the disturbed area were bounded by a concentric circle passing through Middlesborough, it would then contain one hundred and fifteen thousand square miles; and if by one through Killeshandra, as much as one hundred and eighty-five thousand square miles. Thus, the disturbed area can hardly have been less than one hundred thousand square miles—that is, it was at least twice as great as that affected by the Essex earthquake.

The continuous oval curves drawn upon the map represent *isoseismal lines* or lines of equal intensity of the shock; and are determined by reference to the Rossi-Forel scale of seismic intensity, an arbitrary scale in which the degree 1 corresponds to shocks so slight that they could only be felt by the most experienced observers, and the degree 10 to disastrous earthquakes by which whole towns and villages are overthrown. With the two highest degrees of this scale we have fortunately nothing to do in this country. The greatest intensity ever experienced by us, at any rate during the present century, is that numbered 8 in the scale, which refers to a shock capable of throwing down chimneys or cracking the walls of buildings. In the Hereford earthquake, damage of this kind occurred at no less than seventy-three places, fifty-five of which were in the county of Herefordshire. Marking these places on a map, and also those at which, so far as known, there was not the least damage done to buildings, and then drawing a line so as to include all the former and exclude the latter as far as possible, we obtain an isoseismal line corresponding to the degree 8 of the scale, a line which we may for brevity call the isoseismal 8.

Outside this line, no buildings were injured in any way, except in a few isolated cases. Thus, at Knightwick, two miles from the curve, stones fell from the top of a tall church spire, and, at three other more distant places, solitary chimneys were more or less damaged. The greatest destruction occurred in the city of Hereford and in some of the neighbouring villages. The cathedral escaped without very serious harm, but, in addition to some other slight injury, the three pinnacles at the west end were cracked near the top, and in each the upper detached portion was slightly displaced. The spire of St. Martin's Church was cracked right through about twelve feet from the top, and at Barr's Court railway station all the seven chimney-stacks were shattered. From inquiries made among builders in Hereford, Mr. H. Cecil Moore ascertained that certainly not less than two hundred and eighteen chimneys had to be repaired. At Dinedor, three miles south-east of Hereford, all the vicarage chimneys, eight in number, were knocked down and had to be rebuilt. And again at Fownhope, three miles further to the south-east, many chimneys were thrown down, and in falling caused much damage to the roofs of houses. These three

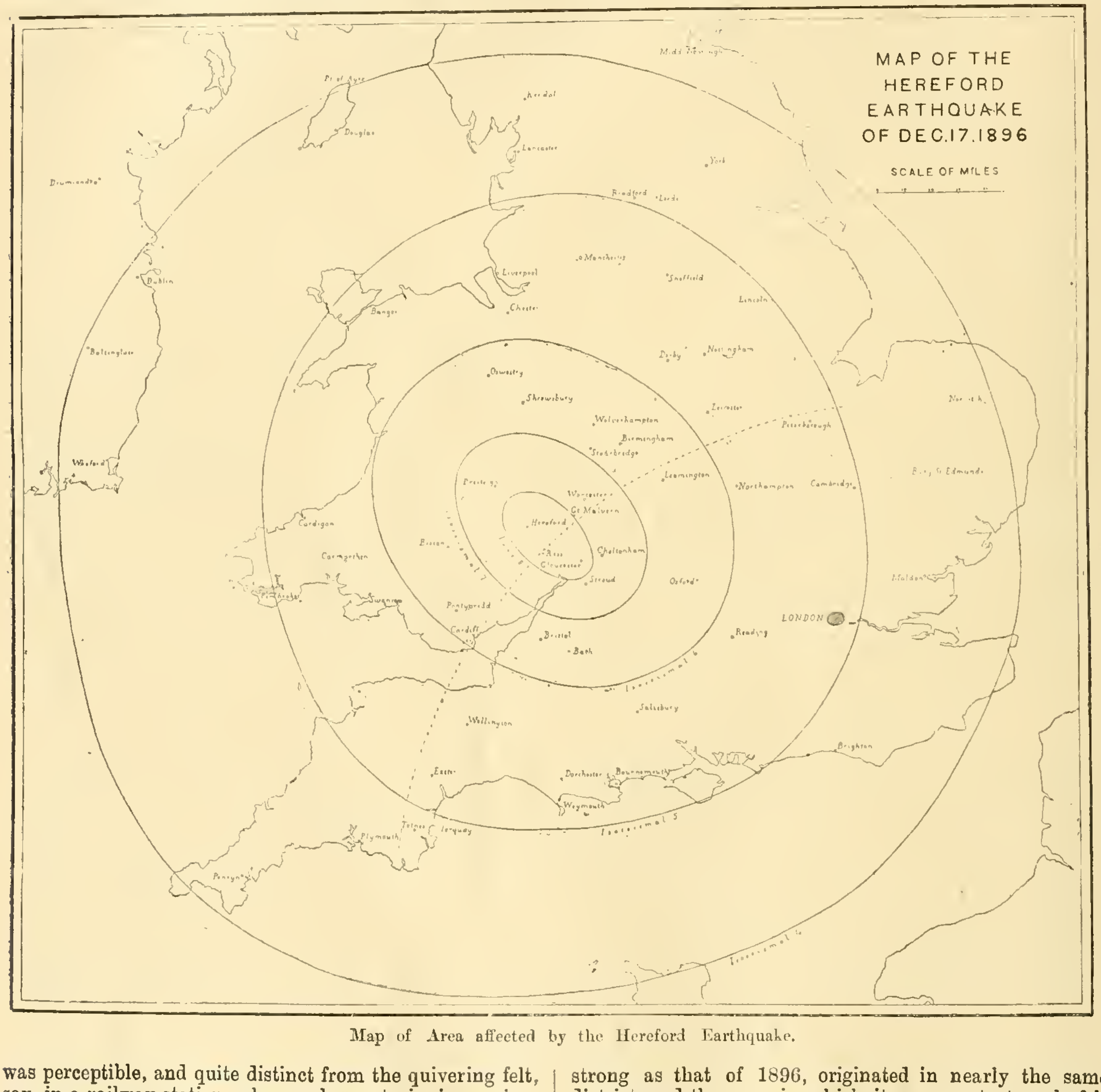
* Abstract of the writer's work on "The Hereford Earthquake of December 17th, 1896," published by Cornish Brothers, Birmingham.

places seem to be those which suffered most severely from the earthquake.

The other isoseismal lines correspond to gradually lessening degrees of intensity. Within the isoseismal 7, the shock was strong enough to overthrow objects such as vases, picture-frames, etc.; the isoseismal 6 bounds places where chandeliers, pictures, etc., were observed to swing, and some difficulty was experienced in drawing this line, as so many observers seem to have slept in darkened rooms. Inside the isoseismal 5, the displacement of the ground was perceptible, and quite distinct from the quivering felt, say, in a railway station when a heavy train is passing. The isoseismal 4, as already mentioned, includes places where the shock was strong enough to make loose objects rattle, such as doors, windows, fireirons, etc. Large parts of the last two isoseismals traverse the sea, and in drawing them we have to be guided by the trend of the curves just before they leave the coast, and also by the known intensity at the nearest places on land. It is possible, of course, that their paths might have been found different had the sea been replaced by land, but as no deductions of any consequence depend upon them, except where they traverse land, the errors, if they exist, cannot be of great moment.

Returning to the isoseismal 8, we find it to be an oval curve, forty miles long and twenty-three miles broad, the longer axis being directed W. 44° N. and E. 44° S. It might be argued that the elongated form of the curve is due to the vibrations being more readily propagated along a north-west and south-east line than in the perpendicular direction. But, in 1863, another earthquake, almost as strong as that of 1896, originated in nearly the same district, and the area in which it was most strongly felt was also elongated, but along a north-east and south-west line. Thus, it appears that the form of these curves must be due to the focus being longer in one direction than in the other; and we may infer that, in the case of the Hereford earthquake of 1896, the longer axis of the focus was directed almost exactly north-west and south-east.

If the initial impulse were uniform all over the focus, the nature of the shock would be nearly the same through-



Map of Area affected by the Hereford Earthquake.

out the disturbed area. The chief variation would be in its duration, which would be greatest at places in the longer axis of the isoseismals, and least at those in the shorter axis. If the initial impulse were greatest at the north-west end of the focus, the shock would have been strongest towards the end at places to the south-east of the focus, and towards the beginning at places to the north-west. Now, this is what actually occurred—at least according to the majority of the observers who made notes on this point. As a rule, however, there was a break in the shock. In the south-east region, a series of rapid vibrations was first felt; then came an interval of two or three seconds, during which no motion was perceptible; and this was followed by a longer series of vibrations, stronger and slower than the first, and compared by many observers to the rolling of a boat when crossing the wake of a steamer, or to the oscillations of a carriage resting on good springs. Some persons at a distance from the centre describe the rocking as gentle and not unpleasant, but near the centre "the vibrations were so fierce and quick that they resembled the beats of an engine going at fifty miles an hour." In the north-west region the order of events was reversed, the first series being longer, more intense, and consisting of slower vibrations.

It is clear, from the variable nature of the double shock, that the focus cannot have been continuous throughout its length. The waves proceeding from a single focus cannot have been divided by reflexion or refraction at the bounding surfaces of different strata. Neither could the two series correspond to the longitudinal and transverse vibrations from one initial impulse, nor to successive impulses at the same focus. We must therefore conclude that there were two detached foci arranged along a north-west and south-east line.

An interesting question now arises as to whether the impulses at the two foci were simultaneous or successive. If they were simultaneous, then, at places along a straight line bisecting the line joining the two foci at right angles, the two series of vibrations would arrive together and only a single shock would be observed. Moreover, the boundary between the north-west and south-east regions in which the two parts of the shock were complementary would coincide with the same straight line. But this is not the case. The boundary is clearly a curved line concave towards the south-east, and the two series coalesce and form a single series at places within a hyperbolic band* which is traversed by the same boundary line. As the distance of any point on this band from the north-west focus is greater than its distance from the south-east focus, it follows that the north-west focus must have been in action a few seconds before the south-east focus.

Evidence leading to the same conclusion is afforded by the sound-phenomena of the earthquake. The deep rumbling sound which nearly always accompanies earthquakes was heard over about two-thirds of the disturbed area. It was most often compared to the noise made by heavy waggons, traction engines, or railway trains passing; sometimes to thunder, wind, the crash of a falling roof or other heavy bodies, or to explosions and the firing of heavy guns. The most marked feature of the sound was its extraordinary depth. It was, in fact, so deep, that it was inaudible to many observers. The records, however, show that persons differ widely in their powers of hearing deep sounds. To some it appeared very loud, like the rumbling of a traction engine heavily laden; while others, in the same places and equally on the alert, heard no sound at all. The audibility of the sound-vibrations must, of course, decrease with the increasing distance from the origin; but in the Hereford earthquake it did not depend only on the distance. For instance, in Herefordshire, the percentage of observers who heard the sound was eighty-seven, in Berkshire it was forty-four, while in the still more distant county of Lincoln it was sixty. If we consider the percentage in each county to correspond to the centre of the county, we can draw a series of curves of equal sound-audibility, which I have called *isacoustic lines:* the meaning of the line marked "60," say, being that sixty per cent. of the observers, within a small area having its centre on the curve, heard the earthquake sound. Now, these lines are irregular in form, and by no means concentric with the isoseismal lines. They are much elongated in two directions, one a little east of north-east, and the other a little south of south-west; and it is remarkable that a line drawn through the points of each curve which are furthest from the centre is concave towards the south-east, and coincides very nearly with the hyperbolic band along which the two series of vibrations were superposed. The explanation is evidently that at places along the line of greatest elongation of the curves the sound-vibrations from the two foci arrived simultaneously, and were audible to a larger number of observers*; and the concavity of this line to the south-east confirms the conclusion already arrived at with regard to the precedence in action of the north-west focus.

Most earthquakes which occur in non-volcanic districts appear to have their origin in the intermittent growth of faults. The mass of rock on one side of a fault slips, in extreme cases, through several feet; in most cases, perhaps, through a small fraction of an inch. But the area over which the slip takes place may be several miles in length, and the weight of the displaced rock-mass may be very great. The friction resulting from the sudden movement may thus be the source of the waves which, when they reach the surface, are known to us as an earthquake shock.

Now, since the surface of the fault is inclined to the horizon, the relative positions of the isoseismal lines will be different on the two sides of the fault, and ought, therefore, to throw some light on the direction in which the fault-surface "hades" or slopes. Referring to the map, it will be seen that the distance between the isoseismals is greater on the north-east than on the south-west side for the inner lines, and less for the outer ones. The inference from this is that the originating fault of the Hereford earthquake hades to the north-east. The fault-line must therefore be approximately parallel to the longer axis of the isoseismal 8, and lie a short distance to the south-west of this axis. Its exact position cannot be determined, but it probably passes through a point about one mile south-west of Hereford.

There is no fault on the Geological Survey map of the district to correspond with that suggested by the seismic evidence. But this is not surprising, for the area in which it lies is one covered by Old Red Sandstone, in which the detection of faults is difficult. A short distance to the south-east, however, there is a small triangular area of Silurian rocks, known as the May Hill anticlinal, the north-east side of which is bounded by a fault which, if produced, would coincide very nearly with the earthquake-fault. It should be noticed that the course of this fault, as traced on the Survey map, ends abruptly on the margin of the Old Red Sandstone, possibly on account of the difficulty of following it any further; and it appears to me

* The broken line on the map passes along the middle of the hyperbolic band.

* The same reasoning apparently leads to the conclusion that the isoseismal lines should have been distorted in a similar manner; but there was less inequality between the sound-vibrations from the two foci than between the larger vibrations which formed the true shock.

therefore not unreasonable to conclude that the earthquake was due to a double slip along a continuation of this fault to the north-west.

Whether this be the case or no is not, perhaps, a matter of much importance. The noteworthy fact is that the earthquake-fault is roughly parallel to the axis of the well-known Woolhope anticlinal, and not far from its south-west boundary; that it probably forms part of the series of movements which have given rise to the structure of this interesting district.

It is not possible to determine the position of the two foci with very great accuracy, but, judging from the form of the isoseismal 8, the course of the hyperbolic band, and the duration of the two series of vibrations and of the interval between them, we cannot be far wrong in estimating the length of the north-west focus at about eight miles, with its centre beneath a point about three miles south-east of Hereford; and the length of the south-east focus at about six miles, with its centre beneath a point two or three miles north-east of Ross. Between the two foci there would thus be an undisturbed portion of the fault-service about two miles in length. With regard to the depth of the two foci, in this, as in every other earthquake, nothing definite can be stated.

One of the most interesting problems in connection with the earthquake is the origin of the double focus: and I venture to suggest the following as the solution. The earthquake fault, as we have seen, runs north-west and south-east. In the neighbourhood of the north-west focus, its hade is to the north-east. The hade may change to the south-west near the south-east focus and the May Hill anticlinal, but this is immaterial to the explanation. If we were to make a section of the north-east rock-mass by a north-west and south-east vertical plane, I imagine that beds originally horizontal would now be curved, so that there would be an anticline where the section passes through the Silurian Woolhope anticlinal, and a syncline through the newer rocks to the south-east, opposite the May Hill anticlinal. Between these folds there would be a region (corresponding to that between the two foci) where there is little or no vertical displacement. Now if the crust-movements which caused the earthquake were such as to accentuate this structure, there would be two slips—one at the north-west focus, that would be partly upwards and partly to the south-west (at least relatively to the rock-mass on the opposite side of the fault), and the other at the south-east focus, partly downwards and partly to the north-east, while in the region between them there would be no perceptible movement.

It should be mentioned, however, that there were several slight shocks—nine before and three after—the principal earthquake, and that three of these appear to have originated in the intermediate region. It is difficult, owing to the scarcity of observations, to locate the foci of some of the other shocks; but the majority of them seem to have been connected with the south-east focus. Possibly this is the reason why, in the principal earthquake, the vibrations from the north-west focus were so much more severe than those which proceeded from the other.

THE DISCOLORATION OF CUT APPLES.

By G. Clarke Nuttall, b.sc.

The processes in the evolution of an apple tart present no difficulty to the most ordinary practical cook, though to the average learned scientist the gradual building up of this eminently English dish is apt to be a matter of some wonder. He wonders because he realizes his ignorance of culinary details and his helplessness if he be confronted with them practically; while, in her, familiarity has bred contempt to such an extent that she does not realize the limits of her knowledge, and can see no one thing in all the various details that calls for wonder or remark. And yet she might well do so, for at a certain stage that happens which has both puzzled and excited the interest of botanist and chemist, though she passes it by ignorant, and yet not knowing her ignorance.

As the apples lie piled up in slices in the dish waiting for their covering of paste, every housewife knows that they have a tendency to turn from their normal white to first a reddish, and then a brown colour, and that if they are left standing in the air uncovered for very long they become an unpleasant dirty-brown hue which is distinctly unappetising. So unappetising is the colour that if part of an apple be eaten and the rest put aside for a short time, a fastidious eater will throw it away rather than finish it, even though the flavour is quite unimpaired. This reddening of the flesh of apples cut and exposed to the air is one of those phenomena whose everyday occurrence has taken away curiosity, and ranged most people on the side of that cook who saw nothing in it to wonder at as "they always went like that!" And yet this change of colour is a Gordian knot which many have attempted in vain to untie, and which even yet is not altogether free.

Why should apples, pears, and, to a less extent, potatoes, thus change colour in the air, and only make this change when they are in their raw uncooked state? What is the true inwardness underlying this external symptom? To simply say it is due to a process of oxidation does not convey much definite knowledge to the inquirer, and, indeed, it is only during the past few years that much progress has been made in understanding better the reason of this change in colour.

The latest and most thorough explanation is one lately put forward by a chemist named Lindet, and it is an explanation of considerable interest. Within the cells of the tissues which make up the fleshy part of the apple—the part that is eaten—there is produced in their jelly-like contents a certain product to which the name malase or laccase has been variously given (malase will probably be the name finally used, as laccase has already been adopted for another product); and this product belongs to a curious class of substances known as enzymes. Enzymes have only been discussed seriously of late years, and even up to quite lately much doubt has been expressed as to what their properties are, and even indeed if they had any real existence or not; however, that point is now practically settled, and, in fact, they have been isolated and examined.

Now, an enzyme is a production of the activity of the cell which has the unique power of influencing other substances in its neighbourhood, and yet remaining unaltered in any way itself. It can exert influence without, apparently, being affected by doing so. Its own constitution is stable, but it possesses power to act, even at a distance, on certain of its surroundings, and produce great effects on the constitution of other matter, in some way not yet thoroughly comprehended. It will be seen at once that this is a very different thing from ordinary chemical action. In chemical action one substance acts on another by effecting some exchange, or producing some re-arrangement of the atoms comprising both substances. In combining with another it must itself be changed according to some definite law, and only through that change can chemical action be effected. Moreover, there is a definite limit to chemical action, and when once the new combination is brought about, and a stable equilibrium ensured, then there is an end of the matter until new substances come into play.

But with enzymes the case is very different. Apparently their power of influencing is illimitable. They do not change themselves and so they can continue to exert the influence that is peculiar to themselves for an indefinite time. There is no point of stable equilibrium in this relationship. Enzymes stand in a position of great interest nowadays when the search among the beginnings of life is so intense, and when the effort to prove or disprove spontaneous generation—the origin of life from the non-living—is so keenly maintained by chemists and biologists, for in one instance certainly where very careful and exact study has been made of an enzyme it is suggested that the substance stands midway between the organic and the inorganic, that it is the stepping stone across the gulf which has hitherto divided the great world of the living from that which has never known life.

Thus it appears that a simple consideration of the change of colour in a raw apple may lead back to the most far-reaching questions, and involve problems which touch closely the most incomprehensible matters of life and being.

The particular enzyme—malase—which is found in the cells of an apple effects its work by causing some of the oxygen of the air to be transferred from the air to a substance also found within the cells—the tannin—and it is suggested that it serves, in some sort of a way, as a carrier. And the result of its influence on tannin is that the nature of the tannin is altered, and dark-coloured substances, compounds of oxygen, are formed which dye the walls, first pinkish, then a dull red, and finally a dirty-brown. It is obvious that though the malase is probably always present in the cells, it cannot exert its influence to any purpose while the apple is whole, and surrounded by a firm clear skin, for the air cannot obtain admission until the peel is removed or the apple cut through, and hence there is no free oxygen to work with. But when the cells have been exposed the air enters, the malase transfers, in some mysterious way, the oxygen, the tannin is changed in nature, and the cells are dyed with the products. It is by no means certain that the malase and the tannin must be side by side in the same cells for this effect to take place. Lindet is inclined to think they are not, and that the malase exerts its influence for some distance, but this is a question which calls for further research before any more definite answer can be given.

The name oxydases has been suggested by Weigert for the enzymes which are engaged in the process of the transference of oxygen, a name which has the advantage of giving a clue to their function. This method of oxidation is quite distinct from the two other more familiar methods by which oxidation may be directly brought about: these two other ways being, first, the life processes in bacteria, where oxidation is an outcome of their vitality; and, secondly, the simple chemical fixation of oxygen, such as when sulphur dioxide (SO_2) becomes converted into the trioxide (SO_3) in the presence of oxygen.

But, as Prof. Lafar points out, the whole subject of oxydases, *i.e.*, of the oxidising enzymes, is yet in its infancy, but sufficient is known to give grounds for hope that it may prove to be a fruitful source of explanation in many instances where hitherto much has been perplexing, and that it may serve to throw light into dark places. The rapid discoloration of fresh vegetable juices is a case in point. These have always proved a source of difficulty to the botanist, and no really thorough comprehension of the subject has been arrived at, but now the recognition of these enzymes in plants is a help out of the maze. For now oxydases have been directly proved to exist in many fruits, such as pears, chestnuts, and quinces, and also in various vegetables, such as carrots, and potatoes, and beet, and the inner tissues of all these, as common experience shows, have a tendency to become discoloured when exposed to the air.

Malase and the other plant enzymes can be isolated by squeezing out the juice of the plant and mixing it with alcohol, when a precipitate is thrown down. This precipitate is then dissolved in water and filtered, and if again alcohol is added to the result a new precipitate will appear, which is the enzyme of the plant juice in question, and which is thus free for further examination and treatment.

It is not known as yet how many kinds of oxydases there are, but several of them are known to be the cause of familiar phenomena. For instance, it is only since 1895 that it has been effectively shown that the darkening of colour sometimes seen in white wines—the "browning of wines"—is due to the action of an enzyme which acts in the same way as malase in the apple, and its discovery has led to further knowledge as to the means of prevention of this trouble in viticulture.

Then, again, with regard to the darkening in colour of mushrooms and allied fungi when broken and exposed to the air, this was in 1895 found to be due to an oxydase which brought about oxidation in a similar way; and only quite recently in ripe olives another has been found which brings about spontaneous decomposition, but is not yet sufficiently studied to allow of much definite knowledge.

The laccase already mentioned earlier is an enzyme which plays the all-important part in the hardening and darkening of the plant juices which are the basis of the celebrated Japanese lacquer.

ON THE TREATMENT AND UTILIZATION OF ANTHROPOLOGICAL DATA.

By Arthur Thomson, M.A., M.B.

III.—RACIAL PROPORTIONS.

Many interesting facts relating to the various proportions of the body in different races may be culled from the vast number of measurements which have been made. Unfortunately, though the material at our disposal is very considerable, so varied have been the different methods employed by those responsible for the measurements that it becomes a matter of endless labour to form any generalisations from the statistics at hand. It has ever been the delight of the physical anthropologist to improve on the methods of his predecessor, and this improvement generally takes the form of some addition to the long list of measurements hitherto taken. In many cases these improvements are but an additional burden to the masses of figures already sufficiently numerous and perplexing. What is wanted, is not an increase, but a reduction in the number of the measurements deemed necessary.

It seems to us that the value of the different methods employed may be tested in a very simple way. Confining our remarks, for the time being, to the question of bodily proportions, it is only reasonable to suppose that the data supplied should be such as to enable a sculptor or modeller to apportion correctly the various members of the body. Subjected to such a test, most of the systems adopted by anthropologists break down miserably. Let anyone try it for himself. Taking the body height as equal one thousand, the various measurements of the limbs and trunk may be worked out in this proportion. If now an attempt is made to plot out on paper ruled in squares of centimetres the proportions thus expressed, the experimenter will at once begin to realise the weakness of many of the systems of measurement. Taking the total height as one thousand, the length of the lower limb can be readily enough ascertained by deducting from this the sitting height. It is obvious, of course, that such measurement does not include the entire length of the femur, but for all practical purposes the length of the leg in the living may be expressed in this way. On looking up the various tables of measurements which the investigator may wish to compare, he will realise that some employ the method above described, whilst others measure the length of the limb from the perineum to the sole of the foot. As a matter of fact, these measurements may be regarded as practically the same. It is otherwise, however, when the length of the limb has been taken from the great trochanter, the pubis, or the anterior superior iliac spine, for then it is necessary to ascertain the exact position of these points in relation to the trunk; and here the difficulties begin. In regard to the length of the leg, using that term to mean the segment of the limb below the knee, we find that this is measured by some from the sole to the articular plane of the knee. In such cases it is easy to mark it off on the plan, but, unfortunately, others measure this distance from the lower border of the projection of the outer ankle instead of from the sole. This, no doubt, gives a more accurate measurement of the length of the bones of the leg as distinct from those of the foot, but, unfortunately, leaves us in a state of uncertainty as to the position of the knee, unless we know the distance of the summit of the malleolus from the ground; a measurement which in many of the tables given is omitted. But whilst, by a considerable amount of care and the exercise of much ingenuity, we may reduce the measurements of the lower limb to a common standard, we will find when we come to map out the proportions of the upper limb that the difficulties are much increased. No fault need be found with the methods recommended for the measurement of the various segments, but the experimenter with these figures will at once realise that there are insufficient data given to fix precisely the position of the summit of the limb. The point from which the entire length of the limb is usually measured is the tip of the acromion process. Now, it is only exceptionally that the height of this process from the ground is given; hence, although we may know the breadth of the trunk at this point (bi-acromial width), we have no means of assigning this width to its proper position in relation to the figure. It seems to us that this is a point of very considerable importance in discussing the proportionate lengths of the limbs; commonly we can readily distinguish the difference between long- and short- armed people by getting them to stand in the military position of attention and then note the level reached by the tip of the middle finger as it is applied to the side of the thigh. Thus Prof. Tylor, in his manual of anthropology, refers to the fact that "negro soldiers standing at drill bring the middle finger tip an inch or two nearer the knee than white men can do, and some have been even known to touch the knee pan." Now this is precisely what we wish to place on record, but so far as we know, the simple expedient of measuring the distance from the tip of the middle finger to the ground has never been adopted. We fear we are falling into the same error that we have discovered in others, but in suggesting such a measurement, we should be able to dispense with others which are of little use. The gain of such a measurement is obvious, for it would enable us to fix with certainty the position of the summit of the shoulder, for that would be easily ascertained by adding the total length of the upper limb to the measure of the distance of the tip of the middle finger from the ground. As the summit of the shoulder corresponds to the position of the acromion process of the blade-bone, it would at once enable us to assign the bi-acromial width to its proper position on the figure. That some such method is necessary must, we think, be admitted by anyone who has taken the trouble to endeavour to construct a figure from the data supplied. Furthermore, attention should be directed to the matter, for in the instructions provided for the measurement of the living, in the Notes and Queries on Anthropology, published by the Anthropological Institute for the use of travellers, there are no measurements suggested, either in what are termed the essential, the additional, or the special measurements, which would enable us either to determine the point on the thigh reached by the tip of the middle finger, or the height of the summit of the shoulder from the ground.

We fully agree with many of the suggestions therein contained. It is of great advantage to have the height of the sternal notch, and chin, from the ground, as these readily enable us to assign the correct proportions to the head and neck as distinct from the trunk. It may be that the measurement of the trunk, as determined by the distance between the perineum and the sternal notch, is not without objection, but, on the other hand, it is much more convenient than taking the length of the trunk from the seventh cervical spine to the perineum or tip of the coccyx, more especially because all the points of measurement may be viewed from the front of the body. We lay stress upon this fact, for it enables us to measure photographs of the nude figure and compare them with the data supplied by other observers. In taking these measurements, however, it cannot be too much insisted upon that the head must in the first instance be correctly adjusted with the axis of vision horizontal; or placed in such a position that the orifice of the ear and the lower orbital margin fall in the same horizontal plane; furthermore, once adjusted it should not be moved until most of the other measurements have been taken, for inattention to this rule leads to errors which oftentimes only attract attention when some such method of reconstruction as that suggested above is adopted. In our own experience in the work of some recent observers we have got results which were without doubt erroneous and misleading, and, no doubt, this was due to a change in the position of the head whilst some of the measurements were being taken.

For the purposes of proportion, apart from those especially relating to the head and face, the following measurements would in most instances suffice:—Total height, chin to sole of foot, sternal notch to sole, perineum* to sole, articular plane of knee to sole, distance from sole to tip of middle finger (assuming the person measured is in the military position of attention), total length of upper limb, length of cubit. If further measurements can conveniently be taken, then measure distance from sole to trochanter, this gives us the total length of lower limb, and we are now in a position to place the bi-acromial and bi-trochanteric widths in their proper positions. Were such data universally adopted it would be possible to map out the general proportions of the figure in graphic form. We do not in the least wish to prevent enthusiastic observers from taking what additional measurements they may consider advisable, but many of those universally adopted, such, for instance, as the span of the arms, are of little or no value.

The next difficulty we have to face is to know what to

* Or the height of the seated figure may be deducted from the total height in order to give the length of the lower limb, or the equivalent measurement,—the distance of the perineum from the sole.

do with all these figures when we have got them. For purposes of comparison between different races, it is essential that we should reduce them to a common standard, and this has been done by many anthropologists with much advantage and profit. The average proportions of different races may be thus numerically expressed, and by careful study and comparison of these figures, results of much value may be arrived at. But, as a matter of experience, we are bound to confess, elaborate tables of measurements convey little to our minds. We content ourselves, as a rule, with reading the summary, which the author may by chance have been good enough to supply; the tables are glanced at, to see if there is anything very striking about them, and then, unless our interest happens to be directed to some particular point, they are set aside, unstudied, and parts which makes it so difficult to realise the true relation of each part to the other when expressed in figures. It seems to us that the only satisfactory method to adopt is to reduce the data to graphic form and so represent them. The advantage of such a system is that the eye is quick to pick out the characteristics of each type, and it is only necessary to run the eye along such a series of types to recognise what are the main features on which their differences depend.

In the diagram here given an attempt has been made to put these views into practice, with what success the reader must be left to judge.

As previously stated, the matter is not quite so easy as might be imagined, the difficulty being due to lack of uniformity in the measurements employed and the omission

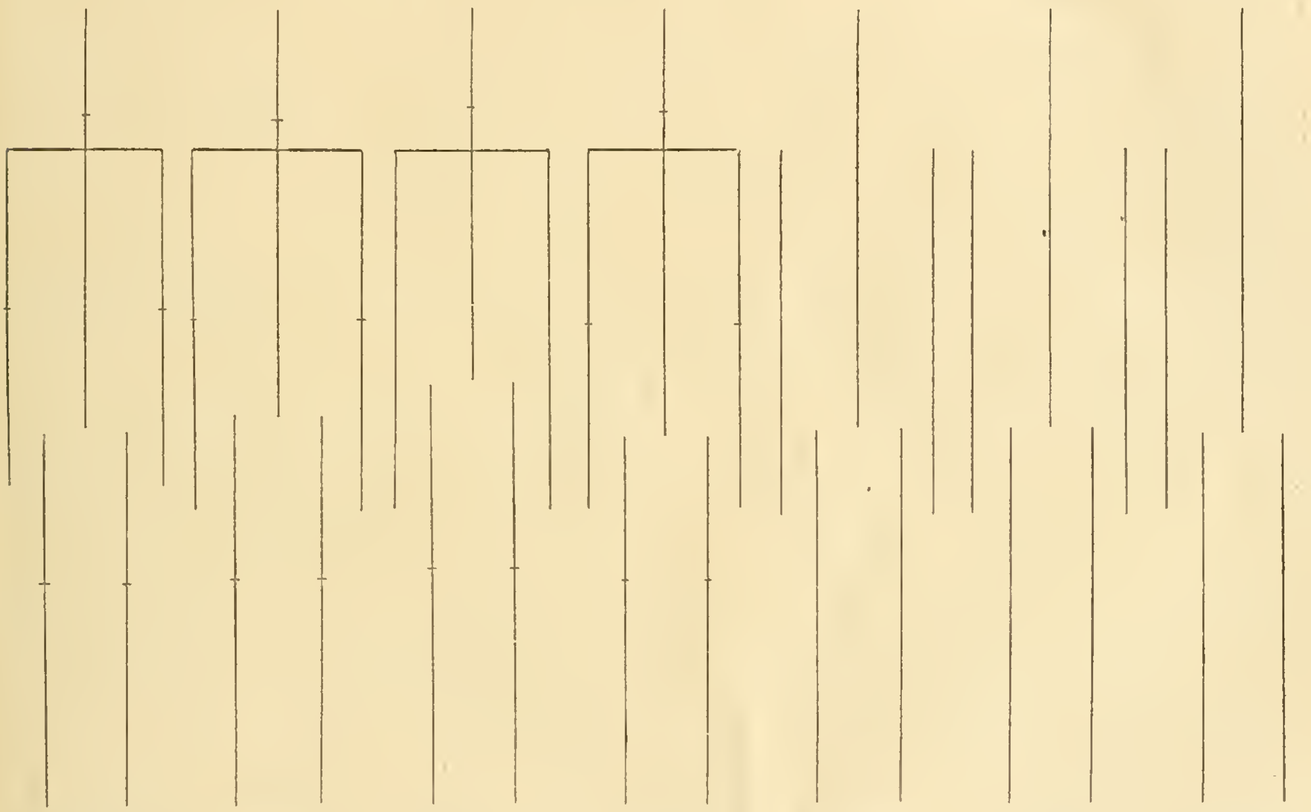


Fig. 1. 10,876 American Soldiers. Fig. 2. 2020 Negroes. Fig. 3. 20 Australians. Fig. 4. 517 Iroquois Indians. Fig. 5. 54 Javanese. Fig. 6. 40 Bataks. Fig. 7. 49 Southern Chinese.

GRAPHIC REPRESENTATION OF THE PROPORTIONS OF SOME RACES.

little appreciated. Now, there must be something wrong in all this. Considering the vast amount of time and trouble spent in securing these data, there should be some more profitable way of demonstrating the results than that usually adopted.

For statistical purposes curves have long been employed, and are extremely useful to express the variations which occur when dealing with one class of measurements (height, for instance), but when we have more than two factors to consider, curves become unmanageable, or, at least, so complicated as to be beyond the reach of all but expert mathematicians. In studying such a question as racial proportion, the reader will recognise that we have to deal with variations in the proportions of trunk to limbs, limbs to limbs, segments of limbs to each other, &c.; it is this complication in the inter-relation of the various of certain measurements which are necessary to the scheme.

Each figure represents the proportion of the limbs, trunk and head in terms of one thousand. The first, second and fourth figures are constructed from data obtained from Topinard's work on Anthropology, the Australian type is based upon measurements given in Spencer and Gillens' "Tribes of Central Australia," whilst Figs. 5, 6, and 7 are derived from the data furnished by Dr. Hagen in his atlas of "Ostasiatischer and Melanesischer Völker" (1898). Apart from the racial characters which are here displayed in graphic form, the figures strikingly illustrate many of the points to which attention has been already directed. In no case have I been able to determine satisfactorily the point from which to draw the length of the upper limb (*i.e.*, the acromion process). In four cases I have assumed that the acromion process lies on a level with the sternal notch, but this is a mere compromise, and as such unsatisfactory. Had we had the measurement from the tip of the middle finger to the ground it would have been easy enough to determine the position of the summit of the shoulder and the level of the bi-acromial width. For lack of satisfactory data the proportion of the head height is omitted in three, and for like reasons it has been impossible to determine the position of the knee, owing to the fact that whilst the length of the limb from the summit of the external malleolus to the articular plane of the knee has been given, the distance of the malleolus from the sole of the foot was omitted, and hence we were at a loss to determine the height of the knee from the ground. Yet, despite these deficiencies, most, we think, will admit that they will learn much more from a hurried comparison of the forms presented than from a prolonged and arduous study of the tables of measurements presented by the various authors. The long arms and the long legs of the negro are at once apparent, the shortness of the upper in contrast with the lower limb in the white man is very evident, whilst the short trunk, and proportionately longer lower limbs of the Australian are very strikingly displayed, The proportion of the upper limbs in the Javanese and Southern Chinamen is almost the same, but the shorter lower limbs of the latter are readily recognised.

It is along such lines as these that we venture to think progress will be made. Provided we can obtain the necessary measurements we can then present the results in a form which will demonstrate with greater clearness and more lasting effect those minor differences, on the sum of which racial distinctions depend.

SECRETS OF THE EARTH'S CRUST.

By Grenville A. J. Cole, M.R.I.A., F.G.S., *Professor of Geology in the Royal College of Science for Ireland.*

III.—THE MAKERS OF FLINT.

The association of flint with limestone, the former material so hard, taking the mark of steel, and the latter so soft and sectile, was observed by the ancients, and even led to some confusion in their nomenclature.* The contrast between the two rocks was striking; their relationship was certainly obscure. Long before limestone was used as a building-stone or for the production of lime, flints had been singled out for the weapons of primitive man. At a later date, the cavernous siliceous beds associated with certain limestones were used for millstones, and were exported from one land to another. When geology became a science, the mode of occurrence of these rocks required explanation; and difficulties were at once forthcoming. The grand curving bands of nodular flint, one beneath the other, on the headlands of the English Chalk, form a veritable feature of the landscape, and mark out the stratification of the series by their horizontal, folded, or even vertical lines. The less known flint-zones in the Portland beds of Dorsetshire play the same part on the pale limestone face, where it is shaped into cliffs against the sea. The darker colour of the Carboniferous Limestone, however, often masks the flint included in it; but in this rock also, throughout England and Ireland, siliceous bands are common. While there is a greater tendency to the formation of continuous beds rather than nodules, yet the Carboniferous flint often crosses from one layer of the limestone to another, and forms irregular lumps, quite in the Cretaceous style.

* *See* the wise remarks of Cæsalpinus, "De Metallicis" (1602), p. 84.

By custom, rather than any accurate definition, flint occurring outside the Cretaceous system has become styled "chert," the *hornstein* of the Germans. Some of these cherts are duller than ordinary flint, owing to a number of inclusions; but this is by no means the rule. Others, however, are merely sandstones cemented by chalcedonic silica, like the brown bands in the "greensands" of Leith Hill. But all kinds alike represent an alteration of the rock in which they occur—a feature that was not present on its deposition from the waters of the original sea or lake.

We must bear lakes in mind, for many flint-beds, crammed with fossils or casts of fossils, clearly originated in fresh water. The Oligocene "Calcaire de la Brie," well known in the wide plateau south of Paris, is often converted into a scoriaceous flinty deposit, which has long been found suitable for millstones. The fossils, *Limnæa*, *Planorbis*, and the spherical oogonia of *Chara*, give no clue to the cause of silicification, and are typical freshwater forms. Long ago, however, Cuvier and Brongniart* showed how the irregular hollows in such rocks resulted from the removal of limestone in solution; and they produced artificial millstone-rocks, or *meulières*, by treating siliceous limestones with nitric acid.

Macculloch,† about the same time, recognised the connection of chert and limestone, and regarded chert as a product of alteration. The views of D'Aubuisson des Voisins‡ were still more lucid, when he attributed the nodular masses of flint in the chalk to the coming together of silica, which was once uniformly diffused throughout the mass.

The origin of the silica, however, has given rise to many speculations. The boiling springs, or geysers, of the present day bring large quantities of silica to the surface in solution. Wherever, again, we find lavas rich in silica—notably the groups of the rhyolites and quartz-andesites—their hollows tend to become filled with opal, chalcedony, and agate; and most of the precious opals come from regions where volcanoes have been active in fairly recent times. Sometimes the entire rock becomes silicified; that is to say, its alkalies, alumina, lime, and magnesia, become removed, and silica insidiously replaces them, the structures of the original rock being still retained. Even basalts have thus been converted into jasper under the influence of percolating waters.§

Seeing that silica may be dissolved in spring-water through the presence of carbonates of the alkalies, it is natural to suggest that such water penetrates underground-masses, and deposits chalcedony in their interstices. This, indeed, seems the easiest way of making flint; and even irregular nodules can be explained as being formed along the more conspicuous water-ways of the rock-mass. Geologists of eminence, like M. Coquand,‖ have not hesitated to accept this view for ordinary flint.

Certainly, when we find "tabular flint," as it is appropriately called, filling up irregular fissures, or coating the planes of faults, we must admit that the material has been deposited there from solution; and the nodular flints occurring in the same rock-mass seem but another phase of the operation. But, even then, has the silica been derived

* "Description Géologique des Environs de Paris" (1822), p. 41.

† "Geological Classification of Rocks" (1821), pp. 565 and 570.

‡ "Traité de Géognosie" (1819), Tome I., p. 318.

§ C. Darwin, "Geographical Observations on Volcanic Islands" (1844), p. 46. A similar case occurs in Anglesey (*Sci. Proc. R. Dublin Soc.*, Vol. VII., p. 114).

‖ "Traité des Roches" (1857), p. 194.

from extraneous sources, or was it once, as D'Aubuisson said, uniformly diffused throughout the mass?

It is necessary to lay some stress on the infiltration theory, because it is so commonly true when applied to lavas, and may thus be true also of certain sedimentary rocks. The waters of modern geyser-regions frequently impregnate the trunks of trees before they have had time to decay under ordinary influences. Step by step, the organic matter passes away in combination with the alkalies of the solution, and the silica is deposited in its place. Here we have an example of the rapid silicification of non-volcanic material.

Yet we can hardly go as far as a recent writer, M. de Cossigny,* and argue, from the occurrence of true flint in fissures, that the nodular flints result from the filling up of cavities in the chalk. Many of these nodules are hollow, and so far remind one of the gradual choking of cavities in lavas, by the deposit of chalcedony on their walls. Such hollows, however, in the flints have long ago received another explanation; and their original contents, which are sometimes retained, have impressed observers as far back as the beginning of the century.

The fact is that, again and again, the fracture of a nodular flint discloses a fossil sponge. The hard parts, the spicular meshwork, of the sponge may be in very various conditions. Sometimes the general form is preserved, but the spicules are lost in a deposit of extraneous silica, which has bound the whole together into a white and knotty mass. Sometimes this mass crumbles between the fingers, sometimes it is almost as resisting as the nodule round it. In the latter case, dark flint will generally be seen filling its interstices, and the spicular structure is revealed in microscopic sections.

At other times, a pseudomorph or replacement of the sponge may occur in limonite, which is mere hydrated iron oxide, or iron rust. This probably results from the decay of a previous pseudomorph in marcasite, an iron sulphide which is highly susceptible to decay. Visitors to the south-east of England will notice how frequently, in the grey Lower Chalk, sponges have thus been replaced by brassy marcasite.

At other times, a mere powder remains in the hollow of the flint, and is found, on microscopic examination, to contain a few spicules, and silicified foraminiferal shells. Such powders offer a fertile field to the student of microzoa.†

Seeing that the enclosed sponges possessed, originally at any rate, siliceous skeletons, it seemed natural to conclude that additional silica had collected round them. Zirkel‡ quotes Parkinson, Guettard, de Luc, Faujas St. Fond, Dolomieu, and Huot, as early observers in this field. But the source of the additional silica still remained in doubt.

The association of flint and chert with sponge-remains became more and more evident as geological surveys spread. The grey flints of the Upper Greensand in the Isle of Wight are shot through, as it were, with minute rods, visible to the naked eye. Similar opaque rods abound in the brown cherts (cemented sands) of the Hythe Beds in the hills of Surrey. These are sponge-spicules in the form of casts, or even the hollows left by them; and their forms show that they also belonged to siliceous genera. The fact that these spicules are so often dissolved, like

* "L'origine des silex de la craie," *Bull. Soc. Géol. de France*, 3me. Sér., Tome IX. (1880), p. 47.

† *See* Jos. Wright, "Cretaceous Foraminifera of Keady Hill," *Proc. Belfast Nat. Field Club*, 1885-6, p. 328.

‡ "Lehrbuch der Petrographie," Second Edition, Bd. III., p. 552.

those of the sponges enclosed in nodular flints, is an important clue to the origin of the flint itself.

Similarly, Gümbel* reports that the siliceous limestones or marls of the Flysch system, in all the localities visited by him in the Alps, consist almost exclusively of sponge spicules. He does not comment on the actual condition of the spicules; but Dr. G. J. Hinde† has remarked that such bodies seldom remain in their original condition. Even when they still consist of silica, this is rarely the colloid form, easily soluble in hot solutions of caustic potash, but a replacement, in whole or in part, by chalcedonic silica. The axial canals of the spicules are, moreover, often filled by green glauconite, the curious silicate which accumulates from sea-water in so many recent deposits, and which colours our fossil "greensands" and glauconitic chalks. On complete solution of the spicule, the resisting cast of glauconite remains, often with the diverging rays that indicate, by their grouping, the division to which the original sponge belonged.

The ease with which the silica of sponge-spicules may go into solution is emphasised in the U. Jurassic beds of Bohemia and Würtemberg, where the sponges preserve their form, but have entirely, or almost entirely, decayed. Calcite has, however, crystallised in the hollows left by the removal of the spicular mesh, and the appearance is that of a complete calcareous sponge. Relics of the original silica may occur; but the character and arrangement of the spicules, and comparison with forms from other localities, serve more fully to convince the palæontologist that a thorough pseudomorphosis has occurred.

A few calcareous sponges, on the other hand, have locally been converted into siliceous pseudomorphs,‡ which adds to the complication. The microscopic study and collation of sponge-spicules has thus become essential, and geologists have reaped the results of the patient labours of the specialists.

In England, Prof. W. J. Sollas and Dr. G. J. Hinde have laid great stress upon the readiness of spicules to dissolve. The solution of such bodies may even be traced in the depths of existing seas. The ends of detached spicules become rounded, the axial canals become enlarged, and it is easy to note all stages of the process of destruction.

Hence the above-named authors have been foremost in urging that, not only did flint accumulate round siliceous sponges, but that the solution of the spicules of these and of other sponges provided the silica which thus accumulated. They see no need for mysterious springs and siliceous infiltrations, the occurrence of which, in association with beds containing sponge-remains, would be in itself a remarkable coincidence. The very absence of spicules from a rock, which otherwise appears to be an oceanic ooze—a rock, in fact, in which spicules should reasonably occur—and the presence of flint instead, is, for Prof. Sollas,§ clear evidence of the origin of the flint.

In 1878, Prof. Sollas‖ wrote: "In compact strata, such as chalk or limestone, it may be taken as an almost invariable rule that the replacement of organic silica by calcite is always accompanied by a subsequent deposition of the silica in some form or other; and thus, if one finds

* "Aus den Alpen"; Letter in *Neues Jahrbuch für Min., &c.*, 1880, Bd. II., p. 287.

† "On Beds of Sponge-remains in the South of England," *Phil. Trans.*, 1885, Part. II., p. 427.

‡ Zittel, "Handbuch der Palæontologie," Bd. I.

§ On the Flint Nodules of the Trimmingham Chalk," *Ann. and Mag. Nat. Hist.*, Ser. 5, Vol. VI. (1880), p. 460.

‖ "On the Structure of the genus *Catagma*," *Ann. and Mag. Nat. Hist.*, Ser. 5, Vol. II., p. 361.

flints, chalcedonized shells, or minute quartz crystals in such strata, one will naturally look for the remains of the siliceous organisms which supplied them, and the search will seldom be unsuccessful."

The same author held that the absence of obvious deposits of silica indicated that the rock originally contained no siliceous fossils; but this point has recently been contested by M. Lucien Cayeux. Dr. G. J. Hinde's* work on the cherts of the Lower Cretaceous strata proved that the spicules of tetractinellid sponges supplied the silica that has cemented certain layers of the sandstones. Hence the abundance of these humble creatures at certain times on the floor of the Cretaceous seas has strengthened the Hythe Beds with sheets of silica, and has been, in all probability, responsible for their enduring qualities. Sponges have thus given us the Leith Hill scarp, the boldest feature in south-eastern England.

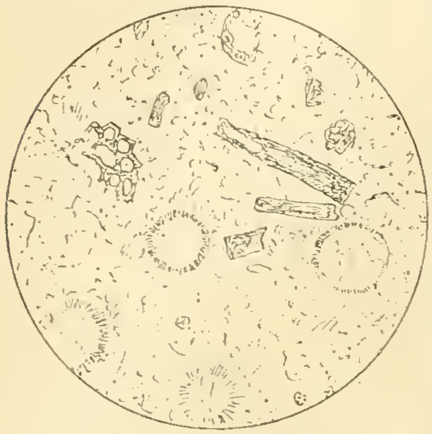


Fig. 1.—Microscopic section of Flint (silicified chalk) from gravel of Ardtun, Isle of Mull. × 100. Traces of sponge-spicules, represented by glauconitic casts of their axial canals; "ghosts" of foraminiferal shells, the interior being filled by clear chalcedony, and the perforations in the shell replaced by tiny rods of glauconite. The glauconitic change doubtless set in in the original chalk, and the siliceous replacement of the calcium carbonate followed.

The fact that Mr. J. T. Young† found that even the freshwater flint of the Purbeck limestone contained spicules of *Spongilla*, a siliceous sponge, placed the sponges, as makers of flint, well in the ascendant. Dr. Hinde‡ showed later that the Carboniferous chert of Ireland gave rise, on its weathered surfaces, to a porous crust consisting of innumerable rod-like sponge-spicules, felted together in the plane of bedding of the rock. All his microscopic sections of these cherts exhibited spicules.

The wide-spread layers of tabular chert and flint, excluding those formed in joints, may be explained by Sollas's§ argument, that many sponges are known to extrude their spicules during life. These become spread out thickly on the sea-floor, and thus each individual sponge does much more in promoting the growth of flint than it could by merely depositing its final skeleton.

In the same paper, Prof. Sollas points out that diatoms and radiolarians must not be forgotten as makers of flint. The warning was, indeed, timely. Continental geologists, notably Dr. Rüst, had begun to describe the beautiful siliceous skeletons of radiolaria from Jurassic formations; and obscurer indications were known to occur even in the Trias. But most of this work dates only from 1879. The well-known Tertiary deposit of Barbados, which supplies the material for dealers in microscopic slides, is loose and incoherent, and has no apparent relationship to flint.

Similarly, the diatomaceous deposits of lakes—the "tripoli" and "kieselguhr" of commerce—were familiar as Tertiary materials, soft and powdery enough. In modern seas, also, especially in the Antarctic Ocean, siliceous oozes, formed of these humble plant-remains, were revealed by successive surveys.

Where, however, were the diatom-beds, freshwater or marine, of older periods? Why, moreover, were radiolaria, practically nowhere beside the host of calcareous fossil protozoa?

Dr. G. J. Hinde,* in 1890, described well preserved radiolaria from chert, occurring among Ordovician rocks in Lanarkshire and other counties in the south of Scotland. This was only the first of a series of papers, and "radiolarian cherts" at present hold the field of interest. Messrs. Hill and Jukes-Browne,† in describing calcite casts of radiolaria from the English chalk, have discussed the instability of the radiolarian skeleton. In fact, vast numbers of the more ancient radiolaria are for ever lost to us. Their remains have been, like those of so many sponges, dissolved and converted into flint.

Similarly, the still more delicate frustules of the diatoms have practically disappeared. Even those described by Mr. W. H. Shrubsole,‡ from the London clay of Sheppey, are converted into discs of iron pyrites. Yet how many flints, particularly those of freshwater formations, may in future be traceable to diatoms?

These three humble groups of organisms, two of them animal, one vegetable, may be regarded, then, as the essential makers of flint. They extract the silica from the sea-water, which derives it mainly in solution from the land; they deposit this as colloid silica in their skeletons; on their death, or, in the case of sponges, on the ejection of their spicules, the silica is slowly picked up again by the water, and ultimately comes out, in the consolidated rock, in the minutely crystalline form, chalcedony or flint. In this form it is proof against long attacks, though its white exterior, and sometimes its crumbling character throughout, show that some solution takes place, and that the unhappy organic skeletons are destined to no certain rest.

Dr. Hinde§ seems to have gone too far in asserting that the Carboniferous chert of Ireland was in no sense a pseudomorph of the limestone. Unless it has actually replaced the limestone, particle by particle, it is hard to account for the occasional ramifications of the chert-masses, and for the crossing of a mass from one bed of limestone to another. Prof. Sollas|| properly insisted that flint may replace all the structures of ordinary chalk—as, indeed, section after section will assure the enquirer with the microscope. The foraminifera, coccoliths, and so forth, and, more rarely, the larger fossils, become completely replaced by the silica as it is redeposited. Similarly, the oolitic structure of some limestones becomes preserved in flint, and may even remain in this form when mineral changes have destroyed it in the actual limestone.¶ The whole position is clearly summarised by Prof. Judd;**

* "Catalogue of Fossil Sponges," British Museum (1883) p. 28.

† "On the Occurrence of a Freshwater Sponge in the Purbeck Limestone," *Geol. Mag.*, 1878, p. 220.

‡ "On the Organic Origin of the Chert in the Carboniferous Limestone Series," *Geol. Mag.*, 1887, p. 443.

§ "A Contribution to the History of Flints," *Sci. Proc. R. Dublin Soc.*, 1888, p. 4. *See* also *Ann. and Mag. Nat. Hist.*, Ser. 5, Vol. VI., p. 450.

* *Ann. and Mag. Nat. Hist.*, July, 1890, p. 40.

† "On the Occurrence of Radiolaria in Chalk," *Quart. Journ. Geol. Soc.*, Vol. LI. (1895), p 600.

‡ *Nature*, Vol. XXI. (1879), p. 132.

§ *Geol. Mag.*, 1887, p. 445.

|| *Ann. and Mag. Nat. Hist.*, Ser. 5, Vol. VI. (1880), p. 447.

¶ *See* "Aids in Practical Geology," ed. 3, p. 204.

** "The Student's Lyell" (1896), p. 255.

and flints in limestone are as fully pseudomorphs as are the massive iron carbonates of Cleveland, or the silicified tree-stems forming at the present day.

Why some deposits contain flints and few traces of siliceous organisms, while others are rich in such organisms and contain no flints, is a question that has been raised, and which is still under discussion. The preservation of spicules may possibly, as Mr. Jukes-Browne* suggests, have been determined by the depth at which the bed was formed, solution going on under pressure in deep-sea deposits before the beds had actually consolidated. M. Lucien Cayeux,† however, leaves the matter very open. He concludes that "calcareous deposits of the same original chemical and organic composition give rise in course of time to three very different beds. The first preserves its silica disseminated throughout the rock; the second becomes an almost pure limestone with abundant flints; the third passes into the condition of a pure limestone without flints."

In the last case, as in the Upper Jurassic of the Mediterranean area, a rock may be full of casts of siliceous sponges and radiolaria, and yet the silica may be entirely withdrawn.

Has it not gone to form flint elsewhere? Even in this indirect fashion, the humble organisms, which are always the most potent, may still be the makers of flint in some other portion of the crust.

* "The Amount of disseminated Silica in Chalk, considered in relation to Flints," *Geol. Mag.*, 1893, p. 545.

† "Etude Micrographique des Terrains Sédimentaires," *Mém. de la Soc. Géol. du Nord*, Tome IV., 2 (1897), p. 443.

A NEW SATELLITE OF SATURN.

NEARLY all the astronomical discoveries made by the aid of photography have related to the fixed stars. In the study of the members of the solar system, the results obtained by the eye are generally better than those derived from a photograph. For many years it has been supposed that photography might be used for the discovery of new satellites, and in April, 1888, a careful study of the vicinity of the outer planets was made by Prof. William H. Pickering. Photographs were taken with the thirteen-inch Boyden telescope, with exposures of about one hour, and images were obtained of all the satellites of Saturn then known, except Mimas, whose light is obscured by that of its primary. It was then shown that Saturn probably had no satellite, as yet undiscovered, revolving in an orbit outside of that of Enceladus, unless it was more than a magnitude fainter than Hyperion. (Forty-third Report, p. 8.)

In planning the Bruce photographic telescope, a search for distant and faint satellites was regarded as an important part of its work, and, accordingly, plates for this purpose were taken at Arequipa, by Dr. Stewart. A careful examination of these plates has been made by Prof. William H. Pickering, and by superposing two of them, A 3228 and A 3233, taken August 16th and 18th, 1898, with exposures of 120^m, a faint object was found which appeared in different positions on the two plates. The same object is shown on two other plates, A 3227 and A 3230, taken August 16th and 17th, 1898, with exposures of 60^m and 122^m respectively. The position is nearly the same on the two plates taken August 16th, but on August 17th it followed this position 33″, and was south 19″, while on August 18th it followed 72″, south 43″. Its motion was direct, and less than that of Saturn, though nearly in the same direction. It cannot, therefore, be an asteroid, but must be either a satellite of Saturn or a more distant outside planet. The proximity of Saturn renders the first supposition much more probable. On August 17th, the position angle from Saturn was 106°, and the distance 1480″. Assuming that it was at elongation, and that its orbit is circular, its period would be four hundred days, or five times that of Iapetus. It was at first identified with a very faint object found on plates taken in 1897, and the period of seventeen months was derived from them. This supposition has not been confirmed.

Measurements of the positions of the images give additional material for determining the form of the orbit. The method of measurement is that described in the Annals, Vol. XXVI., p. 236. The uncorrected positions of the four images referred to the first plate of August 16th as an origin, are for x, 0·0″, +1·2″, +33·6″, and +71·8″; for y, 0·0″, −1·7″, −19·8″, and −42·1″; the corresponding Greenwich mean times are $12^h\ 16^m$, $14^h\ 18^m$, $12^h\ 56^m$, and $13^h\ 12^m$. Correcting for the motion of Saturn, the relative motion with reference to that body is in x, 0·0″, −2·4″, −10·7″, and −22·0″; in y, 0·0″, +0·1″, +2·4″, and +2·9″. It appears from this that the apparent motion is about 10·4″ a day, at a distance of 1480″. A computation shows that if the orbit is circular, the period must be either four thousand two hundred or four hundred and ninety days, according as the satellite is near conjunction or elongation. These values may be greatly altered if the orbit is elliptical. Since the interval of time between the first and last photographs on which the satellite appears is only two days, it is impossible to predict its position with accuracy. It is probable that its position angle from Saturn now lies between 280° and 290°, and its distance between 20′ and 30′. These uncertainties will probably be greatly diminished from measures of plates of Saturn taken in Arequipa on September 15th, 16th, and 17th, 1898, which for some unexplained reason have not yet been received in Cambridge.

The direction of the motion, which is nearly towards Saturn, shows that the apparent orbit is a very elongated ellipse, and that it lies nearly in the plane of the ecliptic. Prof. Asaph Hall has pointed out that this is to be expected in a body so distant from Saturn. The attraction of the latter only slightly exceeds that of the Sun. Hyperion appears as a conspicuous object on all four of the plates, and the new satellite appears about a magnitude and a-half fainter on each. The approximate magnitude is therefore about 15·5. As seen from Saturn, it would appear as a faint star of about the sixth magnitude. Assuming that its reflecting power is the same as that of Titan, its diameter would be about two hundred miles. It will, therefore, be noticed that while it is probably the faintest body yet found in the solar system, it is also the largest discovered since the inner satellites of Uranus in 1851. The last discovery of a satellite of Saturn was made in September, 1848, by Prof. William C. Bond, then Director of this Observatory, and his son, Prof. George P. Bond. The satellite Hyperion was seen by the son on September 16th and 18th, but its true character was first recognized on September 19th, when its position was measured by both father and son (*see* Annals, II., p. 12). Soon after, it was discovered independently by Lassell, at Liverpool.

Prof. William H. Pickering, as the discoverer, suggests that the name Phœbe, a sister of Saturn, be given to the new satellite. Three of the satellites, Tethys, Dione, and Rhea have already been named for Saturn's sisters, and two, Hyperion and Iapetus, for his brothers.

Edward C. Pickering.

April 10th, 1899.

NEBULOUS REGION ROUND THE CLUSTER N. G. C. NO. 2239 MONOCEROTIS.

By ISAAC ROBERTS, D.SC., F.R.S.

THE region to which the annexed photograph refers is comprised between R.A. 6h. 24m. 16s. and R.A. 6h. 29m. 13s., and in declination between 4° 24·8′ and 5° 56·5′ *north.* Scale—one millimetre to twenty-four seconds of arc.

Co-ordinates of the fiducial stars marked with dots for the epoch 1900.

Star	(.)	D.M. No.	1271	Zone	+5°	R.A.	6h. 25m. 30·7s.	Dec. N.	5° 51·7′	Mag. 8·7
,,	(..)	,,	1288	,,	+4°	,,	6h. 25m. 44·7s.	,,	4° 35·2′	,, 8·3
,,	(...)	,,	1302	,,	+5°	,,	6h. 28m. 49·4s.	,,	5° 12·5′	,, 8·3

References to parts of this region have been made by Sir J. Herschel in the G. C. 1420, and by others in the N. G. C. 2237-38-39; also in the *Ast. Nach.*, No. 2918, pp. 253-4, *Astron. and Astro-Physics*, Vol. XIII., p. 178.

The photograph was taken with the twenty-inch reflector, and exposure of 2h. 45m., on 1899, March 5th, and presents the object to us in complete form, and with much detail, so that we may draw inferences, and also pass on to future astronomers' records, of a reliable character, for correlation with others that will be taken in future years, when changes in the structure and positions relatively with the stars can be detected.

The photograph depicts the nebulosity as extending about seventy-seven minutes of arc in *south following* to *north preceding* direction, and about sixty-seven minutes from *north* to *south*, like a cloudy mass broken up into wisps, streamers, and curdling masses—densely dotted with stars all over its surface and over the regions surrounding—many dark areas with and without either stars or nebulosity in them. Other areas have both faint stars and faint nebulosity in them, and they are shown to the faintness of about eighteenth magnitude. Some remarkable black tortuous rifts meander through the nebulosity on the *north preceding* half of the nebula; their margins are sharp and well-defined in the midst of dense nebulosity. They are as cleanly cut as we see the cañons of great rivers, but their width may in reality be millions of miles, for we have no reason to assume that the nebula is nearer to the earth than are the stars. It is indeed possible that the stars which dot the surface are nearer to us than the nebula.

Speculations as to the further development of this nebula (if it be one body and not several) cannot at present add to our existing knowledge, nor can we picture by the imagination what changes in its structure may be developed in, say, a million years; but we have no basis for expecting that more than microscopic changes can be detected in a human lifetime. Let us take these hints for what they are worth. Here is the record made available to all who may desire to exercise their imagination concerning this very large subject.

Letter.

[The Editors do not hold themselves responsible for the opinions or statements of correspondents.]

THE LEGEND OF LOUGH DEREVARAGH.

To the Editors of KNOWLEDGE.

SIRS.—Perhaps some of the fishermen who frequent Lough Derevaragh in West Meath, when the "green drake" is in season, may like to hear the strange old legend attached to its waters, as worded by Sir Henry Piers of Tristernaght, in 1682. "Lake Direvreagh, in the Irish language soundeth 'the lake of a severe or hard judgment,' thus called, I suppose, from the sad exclamation of a poor fellow, of whom the story goes that in a frosty season he attempted to drive a cow he had stolen across the lake, the ice being strong enough, and he in haste, he drove somewhat hard, and the cow chancing to stumble or slide, fell, and in the fall broke one of her legs. Hereupon, not knowing better how to dispose of her, he kills her in the place, and with the help of his companions carries off the hide and flesh. When safe and at rest he found he had forgotten his knife, immediately he returns to the place where the blood and entrails of the cow lay, which by this time had so far thawed the ice, that when he drew near the ice broke under his weight, and falling in, the ice closed again about his neck and cut off his head. The man falling made a hideous outcry—which was heard at a great distance—to this purpose, 'Oh! oh! I have received a sad or severe sentence or judgment.'" Sir Henry Piers also mentions that about Lough Iron and Lough Direvreagh may be found "a small fish without spot, of the shape almost of a herring, a fish very pleasant and delightful, but not taken in large quantities." He tells us it is only found in the mouth of May, and sparingly, and adds, that "the natives call it 'goaske.' I do not know how to English it."

How much of the "Legend of Derevaragh Lake" may be founded on fact is doubtful, but certainly the inhabitants of West Meath possess fertile imaginations and belief in old traditions, as the following "cures" for toothache, which are commonly practised, will show:—"A sufferer seeks for a human skull containing teeth, and pulls out one of these teeth by catching hold of it with his own." Should this operation be properly performed he will never again have toothache! Another superstition is that if a tree has been struck by lightning a piece of the charred wood carried about in the pocket will prevent toothache. But I might multiply such "cures," and will only ask the readers of KNOWLEDGE if the "delightful goaske" fish has ever been discovered in this century, and what it may be?

FRANCES I. BATTERSBY.

Science Notes.

Sir Norman Lockyer has lately been experimenting with flexible film, with the idea of adapting it to spectroscopic photography. The large concave Rowland grating which Sir Norman is now using has twenty thousand lines to the inch ruled on its surface, and is of twenty-one and a half feet radius, giving a spectrum thirty inches long. The focal field of this grating is considerably curved, and it is therefore impossible to get a sharp photograph of the whole spectrum on a glass plate—a difficulty which Sir Norman bridges by the use of a flexible film bent to the curvature of the field. The Kodak Company have sent us a magnificent print of one of the photographs thus taken, and it is without doubt the longest solar spectrum ever photographed at a single operation. It is thirty inches long, and shows the arc spectrum of iron, with a comparison spectrum of the sun from wave-length three thousand six hundred to five thousand two hundred. It is hoped by using these films instead of glass plates at the next solar eclipse a larger number of photographs may be taken than hitherto in any given period of time.

Arrangements are in progress by the British Astronomical Association for the organization of two expeditions to observe the total solar eclipse of May 28th, 1900—the one to Portugal, Spain, and Algiers, the other to the United States. Members and their friends who contemplate

PHOTOGRAPH OF THE NEBULA N.G.C. 2237-9 MONOCEROTIS.

By ISAAC ROBERTS, D.Sc., F.R.S.

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taking part in one or other of these expeditions, should communicate at once with Mr. E. Walter Maunder, director of the European detatchment, or to the Rev. J. M. Bacon, who will have charge of the American party.

Dr. David Gill, her Majesty's distinguished astronomer at the Cape, has been awarded the fifth Watson medal by the American National Academy of Sciences. Rarely indeed has honour been more judiciously bestowed, for Dr. Gill's zeal, assiduity, and the trustworthiness of his work are recognised and appreciated by astronomers the world over.

The *fourth* Annual Congress of the South-Eastern Union of Scientific Societies will be held in the Sir J. Williamson's Mathematical School, Rochester, on May 25th, 26th, and 27th; president, Professor G. S. Boulger, F.L.S., F.G.S. Among many papers that will be read are: "Practical Hints on the Formation and Collection of Coleoptera," by J. J. Walker, R.N., F.L.S.; "The Sun and Eclipses thereof," with special reference to the total eclipse of May 28th, 1900, by G. F. Chambers, F.R.A.S.; and "How to Keep a Botanical Record," by Prof. G. S. Boulger, the president. Various excursions have been arranged, headed by specialists.

British Ornithological Notes.

Conducted by Harry F. Witherby, F.Z.S., M.B.O.U.

Sandgrouse in Lincolnshire.—In the great invasion of Sandgrouse (*Syrrhaptes paradoxus*), in 1888, the first occurrence for Lincolnshire was recorded by me at the time (*Zool.* 88, p. 420), on May 18th, in a parish on the north wolds. There they appear to have continued for some weeks, and several were shot, one of which I got. It is a very remarkable fact that once again these erratic wanderers from Asian steppes have this year appeared, not only in the same parish, but the same field (twenty-five acres of sandy land, recently laid down to permanent pasture, as being too poor to cultivate). These Sandgrouse, about thirty, were first seen by the rabbiter in the last week of January, the same man whose son shot five in 1888; subsequently, by several competent observers in the neighbourhood, some of whom, by previous experience, had become well acquainted with the birds. The locality is lonely and retired, and it says much for those who from time to time saw them that they were never shot at or otherwise disturbed on this or on the adjoining farm. They did not always keep in one flock, but separated into parties, and frequently took a flight of about a mile to two large fields of wheat in the low country, and on being flushed, returned to the same field on the wold. In fact, this locality seems to have offered special attractions, and it was here I got the feathers from one of their dusting-places. During the arctic weather in March they became much tamer; the shepherd on the next farm told me he got so near them that he could see their "little woolly feet,"—and he knew them well, having had one given him in 1888. He also said that they followed each other like partridges, but "wobbled" a good bit when running in the snow. They finally and altogether disappeared about March 23rd, at the break up of the storm. I have since been informed a supposed flight of Sandgrouse were seen on Flamborough Head in March.—John Cordeaux, Great Cotes House, R.S.O., Lincoln, May 13th, 1899.

The Rook as an Egg-Stealer.—The Mistle Thrushes, the operations of which I described in the March, 1898, number of Knowledge, have built in the same spot, within a few yards of my window, again this year. For the last week the birds have been sitting, and I have watched with much interest the sitting bird being fed by its mate. This morning, when both birds had left the nest for a few minutes, a Rook happened to settle in the tree. He immediately saw the nest and hopped on to a bough near it. Here he waited for a moment and looked all round him. Seeing nothing to be afraid of, I suppose, he hopped down to the nest, and taking out an egg jumped to another bough and swallowed the egg whole. After another careful look round, the Rook returned to the nest and made a dig into it with his beak, but in his hurry clumsily pulled out some of the lining of the nest instead of an egg. The accident apparently hid the eggs, because he now began to hastily pull the lining out and put it under his foot. From this an egg dropped to the ground. The Rook saw the egg drop, and instead of pulling out more lining, probed about with his beak and eventually found another egg, which was at once swallowed. Just then, both Mistle Thrushes returned, and seeing the Rook, raised their harsh war cry and flew at him furiously. But before they could reach him, the Rook had left the nest and retired to the thickest part of the tree. The Thrushes continued to swoop at him, and one of them flew so fiercely that it hit a bough and knocked a bunch of feathers out of its own breast. The Rook made no attempt to fight, but gradually edging to the outside of the tree suddenly darted into the open, pursued and tormented by the Mistle Thrushes until out of sight. Half-an-hour afterwards, the Mistle Thrushes were feeding peacefully upon the lawn, but their nest is deserted.—Harry F. Witherby, March 25th, 1899.

Arrival of Swallow.—Last year I was able to report to you that I had seen my first Swallow on March 14th, which was the earliest of all in my records, this year I saw my first on March 29th. This is fairly early considering the bitter weather of a week since, when there were fifteen degrees of frost.—E. Sillence, Church Street, Romsey, 30th March, 1899.

Mistle Thrush swallowing Droppings of Young.—I am fortunate in being able to confirm Mr. Witherby's most interesting account of the extraordinary sanitation of the Mistle Thrush's nest, given in the March (1898) number, so far as a very brief observation goes. Yesterday (May 6th), the last young Mistle Thrush left a nest which is built in the fork of a beech tree five feet from the ground, and twelve paces from my study window; with a pair of field glasses I have an excellent view down into the nest. Unfortunately, I only discovered the nest one day before the last bird left, but what I saw corresponds exactly with Mr. Witherby's account. The parent bird came to the edge of the nest, fed the two young ones, waited a moment, then one of the two nestlings raised the hinder part of the body towards the parent who stood above it, and, leaning over it, when the dropping was extruded the parent bird seized it *in situ*, and promptly swallowed it; that the dropping was large may be inferred from the fact that the birds were just leaving the nest. The young birds were too well feathered to require covering for a quarter of an hour, as in Mr. Witherby's observation, and the parent bird flew away almost at once, but there was no possibility of mistaking that the fœx was really swallowed down, nor did I see any sign of disgorging. Whilst two birds were in the nest a dropping was swallowed at every visit; when only one was left I saw the parent bird leave the nest on two occasions without one, but that, of course, is easily accounted for. Every time I saw a dropping taken it was swallowed, not the largest even were taken in the beak only and dropped away from the nest.—Arthur East, Southleigh Vicarage, Witney, Oxon.

Levantine Shearwater (*Puffinus yelkouanus) near Scarborough* (*Ibis*, April, 1899, p. 308). At the meeting of the British Ornithologists' Club, held on February 27th, 1899, Mr. Howard Saunders exhibited a male example of the Levantine Shearwater, shot by a wild fowler near Scarborough on February 5th. This is, we believe, but the third example of this Shearwater which has been recorded for the British Islands. The bird is an inhabitant of the Mediterranean and Black Seas.

Spotted Sandpiper (Tringoides macularius) in Ireland (Ibis, April, 1899, p. 314). There are many records of this American Sandpiper having visited our Islands, but few, if any, have been properly authenticated. Mr. F. Curtis exhibited, at the February meeting of the British Ornithologists' Club, a female specimen which had been shot on February 2nd, 1899, at Finea, Co. Longford, Ireland, by Mr. Frank Roberts.

Red Grouse and Bantam Fowl Hybrid (Ibis, April, 1899, p. 314). A remarkable hybrid between a male Red Grouse and a female Bantam Fowl was exhibited by Mr. J. G. Millais at the meeting of the British Ornithologists' Club on February 27th, 1899.

Cranes in Norfolk (*Zoologist*, March 15th, 1889, p. 119).—In his interesting "Ornithological Record from Norfolk," which Mr. J. H. Gurney annually contributes to the *Zoologist*, a record is given of four Cranes (*Grus communis*) having been seen by Mr. Pashley near the Gaven on April 7th, 1898. They were next reported as visiting a piece of water near the sea at Weybourne, and were subsequently seen at Runton, after which they took their departure, happily unmolested. Three hundred years ago the Crane used to breed in the fens of the east coasts, but now these birds pay us but the briefest and most occasional visits.

Lesser Whitethroat in the Outer Hebrides (*Annals of Scottish Natural History*, April, 1899, p. 109).—Mr. W. Eagle Clarke records that Mr. W. L. Macgillivray obtained a specimen of this bird on the west side of the remote Island of Barra, on October 24th, 1898. *Sylvia curruca* is a rare bird in Scotland, and has not hitherto, apparently, been obtained in the Outer Hebrides.

King Eider (*Somateria spectabilis*) *in the Shetland Islands* (*Annals of Scottish Natural History*, April, 1899, p. 111, and *The Field*, April 8th, 1899).—A male specimen of this beautiful and very rare visitor from the far north was obtained by Mr. Eustace Blankart, of Sandness, on the west side of Shetland, in Vaila Sound, on February 24th, 1899.

All contributions to the column, either in the way of notes or photographs, should be forwarded to* HARRY F. WITHERBY, *at 1, Eliot Place, Blackheath, Kent.

Notices of Books.

The Life Story of Sir Charles Tilston Bright. By Edward and Charles Bright. 2 vols. (Constable.) Illustrated. £3 3s. net. Your mere reviewer of books stands appalled at this—it is at once so good and so bad! There is too much of it, and there is too little of it. Under no circumstances must it be lightly approached as a biography, for it is a vast deal more. While between its covers one finds the life-story of a man who was at once a genius and a "strong man," so also does one find a very complete history of the pioneer cables of the world. Nor is this all. Would you read technical detail of the manufacture, the laying, and the working of cables? Here you shall find it. Would you read of the customs of the Far East and the Far West? Then take this book. Are you interested in the flora and fauna by land and by sea? Again, this book. But, alas! the arrangement, or want of arrangement, throughout is bad, and one finds much needless repetition and very many stupid misprints. Yet through it all the strong personality of the man, his quaint humour, his calm patience, and his fierce determination are ever with us? To give one striking instance of each of these traits, Sir Charles was, upon one occasion, approached by an old schoolfellow of whom he had lost sight for a number of years, and on this unexpected meeting quite failed to recognise him. The latter recalled himself to Bright by remarking that they had been interrupted in a fight at school. And Sir Charles mildly suggested, "Let's finish it now." As to his patience, we may suggest his remark, "I don't say that we shall do it now, but we shall do it some time"—and this after more than one failure to lay the first Atlantic cable. And, as regards determination, what are we to say of the man who quietly suggested that he was in a position to "take" Arecibo if his operations there should be interfered with, or of the man who worked on while his staff were daily dying of fever—worked on, indeed, till he had actually to be carried aboard a ship bound for home, and even then left his work with great reluctance. It is interesting to note that this same energy of his led him into at least one curious little error. Quite early in the book we read of his having been bothered by a would-be inventor, who argued that the cable would not even sink to the bottom of the Atlantic, but must rather be held suspended at a certain depth by the great density of the water there. Sir Charles stated that this was absurd, since he had specimens of shells, etc., from the bottom of that same ocean. Now this was surely no argument to offer his opponent, since the latter, to be consistent, must surely urge that the *bottom itself was held in suspension*. Indeed, of the book in its entirety one hardly knows how to speak. It is certainly good enough to make us wish it were a vast deal better. The main fault probably lies in that we have some four books rolled into one, and of these four each *per se* would be good; but the tangle by no means brings out the merits of any one of them. The composite result is a record of very many useful and interesting facts, the collection of which must have entailed a vast deal of labour. Yet the interest and the use of the book are constantly tumbling one on top of the other, so that both are, to the reader who has not much time to spare, less easily accessible than they should be.

An Elementary Text Book of Botany. By Sydney H. Vines, M.A., D.SC., F.R.S. (Swan Sonnenschein.) 9s. The production of a satisfactory text book of botany becomes a more and more arduous task in proportion as the wealth of material increases, from which a selection has to be made. Prof. Vines dealt with this mass of detail in an admirable, if somewhat encyclopœdic manner, in his well-known Students' Text Book. But experience has shown the necessity of further subdivision and the preparation of a book mainly addressed to beginners. The present volume occupies a position midway between the Student's Text Book and Prantl's Lehrbuch der Botanik, on which the former was founded. But Prof. Vines has not only reduced the bulk of his book; the contents have been revised, and many topics that are still under examination have been excluded. We think this principle of exclusion might have been carried still further. We are, however, grateful that the subject of nuclear subdivision is treated very shortly—centrospheres and centrosomes, whatever part they play, or are supposed to play in the process of nuclear division, do not appear in the text—but the omission of some other matters where our knowledge is not yet sufficiently precise might be recommended. For reasons of clearness and convenience the book is divided into four parts—Morphology, Anatomy and Histology, Physiology, and Classification, but the student is wisely advised not to read each part separately and consecutively, but to maintain a parallel study in each. In the last section we notice that though Algæ and Fungi are united in the one group Thallophyta; the Mosses and Ferns are not similarly connected under the common division of Archegoniatœ.

Kant on Education. Translated into English by Annette Churton. With an Introduction by Mrs. Rhys Davids. (Kegan Paul & Co.) 2s. 6d. This little book presents to English readers, for the first time, the admirable and suggestive "Thoughts on Education," which Kant prepared for his professorial courses, and which were originally published in Germany (*Immanuel Kant über Pädagogik*) nearly a hundred years ago. The book is furnished with an excellent introduction, in which Mrs. Rhys Davids traces the influence of Rousseau on the mind of the master, and bespeaks for his work the consideration of educators in our own day. "There is much in these lecture-notes worthy to be considered by educators for many a generation to come. Now and again the hand of the writer is on the pulse of the future. Always he is earnest, wise, and sane."

Volcanoes: Their Structure and Significance. By T. G. Bonney, D.SC., LL.D., F.R.S. (Murray.) 6s. The object of this work is well expressed in the title, and the result is to give us one of the most readable, and from the eminence of the author, one of the most instructive books on a series of phenomena whose complete explanation is not yet forthcoming. By picturesque and vivid language Prof. Bonney conducts his readers over historic and interesting ground where volcanoes have been and are in active operation. He calls up the picture that these volcanoes have presented when belching forth their varied contents, by means of descriptions given by eye witnesses, and makes us realize the gigantic forces that must be at work to produce so magnificent a result. He takes us into the laboratory and examines and classifies for us the dust and fragments of the sedimentary or metamorphic or crystalline rocks that have been ejected from the open fissures. The stalactites of lava and the columnar or basaltic joining that are here and there met with are passed under review before the author conducts us into that instructive theatre of extinct volcanoes which the district of Auvergne has preserved for our study and delight. A chapter is given on the history of British volcanoes, the author drawing from and recognizing the admirable treasury of information compiled by Sir A. Geikie. It might seem that the number of facts collected and discussed would be sufficient to afford a complete theory of vulcanicity. Professor Bonney, however, regrets his inability to put forward any completely satisfactory hypothesis. Either some links in the chain of evidence still remain to be discovered, or the relations of those which we know have not yet been fully understood. We can affirm a fact more easily than we can offer an explanation. Admitting that a volcanic eruption is due to the upheaval of more or less explosive material at a high temperature, there still remains to be answered the apparently simple question—What causes the high temperature? Some may think that this question admits of an easy answer, but Prof. Bonney considers both the mechanical and the chemical theories that have been advanced, and finds both deficient.

Laboratory Manual on Astronomy. By Mary E. Byrd, B.A. 1899. (Ginn & Co., Boston, U.S.A.) The astronomy of to-day may be said to have specialized itself into two distinct forms. There is the astronomy of theory and of mathematics, and there is the practical astronomy of observation. Both are good in their kind; but it is to the former that the attention of our schools and colleges is almost exclusively directed, though it must be admitted that the latter is much more potent as a means of training and developing the intellect. It has always been assumed that large and complicated instruments are necessary for the practical working of astronomy, and, as a matter of fact, it is much less trouble to confine oneself to text-books. Miss Byrd's book, therefore, forms quite a new departure in astronomical manuals, and as a guide to the training of beginners in the actual, practical, out-of-door, study of the science, it deserves the highest praise. Apart from the intrinsic value of the manual, Miss Byrd's book will do good service if it persuades our teachers that the study of astronomy should begin with naked-eye observation, and that complicated and well-finished instruments are a hindrance rather than a help to the training of the beginner, where he or she could otherwise be induced to make the elemental instrument necessary to the observation. Though "no inroad has been made into the province of the regular text-book," there are two appendices which we would recommend to the study of observers. The first is by a leading authority—Prof. Arthur Searle—on "The Zodiacal Light," and the second on "Moonrise," by Prof. E. Frisby. We think that the students of Smith College are much to be congratulated in the possession of such an instructor and director of the observatory as we would judge Miss Byrd to be.

Photo-Micrography. By Edmund J. Spitta, L.R.C.P., M.R.C.S., F.R.A.S. (The Scientific Press.) 12s. This is one of the best books on photo-micrography that has yet come before our notice. Most of the volumes on the subject that have been issued of late years are little better than treatises on the technique of photographic processes, with an occasional chapter on photo-micrography culled from papers already published in the proceedings of the Microscopical and other societies. We are therefore glad to welcome a work like this, which devotes itself to its subject, and which is, at once, both original and practical. Every page offers evidence of extensive knowledge of minute detail and wide research, such as could only be shown by one who had a practical acquaintance with the difficulties that are to be met with in laboratory practice. The author treats of his subject under four heads, viz., illuminants, low power work, medium power work, and high power or critical work. The book, as a whole, is so good and so admirably arranged that one regrets to see that occasion is offered for criticism of any kind. The question of illuminants, which is treated of in Chapter I., does not, however, receive that attention that it merits. To dismiss so important a part of the subject with a brief dissertation of nine pages is, in our opinion, a defect which the author would do well to attend to in future editions. One result is that much has been omitted that might have been included with advantage. For example, magnesium ribbon, and the use of minute platinum wire loops with a Bunsen flame, rank among the best illuminants that the operator can use for low power and for medium power work. The author evidently has a *penchant* for lime-light, and, therefore, all other illuminants that do not, in his opinion, lend themselves for critical high power manipulations (a class of work which the majority of students have neither the means nor the opportunities of practising) are either accorded but scant attention or are ignored. Four chapters are devoted to the technique of low, medium, and high power work, and it is in these that Dr. Spitta best shows his grip of the subject. They teem with useful practical hints, and no one, whether a beginner or an advanced worker, can peruse these chapters without adding considerably to his knowledge. We have our doubts whether the author does not lay too much stress on the necessity of working only with the best, and therefore the most expensive apparatus. One of the greatest deterrents to the popularizing of photo-micrography among students has been the idea that good work can be done only with apparatus possessing the most expensive refinements in the way of mechanical adjustments to stages, condensers, lamps and objectives. For the few who do critical, high power work, these are essential, but not so for the majority for whom this book is intended, and who seldom soar above good medium power work. The two chapters on the microscope lenses, eye-pieces, and condensers are not, however, without considerable value, and, like the rest of this admirable work, they will well repay a careful perusal. The book is admirably printed and is profusely illustrated with sixty-three text illustrations and forty-one exquisite half-tone reproductions of the author's own photo-micrographs.

The Sound of a Voice that is Still. By Archie Campbell. (George Redway.) 5s. Accepting the good faith of the writer of this book, which his preface forbids us to doubt, we could wish that the voice in question had remained still until its owner had been able to make himself more familiar with his subject, or to adduce some new fact or fresh incident in his relations with the unseen universe. As it is, the book is of the earth earthy, the manner is almost brutal in its matter-of-fact directness, and its characters are of the most commonplace order. The introduction into such a circle of some spirits of the great departed is altogether too thin, and can only make the reader very tired of the Laird of Auchenoullen.

Journal of the Society of Comparative Legislation. Edited for the Society by John Macdonell and Edward Manson. (John Murray.) 5s. This is the first part of a new series, and contains a number of valuable articles, together with a review of the legislation of the Empire for 1897, with an introduction by Sir Courtenay Ilbert. A very useful article is contributed by Mr. Edward Manson, the Secretary of the Society, on "The Status of English Trading Companies Abroad."

BOOKS RECEIVED.

Annual Report of the Board of Regents—Smithsonian Institution, to July, 1897.

Gilbert White's The Natural History of Selborne. Parts I., II., III., and IV. Edited by Grant Allen. (John Lane.) Illustrated.

Technical Education Returns (England, Wales and Ireland), 29th July, 1898. (Eyre & Spottiswoode.) 1s. 3d.

Thornton-Pickard Album of Prize Pictures. (Dawbarn & Ward.)

Phenomena of Nature as seen from the Workshop and the Field. Part II. By James Walker. (Sonnenschein.) 2s. 6d.

A Manual of Library Cataloguing. By J. Henry Quinn. (Library Supply Co.) 5s. net.

The Naval Pioneers of Australia. By Louis Becke and Walter Jeffery. (Murray.) Illustrated. 7s. 6d.

The Hygiene of the Mouth. By R. Denison Pedley. (J. P. Segg & Co.) Illustrated. 2s. 6d.

Current Papers, No. 3. By H. C. Russell, F.R.S. With plates. (Read before the Royal Society of New South Wales.)

Applied Geology. Part II. By J. V. Elsden, B.Sc. (Quarry Publishing Co.) Illustrated.

The International Directory of Booksellers and Bibliophile's Manual, 1899. (Aldine Press: Rochdale.) 6s.

Energy and Heat. By John Roger. (Spon.) Illustrated. 2s.

Telephones: their Construction and Fitting. Fifth Edition. By F. C. Allsop. (Spon.) Illustrated. 3s. 6d.

The Entropy Diagram. By J. Boulvin. (Spon.) 5s.

Text-book of Practical Solid Geometry. By E. H. de V. Atkinson. (Spon.) 7s. 6d.

Under the Searchlight. By Agnes Weston. (Royal Sailors' Rest, Portsmouth.)

Catalogue Général des Livres de Sciences. J. B. Baillière et Fils, Paris.)

Scientia: Exposé et développement des questions scientifiques à l'ordre du jour. (Georges Carré and C. Naud, Editeurs, Paris.)

A Message to Garcia. By Elbert Hubbard. (George H. Daniels, New York.)

Sewage-Analysis. By J. Alfred Wanklyn and William John Cooper. (Kegan Paul & Co.) 5s.

Man: Past and Present. By A. H. Keane. (C. J. Clay & Sons.) 12s.

Old Clocks and Watches and their Makers. By F. J. Britten. (B. T. Batsford.)

Obituary.

On April 20th, at his studio near Primrose Hill, at the ripe age of seventy-nine, died Joseph Wolf—animal painter. A painter who produced the most beautiful and life-like pictures of animals and birds that have ever been seen, who was characterized by Landseer himself as "without exception the best all-round animal painter that ever lived," Wolf was, nevertheless, quite unknown to the public, and little known to picture lovers. Born on 21st of January, 1820, in the little village of Möerz, near Coblenz, the son of a farmer, Wolf showed at a very early age an extraordinary love for Nature, and that faculty for close observation which enabled him in after years to make live for ever on paper or canvas the animals and birds he loved. His first artistic efforts were paper silhouettes cut out with a pair of scissors. But he soon took to a pencil and a brush, and notwithstanding the greatest possible discouragements from his parents, by the light of his own genius, and the force of his own character, he taught himself to draw, and eventually, at the age of sixteen, won his father's consent to be apprenticed to a lithographer at Coblenz. Three years of the dull routine of a lithographic draughtsman's office, which would destroy all originality in most, left him uninjured—indeed this training in exactness and minutiæ stood him in good stead in after life. After a year at home, he journeyed to Frankfort and Darmstadt with some miniatures of birds and beasts. These were shown to the zoologists, Dr. Rüppell and Dr. Kaup, who recognised his extraordinary talent and first introduced him to the world as an animal artist. From that time onwards Wolf's career was assured. For eight years or so he worked extremely hard on the Continent, illustrating many scientific works, as well as going through the drudgery of an art school. At the age of twenty-eight Wolf came to London, where his first commission was to complete the illustrations for Mr. G. R. Gray's standard book on the "Genera of Birds." It is of course impossible to enumerate here a tithe of the enormous number of works—scientific and popular—which were illustrated or partly illustrated by Wolf. Amongst the chief we may mention the "Proceedings" and the "Transactions" of the Zoological Society of London, the "Ibis," Andersson's "Lake N'Gami" (1856), James' "Æsop's Fables" (1858), Wood's "Illustrated Natural History" (1859), "Zoological Sketches by Joseph Wolf" (1861 and 1887), Stevenson's "Birds of Norfolk" (1866), Elliot's Monographs (1872—1873—1883), Gould's "Birds of Great Britain" (1873), and "Birds of Asia" (1883), Dresser's "Birds of Europe" (1879), Brehm's "Thierleben" (1876), "Big Game Shooting," Badminton Library (1895). Those who knew Wolf deplore his loss, not only as a consummate artist and accomplished naturalist, but as a kind and generous friend, unmercenary, a man of noble character, a hater of all that is false and a lover of all that is true. We would refer those who wish for a full account of Wolf's life and work to Mr. A. H. Palmer's "Life of Joseph Wolf," published in 1895 by Messrs. Longmans.

WIRELESS TELEGRAPHY.

A MODEST genius, James Bowman Lindsay, who lacked the art of self-advertisement, first discovered wireless telegraphy, and fully appreciated the possibilities of the invention, but he was unable to secure sufficient public attention to carry his idea into the domain of practical utility. He conceived the project in 1831, nearly three-quarters of a century ago, and in 1857 he transmitted messages across the Earl Grey Dock without the aid of wires; while, later on, he made calculations tending to show that by selecting two stations in Britain—one in Scotland and one in Cornwall—and two corresponding stations in America, it would be possible to send messages across the ocean without the intervention of a cable. According to Tesla, a German electrician, some years ago, also sent messages over a space of about thirty-six miles without the use of wires. Moreover, a passage in the *Spectator* (No. 241, 1711) has an interesting bearing on this subject; it reads thus:—"Strada, in one of his prolusions, gives an account of a chimerical correspondence between two friends by the help of a certain loadstone, which had such virtue in it that if it touched two several needles, when one of the needles so touched began to move, the other, though at never so great a distance, moved at the same time and in the same manner. . . . . By this means they talked together across a whole continent, and conveyed their thoughts to one another in an instant over cities or mountains, seas or deserts."

To Hertz belongs the distinction of having discovered the electric waves, and by his experiments he proved that electricity in its progress through space follows the laws of optics, but, so far, no one has obtained such practical results with these Hertzian waves at anything approaching the distance as Signor Marconi. Fog, or even the most solid substance, has no effect on the waves; they can penetrate walls or rocks without being materially affected, but in the case of large metallic bodies intercepting the path of the rays there remains some slight difficulty to overcome. These ether waves, as Prof. Fleming calls them, travel through space with the velocity of light, about one hundred and eighty-six thousand miles a second, and when they impinge on the receiving apparatus at a distant station they excite a sympathetic current, something after the fashion of a violin or piano, the strings of which respond to sounds of the same wave-length. As to how far Signor Marconi's system is an invention and how much a development, the words of Mr. W. H. Preece are to the point. He says: "Mr. Marconi has invented a new relay, which, for sensitiveness and delicacy, exceeds all known electrical apparatus . . . he has not invented any new rays, his transmitter is comparatively old, his receiver is based on Branly's coherer. Columbus did not invent the egg, but he showed how to make it stand on its end, and Marconi has produced from known means a new electric eye more delicate than any known electrical instrument, and a new system of telegraphy that will reach places hitherto inaccessible." Indeed, many workers have devoted their time and skill in the laboratory to the perfecting of the details, so to speak, of the new scientific machine which Signor Marconi has forged from their materials as a new weapon competent to in some measure annihilate time and distance, which form such formidable barriers to the world's progress. A vast gulf separates laboratory experiments from practical large scale demonstrations conducted with all that regularity and freedom from failure which constitute the imperative condition in order to be of public utility.

In 1866, Mr. S. A. Varley discovered that certain metals in powder cohere together when electrified wires act upon them, a subject which was further developed by Mr. E. Branly in 1890. Marconi produces his ether waves by electric sparks passing between four brass balls, a device of Prof. Righi, following up the classic researches of Heinrich Hertz. A thin layer of nickel and silver dust, mixed with a trace of mercury, is placed between two knobs or electrodes fused into a glass tube. Ether waves from a distant station cause this metallic dust to cohere and so convert it into a conductor of the electric current, which is conveyed to a Morse receiver, and so marks the signals in ink on a travelling slip of paper. A hammer, worked by an electro-magnet, is arranged so as to tap the tube in order to shake loose the metallic dust and so break the current between each stroke of the recording pen. Metal conductors are so disposed in the instrument as to admit of adjustment in order that only ether waves of a certain kind may pass through. By this means a single transmitter can work a number of receivers, provided they are tuned by adjusting the conductor, as a tuning-fork resounds to a certain note.

For communicating over thirty, or even a hundred miles, the entire outfit does not exceed more than one hundred pounds in all, and, apart from the high flagstaff, the whole apparatus can be arranged on a small kitchen table.

Marconi's new instrument can be fixed upon a vessel and influenced from a transmitting station on shore. A ship fitted with a receiver may have an electric bell inside it, which can be revolved so that only when pointing in the direction of the transmitting station will the ether waves operate on the bell. Thus, a ship in a fog will be able to ascertain its bearings as accurately as with the compass. For war purposes, the apparatus can be installed snugly in the middle of the ship, out of reach of the enemy, and, unlike flags, semaphores, or lamps, unseen by the foe. It has been shown that, by means of parabolic reflectors, the rays can be projected in any desired direction, and received by a similar reflector, a feat which has been accomplished by Marconi up to a distance of some two and a half miles; although the instrument fails to act if it is more than a certain distance to the right or left of the centre line of the beam, this part of the problem presents a promising field for further investigation.

Already successful installations of wireless telegraphy have been worked between Alum Bay and Bournemouth, fourteen miles; Poole and Bournemouth, eighteen miles; signals have been regularly exchanged, and the experience of fourteen months has proved that no kind of weather in England could stop the working of the apparatus. Last autumn an installation between the Royal Yacht "Osborne," and Osborne House, during the Prince of Wales' illness, showed that as the yacht moved about in various portions of the waters round the Isle of Wight, there need be no doubt as to the possibility of telegraphing across long stretches of land. The system has been in operation since December between the South Foreland and the East Goodwin Lightship, a distance of twelve miles, and during the past month France and England have been successfully connected. The English station is at the South Foreland Lighthouse, near Dover, and that of the French at Wimereux, near Boulogne; messages were passed backwards and forwards with the greatest ease, and the experiments open up boundless possibilities for the application of wireless telegraphy in the everyday business of life.

It is to the employment of the vertical conductor that Marconi attributes his success. A length of 150 feet of copper wire is run up a flagstaff to draw its message out of space, and print down in dot and dash on the paper tape the intelligence ferried across thirty miles of water by the mysterious ether. Up to certain limits the distance to which signals can be sent varies as the square of the height of the flagstaff. A wire, twenty feet high, carries a signal one mile; forty feet high, four miles; eighty feet, sixteen miles; one-hundred and sixty feet, sixty-four miles; and so on. The speed at which messages can be sent is equal to that of the cable, from twelve to eighteen words a minute. A remarkable circumstance is that simply by the appearance of the dots and dashes recorded on the tape, Marconi can tell which of the three operators at Boulogne is transmitting a message, brought about by a difference in the touch. "There is a distinctive handwriting about it."

Sanguine as some are for the future of Marconi's system, many eminent scientific men see nothing in it; indeed, the new acquisition is passing through the usual ordeal which all great innovations have to endure. About seventy millions of telegraphic messages are sent annually in this country, while telephonic messages have reached not less than four-hundred and fifty millions, but no one believed such a result would ensue when the telephone system was launched. Whatever may be the future of the system, the late demonstrations inspire much hope for the speedy development of another great scheme of international communication. J. M.

THE KARKINOKOSM, OR WORLD OF CRUSTACEA.—IX.

By the Rev. Thomas R. R. Stebbing, M.A., F.R.S., F.L.S., F.Z.S., *Author of "A History of Crustacea," "The Naturalist of Cumbrae," "Report on the Amphipoda collected by H.M.S. 'Challenger,'" etc.*

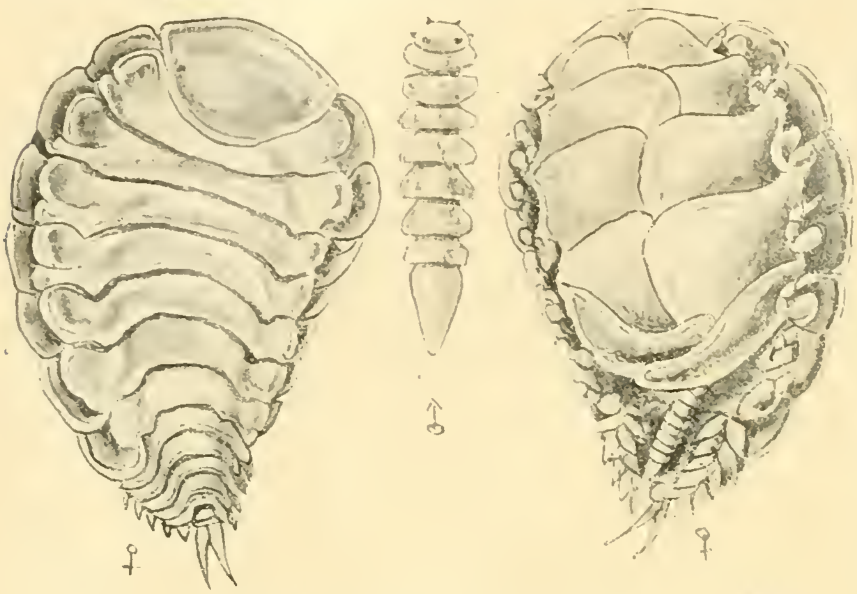
LA DIGNITÉ DU CHEZ-SOI.

The ancient Egyptians were a wise and understanding people. But the system they adopted of mummifying themselves and their cats only showed an amiable weakness. It was a vain attempt at thwarting that law of existence which calls upon every conscientious vegetable and animal to live and let live, or, in other words, to eat and be eaten. Like all other creatures, the crustaceans are anxious to prolong to the utmost limits the first part of this alternative. Hence, though they don't care for embalming, they have been driven to evolve or invent resources of shelter and seclusion, that might otherwise seem unnecessary for beings free to range or to repose in the soft and roomy bosom of the ocean.

Houses and clothes are not, like food, an original necessity of animal life. They are an acquired taste, the beginnings of luxury and civilization. Probably they were adopted by man in the guise of fortress and armour before they became the costly ministers of his comfort and vanity. But, however the desire for a domicile may have arisen among ourselves, the construction and use of a homestead are no exclusive triumphs of human intelligence, although the fettering of freedom thereby entailed, the rates and taxes, the overcrowding and the drainage, may be all our own.

It must not be expected that marine invertebrates will show any great advances in architectural skill. Of crustaceans it may be said, that, whatever else their dwellings are designed for, they are never designed for display. But, simple as each dwelling viewed by itself may be, when considered in the mass these habitations show no inconsiderable variety of structure and material and position.

In the history of evolution a very odd question arises in regard to this matter. At the first thought it might seem childish to ask whether the crustacean made the dwelling or the dwelling made the crustacean. But there are instances in which we know for certain that the occupant did not make its house, and yet is so curiously adapted to it that we may speak without extravagance of the house having made its occupant. By making is not intended original creation, but that modifying which gives the creature its place in classification. Take, for example, the isopod *Bopyrus*, of which the female brings into the world her numerous offspring while ensconced on one side of a prawn beneath the carapace. Or study, in Sars' "Crustacea of Norway," the *Pleurocrypta marginata*, a similar animal similarly situated in a *Galathea*. Notice in either case the rows of little dumpy ineffective legs. Notice what an awkward, one-sided twist the body has. Yet many of their relatives have legs large and long, and capable of making good play; many of their relatives are perfectly symmetrical, and so are their own small insignificant husbands. But the mothers, in that lying-in home which they have borrowed from prawn or *Galathea*, close to the branchial chamber of the host, where the supply of wholesome water for their young is always turned on, are no longer in need of wandering feet. As for their figure, since they cannot make the lodging exactly fit it, they let their figure be canted to fit the lodging.



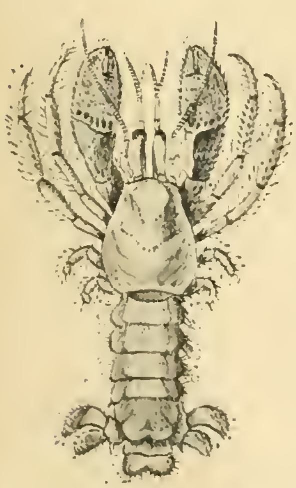
Pleurocrypta marginata Sars. Female in Dorsal and Ventral View; Male on Breathing-plates of Female; and also detached.

Still more striking examples are afforded by the hermit crabs. The name, *Pagúrus*, under which Fabricius grouped them rather more than a century ago, is a Greek word which has been variously explained and variously applied; but, if we take it to mean, as it very well may, the Fixing Tail, it will be found highly appropriate to the characteristic members of this group. Everyone knows the general appearance of one of these hermits, a sort of cross between a deformed crayfish and a periwinkle. Its usual abode is the shell of some univalve mollusc. This it occupies either as an abandoned tenement, free to the first comer, or by picking out the original occupant, or else by right of conquest over some other hermit. At the approach of danger or inquisitorial notice, a suspiciousness, bred perhaps of its own want of scruple, bids the hermit retire quite out of sight into the recesses of the shell. At other times it freely protrudes its front, with the stalked eyes and antennæ, the large claws, and the tips of the two long pairs of walking legs. Often, as in so many other crustaceans, the claws are unequal, some species being commonly, so to speak, left-handed and others right-handed. The business of the larger claw is not only to repel the foe and seize the prey, but also to bar the entrance, the massive hand and finger themselves forming a tightly fitting and efficient door, and sometimes a very handsome one. In *Pagurus granulatus*, the great West Indian hermit, the granulation to which the specific name is due gives the large claws an appearance of being closely studded with jewels. The next two pairs of legs, which are long and slender, enable these animals to walk with agility, with their houses on their backs, not only

Pagúrus arrosor (Herbst). From Savigny.

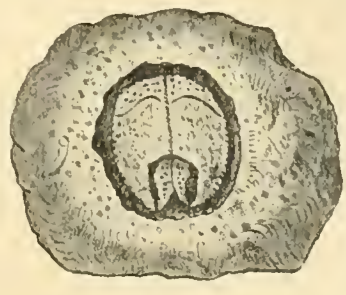
under water, where the weight would be less appreciable, but in the open air on the sea-shore, and in the case of some species to great heights and distances inland. In ordinary crabs the two remaining pairs of trunk legs take their share in the walking, running or swimming movements for which many crabs are exceptionally well endowed. But in the hermits the two pairs in question are so abruptly shorter than their predecessors, and are so placed that they cannot co-operate in this way. Their services to the organism, however, are none the smaller for their stunted growth. As Dr. C. W. S. Aurivillius has shown, their size, their armature, the plane of motion of their joints, are all convenient adaptations. They are bound to be short and specially folded to suit the conditions of their house-room. The strange-looking pads upon them, when pressed against the smooth sides of the house, supply a fulcrum to enable the animal to draw in and out the heavy claws and trunk. The masses of hairs serve to transfer a glandular secretion from little pits in the carapace to plaster the walls of the dwelling.

Next we come to the tail part, or pleon. From one point of view this flabby corkscrew of a tail, as seen in common hermits, is very unsatisfactory. It is shockingly unsymmetrical, with some of its appendages entirely wanting on one side. Though belonging to a crustacean, it is to a great extent not crustaceous. This is very unlike a proper crab, the tail of which is practically nothing but crust, and it is equally unlike the tail of a lobster, in which solid meaty muscle is enclosed in a firm, neatly-jointed covering. But it is evident that the hermit, after thinking out the idea of annexing the shell ready-made by a univalve, found it a great convenience to grow a soft and curly tail part, while symmetrical pairs of pleopods or swimming-feet were no longer indispensable when it had given up the practice of swimming. Only in the apex of the tail, that part which in crawfishes and prawns and the like forms the powerful terminal "fan," the hermit had good reason for preserving, not indeed symmetry, but strength of integument. If anything ever was evolved or designed for a special object, one would say that the caudal fan of the Macrura was designed or evolved to facilitate the motion of the animals possessing it. The hermit crab, by twisting it into the recesses of a univalve shell, has twisted it into an instrument for resisting motion. By means of this so tightly does it cling to its adopted home, that it repels any invitation to leave it as stoutly as Charles the First's little son repelled the hypothetical proffer of a crown, and translates into action the child's emphatic language, "I will be torn in pieces first."



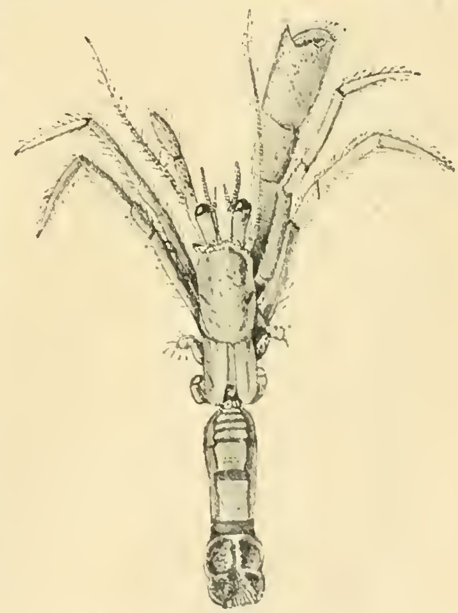
Pylochéles Agassizii A. Milne-Edwards.

What now will happen if the obliging mollusc should not be at hand to accommodate the hermit? It is not a simple answer that can be given to this question. As Mr. Edward Step has lately observed, a homeless hermit may shelter itself in a niche of a rock. As Aurivillius has shown, various zoophytes come to the assistance of the crustacean, on what may be called reciprocal terms, though we are not just now concerned with the bargain. Most persons know the inconvenience of accommodating an increasing family in a house not made of india-rubber or other elastic substance. They will understand, then, the position of a hermit-crab which goes on growing, whereas its home, the shell of an absentee mollusc, has lost the power of growth. Where shells are plentiful, a change may easily be made from a small one to a larger. But in some districts such changes become difficult or impossible. Then it is that the living and growing zoophyte, over-spreading the shell, enlarges the borders of it for the benefit of the crustacean tenant. Again, several members of the Paguridean tribe are exempt from any bigoted devotion to conchology. There is the species *Pylochéles Agassizii*, which ensconces itself in the hollow of a stone, or of a hard silicious sponge, and, as no twisting of the tail is required for such a residence, the sensible little animal preserves its symmetry. So, too, in the tail-part does *Xylopagúrus rectus*, which lives in a piece of reed or of hollow wood, and of which a peculiar habit has been noted or inferred. Pagurids in general, almost of necessity, enter their house tail foremost. But the *Xylopagúrus* is widest at the tail-end, and has been found neatly fitted into a domicile in which the back entrance is wider than the front.



The same in a hollow stone, closing the entrance with its claws. From Huët and Bouvier.

As, therefore, the tail could not have passed the front doorway, it is reasonable to conclude that the head was introduced at the postern. Some Pagurids neither appropriate shells nor any other ready-made houses. Among these is the head of the tribe, the great *Birgus latro*, symmetrical in shape, terrestrial in habit, fat, and well-flavoured. It is surnamed the Robber, not because it is any more a robber than the rest of us, but because it happens to have come into rivalry with man, the universal robber, in an acquired taste for cocoanuts. These it eats, using also the fibres of the husk to line its deep burrow in the ground. Its tree-climbing powers have been disputed; but on this point we now have Mr. J. Stanley Gardiner's authoritative statement, quoted in Mr. L. A. Borradaile's recent paper (*Proc. Zool. Soc. Lond.*, June 7, 1898): "The robber-crab is very commonly found in the tops, both of Pandanus and of cocoanut trees, from which latter I have had it thrown down to me by the natives. It is stated by them to break off the nuts, and often to fall with them, never killing itself, as the cocoanut is underneath. I have seen them constantly clinging to the fruit of the Pandanus,

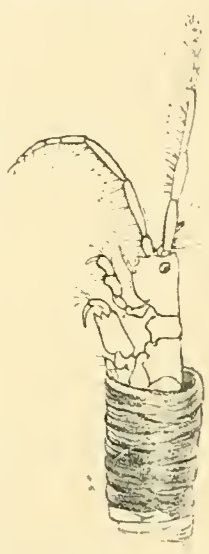


Xylopagúrus rectus A. Milne-Edwards. From Huët and Bouvier.

the fallen segments of which, after they have been chewed by the crab, cover the ground." Mr. C. Hedley (in Whitelegge's "Crustacea of Funafuti," Sydney, 1897) observes that as "the cocoanut is foreign to the native flora, and of comparatively recent introduction from abroad, it follows that the taste for this nut has been acquired in historical times by *Birgus*, whose original food was probably Pandanus fruit." Major Alcock ("A Summary of the Deep-Sea Work of the *Investigator*, 1899") recalls to mind Sir Francis Drake's report of certain desirable oriental crabs that "for want of other refuge, when we came to take them, did climb up into trees to hide themselves, whither we were enforced to climb after them." For additional proof that this was no mere traveller's tale, Mr. C. W. Andrews, in his recent visit to Christmas Island, brought the camera to bear on the question, and photographed a crab in a tree-top, and a crab in the act of climbing a tree.

Mr. Gardiner, again quoted by Mr. Borradaile, gives the following interesting account of the domesticity of a species in a quite different group of crustaceans. The *Lysiosquilla maculata* (Fabr.) is found, he says, in the boat channel at Rotuma. "It lives in pairs in tunnels on the sandy bottom. These are sometimes as much as twenty feet long, and usually have two exit holes. Each hole is inhabited by a male and a female, which take up their positions at the two exits, with the *dactylus* and *propodite* of the raptorial claw widely extended, and just projecting. Any small fish passing over is seized, and the animal retreats with it into its tunnel." Such then is a hunting lodge, as employed by some of the rapacious and strongly armoured Squillidæ. Similar tunnels are used, no doubt for similar freebooting purposes, by various more or less prawn-like animals, such as *Upogebia* and *Callianassa*, of which specimens are occasionally found on our own coasts. The *Callianassa* has an additional reason for hiding in a sub-aquatic tunnel, in that it is a very soft-bodied animal. It is of singular appearance because of the size and strength exhibited by the terminal joints of a single claw. A strange crustacean, nearly allied to the two genera just mentioned, is the *Thalassina anómalus*, and Dr. J. Anderson gives a strange account of its dwelling-place. The notice occurs in his description of the reptiles of the Mergui Archipelago (*Jour. Linn. Soc. Lond.*, Vol. XXI., p. 344, 1889). Where a lizard was common in a swamp, at the mouth of a small freshwater stream, there, among the palms, the crustacean "had thrown up the great mud mounds that occur over its underground chambers. They were strewn with the fallen leaves of the palm, and were more or less riddled with holes made by the crustacean, the eminences being converted into islets at high tide."

On the river-crabs that by the winding streamlet, beneath the roots of large umbrageous trees, construct their burrows, and that sit at the entrances with one eye on the romantic scenery around them and the other on any suspicious-looking tourist passing by, there is not time to dilate as they deserve. A cursory hint must suffice for the *Dromia*, which, with singular coolness and inflexible tenacity, embeds itself in a colony of compound ascidians, and for the miscellaneous crustaceans which in early life find their way into the glassy network of a Venus's Flower Basket, destined, it would seem, to live and die in that graceful enclosure. The crowd of crabs and shrimps and cumaceans and isopods and amphipods which simply bury themselves for protection in the sand from time to time at any convenient spot, can scarcely be said to have homes. In their case the facility of change, the absence of all local obligation or of any need to think about repairs, must destroy the very idea of a house. But this happy-go-lucky freedom from care is not shared by all even of the small crustacea. Those which, like the isopod known as the Gribble, and the amphipod called *Chelura terebrans*, bore into submerged timber, have indeed, a sort of home, though they are continually changing it; but the change is made by almost imperceptible degrees and on very easy terms, since it appears that they only leave one chamber because they are eating their way into the next. Some amphipods, however, construct tubes, either free or attached, by help of a glandular secretion, which issues through a tiny aperture in some of their toes. This becomes a firm cement, and the structure is often consolidated still further by interwoven bits of seaweed, fragments of shell, grains of sand, and other contributories. Pity would be wasted on the cramped area of the lodging, since it is always ample for the lodger. An instance of this is afforded by Mr. Robert Templeton's account of a little tubicolous amphipod which he picked up "at Mauritius, or on the way thither," between sixty and seventy years ago. "While watching it," he says, "which I did for some hours, I was exceedingly surprised and amused to find it disappearing from one end of the tube, and reappearing like magic at the other, having doubled itself up towards its belly in the passage, but with such quickness, considering the narrow calibre of its mansion, that I could hardly credit my eyes but that it had two heads, and, indeed, a gentleman who was with me in the pavilion at the time could not be persuaded to the contrary. The animal, however, scarcely remained a second at this extremity, but shot back to the one it had formerly occupied; and during the time I watched it I never saw it remain permanently at it, or rather, I should say, for a longer period than a second, or a second and a half at furthest." So independent is real energy of the narrowness of the sphere in which it works.



Cerapus abditus Templeton, emerging from its tube. From Templeton.

Microscopy.

By JOHN H. COOKE, F.L.S., F.G.S.

In biological laboratories, where the microtome is in constant use, it is of importance that the edges of the microtome knives should be kept in as perfect a condition as possible. To prevent dulling of the edge, which results from oxidation, the knives should be kept immersed in a one per cent. solution of carbonate of sodium. This treatment will not only prevent them rusting, but will also render them perfectly asceptic.

Dr. Buchner's recent discovery that the alcoholic fermentation set up by the yeast plant, is due to the chemical power of an amyloyte acting in a manner similar to digestive ferment, caused a sensation among those who had hitherto held that the action of yeast could not be dissociated from the living plant. To demonstrate the action of this ferment, the yeast cells should be thoroughly disrupted by grinding them up with quartz sand, and, subsequently, submitted to a pressure of about five hundred atmospheres. Some few cells may escape destruction in this process, and these should be searched for with the microscope, and either disrupted or removed. The resultant powdered mass will act similarly to untreated yeast, thus showing that the fermentative action hitherto attributed to the living cell is, in reality, due to a fermentative enzyme.

The nucleus of the malarial parasite has been demonstrated by Ziemann with the aid of a new stain, consisting of a mixture of a one per cent. watery solution of rectified methylene-blue and a one per cent. watery solution of eosin.

At a recent meeting of the Royal Microscopical Society of London, Mr. E. M. Nelson exhibited a new objective by Zeiss, called a "plankton-searcher," a low-power water immersion objective, designed for use in examining living objects in water.

Vegetable fibres may be distinguished from animal fibres by treatment with iodine and dilute sulphuric acid. The former take a characteristic colour, either yellow or blue, while the latter do not. The re-agents should be prepared as follows:—Dissolve one part of potassium iodide in one hundred parts of distilled water, and add an excess of pure iodine, so that the solution shall always remain saturated. Mix one part of distilled water with three parts of sulphuric acid, and, when cool, add two parts of Price's glycerine. Both re-agents should be kept in glass-stoppered bottles, and as they are liable to change they should be occasionally tested on known fibres.

These re-agents, applied under the microscope, afford a means of determining the species from which the fibre is derived. To do this, some cells should be separated, extended on a glass slip, and slightly moistened with glycerine. The length and breadth may then be determined with a micrometer, and note should be made, at this stage, of the shape and degree of taper of the cells. Allow a small drop of iodine to flow under the cover, removing any surplus with blotting paper. As soon as the iodine has penetrated, apply the sulphuric acid in the same way, carefully watch the results, and compare them with the action of the re-agents on known fibres.

A cheap and effective section-lifter may be made by hammering out flat the end of a copper wire of one-eighth inch in diameter and four inches long. The hammering should be done on a smooth iron, and when it is of the requisite width it may be trimmed with a pair of scissors and smoothed on a whetstone.

The current issue of the *Proceedings of the Royal Society of London* contains a suggestive article by Miss Catherine Raisin "On certain structures formed in the drying of a fluid with particles in suspension," in which are described the many interesting forms that the powders of various rocks exhibit when mounted in water and dried. These forms are classified, the conditions and causes of their formation are discussed, and suggestions are made as to the possible explanation they afford of the origin of many of the structural characters of rocks in Nature.

Excellent finishing varnishes may be made by well mixing on glass artists' oil paint with gold size. Only sufficient for immediate needs should be mixed at one time. Sealing wax, dissolved in alcohol, is also useful, but only the best wax should be used, otherwise the varnish is liable to chip and leave the glass.

Dr. G. H. Bryan suggests, in the pages of the *Journal of Applied Microscopy*, the following ingenious device for the more effective preparation of desmids, diatoms, and other minute mounting material. The removal of all traces of acid necessitates frequent washings and decantations of the residues. It is, therefore, important that the vessel in which these operations are performed should hang vertically, otherwise much of the residue rests against the sides of the vessel and gets carried away during the decantation. Dr. Bryan gets over this difficulty by suspending the test-tube by a U-shaped piece of wire across the base of which an india-rubber ring is fixed. The test-tube is placed in the ring, the elasticity of which allows the tube to hang perfectly freely. The precipitation of the diatoms is hastened if the tube be set swinging slightly. This device will also be found useful for washing and collecting the insoluble residues of limestones and other rocks.

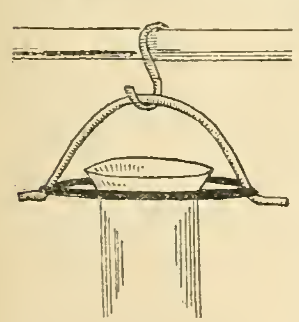


Fig. 1.

Cross-sections of fibres may be obtained by glueing together a mass of the fibre, bedding in paraffin, or by rolling them like a cigarette in a piece of sheet wax. When cut, the mass of mixed sections is placed in benzole or alcohol, when the wax soon floats on top and may be poured off.

The following method of mounting in balsam on the cover, and backing up with black varnish, will be found useful for such objects as foraminifera, minerals, seeds, etc. Cement a thin glass cover to a slip by applying a little balsam to the edge of the cover, and accurately centre it on the turntable. Place and arrange the objects on a thin coating of balsam in the centre of the cover. When dry and set the objects may be completely covered with balsam and put into the dry oven until hardened. If the objects are white a layer of Brunswick black is now laid all over the balsam; if the objects are black white zinc cement should be used. In either case care should be taken to lay them on in thin coats, and allowed to dry in the open air before the next layer is applied. Now remove the glass cover from the slip by slightly heating it. It may now be turned over and mounted on the cell designed for it. Gelatine dissolved in water, with enough alcohol added to liquefy it from the jelly state, is a good preparation for fastening the cover to the cell.

NOTES ON COMETS AND METEORS.

By W. F. Denning, F.R.A.S.

Swift's Comet (1899a).—During May this object proved an extremely interesting one, and was faintly visible to the naked eye. It will continue favourably visible in June, though with rapidly declining brightness. The comet will be situated in the head of Draco on June 1st, and it may be seen about 1° south of the fourth magnitude star ξ Draconis. On June 8th the comet will pass over the star ν Herculus (magnitude 4·7), according to the ephemeris by Moller in *Ast. Nach.*, 3556, of which the following is an abbreviation:—

Date. 1899.	R.A. h.	m.	s.	Dec.	Distance in Millions of Miles.	Brightness.
June 2	17	36	8	+ 55° 14′	53	1·34
" 6	16	24	46	+ 49° 35′	57	1·03
" 10	15	39	2	+ 43° 2′	63	0·75
" 14	15	9	57	+ 36° 59′	71	0·53
" 18	14	50	51	+ 31° 49′	80	0·38

Moonlight will then interfere, and at the end of June, when our satellite will have left the evening sky, the comet will have practically travelled beyond the reach of ordinary telescopes.

Tempel's Comet (1873 II).—The return of this comet is now expected under favourable circumstances, and the following ephemeris has been published by M. Schulhof, *Ast. Nach.*, 3554:—

Date. 1899.	R.A. h.	m.	s.	Dec.	Distance in Millions of Miles.	Brightness.
June 5	19	40	19	− 4° 5′	55	1·27
" 9	19	46	12	− 4° 25′	52	1·44
" 13	19	51	57	− 4° 54′	50	1·63
" 17	19	57	35	− 5° 33′	47	1·83
" 25	20	8	31	− 7° 23′	43	2·28

The comet moves slowly eastwards in Antinous.

Tuttle's Comet cannot be seen to advantage, as its position will be near to, and south of the sun.

Holmes's Comet is shortly expected, and Zwiers gives a sweeping ephemeris in *Ast. Nach.*, 3553. The brightness of the comet is steadily increasing. Its position at the end of June is close to λ Arietis, forming a triangle with α and β Arietis, but it will become more favourably placed at a later period of the summer. At the opposition of this comet in 1892, about six hundred observations were made, and the orbit has been determined with considerable accuracy. Prof. Barnard, of the Yerkes Observatory, does not, however, regard the reappearance of the comet as at all certain. He says: "The failure to see the comet previous to its sudden apparition on November 6th, 1892, near the Andromeda Nebula, its uncometary appearance, its peculiar freaks, and final, utter disappearance from the heavens, connected with the nebulous appendage shown on the photograph of November 10th, would strongly suggest that the object was not a comet at all, but more probably a result of some celestial accident. I think there is no question but this comet will never be seen again, and doubtless before now it has ceased to exist as an individual body" (*Monthly Notices*, 1899, March, p. 357).

THE LEONID METEORIC SHOWER.—In an interesting and valuable paper (*Ast. Nach.*. 3555), Drs. Stoney and Downing give the results of some calculations of the "Perturbations of the Leonids," made by various members of the computing staff at the *Nautical Almanac* office. They find that the earth will encounter the main stream (*i.e.*, the region through which the earth passed in 1866, November 13th) on 1899, November 15th, 18th, or just before sunrise on November 16th next. This conclusion is, however, based on two assumptions, and the authors point out that the predicted time of maximum, as above stated, "can only be offered with reservation."

In the *Astrophysical Journal*, March 1899, Prof. Barnard gives the details of his observations of the Leonid meteors in 1898. On November 9th, at 10h. 50m., he saw a magnificent golden fireball, four or five times brighter than Venus, shooting from near α Cassiopeiæ to the stars in the head of Draco. This meteor was probably a Cetid with radiant at about 45° + 6°. On November 14th, Prof. Barnard found the radiant point of the Leonids at 149° + 24° from the recorded paths of thirteen meteors. On November 15th the great Yerkes telescope was turned towards the radiant, and two new nebulæ were discovered. Prof. Barnard expresses the opinion that though the moon will be present at the Leonid epoch next November, her light will not materially interfere with photographic observations of the meteors in cases where the exposures are not too prolonged.

APRIL METEORS (LYRIDS).—Observations of this shower were comparatively meagre this year owing to moonlight and partially overcast skies. Prof. A. S. Herschel, at Slough, watched the heavens on April 16th, 17th, and 19th, but noticed little indication of the radiants in Virgo, Scorpio, Aquila, etc., which usually furnish many of the meteors seen at this period. A shower in Canes Venatici appeared, however, to be in active evidence. On April 4th, 11h. 51m., he saw a meteor as bright as Sirius, with path from 215° + 64° to 188° + 41°, which it pursued slowly. On April 19th the Rev. T. E. R. Phillips, of Yeovil, saw a fine meteor, two or three times as bright as Jupiter, descending from 209° + 5° to 190° − 26°. The colour of the meteor was pale green; it was four seconds in traversing its path. This object, like that seen by Prof. Herschel on April 4th, accords with a radiant in Cepheus at 315° + 60°. On April 30th, 9h. 55m., Mr. Taylor, of Henley-on-Thames, observed a meteor as bright as Arcturus, passing from κ Serpentis to midway between ε and ζ Herculis. On May 3rd, 12h. 5m., Prof. Herschel recorded a second magnitude meteor travelling from 191° + 16½° to 167° + 42°. It was orange yellow, length of path 32°, and duration of flight three and a half seconds. The two latter meteors appear to have been directed from a well-known April shower of Virginids at 208° − 10°.

In June no very special showers are observable, and meteors are often scarce in the strong twilight prevailing at this season. Fireballs are sometimes casually noticed, and they appear to have belonged to a southerly radiant in Scorpio.

THE FACE OF THE SKY FOR JUNE.

By A. FOWLER, F.R.A.S.

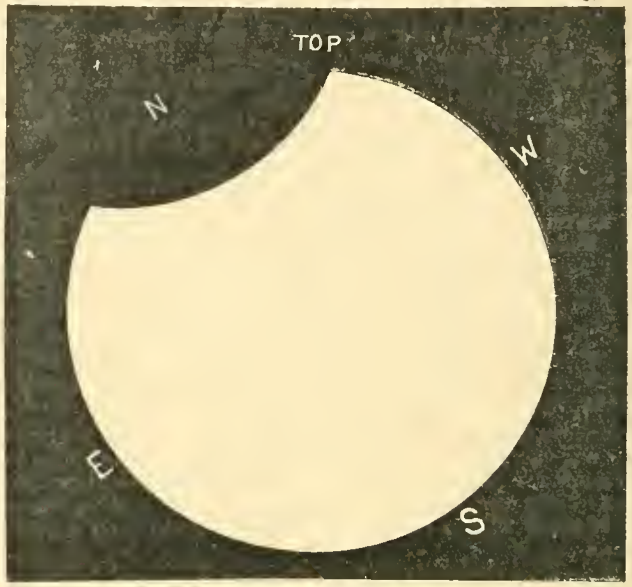
THE SUN.—On the **1st** the Sun rises at 3.50, and sets at 8.6; on the **30th** he rises at 3.48, and sets at 8.18. He enters Cancer, and summer commences at 4 P.M. on the **21st.**

There will be a partial eclipse of the Sun on the morning of the **8th**, which will be visible throughout the British Islands and northern Europe. The following table, giving local particulars, has been drawn up from the data given in the *Nautical Almanac.*

Locality.	Magnitude.	Begins.	Greatest Phase.	Ends.	Angle from North Point. First Contact	Angle from North Point. Last Contact	Angle from Vertex. First Contact	Angle from Vertex. Last Contact
		A.M.	A.M.	A.M.				
Greenwich ..	0·188	4.43	5.17	5.53	42° W.	29° E.	6° W.	70° E.
Cambridge ..	0·197	4.43	5.19	5.56	43° W.	30° E.	7° W.	71° E.
Oxford	0·200	4.43	5.18	5.55	43° W.	31° E.	7° W.	71° E.
Liverpool ...	0·233	4.44	5.22	6.1	46° W.	34° E.	12° W.	73° E
Edinburgh ..	0·263	4.46	5.26	6.8	49° W.	37° E.	16° W.	73° E.
Dublin ..	0·253	4.19	4.57	5.38	48° W.	36° E.	15° W.	74° E.

The magnitudes are expressed as fractions of the Sun's diameter; the times are all Greenwich mean times with the exception of those for Dublin, which are Dublin mean times. All position angles are for direct image.

The accompanying diagram illustrates the amount of the eclipse for Greenwich and the immediate neighbourhood, and shows the position of the eclipsed part with respect to the horizon.



THE MOON.—The Moon will be new on the **8th**, at 6.21 A.M.; enter her first quarter on the **16th**, at 9.47 A.M.; will be full on the **23rd**, at 2.20 P.M.; and will enter her last quarter on the **30th** at 4.45 A.M.

On the **28th**, there will be an occultation of κ Piscium, magnitude 5·0. Disappearance at 11.22 P.M., at 32° from north point (70° from vertex); reappearance at 0.10, 278° from north point (315° from vertex).

On the **23rd** there will be a total eclipse of the Moon, invisible at Greenwich, but visible in India, China, Australia, New Zealand, and the Pacific Ocean.

THE PLANETS.—Mercury is not favourably placed for observation this month. He is a morning star until the **14th**, when he is in superior conjunction with the Sun.

Venus also is a morning star, but is too near the Sun for easy observation with the naked eye. Her distance from the earth is increasing, and the apparent diameter is only 11″.

Mars may still be seen in the evening, but he will not be very conspicuous, and only those observers who have large telescopes can hope to make out any of his markings. At the beginning of the month he lies a little to the north-west of Regulus, and afterwards describes a path towards β Virginis. It will be interesting to note his proximity to Regulus on the **11th**, **12th**, and **13th**. He sets shortly after midnight at the beginning of the month, and about 11 P.M. at the end.

Jupiter will be seen in the evening in Virgo. His path is a slow and short westward one until the **28th**, when the planet is stationary. The polar diameter diminishes from 39·6″ to 36·8.″ On the **1st** he will be due south at 9.18 P.M., setting about 2.30 A.M.; and on the **30th** he will set about half an hour after midnight. The satellite phenomena are most interesting on the evenings of the **6th**, **7th**, **14th**, **15th**, **22nd**, **25th**, **29th**, and **30th**.

Saturn will be in opposition on the **11th**, so that the present month is very favourable for observations of this planet. The planet, however, is nearly 22° south of the equator, and he will, therefore, have a low altitude even when on the meridian. He describes a westerly path, lying about 3° north of θ Ophiuchi. On the 4th the polar diameter of the planet will be 17″, the outer major axis of the outer ring 42·6″, the outer minor axis of the outer ring 19·1″, the inner major axis of the inner ring 27·1″, and the inner minor axis of the inner ring 12·2″. The rings are widely open, and their northern surfaces are visible.

Uranus may be observed throughout the evening, but he is very low in the heavens. He may be found almost midway between ν Scorpii and ρ Ophiuchi. The meridian passage is about 11.30 P.M. at the beginning of the month, and 9.36 P.M. at the end. The apparent diameter is 3·6″.

Neptune is not observable. He is in conjunction on the 15th.

The Stars.—About 10 P.M. at the middle of the month, Cygnus will be in the east; a little south of east, at a considerable altitude, will be found Lyra; while in the same direction, but a little lower, Aquila will be seen. Near the meridian will be Hercules, Corona Borealis, α Ophiuchi, Libra, and Scorpio. Arcturus will be a little west of the meridian, Virgo rather low in the south-west, and Leo almost due west.

Chess Column.

By C. D. Locock, B.A.

Communications for this column should be addressed to C. D. Locock, Netherfield, Camberley, and posted on or before the 10th of each month.

Solutions of May Problems.

No. 1.

(By H. Bristow.)

1. Q to K7, and mates next move.

No. 2.

(By T. Hane.)

Key-move—1. Q to Kt2.

If 1 . . . K to K6, 2. R to R4, etc.
1 . . . K to K4, 2. Q to Bsq, etc.
1 . . . K to B4, 2. K to Q4, etc.

Correct Solutions of both problems received from E. Servante, Alpha, John Baddeley, H. Le Jeune, A. H. Doubleday, G. J. Newbegin.

Of No. 1 only, from Miss Theakston, W. de P. Crousaz, Percival K. Hogg, W. Clugston, G. G. Beazley, W. J. Bearne.

Of No. 2 only, from Capt. Forde, G. C. (Teddington).

Two or three correspondents are thanked for pointing out that No. 1 in the April number is by W. Finlayson.

W. S. Branch.—Many thanks for the information, problems (which appear below), and copy of the *Cheltenham Examiner.*

Capt. Aguilar.—There are no practical jokes in Knowledge. The main variation of No. 2 (April) is 1. B to R8, K × R; 2. K to Kt7, K moves; 3. K. mates. There is no stalemate.

Capt. Forde.—The defence to 1. B to QB2 is K to Q4; a near "try." You appear to have mastered the greater part of No. 2.

D. R. Fotheringham.—There is a defence to 1. B to Kt6, provided by 1. . . B to Ktsq.

Miss Theakston.—After 1. K to Q4, K to Kt6 (best); 2. R. to Kt6ch, K to B7 (best), and there is no mate. It is an excellent try, probably foreseen by the composer.

G. C. (Teddington).—If 1. B to QB2, K to Q4.

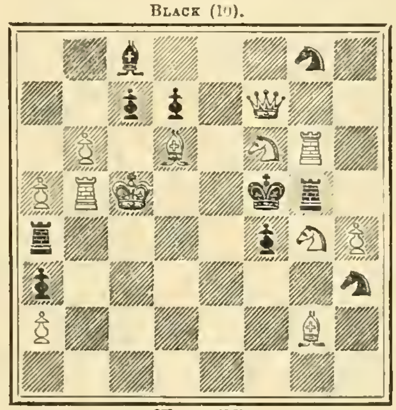
E. Servante.—Congratulations on your very successful first attempts. Your solutions were the first to arrive.

PROBLEMS.

By W. S. Branch (Cheltenham).

No. 1.

Black (10).

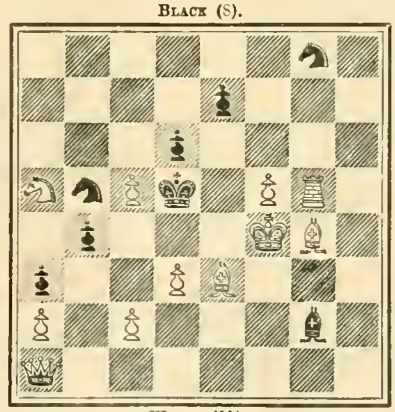


White (12).

White mates in two moves.

No. 2.

Black (8).



White (11).

White mates in two moves.

CHESS INTELLIGENCE.

Mr. Showalter won his return match against M. Janowski by $4\frac{1}{2}$ games to $2\frac{1}{2}$. He had previously defeated the same opponent in a "series" of six games by 4 to 2, and has evidently greatly improved since his severe defeat in the first encounter.

On April 21st and 22nd, a match between Oxford and Cambridge combined against the combined Universities of America was played by Atlantic cable. The English team won by $3\frac{1}{2}$ games to $2\frac{1}{2}$. The score was as follows:—

British Universities.		American Universities.	
C. E. C. Tattersall (Camb.)	½	K. G. Falk (Columbia)	½
A. H. W. George (Ox.)	0	A. S. Meyer (Columbia)	1
L. McLean (Camb.)	1	C. S. C. Avensberg (Harvard)	0
A. P. Lacy-Hulbert (Ox.)	0	L. A. Cook (Yale)	1
G. E. H. Ellis (Ox.)	1	W. W. Young (Princeton)	0
H. G. Softlaw (Camb.)	1	W. Cutchings (Harvard)	0
	3½		2½

The following game was played in the Anglo-American cable match last March:—

"Ruy Lopez."

White. (C. D. Locock.)	Black. (S. P. Johnston.)
1. P to K4	1. P to K4
2. KKt to B3	2. QKt to B3
3. B to Kt5	3. Kt to B3
4. Castles	4. Kt × P
5. P to Q4	5. Kt to Q3
6. B × Kt	6. KtP × B (*a*)
7. P × P	7. Kt to Kt2
8. Kt to Q4 (*b*)	8. Kt to B4 (*c*)
9. Kt to Q2 (*d*)	9. B to K2
10. P to QKt4	10. Kt to K3
11. Kt × Kt	11. QP × Kt (*e*)
12. Q to Kt4	12. Castles
13. Kt to K4	13. K to Rsq
14. R to Qsq	14. Q to Ksq
15. R to Q3	15. P to KB4
16. P × P en pass	16. P × P
17. Kt to Kt3 (*f*)	17. P to KB4?
18. B to Kt2ch	18. B to B3
19. B × Bch	19. R × B
20. Q to R4!	20. R to Bsq
21. QR to Qsq (*g*)	21. Q to Kt3
22. R to Q8 (*h*)	22. B to Kt2
23. R × Rch	23. R × R
24. Q to Q4ch	24. K to Ktsq (*i*)
25. Q × P (*j*)	25. P to B5 (*k*)
26. Q × B (*l*)	26. P × Kt (*m*)
27. Q × P (B6)	27. Q to R4 (*n*)
28. R to Q2 (*o*)	28. Q × Pch
29. K to Bsq	29. Q to R8ch
30. K to K2	30. P × P
31. Q × Pch	31. K to Rsq

Drawn Game.

Notes.

(*a*) Possibly to avoid a similar position to that which occurred on two other boards in this match. Another reason may be found in the next note.

(*b*) Steinitz gives 8. B to Kt5, B to K2; 9. B × B, Q × B; 10. R to Ksq, and erroneously concludes in favour of White. Black has merely to Castle, followed by Q to K3, with a perfectly safe game.

(*c*) Very risky would be the attempt to win a Pawn by 8. . . P to QB4, 9. Kt to B5, P to Q3; 10. Q to B3, P × P; 11. RQsq, Q to B3; 12. B to Kt5. Nor can he move the KB, on account of Q to Kt4.

(*d*) With a view to Kt to Kt3; but he decides afterwards on attacking the Knight in a bolder manner.

(*e*) Forced, if he wishes to Castle; for if he take with the BP, White checks first, and then plays the Queen to KB3.

(*f*) Probably best, if only to make room for the Queen at K4 in case Black plays P to K4. Black's reply looks like a blunder; his best move was 17. . . P to QR4 probably.

(*g*) 21. Kt × P can be played, but is not so strong as the move made, which avoids all complications. White is correct in thinking that the quickest way of winning is by obtaining a passed Pawn on the Queen's side.

(*h*) For similar reasons, White rejected here 22. Kt to R5, P to K4; 23. R to KKt3, Q to R3, etc.

(*i*) Best. Q or R to B3 would lose the exchange.

(*j*) The Pawn will keep. 25. P to KB4 first prevents any reaction, and would secure an easy victory.

(*k*) The best chance; for if 25. . . B to Bsq, then 26. P to KB4, as before.

(*l*) Too risky. He should play the Knight to Bsq.

(*m*) After 26. . . Q × P; 27. R to KBsq, P × Kt, it would be very difficult for White to win. For this reason White decides to run a great risk at his next move.

(*n*) Very ingenious, though it happens to be unsound.

(*o*) Intent now on saving what looked like a lost game, White finds the only move to draw. But he could have obtained a very lucky win by 28. Q × Pch, K to Rsq; 29. R to Q8!, Q × Pch; 30. K to Bsq, Q to R8ch; 31. K to K2, Q to R4ch; 32. P to B3, Q to QKt4ch; 33. P to B4, Q × QKtP; 34. Q to B6ch, etc., exchanging all the pieces and winning with the QRP or KBP.

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CONTENTS.

SPONGES AND THE SPONGE TRADE.

By R. LYDEKKER.

THE ordinary conception of sponges being derived from the horny skeletons of the various kinds employed for domestic purposes, it is by no means generally realised that the graceful object known as Venus's flower-basket is the skeleton of another member of the same group; neither is it by any means a matter of common knowledge that sponges really belong to the animal kingdom. Indeed, it is not many years ago that Messrs. Cresswell Brothers and Schmitz, the great firm of sponge-importers in Red Lion Square, received an official letter in which they were addressed as sponge *manufacturers*.

Much of the ignorance connected with sponges is doubtless attributable to our acquaintance with these organisms being generally limited to the skeleton, or framework, whether this be horny, as in the case of the toilet-sponge, or flinty, as in the Venus's flower-basket. Were the sponge, as brought up fresh from the sea-bed, a familiar object, little, if any doubt would be entertained as to its animal nature.

As it comes up from the sea, an ordinary sponge is a fleshy-looking substance covered with a firm skin, in which apertures appear and disappear at intervals. If cut, the interior presents somewhat the appearance of raw meat, intersected by numerous canals and cavities. These latter are lined with a sticky, greyish-brown substance, termed "milk" by the sponge-gatherers, and sarcode by anatomists. In a sponge of simple structure, such as one of the "fingers" of the glove-sponge (Fig. 1), the water is drawn

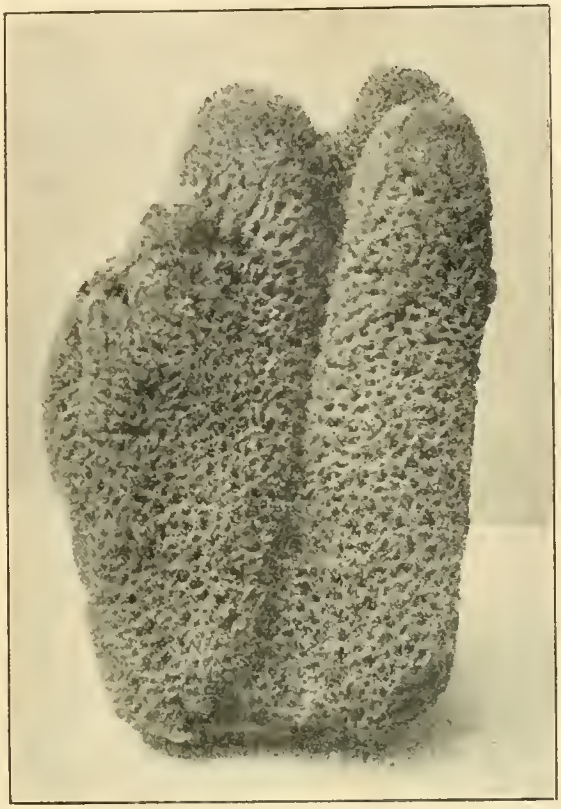


FIG. 1.—Fine Glove-Sponge. *Spongia officinalis tubulifera.* West Indies.

from the exterior through a number of pores in the surface of the sarcode, and after passing through the canals and chambers of the interior of the sponge-substance, is finally discharged by the oscula, or "waste-pipes," at the summits of the "fingers." In its course from the pores to the mouths the water passes through minute sacs, or chambers, lined with ciliated cells; and it is the currents induced by the waving of the fine hairs borne by the ciliated cells that keep up the circulation of water, and thus bring a continuous supply of food to the organism. As regards the reproduction of sponges, it will suffice to say that this is generally carried on by a true sexual process; the fertilised germs being carried out by the waste-pipes, and settling upon some neighbouring rock, pebble, or other object, where it commences to grow. Concerning the rate of growth of sponges, it may be mentioned that an ordinary bath-sponge measuring about a foot in diameter is approximately ten years old.

Commercial sponges, forming the family *Spongiidæ*, are the typical representatives of the entire group, and belong to a section in which the skeleton is composed of a horny substance, nearly related in structure to silk, and technically known as spongin. In many members of the section this spongin is hard and brittle, and it is only those kinds in which it takes the form of a soft elastic network that are of any commercial value.

The first thing to be done after a commercial sponge is brought to the surface is to remove the sarcode, or flesh, as otherwise putrefaction speedily sets in and destroys the elastic nature of the spongin. This preliminary cleansing process is carried out at the gathering grounds, in some cases even before the vessels reach the shore. Sponges in this condition are commercially spoken of as "raw," and have to undergo a further cleansing process before they are suitable for use. How far this cleansing, or bleaching, process is carried depends on circumstances. When carried to its fullest extent, the sponge (as we may now call the cleaned skeleton) becomes of a beautiful lemon-yellow tint, and is known in the trade as "bleached"; on the other hand, when this process is carried out only to a limited degree and a more or less decided brown tint remains, the sponge is said to be "unbleached." In all cases, however, bleaching of some kind has been resorted to—a raw sponge being unusable.

The various descriptions of commercial sponges grow at all depths between two and one hundred fathoms, in seas where the temperature and other conditions are suitable. The finest descriptions and largest quantities are yielded by the Mediterranean, the chief grounds being off the Greek and Turkish islands, thence through the Dardanelles to the Sea of Marmora, and so along the coast of Asiatic Turkey and Syria to Cyprus. From there the Egyptian coasts may be followed, and thence westwards, with some local exceptions, sponges may be traced along the coasts of Tripoli and Tunisia nearly to Algeria. The Spanish, French and Italian coasts are, indeed, devoid of sponges, although they occur on the Turkish shore of the Adriatic. The very best descriptions, such as the cup-shaped toilet-sponge, are, however, met with only to the west of Malta; and as the Algerian coast is approached the sponges become gradually coarser.

Large quantities of sponges are met with off the West Indian Islands, whence the banks extend to the coasts of Florida, Mexico, and British Honduras. All these West Indian sponges, as they are collectively called in the trade, are, however, coarser, and therefore cheaper, than their Mediterranean representatives. Commercial sponges also occur in the Red Sea, the Indian Ocean, and on the Australian coasts, especially on the Great Barrier Reef. Hitherto, however, none of these have been regarded by the trade as of sufficiently good quality to repay the cost of gathering. Owing to the constant drain upon it, the sponge-fishery on the old grounds is becoming rapidly exhausted; and prices have for the last few years been advancing by leaps and bounds. The ordinary depths for fishing vary between fifteen and twenty fathoms, but of recent years sponges have been gathered off Malta at a depth of thirty fathoms. And it is hoped that the possibility of fishing at still greater depths may before long lead to the introduction of a large fresh supply of this invaluable article. By the adoption of a specially heavy diving dress, so constructed as to resist the terrible effects of pressure at such a depth, it is confidently expected that collecting in forty fathoms of water may ere long be found practicable. In the Mediterranean sponges are chiefly gathered by divers (either with or without the aid of the diving apparatus), but trawl-nets and the harpoon are also largely employed. Trawling, however, produces only damaged and inferior samples, while even harpooning does considerable harm. All Transatlantic sponges grow in shallower water, and are therefore more easily fished than the Mediterranean; and this is doubtless one, though not the sole reason, of their coarser structure. Except in British Honduras, Transatlantic sponges are collected only by means of the harpoon. An exhausted sponge-ground may be profitably reworked after an interval of four years, that period being sufficient to allow sponges that were not worth gathering at the time of cessation to grow to respectable dimensions.

Commercial sponges may be divided into two very distinct groups, the toilet-sponges (*Spongia*), and the coarser bath-sponge (*Hippospongia*). In the members of the former group the inhalent pores are situated over the whole of the outer surface; while the oscula, or waste-pipes, form much larger cylindrical apertures on the upper surface, which may be cup-shaped. Of this group two species may be recognized, namely the soft toilet-sponges (*S. officinalis*) and the hard toilet-sponges (*S. zimocca*); each of these being again divided into a number of sub-species. And here it may be mentioned that the experienced sponge dealer distinguishes many more varieties of sponges than are at present admitted by the naturalist.

The finest and most expensive of all the commercial descriptions is the fine Turkey toilet-sponge (*S. officinalis typica*), found in greatest perfection off the coasts of the Levant, where it assumes the well-known cup-like form The average wholesale price of picked specimens of this description ranges from five to nine shillings each. Next in value are the so-called "Turkey solids" (*S. officinalis adriatica*), in which the cup-shape is lost and the top of the sponge is flat. These are the only kind of Turkey found to the westward of Malta. Their wholesale price is from two shillings to half-a-crown each. In these sponges the apertures of the waste-pipes are larger than in the Turkey cups. Another remarkable variety of this species is the *lago-fitus*, or elephant's ear sponge (*S. officinalis lamella*), of the Adriatic. These form huge fungus-like lappets, which sometimes join at the edges so as to produce large open cups. Cut into small pieces they are used for house-cleaning, but the most important use of the larger sizes is for certain surgical operations; they are also employed for stuffing saddles. The wholesale price of the best descriptions varies from thirty shillings to sixty shillings per dozen.

In American waters the Turkey cup is unknown, the only cup-shaped American sponge occurring in the Gulf of Florida, and more especially at Tarpon Springs. The West Indian representative of the Turkey toilet is the glove-sponge (*S. officinalis tubulifera*) (Fig. 1), which tends to grow in a number of finger-like processes, each, when fully developed, terminating in the aperture of a large waste-pipe. The best descriptions fetch half-a-crown per pound wholesale. The fine reef-sponge of the West Indies is another variety of *S. officinalis*, which assumes neither a cup nor a finger-shape, but is generally somewhat pyramidal and pointed, with the apertures of the waste-pipes forming distinct prominences. Very characteristic of the West Indies is the grass-sponge (*S. officinalis punctata*). The ordinary form (Fig. 2) is cylindrical, with a flat upper surface; the border of that surface, like the sides, is of fine texture and perforated by the inhalent pores, but the centre is occupied by the numerous small and closely crowded apertures of the waste-pipes. The margins of these apertures are more or less prolonged into a delicate lace-like fringe; and in one sub-variety, locally known as *peludo* (hair), these prolongations take the form of delicate cups. The Florida grass-sponge is a sub-variety which assumes a cup-shape, the waste-pipes all opening within the cup.

Passing on to the hard toilet-sponges, we find these easily distinguished by their denser and less resilient texture; this being due to the greater thickness of their component fibres. In all essential features they agree, however, with the soft toilet-sponges; the sides being perforated by the pores alone, while the waste-pipes open among the pores on the upper surface. The species is typified by the

European zimocca sponge (*S. zimocca typica*), which usually assumes the form of round disks, convex below and flat above, the waste-pipes opening on this flat upper surface. In the West Indies and America the species is represented

Fig. 2.—Grass-Sponge. *Spongia officinalis punctata.* West Indies.

by the hard-head and yellow sponges (*S. zimocca corlosia*). In both these the shape is more or less loaf-like, with the apertures of the waste-pipes distributed somewhat irregularly over the upper surface. In the hard-head, the general surface is fairly uniform, and the margins of the apertures of the waste-pipes are distinctly produced. On the other hand, in the yellow sponge (Fig. 3), the general surface is traversed by a number of irregular fissures, and the apertures of the waste-pipes are not produced, the whole appearance of this sponge being coral-like. None of

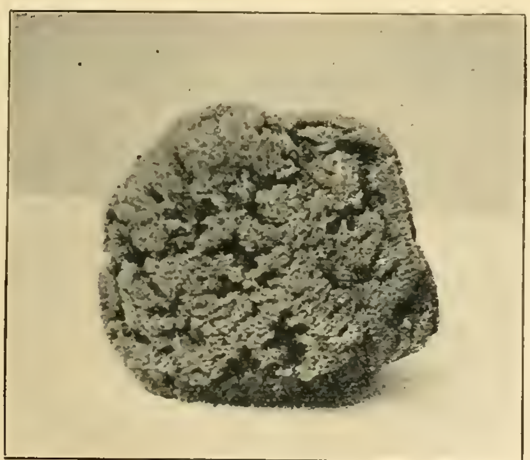


Fig. 3.—Yellow Sponge. *Spongia zimocca corlosia.* West Indies.

these hard toilet-sponges bear a high value; the price of good samples of the West Indian varieties ranging from about two to three shillings per pound at the wholesale dealers.

Much coarser, and of a totally different type of external structure, are the bath-sponges of the genus *Hippospongia*, which are also common to the Mediterranean and the American side of the Atlantic. Most persons, if they gave any attention at all to the subject, would probably consider that the large apertures in a bath-sponge correspond to the oscula, or apertures of the waste-pipes, in a toilet-sponge, and the smaller holes of the former to the pores of the latter. Such a supposition would, however, be totally incorrect, for, as a matter of fact, both the oscula and the pores open on the surface of the tortuous tubes leading from the large apertures into the body of the sponge. A bath-sponge, therefore, really consists of complexly-folded layers, with the system of incurrent and excurrent canals in their thin walls. To the large apertures in sponges of this type the name of pseudoscula is applied; while the twisting passages leading from them are known as vestibules. The typical bath-sponge (*Hippospongia equina typica*) is a Mediterranean species, ranging from Eritra, opposite the Island of Chios, to Tunisia, being represented by a very coarse dark brown variety at Gibraltar. It attains to very large dimensions, and its form and general appearance are too well known to require description. In the trade it is termed honeycomb sponge, and is sub-divided into bath and toilet descriptions; the two latter terms being thus used in a different sense from their scientific application. For large specimens of the best quality the wholesale price ranges from ten shillings to twelve shillings and sixpence each.

On the other side of the Atlantic the ordinary bath-sponge is replaced by a somewhat coarser variety known as the wool-sponge (*H. equina gossipina*). The essential feature of this sponge (Fig. 4) is the production of the

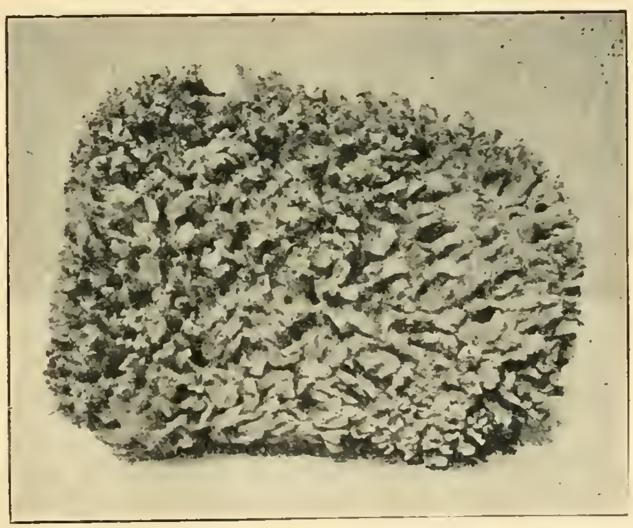


Fig. 4.—Wool-Sponge. *Hippospongia equina gossipina.* West Indies.

free edges of the laminæ into long tag-like processes, thus giving to the whole a somewhat woolly appearance. It is of inferior value to the European variety. Good samples of these sponges realise from eight shillings to eight shillings and sixpence per pound.

The last kind to be noticed is the West Indian velvet-sponge (*H. equina meandrina*), which, although here regarded as a race of the bath-sponge, is so distinct, as to have considerable claims to rank as a species by itself. Apart from the large "pseudoscula," this sponge (Fig. 5), as its Latin name denotes, presents a considerable likeness to the brain-coral. The pseudoscula are not only large, but are also very numerous. Between these the edges of the laminæ are smooth and velvety, the intervening apertures mostly taking the form of irregular sinuous slits, although tending to become circular round the margins of the pseudoscula. Velvet-sponges are inferior in value to the wool-sponge, the best samples selling at about four shillings and sixpence each.

Before concluding this portion of the subject, a few additional lines may be devoted to the distribution of the Mediterranean sponges. On the east shore of the Adriatic,

Fig. 5.—Velvet-Sponge. *Hippospongia equina meandrina.* West Indies.

and the coast of Greece from Trieste to the Bay of Nauplia, it appears that only the elephant's-ear-sponge is met with. From Nauplia and Candia to Eritra, on the coast of Asia Minor, both the Turkey toilet and the Zimocca sponge are met with. Except off Cyprus, where the latter does not grow, the Turkey toilet, the Zimocca, and the bath-sponge are met with from Eritra to Tripoli. West of the latter place the Zimocca disappears; the bath and Turkey alone extending from Tripoli to Tunisia, and the former, as already said, being represented by a coarse variety known as gerbis, in the Strait of Gibraltar. The limitation of the Turkey cups to the seas east of Malta has been already referred to.

Many years ago the head-quarters of the sponge-trade were located at Trieste; subsequently they were transferred to Paris, whence they finally migrated to London, the great bulk of the trade being in the hands of the Messrs. Cresswell.* As regards the volume of the British trade in this commodity, the following figures give the amounts and values of the imports between the years 1862 and 1870, subsequently to which no returns were published for a considerable period :—

Year.	Amount.	Estimated Value.
1862	544,882 lbs.	£100,204
1863	474,748 ,,	77,907
1864	540,172 ,,	60,278
1865	694,128 ,,	103,780
1866	895,369 ,,	96,768
1867	980,259 ,,	86,201
1868	997,447 ,,	119,917
1869	1,221,673 ,,	156,965
1870	837,159 ,,	160,162

* To the members of this firm the author's best thanks are due for much valuable information, and likewise for the specimens from which the descriptions and figures are taken.

These figures indicate, on the whole, a progressive annual increase in the amount of the imports, with very considerable fluctuations in value. According to the Board of Trade returns, the amount of the imports in 1897 was one million nine hundred and fifteen thousand and seventy-five pounds, with a declared value of two hundred and twenty-seven thousand two hundred and forty-six pounds. The latter must, however, be regarded as only a very rough approximation to the reality. As regards the great excess in the amount of the imports over those given in the foregoing table, it must be borne in mind that during the former period the great bulk of the trade went to foreign ports. In 1875, for example, the French imports reached two hundred and forty-six thousand six hundred and sixty-six kilogrammes, and two hundred and fifty-seven thousand eight hundred and seventy-eight kilogrammes in the following year. It is accordingly quite possible (although we have no data to go on) that the total annual yield of sponge for the world's supply may now be considerably less than formerly.

As regards the dressing of raw sponges, it may be well to mention that the so-called unbleached descriptions are treated locally with a bath of weak sulphuric acid, by which they are turned light brown. After being washed in sea-water and sprinkled with sand to increase their weight, they are packed in bales, and on arrival are sold in this condition. On the other hand, the bleached sponges arrive in this country in the raw condition, stowed in bags, and pressed flat. After a good maceration in Condy's fluid, they are soaked and squeezed in a solution of sodium hypo-sulphite and hydrochloric acid, after which they are wrung, dried, sorted and trimmed. Their lighter colour gives them a decided advantage in appearance over the unbleached descriptions, but there is the drawback that the strength of the fibre is very slightly weakened by the processes to which they have been subjected.

THE ENERGY OF RÖNTGEN RAYS.

By Dr. J. G. McPherson, f.r.s.e., *Science Examiner in the University of St. Andrew's.*

SINCE the marvellous properties of the Röntgen rays were discovered, very many experiments have been made to bear upon their application to physiology and surgery. Dr. Polland's Atlas of the development of the formation of the bones of the wrist from birth till seventeen years of age is one of the most startling of the recent successes of the process; and this has overturned to some extent the old theory of the formation of these bones.

There has been, however, as yet but little done to determine the *energy* of these rays. The Rev. Alexander Moffat, b.sc., has been studying the subject in Erlangen, and has submitted to the Royal Society of Edinburgh the result of his investigations.

A. Rotti was the first to attempt to determine the duration of the Röntgen rays. He used a Ruhmkorff coil with a rotating interrupter to make and break the current in the primary circuit. On the interrupter he mounted a photographic plate, and in front of it had a screen of lead with a slit in it. The Röntgen rays were made to pass through the slit and make a photograh of it on the plate. From the amount of broadening of the photograph he found that the duration of a discharge was about $\frac{1}{600}$ second.

Dr. Trouton, of Liverpool, adopted the method of rotating a zinc-toothed wheel between the Röntgen lamp and the photographic plate. A photo of the moving teeth was secured by making one interruption of the primary current in the induction coil, thereby letting one discharge pass. The duration of the radiation was determined by the departure from sharpness of outline of the photo; and he concluded that the duration of a discharge was from $\frac{1}{800}$ to $\frac{1}{10000}$ second. M. Colandeau, adopting the same method, found the result to be about $\frac{1}{1000}$ second.

M. Morize adopted Rotti's principle. He fixed the plate to one end of the axle of an electrometer, and at the other end he placed a toothed wheel which interrupts an electric current, and makes a contact which registers itself on a chronograph band. From the broadening of the image of the slit he found the duration of the discharge to be a little over $\frac{1}{1000}$ second.

Mr. Moffat has now determined that this figure is far too low. In fact he proves that the real duration is about a tenth part of that determined by Colandeau and Morize. He used an optical bank with a screen of barium platino-cyanide and the Röntgen lamp at one end; an amyl-acetate lamp, as a source of light, being at the other end to note the standard of comparison. Between these was a movable photometer. In order to obtain as strong Röntgen rays as possible, he introduced an air spark into the circuit, thereby driving away the particles of dust in the air and making the discharge more sudden. The Röntgen lamp and the spark interrupter were enclosed in a box, the lamp being fixed near one side. At the place where the rays from the anti-cathode were to be transmitted, a small hole was bored and covered with thin black paper. On the other side of this paper the screen was fastened. In front of the screen was fixed a piece of cardboard with a small hole in it, and through this the light-emitting surface of the screen appeared.

The light from the test lamp had to be weakened, because the light proceeding from the screen was very faint. This was done by putting the lamp inside a wooden box. A hole was made in front of the box, and covered with translucent paper. In front of this was placed a piece of green glass. For a photometer he used simply two mirrors set at right angles to one another; in this way very little of the light was lost. To determine the quantity of light emitted by the translucent paper from the amylacetate lamp, he put at one end of the optical bank a lamp, and at the other end the box with the translucent paper thus illuminated. He found that the light emitted by the paper was one-twentieth of that of the lamp.

He then removed the translucent paper, and determined the extinction co-efficient of the green glass by measuring the intensity of the light transmitted by them in comparison with that of the lamp alone. He found that the intensity of the light coming from the translucent paper, when weakened by transmission through the green glass, was about $\frac{1}{50000}$ lamp.

Now, the light of the lamp is emitted during the whole time it is burning, but the Röntgen rays only during very short intervals of time. To determine the upper limit to the duration of these intervals, Mr. Moffat put in front of the screen an opaque screen with a small vertical slit, and examined the image of the slit in a rotating mirror. The slit was three millimetres broad, and the mirror was exactly opposite it at a distance of 27·5 cm., revolving at the rate of about ten revolutions per second. Now, he saw that the image was broadened one-tenth part. Accordingly, the duration of a discharge must have been about $\frac{1}{2} \times \frac{1}{10} \times \frac{1}{10} \times \frac{3}{275} \times \frac{7}{44} = \frac{1}{1200000}$ second.

By a series of successful experiments Mr. Moffat has averaged the duration of a discharge of the Röntgen rays at $\frac{1}{1000000}$ second. This, at least, is the upper limit.

THE STORY OF THE ORCHIDS.—I.

By the Rev. ALEX. S. WILSON, M.A., B.Sc.

THE family of Orchids is represented in this country by a number of species some of which are among the most handsome of our native wild flowers. Even from a florist's point of view, the purple spikes of *Orchis mascula* and *O. latifolia* are but little inferior to garden hyacinths and greatly excel them in scientific interest. Some of the tropical kinds, which are so largely cultivated under glass, present the most fantastic shapes and are arrayed in the utmost variety of gorgeous colouring. Orchids are herbaceous plants with sheathing, strap-shaped, parallel-veined leaves; they have close affinities with the irises, daffodils and lilies. In Monocotyledons the two sets of floral envelopes are coloured alike and not readily distinguishable; we do not therefore speak of a calyx and corolla, but of an outer and inner whorl of the perianth. The gay-coloured parts of the orchid are the perianth segments; Monocotyledons with a bright-hued perianth of this description constitute the sub-class, Petaloideæ. As in the irises and daffodils, the ovary of the orchid is placed below the flower; in the two former it contains three cells; the ovary of the orchid is one-celled with the ovules attached to the internal walls. During the development of the flower the ovary twists so that those parts which are uppermost in the bud become lowest in the fully expanded blossom. The fruit is an elongated capsule which splits by longitudinal slits and discharges the minute seeds. The latter are exceedingly numerous; the contents of a single capsule have been computed in some cases to amount to as many as one million seven hundred and fifty thousand. The name orchis refers to the root, which in the early purple orchis consists of two rounded nodules or tubers. If these be examined after the plant has flowered, one of them is found to be soft, flaccid, and withered; the other hard and fresh. The starchy materials, elaborated by the leaves out of the atmospheric carbonic acid during the summer months, have accumulated in the hard tuber, and in ordinary course would be expended next spring in the production of stem, leaves, and flowers; the tuber would then have acquired the withered appearance of its neighbour, which has already been exhausted in the formation of the leaves and flowers of the present season. By that time, however, a new tuber would have formed, containing reserve materials for the following year. The tuber is thus a kind of vegetable savings-bank, in which little piles of starch granules take the place of silver and golden coins. The curious bird's-nest orchid receives its name from the rounded mass of interwoven root-fibres. The whole plant is of a dingy brown colour. Having no chlorophyll, it is incapable of assimilating the atmospheric carbon. Its mode of nutrition resembles that of the mushroom, toothwort, and other saprophytes, which obtain their food from decaying organic matter in the soil.

FIG. 1.—Spike of Early Purple Orchis.

A large proportion of orchids are epiphytes, or air-plants, growing on trees; these often produce aerial tubers, and have long pendant roots, which do not, however, establish any connection with the soil. A few are climbers, others grow on rocks, but the majority are terrestrial like our British species, which abound in damp meadows.

The perianth of the lilies, irises, and daffodils, is regular, all the parts in each whorl being of similar size and shape; orchids, on the other hand, have a highly irregular perianth. Notwithstanding the eccentricities of their shapes, however, the flowers of orchids are comparatively simple in structure, and may be regarded as merely modifications of the ordinary lilaceous type, which is made up of five alternating whorls of five parts each. The irregularity of the perianth is mainly due to the extraordinary development of the labellum or lower lip. This organ is formed by the combination of one of the inner segments of the perianth with two sterilized stamens of the outer staminal whorl, its composite nature being usually indicated by its

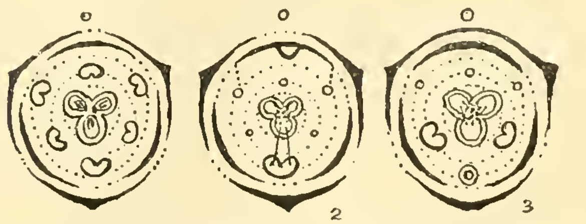


FIG. 2.—Floral Diagrams: 1, Lily; 2, Orchis; 3, Cypripedium.

three lobes. The labellum is frequently more highly coloured than the other parts; in many species it is prolonged into a hollow spur behind; in others it is tongue-shaped; while in the slipper orchid it forms a concave pouch or cup in front of the flower. At first the labellum is superior, but in many species, by the twisting of the ovary, the flower is inverted so that the labellum comes to be available as a landing-stage for visitors. Sometimes it is divided by contractions into three regions, which are distinguished as the hypochilium, next the base, the mesochilium and epichilium.

Of the six stamens, which, theoretically, the flower ought to possess, only one is fully developed, the others being represented by abortive structures termed stammodes. The single fertile stamen is adherent to the style, a condition described as gynandrous, and the combined structure constitutes the column. The pollen contained in each of the anther-lobes coheres into a waxy mass or pollinium, the stalk of which is furnished with a viscid disk at its lower extremity. The only other flowers in which pollen-masses of this description occur are the Asclepiads, an order of Dicotyledons, having no affinity whatever with the Orchidaceæ.

A characteristic structure in orchid flowers is the rostellum, which in our commoner species is a little knob projecting from the top of the column, just above the entrance to the spur of the labellum. It appears to be one of the three stigmas of the original type, metamorphosed in a remarkable manner. The rostellum consists of a membraneous pouch containing two little rounded disks of sticky matter which are attached to the bases of the two masses of pollen. When any object touches it, the membrane of the rostellum ruptures, and the sticky disks are exposed, whereby the pollen-masses are glued to the object. This can easily be verified by inserting a pencil into the flower; on withdrawing it the pollen-masses will be seen to have fastened themselves to the pencil by their sticky glands.

On the lower side of the column, immediately behind the rostellum, the two functional stigmas are situated; they are merely flat viscid areas, to which pollen readily adheres, and may be more or less confluent from the line of division becoming obliterated.

The early spring orchis, *O. mascula*, may be taken to illustrate the mode in which cross-fertilization is accomplished. Humble bees are its most frequent visitors, and the flower is specially adapted to their visits. Alighting on the labellum the insect thrusts its tongue into the hollow spur, the mouth of which is wide enough to admit of this being easily done without touching the rostellum. But the insect's head is too large to enter the spur, which is longer than the bee's proboscis; in the effort to reach the bottom of the spur the visitor pushes its head against the rostellum, with the result that the two pollen packets adhere to its forehead, and are removed when the insect withdraws from the flower. At first the pollinia stand erect, but in the course of thirty seconds or so they spontaneously curve into a horizontal position, and project in front of the bee's head. If now the insect should enter another orchid the pollina are so placed that they must inevitably be pressed against the viscid surface of the stigmas, on which one or both may be left adhering. Generally a portion only of the pollen is left on the stigma, the remainder being available for other flowers which the insect may subsequently visit. The stigmas being placed below the anther, the pollen-masses, if they retained their erect position, could not be delivered at their proper destination; instead of being transferred to the stigma they would be pressed by the insect against the anther of the second visited flower. The automatic bending of the pollen-masses is thus a provision for insuring their proper delivery. It is a rather remarkable circumstance that in the genus Orchis the spur never contains any nectar; not without reason therefore have the various species of orchis been described as "sham-nectar producers," or flowers which practice deception upon their visitors. It has been shown, however, that insects pierce the succulent tissue which lines the interior of the spur, and that probably from its cells they extract a sweetened sap. A bee at work on the early purple orchid has been observed to spend three or four seconds in each flower-bell, which is long enough to allow the cement of the sticky disks to harden sufficiently; two seconds or so are spent in passing from one flower to another; and as the visitor rarely remains more than twenty seconds on one spike, it has passed to another spike before the pollinia belonging to the first have assumed the horizontal position. The cross-fertilization is thus insured not merely of separate flowers but of distinct individual plants.

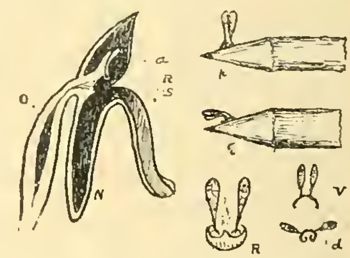


FIG. 3.—Diagrammatic Section of Orchid: *a*, anther; *r*, rostellum; *s*, stigma; *p* and *q*, pollinia; *v*, pollinia of *O. pyramidalis*, with saddle-shaped disk.

The marsh orchis, *O. latifolia*, and the spotted orchis, *O. maculata*, two of the commonest species, are fertilized very much in the same way as *O. mascula*. Their spurs are slightly shorter, however, and, perhaps, for this reason the spotted orchid is frequented by flies fully more than bees. The fragrant orchid, *Gymnadenia conopsea*, has a much longer spur than any of those previously named; its flowers are visited by numerous moths and butterflies, the abundant nectar being only accessible to Lepidoptera.

MICROBES IN CO-OPERATION.

By G. CLARKE NUTTALL, B.Sc

OF late years botanists have been made very familiar with that kind of relationship shown to exist in certain instances in the plant world which is known as Symbiosis. In these instances we find two organisms living a common life of mutual benefit, each supplying the other with some requisite of its existence, and receiving in return some essential to its own well-being. The arrangement does not necessarily benefit both sides equally, and never is the advantage of the same nature on either hand; the essential point is that there is a common life of two organisms with a mutual advantage of some kind or other. A lichen is, perhaps, the best and most striking illustration of a symbiotic union, where a minute rudimentary green plant—an alga—and a fungus, living and growing in intimate connection, give rise to that product which we term a lichen thallus. In this case the mutual benefit lies in the fact that the alga provides food for the fungus, and the fungus stimulates and shelters the alga.

Metabiosis—we owe the name to the French chemist Garré—is another kind of relationship existing in certain cases which is of later recognition and not so generally known at present. For one thing, all the instances yet found of this condition are confined to the world of the bacteria, and hence do not furnish so obvious or so familiar examples as the lichens do of symbiosis; moreover, there is lacking in metabiosis that suggestion of sensationalism which caused so much interest and controversy when the double nature of the lichen household was first put forward for acceptance. Nevertheless, metabiosis, as a condition of life, has, for an interested observer, a fascination peculiarly its own.

Now, metabiosis may be broadly defined as that relationship which exists between two organisms when for one of the two to flourish and live in a certain medium it is necessary that the other should have preceded it and prepared the way for it. The development of the one with its consequent reaction on the environment is a necessary condition of the development of the other. The first is independent of the second and in no way touches it in any intimate way; the second is wholly dependent upon the good offices of the first, for without its predecessor had lived and developed and through its living changed the character of its environment it could never have been called into active life.

An example will perhaps best serve to illustrate the point. It was found some time ago that certain of the very finest wines produced in the vineyards of the Rhineland were made from grapes that, after they had been gathered, were allowed to stand and go mouldy and "bad," and apparently become absolutely useless and disagreeable. Yet it was from these very grapes that the wines possessing the best flavour resulted. Now, a clever German chemist, Müller Thergau, examined the matter from a scientific point of view, and he found that the mouldiness which appeared on the grapes after standing was a fungus which lived on the contents of the grapes, and which in absorbing its food changed the chemical constitution of those contents, so that when the fermentation processes began through the agency of yeast organisms, they were favoured and affected for the better by the changes which had already been brought about by the mould fungus. Here then the yeast stands in a metabiotic relationship to the mould fungus. The mould is absolutely independent of the yeast and appears under any circumstances, the yeast organism can only take that particular line of development with the resulting production of "bouquet" when the way has been prepared for it by the mould fungus. It is dependent upon its predecessor for its particular action—that is to say, we have here a condition of metabiosis.

Prof. Lafar gives an instance of a whole series of metabiotic relationships when he explains, with much lucidity, the sequence of events in the evolution of wine from the grape.

The skin of the grape, he says, is naturally the home of many varieties of fungi, especially bacteria, and when the grapes are gathered and pressed down these germs are naturally also to be found in the "must." And since the germs are of many varieties, they, of necessity, differ as to the conditions most favourable to their development, and as to the length of time they demand for the various stages in their life processes.

The first to develop are the yeasts—the organisms which bring about ordinary alcoholic fermentation. These seize upon the sugar of the grape for food and split it up into carbon dioxide and alcohol, and thus at once the original constitution of the "must" is greatly altered. Another species of germs, hitherto lying dormant, then spring into activity, as the conditions are now those which most favour its development. These are the organisms which bring about acetic fermentation, for their food is the alcohol which the yeast brought into existence, and they, in acting upon it, oxidise it by means of the free oxygen in the air, and thus produce acetic acid. It is obvious that the relationship between the two species is here again one of metabiosis; the bacteria producing acetic acid could not have developed in the "must" as it was in its earliest form, for no alcohol was then to be found in it; the germs might be abundantly present in the liquid, but their growth was wholly dependent on the yeast preceding them and preparing the way for them. Thus they are under an absolute obligation to the yeast, though the yeast is entirely independent of them. The result of this second stage in the proceedings is therefore a strongly acid liquid.

But now a third kind of bacteria come into play, which themselves stand in a metabiotic relationship to the second. An acid liquid is their natural home, and as the originally sweet "must" has become distinctly acidified, the dormant germs of this species are aroused into activity. They seize upon the acetic acid present, and under their influence it rapidly becomes split up into carbon dioxide and water. The bacteria accomplishing this are the thread fungi (the vinegar eel is one of the members of this variety), who thus form a third link in the metabolic chain, and their special work is the elimination of the acid.

And the thread fungi are themselves the forerunners of yet another new-comer. Certain Schitzomycetes—bacteria which promote putrefaction—had entered the "must" with the dust and air in the first instance, but had had no chance of growth until this late stage, for alcohol is poison to them and acetic acid distinctly injurious. So while the yeasts were producing alcohol and the second species was replacing it with acetic acid they were compelled to remain quiescent, and it was not until the alcohol had been removed by the bacteria promoting acetic fermentation, and the acetic acid had in its turn been reduced by the thread fungi, that the way was clear for their appearance.

The above sequence of changes thus gives us several instances of metabiotic relationship, and indeed it is probable that in most cases of fermentation and putrification we have much the same sort of thing happening; in all cases, that is, where several varieties of bacteria have their habitat in the same medium.

It is difficult to over-estimate the practical value which a full recognition of the possibilities and limitations of metabiosis may have. At present we can scarcely claim to do more than stand on the threshold of the new study. Up to now the aim of the bacteriologist has been chiefly to isolate single kinds of bacteria, and by cultivating them in a pure state to study each species by itself, ascertaining its exact nature and its power of work; but in the future he will find this is only the preliminary to the more complicated study of combination, and he will have his most fascinating work in combining, adding, and subtracting, in endless variation, different species of bacteria in the same medium, and thus get an infinite number of independent results. Here is a simple example of a combination that has been artificially brought about.

A certain bacterium has been found to have the power of fermenting starch into glucose, and a certain yeast, it has been ascertained, can change glucose into alcohol. Now by putting together pure cultures of this particular bacterium and of this particular yeast into starch, alcohol can be obtained as a result of their joint efforts. This simple illustration of the power of combination merely points the way to others of greater import which may be arranged in the future, and, in fact, in judicious blending and combining probably lies the greatest development of bacteriology in the near future.

The ripening of the curd in cheesemaking is now shown to be the work of bacteria whose home is in the milk, and this is proved by the fact that if the milk is sterilised prior to cheesemaking no proper cheese can be produced, as the curd never ripens. But no single bacterium is responsible for the whole result, rather several species are involved, each contributing part, and part only, of the whole work, and living almost certainly in metabiotic relationships. For example, in certain investigations made by Dr. Weigmann in this matter, he found in several instances that two different forms of bacteria were present, and that a characteristic smell and taste accompanied their development; but when these two forms of bacteria were isolated and cultivated separately, neither was able alone to give the specific taste and smell, and not until the companionship was restored was the original result attained.

So, too, in buttermaking. It is bacteria again who are responsible for turning the cream sour and who bring about the changes in its constitution which give aroma and flavour to the butter. Dr. Weigmann, in his observations at Kiel, discovered that no culture of single species alone could give a good taste with stability when introduced into cream. Perfection of flavour with "keeping" properties were invariably the result of a blending together of several forms of these germs, and that if artificial souring was to be successful, a knowledge of judicious blending was absolutely necessary. This implies nothing more nor less than metabiotic relationships between the different kinds of the bacteria concerned. These instances are sufficient to indicate, at any rate, the vital importance of metabiosis in our study of the lives and works of the innumerable species of bacteria, and the great stress that must be laid on a right comprehension of this relationship in all future considerations in this direction.

DISTRIBUTION OF STARS IN SPACE.

By Gavin J. Burns, B.Sc.

Is the stellar universe infinite? As the power of the telescope is augmented, do we penetrate further and further into infinite space, ever encountering fresh systems of stars? Or do the stars ultimately come to an end leaving unfathomable and unknowable space beyond? These are questions which the study of sidereal astronomy forces on our attention, and which we cannot help seeking to answer however unanswerable they may be.

But although we may be unable to give a definite answer, yet we may obtain evidence as to the most probable hypothesis. A study of the distribution of stars of different magnitudes leads to results as to distribution in space of stars of different intrinsic brightness. Let us begin by supposing that stars of every grade of intrinsic brightness are scattered indifferently throughout all space. As there is no possible reason for supposing that stars of any one intrinsic brightness occupy one portion of the stellar universe rather than another, this is antecedently the most probable hypothesis of stellar distribution. Now consider the appearance which such a universe would present to an observer placed at any point in it. Let us, in the first place, confine our attention to stars of some given intrinsic brightness. Let x be the distance at which such a star appears to be of the first magnitude. Then, if 2·512 be the light ratio of two successive magnitudes, a star of equal intrinsic brightness will appear of the second magnitude at the distance $\sqrt{2{\cdot}512}.x = 1{\cdot}585\,x$; of the third magnitude at the distance $(1{\cdot}585)^2x$; and of the nth magnitude at the distance $(1{\cdot}585)^{n-1}x$. Next, imagine a series of spheres of the radii x, $1{\cdot}585\,x$, $(1{\cdot}585)^2x$, $(1{\cdot}585)\,x$, $(1{\cdot}585)^{n-1}x$. Then the first sphere will contain all the stars of the first magnitude and over, the second sphere all the stars of the second magnitude and over, and the nth sphere all the stars of the nth magnitude and over. Since the content of a sphere is as the cube of the radius, it follows that the number of stars in each successive sphere will be as the numbers 1, $(1{\cdot}585)^3$, $(1{\cdot}585)^6$, $(1{\cdot}585)^9$, etc., or nearly as the series, 1, 4, 16, 64, 256, etc. In the second place, let us take the stars of some other given intrinsic brightness, and let y be distance at which such a star appears of the first magnitude. Then imagine a series of spheres of radii y, $1{\cdot}585y$, $(1{\cdot}585)^2y, \ldots (1{\cdot}585)^{n-1}y$. As before, each successive sphere will contain all the stars which appear to be of each successive magnitude or over, and which are of the order of brightness under consideration. The number of stars in each sphere will also be as the series 1, 4, 16, 64, 256, etc. Precisely the same reasoning will hold good of stars of any other order of intrinsic brightness. The final result is that the number of stars of each magnitude and over will form a series proportional to the series 1, 4, 16, 64, 256, etc., provided only that stars of each grade of intrinsic brightness are scattered indifferently throughout space. This result is quite independent of the relative numbers of stars of each grade of brightness.

It appears, further, that if the number of stars of the first magnitude and over is represented by 1, the number of stars of the second magnitude and under the first is represented by $4-1=3$, of the third magnitude and under the second by $16-4=12$, and so on, the series being 1, 3, 12, 48, 192. Further, the number of stars between the n and $n-1$ magnitude will always be three times the total number of stars over the $n-1$ magnitude. Let us compare these results with observation.

The following table, showing the number of stars of each magnitude in the northern hemisphere, is given on the authority of Mr. Plummer.* The table is derived from the data in Argelander's *Durchmusterung*:—

* *Monthly Notices*, XXXVII., p. 436. The numbers in the last column have been added by myself.

Magnitude.		Number.		Ratio to total of preceding stars.
1·0 to 1 9	...	10	...	—
2·0 to 2·9	...	37	...	3·7
3 0 to 3·9	...	130	...	2·8
4·0 to 4·9	...	312	...	1·7
5·0 to 5·9	...	1001	...	2·0
6·0 to 6·9	...	4386	...	3·0
7·0 to 7·9	...	13823	...	2·2
8·0 to 8·9	...	58095	...	2·9
9·0 to 9·5	...	237131	...	3·5

It will be observed that there is no striking deviation from the theoretical ratio, except in the case of stars of the 9·0 to 9·5 magnitude, where the actual ratio is three and a halt times the theoretical amount for a half magnitude.

For comparison with the above I have constructed, from the data contained in *Uranometria Oxoniensis*, the following table, which contains the stars in the northern hemisphere down to the sixth magnitude :—

Magnitude.		Number.		Ratio to total of preceding stars.
Over the 2nd	...	17		—
2 to 2·99	...	40		2·35
3 to 3·99	...	133	...	2·33
4 to 4·99	...	407		2·14
5 to 5·99	...	1265	...	2·12

The above table shows that, so far as the sixth magnitude, the stars are really much more regularly distributed than appears from the *Durchmusterung*, and suggests that the irregularities from the sixth to the ninth magnitude are due to errors in the estimation of magnitude.

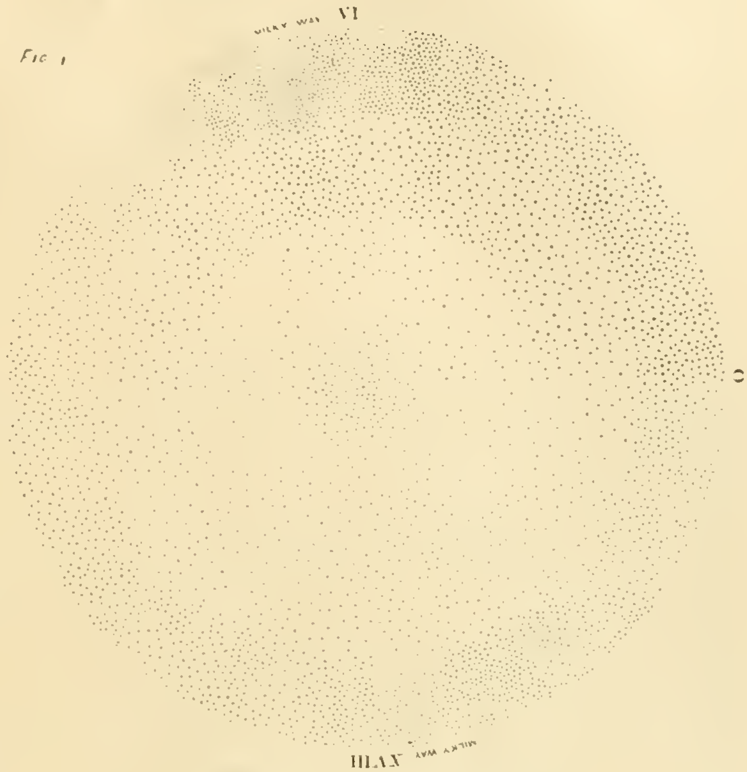
Another question that arises is whether the stars of various magnitudes are scattered indiscriminately in the sky, or whether bright and faint stars are aggregated in definite localities. In order to test this point, I have made an enumeration of all the stars in the *Durchmusterung* lying between 1° N. and 1° S. declination, with the following result:—

Magnitude.		Number.		Ratio to total of preceding stars.
1·0 to 1·9		*Nil.*		
2·0 to 2·9	..	2		
3·0 to 3·9	...	5	...	2·5
4·0 to 4·9	...	10	...	1·4
5·0 to 5·9	...	21	..	1·2
6·0 to 6·9	...	71	...	1·9
7·0 to 7·9	...	283	...	2·6
8·0 to 8·9	...	1789	...	4·6
9·0 to 9·5	...	7526	...	3·5

It will be seen that, while the actual proportion of the stars of each magnitude varies considerably from that in the whole hemisphere, there is a similar marked increase in the number of stars below the 8th magnitude.

The accompanying diagram (Fig. 1) represents an ideal section through the stellar universe, showing how stars of equal intrinsic brightness would have to be distributed in order to appear as they are shown in the above table. When we look through a telescope, the stars included in the field of view actually lie in a cone, having the eye at the apex, and the volume of the cone is as the cube of the distance to which the telescope penetrates. Now, in this diagram, the stars within the cone are plotted on a plane sector, the area of which is as the square of the distance from the centre. The distance of a star has been assumed to be inversely as the square root of the apparent brightness. Hence, in order that the distribution, as shown on the plane surface, may truly represent to the eye the assumed distribution in space, the number of stars of

Fig. 1



Section through the Stellar Universe.

each magnitude has been multiplied by a co-efficient. Further, the stars here dealt with, viz., those within one degree of the equator, were divided into groups, each occupying thirty minutes of right ascension, and each group plotted in its proper sector. The following table, showing the calculation for one group, will explain the process :—

Magnitude	2·0 to 2·9	3·0 to 3·9	4·0 to 4·9	5·0 to 5·9	6·0 to 6·9	7·0 to 7·9	8·0 to 8·9	9·0 to 9·5
No. of Stars ...	0	0	0	0	1	8	25	143
Multipliers	10	6·31	3·99	2·51	1·58	1	·63	·45
Relative density projected on a plane	0	0	0	0	1·5	8	16	64

A similar calculation was gone through for each thirty minutes of R.A., except that stars under the sixth magnitude were taken together, on account of their small number. The numbers in the last line are those shown on the diagram.

A glance at the figure shows the general character of stellar distribution in the plane of the equator. The distribution is approximately uniform towards the centre, with a marked increase of density towards the circumference, which becomes emphasised where the equinoctial plane crosses the Milky Way.

The increased number of stars below the eighth magnitude is very remarkable if it is fact; but this depends entirely on Argelander's magnitudes being photometrically correct. There is, in fact, reason to believe that the magnitudes of the fainter stars are over-rated. An examination of the first six hours of zone − 0° showed that out of one thousand one hundred and seventy-seven stars three hundred and eighty-five were rated at 9·5 magnitude. Now, it is very unlikely that a third of a thousand stars taken at random should be within a tenth of a magnitude of 9·5. It certainly looks as if all stars observed fainter than 9·4 were indiscriminately put down as 9·5. In order to put the question of the supposed rapid increase of faint stars to a practical test, I took six gaugings in zone $-0°$, R.A. 5h. 30m. to 6h., with apertures of two and a-quarter inches and three and three-quarter inches, with the following result:—

Stars visible with aperture of	$2\frac{1}{4}$	inches	...	64
Additional do. do.	$3\frac{3}{4}$	do.	...	57

According to the *Durchmusterung* there are in the same region:—

Stars of 8·9 magnitude and over	25
Do. of 9·0 to 9·5 magnitude	126

The increase of aperture from two and a-quarter inches to three and three-quarter inches represents about one magnitude, so that, if the magnitudes in the *Durchmusterung* were correctly estimated, we should have expected to see about ten times as many with the larger aperture instead of barely double the number.

With a view to throwing some fresh light on the question of the increase in the number of faint stars, I determined to make a series of gaugings in the following manner: A three and three-quarter inch refractor was provided with a series of five diaphragms of diameters ·75, 1·50, 2·25, 3·00, and 3·75 inches respectively. The diameter of the field was approximately sixty-four minutes, and each set of observations consisted in counting the number of stars visible with each successive aperture. One advantage of this method is that there is a direct relationship between the aperture and the space-penetrating power, which is simply proportional to it. Another is that, as each set of observations is made consecutively with the same instrument on the same evening, the result is free from errors due to changes in the atmosphere or the use of different instruments. Although the photometric magnitude of a star will be different under different conditions for the same aperture, yet the difference of magnitude for two different apertures remains constant.

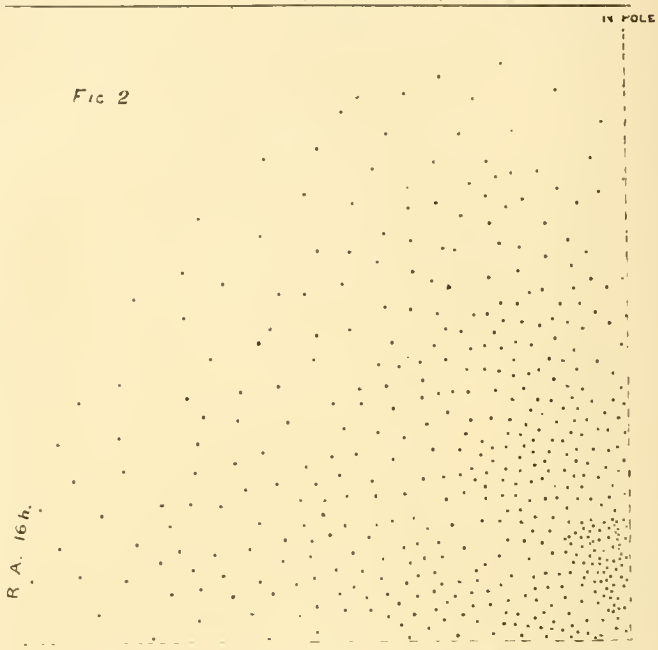
As has been already remarked, the stars seen in a telescope are contained in a cone whose vertical angle is the angular diameter of the field. If we assume that all stars are of equal intrinsic brightness, the height of the cone is proportional to the aperture, and its volume to the cube of the aperture. The following table shows the relationship of the various apertures we are dealing with and the volume of the space penetrated:—

Aperture.	·75	1·75	2·25	3	3·25
Space-penetrating power ...	1	2	3	4	5
Volume of space penetrated ...	1	8	27	64	125
Increase for each aperture ..	1	7	19	37	61
Ratio of increase to volume for next lower aperture ..	—	7	$\frac{19}{8}$	$\frac{37}{27}$	$\frac{61}{64}$
Or (approximately)	—	7	2·4	1·4	1·0

On the hypothesis of the equal distribution of stars in space, the third line gives the relative number of stars that ought to be visible with each aperture, and the last line gives the ratio of the additional stars seen with the larger aperture to those already in the field with lower aperture.

The following table gives the actual result of one hundred gaugings made in the manner above described:—

Aperture in Inches.	·75	1·5	2·25	3	3·25
Total number of stars visible with each aperture ...	118	466	923	1482	1824
Additional number for each aperture	—	348	457	559	342
Ratio of additional number to previous total ...	—	2·9	·98	·60	·23
Ratio on hypothesis of equal distribution	—	7	2·4	1·4	1·0



Stars of equal intrinsic brightness as actually seen.

Ninety of the gaugings above tabulated were taken on the sixteenth meridian between the pole and the equator, one to each degree. The results of these ninety gaugings are shown in Fig. 2, which has been constructed on the same principle as Fig. 1. The observations for each five degrees of the quadrant were added up, and the total, multiplied by a co-efficient, was plotted on the corresponding compartment in the diagram. These co-efficients, as has been explained, are required in order that the density may be truly represented on a plane; they are 1, $\frac{3}{7}$, $\frac{5}{19}$, $\frac{7}{37}$, and $\frac{9}{61}$ for the successive apertures. Fig. 2 consequently represents an ideal section through the stellar universe at R.A. 16h., showing how stars of equal intrinsic brightness would have to be distributed in order to appear to an observer on the earth as actually seen.

A comparison of these two figures will show at a glance that they indicate two totally distinct systems of stellar distribution. In the one case there is a continuous thinning out of stars as we proceed outwards, while in the other case there is a decided increase in density of the stars in the more remote parts of space.

That faint stars are really much less numerous than they would be on the hypothesis of equal distribution in space, may be shown by comparing the actual number observed with the number calculated from the numbers of superior magnitudes, on the assumption that number and magnitude continue to be related by the same law. The following statement shows the result of such a comparison:

Number of stars of the 17th magnitude that ought to be seen within a circle of 1 degree in diameter if the relationship of number and magnitude, indicated by the *Durchmusterung*, continued to the 17th magnitude.	180,000

Number of stars of the 17th magnitude that ought to be seen within a circle of 1 degree of diameter according to the relationship indicated by the *Uranometria Oxoniensis*.	33,000
Ditto ditto ditto by my own observations.	5,000
Actual number counted in a circle of 1 degree in the photograph published in the February number of Knowledge.	1,128

Upon the whole I think it very probable that faint stars are actually less numerous than they should be on the hypothesis of equal distribution in space, and that the apparent increase of density shown by the *Durchmusterung* is really due to the magnitudes of faint stars being over-estimated.

THE ZODIACAL COINS OF THE EMPEROR JAHĀNGĪR.

By E. Walter Maunder, f.r.a.s.

That acute critic in Wonderland, Alice, remarked "What is the use of a book without pictures or conversations"; and we are afraid that to the ordinary lay mind unversed in numismatics, the great majority of Muhammadan coins must lie under the same ban. For, in accordance with the exhortation of the Qur'ān (Sūra, v. 92), "O ye who believe! verily wine and al maisar and statues and divining are only an abomination of Satan's work; avoid them that haply ye may prosper," as a rule such coins bear only inscriptions, but no device.

There are, however, some exceptions, and these of much more than ordinary interest, to which our attention was called during our stay in India some sixteen months ago.

It was our great good fortune, when passing through the city of Ahmadābād, that most interesting capital of the ancient kingdom of Gujarāt, to be introduced to Dr. George P. Taylor, m.a., who not only constituted himself our guide to all the chief buildings of the city, but who treated us to a sight of his collection of silver rupees, the most complete in the world after those of the public museums of Calcutta and Lahore. Hardly a year is wanting in the succession of coins that recall the history of the great Moghul Empire from the accession of Akbar the Great, whilst the reigns of the Sultans of Gujarāt, stretching backwards some two centuries earlier, are well represented. It was the rule of these sultans that impressed upon Ahmadābād its striking and characteristic architecture—Muhammadan ideas being carried out in Hindū workmanship.

Amongst these our attention was at once caught by several coins, which not only appeared beautiful even to our unpractised eyes, but which were evidently also astronomical. These were some of the zodiacal rupees of the Emperor Jahāngīr, son of Akbar the Great.

The story of how these coins, which seem so distinct an infraction of the Muhammadan rule which forbids the making of "any graven image, or any likeness of anything that is in heaven above, or that is in the earth beneath, or that is in the water under the earth," came to be struck is a very interesting one. Neither Akbar nor his son and successor Jahāngīr were at all bigoted Muhammadans. The former, indeed, was a decided eclectic, and, in accordance with his exceedingly broad views, had married a representative of each of the three great faiths with which he was acquainted—the Christian, Muhammadan, and the Hindū. Jahāngīr, or Prince Selim, as he was called before his succession, was the son of the Muhammadan wife, but with the influence of his father's example before him it was not perhaps surprising that he held his mother's creed but laxly.

A far more potent influence came into his life when a Persian, named Kwāja Ghyās-ud-Dīn, accompanied by his beautiful wife, and yet more beautiful daughter, visited his father's court. With the latter, Mehr-un-Nissa by name, he fell desperately in love. The emperor, in order to prevent the *mésalliance*, hurried the beautiful Persian into marriage with a valiant Turk of the name of Shere Afgan, whom he appointed as Deputy-Governor of Burdwan. Shere Afgan did not long survive his royal master, owing to circumstances upon which the new emperor, Jahāngīr, has not thought fit to enlarge in his *Memoirs*. It was not, however, until six years later that Mehr-un-Nissa was married to the emperor, under the title of Nūr Mahal ("Light of the Palace"), changed two years later into the title by which she is best known, Nūr Jahān ("Light of the World").

The extraordinary influence which this great queen exercised is a well-known fact of history, and is illustrated by coins both in silver and in gold, which bear her name along with that of her husband. Dr. George Taylor, who has kindly allowed me to quote freely from a paper of his, writes concerning these coins:—"As in the history of the Mughal Emperors of India she alone of all the Queens-Consort wielded practically supreme power, so of all the Queens-Consort her name alone is found on any purely Indian coin. On the coins of a much earlier date the name of Sultānā Ridīya does indeed occur, but she was for three years a Queen Regnant (a.d. 1236-1239). The rupees of Nūr Jahān are still occasionally to be found in the bazārs of Gujarāt. My collection contains twelve, of which nine were struck at Sūrat, between the Hijrī years 1033 and 1036, one at Lāhor in 1034, and two at Ahmadābād—a very rare issue—in 1036 and 1037. Other mints of this coin are Agrah and Patna. The legend, covering both the obverse and the reverse, runs:—

"By the order of Jahāngir Shāh, gold has gained a hundred splendours through the name of Nur Jahān Pādshāh Begam."

"The jeweller Tavernier, whose travels took him into Persia and India about the year a.d. 1670, records at length how the famous zodiacal muhrs and rupees came to be struck during the four-and-twenty hours that Jahāngīr permitted his wife to reign in his stead. On these coins, instead of the name of the month of issue, was stamped the figure of the sign of the zodiac corresponding to the particular month.

"The story, as recounted by Tavernier, runs thus:—

"One day that the king was extremely well pleased, and having drunk briskly began to be merry, after the queen had danced in his presence, he took her and sat her by him, protesting to her that he loved her above all the princesses in his court. . . . The queen seeing the king so highly affected towards her, failed not to make use of so favourable an opportunity. 'To which purpose, sir,' said she, 'if it be true that your majesty has that kindness for me of which you would persuade me to assure myself, I know you will grant me one favour which I have passionately desired a long time; that I may only reign as sovereign the space of twenty-four hours.' This request surprised the king, and kept him sad for some days, being unwilling to deny her anything, and yet being as loath to grant her a boon of so high a nature. In the meantime the queen plied the king with pastime and divertisements, pretending to take no notice of his melancholy. At length, the fifth day after she had made her petition, the king, no longer able to resist her charms, nor the strong passion he had for her, told her he would retire for twenty-four hours, and that she might assume the absolute command of the kingdom during that time. . . . It was a long time before that the queen had made everything ready, and that she had secretly hoarded up great quantities of gold and silver in all the cities where the mints were appointed, and had distributed the stamps as she thought convenient. And indeed it was a wonderful thing that a woman should so politically carry on so great a design as to have four-and-twenty stamps engraved, and to keep in readiness in gold and silver about two millions in all the cities, without being discovered to the king or any of the court. . . . The day being appointed, she sent away messengers to all the cities, commanding them on that date to coin rupees of gold and silver to the value already mentioned. . . . The thing was so suddenly done, especially in the cities near at hand, that within two hours after she was sate upon the throne, she caused several quantities of that gold and silver to be thrown among the people, which during the reign of Jahāngir went currently for rupees. But when Sultān Kharram, who took upon him the name of Shāh Jahān, came to the throne after the death of his father, he forbade all persons to use those rupees upon pain of death, and commanded all that had any of them, either in gold or silver, to carry them to the mint, where they should receive the value of them, to the end they might be melted down. For which reason they are at present very rare, particularly those in gold. Among the rest, two or three of them are so hard to be found that an hundred crowns has been given for one of them. The rupees of gold are worth one-and-twenty livres of our money, and those of silver thirty sous. The queen, during her reign of twenty-four hours, had that respect for the king that, on the back-side of the pieces, whereon the twelve signs were engraven, she caused the name of Jahāngir to be stamped with her own, and the name of the place where they were coined, all in Arabic letters."*

"One is tempted to regret the necessity to relegate this artless story to the domain of fiction. But its refutation comes from the coins themselves, for the dates they bear cover no less a period than nine years, the Higrī years from 1026 to 1034. Still, that there is a substratum of truth in the legend may perhaps be granted from the fact that at least three of the zodiacal coins do present the name of Nūr Jahān. These are: (*a*) A gold Sagittarius of 1035, now at Paris; (*b*) a gold Cancer of 1034, mint Ajmīr, once in the possession of the late Hon. Mr. James Gibbs; (*c*) A silver Leo of 1028, described a century ago by M. Anguetil du Perron.†

"The many evident errors in Tavernier's narrative notwithstanding, I confess I should be surprised if 'my lady magnificent,' who at this time so distinctly held the *rôle* of 'predominant partner' in matters imperial, should prove to have been entirely innocent of connection with these zodiacal coins, forming, as they do, a series quite the most beautiful of all issued in Jahāngīr's reign. That he himself claims them as 'my own innovation,'‡ scarcely determines the question, for, as Talboys Wheeler says, 'Jahāngīr always exaggerated; he never told the truth in anything.'§

The emperor's own account is given in the *Waqi'at-i-Jahāngīrī*:—

"'Formerly it was customary to strike my name on one side of the coin, and that of the place and the month and the year of the reign on the reverse'—this, we have already seen, had been the custom during the seven preceding years, that is, from 1020 to 1027 H.—'It now occurred to my mind,' Jahāngir adds, 'that instead of the name of the month the figure of the sign of the Zodiac corresponding to the particular month should be stamped. . . . . This was my own innovation. It had never been done before.'"—Dowson's "Elliot," VI., 357.

"Of the zodiacal coins it would seem that 'with one or two exceptions the gold muhrs were all struck at Agra and the silver rupees at Ahmadābād.' This at least was the conclusion arrived at by the late Honourable Mr. James Gibbs, C.S.I., and communicated to the Bombay Branch of the Royal Asiatic Society in a paper read by him as President in the year 1878. (Jo. B.B.R.A.S., No. 36, Vol. XIV.)

"Of all these zodiacal coins, the reverses, struck from dies probably engraven by a European artist, and one of no mean order, exhibit on a background of solar rays some one of the conventional signs of the zodiac, while in a few cases (Cancer, Leo) even the stars of the constellations are represented. Beneath the sign comes the regnal year 13 and the phrase 'Sanah Julūs,' or, in the case of Gemini, Cancer and Scorpio, the word 'Sanah' alone.

"Of the complete series of the twelve zodiacal Ahmadābād rupees it will be seen that four (Virgo, Libra, Sagittarius, and Aquarius) are quite unrepresented in the published catalogues. That all the twelve were issued there is no room to doubt, and James Forbes, writing his 'Oriental Memoirs' in 1813, expressly states: 'I once saw an entire collection of these rupees in silver, and a few others procured by chance of the same metal.' (2nd Ed. II., 215.) While poor imitations of the whole series are still sometimes exposed for sale (in Bombay I have been offered the twelve for Rs. 25), it is much to be feared that the complete sets formerly met with, as Forbes quaintly puts it, 'in the cabinets of the curious,' have long since been broken up and dispersed."

It will be observed that in the preceding paragraph Dr. Taylor is confining himself entirely to the question of the silver rupees minted at Ahmadābād. As the plate (which, by the kind permission of the Keeper of the Department of Coins and Medals at the British Museum, we are enabled to give) shows, the British Museum collection of coins contains representatives of every one of the signs for the gold mohurs, minted at Agrah, and several forms for some of them. The plate contains nineteen of the mohurs, the twentieth giving an example of the inscription on the reverse. Of the eight signs known to exist of the Ahmadābād rupees, the British Museum collection contains all but Pisces, the last coin in the plate being a reproduction of the reverse of one of the silver rupees. I am indebted to Mr. E. J. Rapson, M.A., to whom I would here desire to express my great obligation, for the casts from which the photograph was taken.

In a large number of cases the design is evidently European. Numbers 1 and 21 show us the typical ram of Aries with the reverted head, significant, no doubt, of the position of Aries as the last and not the first of the signs of the zodiac at the time when they were originally mapped out. Number 22—the Taurus rupee—gives us again the traditional figure, the half bull charging from out of the cloud, which we still have in our atlases. Numbers 2 and 3 are, however, more strictly Indian in design, showing the humped Indian Bull in full figure; and the two examples face different ways, showing that the artist attached no significance to the direction in which the sign was turned, and that strict astronomical accuracy was not sought by him. Numbers 4 and 23—the Twins—follow the Indian and not the European zodiacs, in representing a man and woman, and not the Dioskouroi. This form—the man and woman—is common to nearly all the Oriental zodiacs, but we have seen its place taken on a Burmese zodiac by a single female figure. The Crab, Numbers 5 and 24, is a very spirited figure, and stands in high and sharp relief. The Lion, Numbers 6, 7, and 25, is one of the poorest designs, and can scarcely have been due to the same artist who designed Numbers 5, 14, and 22. It will be seen that the Lions in Numbers 6 and 7, like the Bulls, face different ways. Three forms for the Virgin follow: Numbers 8 and 9 are, without doubt, of Indian design; Number 10 recalls the conventional one known in Europe. The Scorpion is shown under several forms,

* "The Six Voyages of John Baptista Tavernier," made English by J.P., 1678 Edition, page 11.

† "Notes on the Zodiacal Rupees," by the Hon. J. Gibbs, in *Journal of the Bombay Branch of the R.A. Society*, Vol. XIV., No. 36 pages 157, 160, and B. M. Catal. Mughal Emperors, page LXXXI., Note *.

‡ Dowson's "Elliot," VI., 357.

§ Talboys Wheeler: "History of India," Vol. IV., Part I., page 203, Note 20.

GOLD MOHURS MINTED AT AGRAH.

SILVER RUPEES MINTED AT AHMADABAD.

ZODIACAL COINAGE OF THE EMPEROR JAHĀNGĪR.

Numbers 12 and 13 being probably Indian, whilst the sun is omitted from the background of Number 26, possibly a reminiscence of the evil astrological repute of this "dark" and "ill-starred" sign. The Sagittarius of Number 14 is, perhaps, the finest design of the series, but the Archer is represented as firing a Parthian shot, and not, as in our zodiac, shooting before him. Capricornus, Numbers 15 and 27, would appear to have the head of a gazelle rather than of a goat. The fish-tail is very strongly emphasized in both cases. The three designs for Aquarius are evidently native, Number 17 being simply an ordinary *lotah*.

Whether we owe to Jahāngīr or to his far more gifted empress the original idea of employing the zodiacal symbols as designs for coins, it must be admitted that they have proved themselves admirably suited for the purpose. There are few indeed in the long array of stiff and formal British coins with anything like the grace aud beauty of the best of these Moghul mintages.

GALILEO'S TOWER AT FLORENCE.

By W. Alfred Parr.

FEW astronomers passing through Florence will fail to pay a visit to the picturesque old tower known as the "Torre del Gallo." This interesting old building, situated on one of the hills to the south of the city, close to the present Arcetri Observatory, is supposed to have served at one time as an observatory to Galileo. Whether this be so or not, and it has been sometimes doubted whether the founder of telescopic astronomy ever actually utilized the tower as his observatory, the building and its vicinity possess so many reminiscences of the great man that the astronomical visitor cannot fail to have his interest aroused.

One of the rooms of the tower has been fitted up as a museum, and contains an interesting collection of engravings, documents and other relics relating to the life of Galileo. A photograph of the well-known painting which

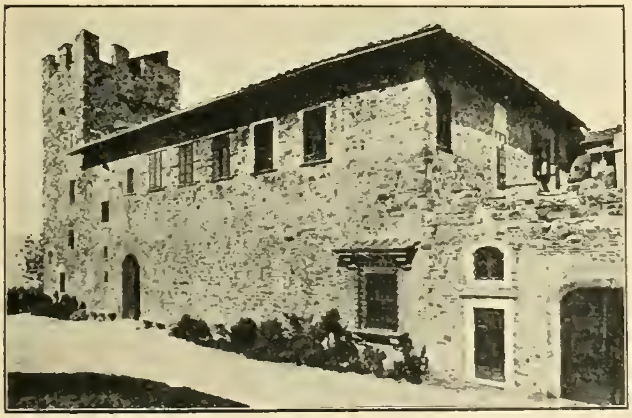


Fig. 1.—The Torre del Gallo, Florence; supposed to have been used as an Observatory by Galileo. (Photo by Brogi, Florence.)

represents Galileo before the Judges of the Inquisition is of special interest. The great astronomer stands before the assembled dignitaries of the Church, and has just pronounced his celebrated recantation of his theory of the earth's motion, when averting his head he mutters: "E pur si muove."*

Some old instruments, dating from the time of Galileo, are also exhibited here, but a far finer collection of old telescopes, some of which were in the actual possession of Galileo, is preserved in Florence at the Museum of Physical Science. Nowadays every tyro in astronomy possesses a telescope superior to Galileo's "optic glass," and it is only when contemplating these primitive old

Fig. 2.—Museum in the Torre del Gallo. The wooden staircase leads to the platform on the top of the Tower, from which Galileo is said to have made his observations. (Photo by Brogi, Florence.)

instruments that one fully realizes the greatness of the man who, with such meagre optical means, was yet able to achieve such far-reaching results.

From the top of the tower a most magnificent panorama unfolds itself, the view extending from the wooded heights of Vallombrosa on the east to the distant Carrara mountains on the west, while below, in the valley of the Arno, lies Florence.

Not far from the Torre del Gallo is situated the Villa of Galileo, where the great Florentine passed the closing years of his life, latterly deprived of sight but surrounded by a few faithful friends. It is here that he was visited by Milton in the year 1638, and here he died in 1642.

* "But it *does* move."

Science Notes.

Refrigeration is one of the most recent, and at the same time one of the most important applications of mechanical engineering on board ship. It is not yet twenty years since the frozen meat trade was begun between Australia and England. At the outset comparatively small cargoes were carried, but as machines were improved and experience was enlarged so larger cargoes were carried, and a new branch of the shipping industry was created. The first refrigerators were designed to deal with one hundred and fifty tons of meat. Now machines are constructed capable of dealing with three thousand tons, while they occupy only two and a half times the space and consume about three times the coal required for the first machines. Sir William White has recently pointed out that in 1881 about fourteen thousand carcases were brought to this country from the Colonies; in 1899 he anticipates that from eighteen to nineteen millions will be delivered from the Colonies and various parts of the world. In addition to meat, large quantities of butter, fruit and other perishable cargoes are now carried from the far ends of the earth and delivered in good condition.

Mr. R. A. Emerson has communicated to the Academy of Sciences, Nebraska, some interesting observations made by him, over a period of four years, on the temperature inside tree trunks. When the trunks and limbs of trees are shaded, their temperatures, if above that at which water freezes, vary according to the temperature of the outside air. Moreover, in the shade, tree temperatures above the freezing point of water are higher than the air temperature when both are falling and lower when both are rising. When exposed to bright sunlight, however, the tree temperatures, in circumstances otherwise similar, are higher than the air temperature, not only when both temperatures are falling, but are often higher also when both are rising. One side of even a small limb may consequently have a temperature much higher than the air and the opposite side a temperature lower than the air.

A recent meeting of the Linnean Society was very full of interest. Mr. Botting Hemsley, F.R.S., exhibited plants from high altitudes, collected by several well-known explorers. Mr. Valentin sent photographs and lantern slides of an elephant seal eighteen feet in length, which he recently examined alive on the shore on the Falkland Islands. It was a male, the trunk being only possessed by this sex. The latter was inflated till it was a foot in length from the tip to the gape. Mr. Harting had living specimens of the rarer British vole from Skomer Island, off the coast of Pembroke. The young are brown, the adults reddish, and the hair grows remarkably fast. The President, Dr. Günther, produced a letter bearing upon the case of the gigantic land tortoises of the Seychelles, sent by the Administrator there to Mr. Chamberlain, and exhibited photographs of several specimens. The letter arose out of Dr. Günther's presidential address of last year, which treated of these reptiles and their chances of soon becoming extinct. Afterwards Sir John Lubbock read a paper on some wingless insects of Australia, and, finally, an account was given of a unique specimen of a crustacean found in a whale.

It is now over twenty years since Raoul Pictet, of Geneva, announced the results of experiments carried on with the object of liquefying that most refractory of all the so-called permanent gases—*hydrogen*, but up to a week or two ago all efforts in this direction were, at the best, problematical and unconvincing. Now, however, a grand achievement has been effected by Prof. Dewar and his able assistant, Mr. Robert Lennox. These investigators, by the undoubted liquefaction of hydrogen, have put the finishing stroke on the line of research initiated by Faraday when he first reduced the gas chlorine to a liquid. The new agent of scientific research—liquid hydrogen—congeals the air surrounding the containing tube into a snow-like solid, and a piece of cork sinks to the bottom when put in the liquid; the temperature at the boiling point is 21° absolute, or $-252°$, a temperature representing a pressure which is immeasurable. The liquefaction of hydrogen is a triumph of theory as well as practice, for in face of all the enormous difficulties which have been encountered, theorists have never deviated one jot from the conviction, which sound reasoning long ago showed, that there is no such thing as a permanent gas.

British Ornithological Notes.

Conducted by Harry F. Witherby, F.Z.S., M.B.O.U.

"Nightingale Thrushes."—Between Eltham and Sidcup, Kent, are several thickets in which the Thrush abounds, and in which the Nightingale is very common in its season. The effect of this close association of the species is apparent in the song of some of the Thrushes there. In January and February a wonderfully good rendering of some typical strain of the Nightingale is often heard from a Thrush. A friend remarked upon this, he having felt assured that he was listening to a Nightingale (in March) until the bird was revealed close at hand as a Thrush. The Thrushes never attain to a good rendering of the long-drawn sweet note of the Nightingale, but they try to do it, and give a long "straight" whistle, like "pee pee pee," in the effort. Some of the other strains, however, are more successful. I have heard the "pee pee pee bobloblоble" and the full bubbling note (like that of the Lesser Whitethroat) given with exactly the emphasis and accent of a Nightingale, by a February Thrush. Then the alarm, "whit-urrrr," of the Warbler has been given with exactness two months before the arrival of the bird. Many of the phrases of the Thrushes at the spot indicated also include a very rapid repetition of two notes many times, one note being a few tones higher than the other. This is a feature no doubt derived from the Nightingale, whose song so often contains a similar variation. Near Charlton Kings, in Gloucestershire, late in March, I heard a Thrush give a true strain of the Nightingale, and asked if the latter bird had not been found there last year. The answer was that a Nightingale had been heard close to the spot. My observations lead me to conclude that the best singers of Thrushes and Robins (at least) are found not rarely year after year in the same spots. I never heard the Eltham Blackbirds try to imitate the Nightingale, but one of them, this year, was certainly uttering a song consisting sometimes of nothing but one note repeated, and that note was also the note of some young Ducks! The Ducks had been there for a couple of months or more, and were noisy as usual—with the result that the poor Blackbird found himself unable to originate any better song than a kind of musical "work work work." He would give five or six phrases of nothing but this note, then add a few whistled sounds. This incident was chiefly noticeable at dawn; and it was plain that the Blackbird was very desirous to utter a nobler song, for after a time he wholly abandoned the primitive strain, and sang only the usual, varied, full songs of his species.—Charles A. Witchell.

Spring Immigration of the Golden-crested Wren.—There was a very considerable immigration of Golden-crested Wrens on the Yorkshire coast in the third week of April. At Flamborough on the 21st they swarmed, and in the Spurn district were numerous on the 18th and subsequently, some being picked up dead, which fact is suggestive of a long and exhaustive flight. The wind during the period was strong north-east, and the weather was hazy. This movement of the Golden-crested Wrens is very remarkable, as, so far, we have no notice or record of a spring immigration of the species. We know that immense numbers arrive in October on our eastern shores at the same time as the Woodcocks, and that many again leave the country about the last week of March or early April at the same time when the Woodcocks are leaving. The spring movement is, however, much less observable, as these small wanderers then approach the coast in straggling fashion and not in the larger flights of autumn. Under unfavourable meteorological conditions I have known them congregate in considerable numbers in the coast hedgerows, biding their time. This spring immigration of Gold-crests has, probably, been caused by migratory flocks going north meeting with bad weather over the North Sea, driving them considerably westward of their normal route on to the East Coast of England.—John Cordeaux, Great Cotes House, R.S.O., Lincoln.

Notices of Books.

Corona and Coronet. By Mabel Loomis Todd. (Houghton, Mifflin & Co : Boston and New York.) Mrs. Mabel Loomis Todd has written a very charming account of the Amherst Eclipse Expedition, which went to Japan in 1896, to observe the total eclipse of the sun on the 9th of August. Mrs. Todd and her husband, Prof. David P. Todd, were the guests of Mr. James, who kindly placed his schooner yacht "Coronet," at the disposal of the observers in search of the "Corona," hence the title of the book. The author describes in an easy, conversational style, the preparations that were made to capture the fleeting light of the corona, and despite the fact that a faint mist intervened at the critical moment, yet her description of the veiled coronal light is a picture-poem in itself. To those interested in the coming total eclipse of the sun, in 1900, the book affords some idea of the preparations necessary in order to observe a total eclipse of the sun, and the trials that await those who propose to follow "in pursuit of a shadow." This unscientific account of a scientific expedition is treated in a masterly way by the bright, sympathetic author, who knows so well how to describe the picturesque scenes and people, and the many delightful experiences occurring during this eventful cruise. She weaves the charm of romance around actual facts, and a keen sense of humour adds greatly to the interest of the book. Mrs. Todd knows not only how to tell a story, but how to tell it well.

On Buds and Stipules. By the Right Hon. Sir John Lubbock, Bart., M.P., F.R.S., etc. (London : Kegan Paul, Trench, Trübner & Co., Limited.) 5s. This new volume belongs to the deservedly popular International Scientific Series. That it is from the pen of Sir John Lubbock is evidence enough of its interest, even for the general reader. Vaucher long ago called attention to the fact that some species of rock rose have stipules while others have none, and suggested that it would be interesting to ascertain the reason for this difference. Sir John Lubbock has devoted himself to the question, and has been contributing his conclusions to the Linnean Society since 1890. In the present volume a selection of parts of the papers likely to be of general interest has been made. Every reader knows what a bud is, and the meaning of stipule is thus clearly defined by the author: "Stipules are normally more or less leaf-like structures at the base of, or just below, and one on each side of, the leaf-stalk. They are very variable in size and appearance" (p. 224). Among the conclusions arrived at may be mentioned that the general functions of stipules is to protect the younger leaves ; their presence or absence depends in great measure on the need for such protection. Speaking generally, where the leaf-stalk is broad and covers the bud there are no stipules, and where it is too narrow to protect the bud stipules are present. But though the protection of the bud is the chief business of the stipule, it often performs other useful work. Sometimes it behaves like a leaf ; often it forms hooks or tendrils ; in other cases it secretes gum, or a sweet substance which attracts wasps ; while in some plants it holds water—acts as a reserve of nourishment for the plant—or even makes a support for the stem. The book is lavishly illustrated at the rate of three good pictures to every two pages, and in addition to this there are four coloured plates. We cordially recommend the volume to "everyone who loves a garden," to use the words with which Sir John Lubbock commences. It is simply written in the author's well-known style, and many of the observations can be repeated by any intelligent reader.

Annals of the Lowell Observatory.—Vol. I. *Observations of the Planet Mars during the Opposition of* 1894-5, *made at Flagstaff, Arizona.* By Percival Lowell, Director of the Observatory. (Boston and New York: Houghton, Mifflin & Co., 1898.) Some six or seven years ago, M. Flammarion brought out an admirable monograph on the planet Mars, embodying the principal results of all the physical observations made upon the planet up to that date. Now we have in the first volume of the "Annals of the Lowell Observatory," a book of nearly four hundred quarto pages, and illustrated by twenty-one fine plates—nearly as large a book, that is to say, as Flammarion's monograph—as the result of the work of a single observatory during a single opposition. This in itself is a very remarkable achievement. It is the result of an adherence to the principle which Schiaparelli was the first to thoroughly exemplify ; the principle of studying the planet, not just for a few weeks at opposition, but as continuously and as long as it was possible to do so with any good effect. To this principle Mr. Lowell added another. Before beginning his observations he made a most careful search for the most favourable site in which to erect his observatory. Schiaparelli, by his detailed and continuous observations in the fine climate with which he was favoured, revolutionized our ideas of the appearance of Mars, and carried its observation into quite a new sphere. In the main, his results have received ample confirmation. Mr. Lowell has carried areography into a higher sphere still. At present his results rest simply on his own observation and those of his two assistants, Mr. W. H. Pickering and Mr. Douglass. It would be unscientific, and eminently unjust, to reject his work because as yet it transcends the experience of less favoured, or less persevering observers. It would certainly be rash to accept them blindly until they have received support from entirely independent sources. In any case, Mr. Lowell's energy and perseverance, the thoroughness of his devotion to the study of this most interesting planet, and the lavishness with which he has devoted both money and personal effort, deserve the highest recognition and praise. The volume gives the observations made of the planet in great detail. An exceedingly minute survey of the South Polar cap affords incidentally a means for demonstrating in an ingenious manner the presence on Mars of air, water, and a temperature not incomparable with that of the earth. After some valuable determinations of a number of fundamental longitudes, follow measures of the diameters of the planet, giving a polar flattening of $\frac{1}{190}$, and, more remarkable still, a determination of the twilight arc of ten degrees as against eighteen degrees on the earth. The question of the seasonal changes on Mars is then worked out in great detail, but the bulk of the book is taken up with the study of "canals" and "oases." Mr. Lowell concludes that there is little water on Mars ; that it is locked up in the South Polar snows during the southern winter, and that when liberated by the return of spring, it is led off by artificial canals, and distributed over the surface of the planet. The fine lines which we call "canals" are not these waterways themselves, but the zones of vegetation which spring up along their banks. An elaborate discussion of irregularities on the terminator occupies over eighty pages, the projections being ascribed to Martian clouds. These conclusions may or may not be verified in the future, but one result will certainly follow. It will no longer be considered sufficient for a great observatory to make ten or a dozen drawings of Mars at opposition as its contribution to our knowledge of the planet. Other observatories must give the same earnestness and energy to this study as has been done at Flagstaff, or they must leave it alone altogether.

Old Clocks and Watches and their Makers. By F. J. Britten. (Batsford.) Illustrated. 10s. net. Mr. Britten, already known as the author of several books, and as secretary of the Horological Institute, has here presented us with an account of the history of clocks and watches, their mechanism and ornamentation, to which is appended a list of about eight thousand old makers with descriptive notes. There are some four hundred illustrations, many of which have been reproduced from photographs of choice and curious examples of clocks and watches of the past, in England and abroad, including the finely-ornamented bracket clocks of the seventeenth century with their ingenious mechanism, and the tall and elegant cases of the eighteenth century ; also a judicious selection of portraits of the most renowned masters of the clockmaker's art. Technical terms, so exasperating to people uninitiated into the mysteries of horological phraseology, are subordinated to the utmost, and are only allowed to show themselves when popular language is utterly inadequate to present an exact exposition of the subject in hand. One is, at first, puzzled as to how the author has been able to bring together such a vast collection of rare specimens of timekeepers, on which artists have lavished their resources in variety of design, and inventors their skill in all sorts of ingenious contrivances for self-winding, perpetual motion clocks, mystery clocks, rolling clocks, and so on, but the author, in addition to availing himself of the collections at South Kensington and the British Museum, has had access to many private collections, and has also elicited particulars not to be met with in ordinary channels, by consulting old tradesmen's cards, the Hon. Gerald Ponsonby, among others, having brought together a magnificent show of this kind. A very useful summary, in tabular form, of incidents connected with the development of clocks and watches is given, ranging from the invention of weight clocks, attributed to Gerbert, 990 A.D., to duties imposed on owners of watches and clocks in 1797. Pitt, in that year, levied a tax of eight shillings an ounce on gold cases, and at the same time imposed a tax on all persons in respect of the possession and use of watches as well as clocks—an annual duty of two shillings and sixpence.

The Resources of the Sea, as shown in the Scientific Experiments to test the Effects of Trawling, and of the Closure of certain Areas off the Scottish Shores. By W. C. McIntosh, M.D., LL.D., F.R.S., etc. (London: C. J. Clay & Sons.) 15s. net. This handsome and well illustrated volume gives, with other important information, in a very readable form, an account of the work conducted by Prof. McIntosh for the Royal Commission on Sea-Fisheries (1883–85). A discussion of the results of these extensive researches also, very naturally, takes a place of considerable importance among the contents of the volume. The author, whose unique experience gives him a position of great authority, is unable to agree with the line of conduct of the Fishery Board for Scotland. This spirited criticism of the plans and conclusions of the Board will provide deep-sea naturalists, and students of the fisheries question in particular, with material enough for much serious thought, and a great deal of further experimental work. It is quite certain that the conclusions here set down will not be universally accepted by all specialists in this branch of technical biology, though we are equally sure that every chapter of the treatise will receive careful attention. Prof. McIntosh never leaves any doubt as to the points on which he holds his own opinion. Thus, on page 58, in referring to the closure of certain areas by the Fishery Board, he remarks: "No one will question the right of the Government to take such a step in the interests of the fishing population, on philanthropic, social, or even political grounds, but if such a step were taken on the basis of the scientific evidence furnished by the Fishery Board, then it would appear that the premises (and here all matters of fact are included) do not warrant the conclusion." Successive chapters are given to investigations of sea life by trawling in St. Andrew's Bay, the Frith of Forth, the Moray Frith, and the Frith of Clyde. Summarizing his remarks concerning the particulars to hand respecting St. Andrew's Bay, the author remarks: "If they show anything more than another it is that the closure of such areas has no appreciable influence on the increase or diminution of the fishes within their own boundaries or in the neighbouring waters. The problem is too vast to be solved by such pigmy measures" (p. 132). Again, in recapitulating his considerations of the trawling experiments in the Frith of Forth (p. 184), Dr. McIntosh declares that the conclusion of the Fishery Board "that there has been a decrease in the abundance of flat fishes in the closed waters of the Forth" rests on the most uncertain foundations, and is of little moment in dealing with so large a question. These selections are sufficient to show that there is much in this volume to be carefully weighed by every Fishery Board. The book contains a beautiful series of plates, including several views of the Gatty Marine Laboratory, St. Andrew's, pictures of various phases of a fisherman's life, a view of Aberdeen fish market, and many others equally interesting. Thirty-two tables of statistics furnish an invaluable appendix. Altogether the book is an important addition to applied marine zoology.

River Development, as Illustrated by the Rivers of North America. By Prof. I. C. Russell. (Murray.) 6s. The author has preferred to indicate by his title that his observations have been made in the country of magnificent streams where ample space permits the display of their capacious development, but it is evident that the same suggestive reasoning and acute observation must apply to the behaviour of the streams of all lands. Local conditions modify, but principles remain intact. One great fact that many of us may well learn from this interesting work, brightly and pleasantly written, is our own poverty of observation. There is a minuteness of detail worthy of consideration in the progress of stream sculpture that is apt to be overlooked without the assistance of an adept to call our attention to small niceties. Questions connected with the shape, the current, the banks, the eddies, and with the forces in action that are continually moulding and affecting the character, the development, and the behaviour of a small stream are many and far reaching. Another class of queries may come before us when carried on some commodious steamer over a broader river, past docks that tell of commerce and enterprise, out to the ocean beyond where a machinery of lighthouses and signals is necessary to enable us to avoid shifting sandbanks and accumulated material brought down by the river current. Unless we can explain all the facts that are brought to our notice between the source and the mouth of a river, we shall do well to pass an hour or two in the company of Prof. Russell. Many but by no means all of the questions which the river puts to us, or we put to it, he can and does answer pleasantly and satisfactorily. The illustrations, principally from photographs, make a very welcome addition to the pleasures of the text.

The Art of Writing English. By J. M. D. Meiklejohn. (A. M. Holden.) It is idle to set a limit to the ambition of a Scotchman. Not content with dominating the House of Commons and populating the learned societies, he has now (in the person of the genial professor of St. Andrews) launched this altogether admirable manual on the art of writing English at the head of the decadent Southron. It is badly needed, but we are quite sure it will not be studied by the men (or the women) who write; yet we may give expression to the fervent hope that the book will do something to thin the ranks of the muddleheaded among us. "Sir Thomas More was an Irishman. He was also a great lyrical poet. He soon gave up poetry, however, and went into the army. Shortly after he won the great battle of Corunna, in the Peninsular war. He was killed while walking about the deck with all his medals on; but he did not die ere he knew that he had won the great victory of Trafalgar." It would require a Kipling to do full justice—adjectival justice—to this muddleheaded study in black and white, but we feel it to be quite a moderate example of the mixed information which so largely serves to make our nationhood. And we wish Mr. Meiklejohn well in his heroic attempt to induce a little clear thinking across the border.

We have received *The Photo-Miniature*, a new American monthly magazine. (London: Dawbarn & Ward.) That there is room for another photographic magazine is a doubtful point. However, the *Photo-Miniature* is striking out on somewhat new lines, its aim being to supply "a sound general understanding" of any one section of photographic work. Judging by the one long and fairly exhaustive article before us on modern lenses this will be well carried out.

A second edition of *Chemistry for Photographers*, by C. F. Townsend, F.C.S., F.R.P.S., has been issued. A careful revision has removed the slight errors of the previous issue; a very useful book is the result.

The Open Court Publishing Company, of Chicago, have sent us some specimens of its projected series of portraits of the leading philosophical and psychological thinkers of the world. We think the idea an excellent one, and so far as the reproductions before us are concerned, it has been most efficiently carried out.

BOOKS RECEIVED.

Colour: A Handbook of the Theory of Colour. By George H. Hurst, F.C.S. (Scott, Greenwood & Co.) Illustrated. 7s. 6d.

Living Pictures: Their History, Photo-Production, and Practical Working. By Henry V. Hopwood. Illustrated. 2s. 6d. net.

All About Birds. By W. Percival Westell. ("Feathers" Publishing Co.) 1s. 6d.

Early Work in Photography. Second Edition. By W. Ethelbert Henry. (Dawbarn & Ward.) Illustrated. 1s. net.

Scientific Chemistry in Our Own Times. Prof. Tilden, F.R.S. (Longmans.) 5s. net.

Curious Epitaphs. By William Andrews. (Wm. Andrews & Co.) Illustrated. 7s. 6d.

The Use of Lead Compounds in Pottery. By William Burton, F.C.S. (Simpkin, Marshall, Hamilton, Kent & Co.) 1s.

The Geography of Mammals. By W. L. Sclater and P. L. Sclater. (Kegan Paul.) Illustrated.

Animals in Motion. By Eadweard Muybridge. (Chapman & Hall.) Illustrated. 20s. net.

The Choruses of Sophocles—"Antigone." By F. Abdy Williams. (Breitkopf & Härtel.)

Evolution by Atrophy in Biology and Sociology. By Demoor, Massart, Vandervelde. (Kegan Paul.) 5s.

Liverpool Observatory, Report of the Director for 1898.

Handbook of the Marriage Act, 1898. By M. Roberts-Jones. (Evan Rees: Cardiff.) 2s.

A Russian Province of the North. By Alexander Platonovich Engelhardt. (Archibald Constable & Co.)

Sport in East Central Africa. By. F. Vaughan Kirby. (Rowland Ward, Limited.) Illustrated. 8s. 6d.

THE MYCETOZOA, AND SOME QUESTIONS WHICH THEY SUGGEST.—IV.

By the Right Hon. Sir Edward Fry, d.c.l., ll.d., f.r.s., and Agnes Fry.

Capillitium.—It is impossible to consider the form of the sporangium without reference to the *capillitium, i.e.*, the system of hairs contained within it, and sometimes entering into union with it as part of its structure. This capillitium is often of great beauty. It is formed before the spores in the course of development, and it is probable that it performs a part in the dispersal of the spores. Sometimes, as in *Trichia* (Fig. 12), the hairs lie free amongst the spores. In this genus the hairs are furnished with spiral thickenings, which give them very much the appearance of a twisted cord, and they are hygroscopic, *i.e.*, under the influence of moisture they twist and twirl and thus separate and disperse the spores. In *Trichia* the sporangium opens by the bursting of the upper part of the case, and then the hairs, covered with the spores, pour out over the remaining part of the sporangium, so that it appears as if covered by a piece of delicate fur.

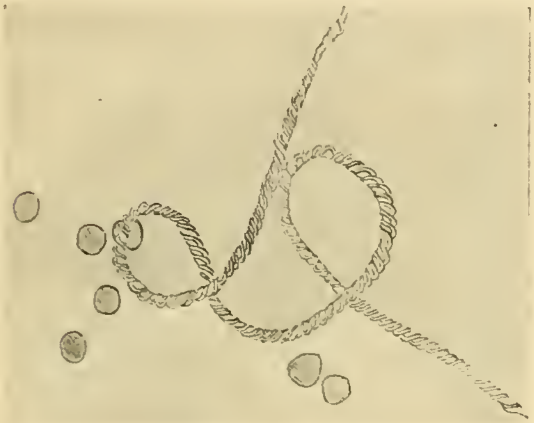


Fig. 12.—Elaters and spores of *Trichia varia.*

In some cases the hairs have not only a spiral thickening, but are furnished with projections, bristles or cogs of varying shapes. In one species, *Hemitrichia rubiformis*, the hair is so thickly beset with bristles that under the microscope it looks like the prickly stem of the bramble, and hence it derives its specific name. In some genera the hairs, as well as the spores, are remarkable for their bright golden yellow colour.

A connected system is presented by the capillitium of the beautiful genus *Arcyria* (Fig. 6). The immature sporangium is a long egg-shaped case standing on a pedicel; as it ripens the upper half or two-thirds of the membrane burst and fall off, leaving the lower part to form a cup (*c*), from which is seen to arise a thick web of fibres, almost like a pillow made of delicate horsehair (cap). These fibres are elastic, and so soon as the wall of the upper part of the sporangium gives way they expand to a height and breadth greatly in excess of the capsule in which they were contained. There can be little doubt but that these elastic fibres when mature must exert a great upward and outward pressure on the walls of the sporangium, and no doubt they hasten the disappearance of the upper parts of the wall.

In some species the system of hairs remains attached to the cup, which is the abiding part of the sporangium wall; in other species it is attached to the interior of the stalk only by a few branches, and then it is apt to fall away from its cup.

The likeness between the hairs of the sporangia of the genera *Trichia* and *Hemitrichia*, and of the *Jungermanniæ* is very close, and the same variety of arrangement is found in both cases. Both families exhibit elaters marked by spiral thickenings (*see* Fig. 12); but in the myxies these thickenings appear to be external, whilst in the Jungermanniæ they are generally, or always, internal. Both groups show differences in the number of these spiral thickenings; they are sometimes single (as in *Hemitrichia Wigandii*), or double, and sometimes reach to as many as six (in *Hemitrichia clavata*). In both groups the hairs are sometimes free and lie loose amongst the spores, and, in other cases, are joined together into a system—a regular capillitium, attached to the base of the sporangium. The *Jungermannia epiphylla* is a good illustration of such a regular system of hairs. In both groups the hairs or elaters appear to perform the same duties, of assisting by a pressure from within in forcing the sporangia open and of dispersing the spores by means of their hygroscopic activities.

In some sporangia, the most marked feature is a *columella—i.e.*, a prolongation of the pedicel, usually forming a column or a central line through the sporangium, but sometimes hemispherical and globose. In some genera it extends for only part of the height of the sporangium; sometimes for its entire height. A portion of such columella is seen in Fig. 13. To the columella the system of hairs is attached in many divers forms and ways. In *Lamproderma* the column reaches part of the way up the sporangium, and from near its summit it gives off a great mass of hairs spreading in every direction, so as to form a globe of anastomosing hairs. In *Enerthenema* the column is carried to the top of the sporangium, and spreads into a sort of capital, the top of which is part of the surface of the sporangium, and here the globe of slightly branching hairs is attached to the top, and falls down and fills the sporangium.

More complicated and more beautiful forms arise when the hairs branch out from all along the columella, and anastomose with one another so as to form a perfect network. In these cases the whole of the walls of the sporangium is supported by the ends of the hairs, and is usually very fugacious, and soon falls off, leaving a tree-like structure of delicate branches. The genus *Comatricha* shows round or ovoid heads, not unlike the system of branches of an oak (see Fig. 14). The genus *Stemonitis* has taller tree-like growths, which often remind one forcibly of a Lombardy poplar. Fig. 7 shows a group of sporangia. Fig. 13 shows a portion of the capillitium when the spores have been shaken out.

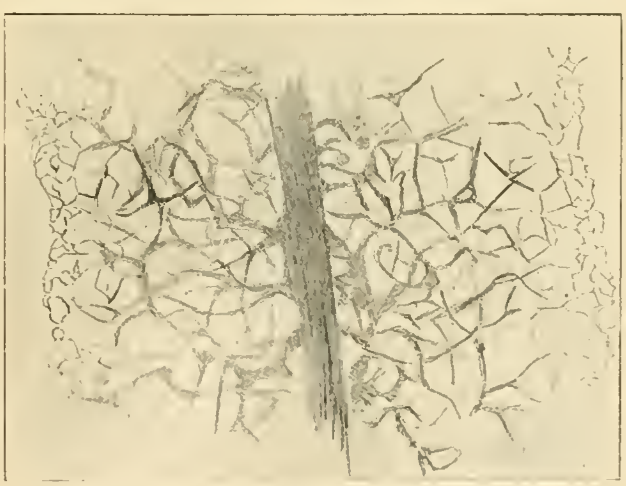


Fig. 13.—Capillitium of *Stemonitis fusca.*

It is curious thus to see these similar forms assumed by the mighty trees and by their poor little and very distant relatives the myxies; and yet, perhaps, this similarity is not a mere accident, but the same physiological necessity has in each case produced the same result. In order that the leaves and flowers and fruit may be exposed to the greatest amount of sun and air, and that the fruit may be spread far and wide, it must be supposed that the tree-like form has been assumed. A globe suggests itself as the most natural form in which a solid mass can obtain an extensive exposure to the action of the sun and of the atmosphere if they operated equally all round. We say the most natural, as it would result from an equal and universal outward growth, but for the purpose of exposing its surface, the globe must be mounted on a stand; but as the lower part will be of less value than the top and sides, because less exposed to the action of the sun, it will be convenient that the globe form shall be modified: and this has been sometimes attained by horizontal, sometimes by vertical expansion. Some such physical necessities seem to have influenced the shape of trees; and similar ends are, we suppose, subserved by the dendroid forms of the capillitium in *Comatricha* and *Stemonitis*. How has the chasm between the need and the supply been filled up in these minute organisms or in the stately oak?

Fig. 14.—Pedicels and Capillitia of *Comatricha obtusata*.

Another fact which creates further varieties in the form of the sporangia is the presence of lime in the capillitium and in the coats of the sporangium. In this presence of the carbonate of calcium in the sporangium, a character has been found for one of the subdivisions of the myxies, the so-called *Calcarineæ*. In some cases the lime is found in small grains in the substance of the covering membrane, in other cases it is found in star-shaped crystals lying on the outside of the membrane. These are very beautiful objects, and may both be seen in the genus *Didymium*.

In some cases the walls of the sporangium alone have the lime and the capillitium is without it; in many other cases the lime is found also on the capillitium, and that in different forms. We have already in our sketch of the life-history of *Badhamia utricularis* described the delicate lime structure of its sporangium.

Amongst all the delicate forms of the myxies there is none perhaps more beautiful than that of the genus *Craterium*. The sporangium, as the name of the genus is meant to tell, is goblet-shaped, and the top of the cup is usually covered with a distinct lid, which rests on the sides of the cup. In *C. pedunculatum* the colours sometimes suggest the notion of a golden cup with a silver lid, and in this dainty cup is found a capillitium of large white lime knots, connected by delicate hyaline or yellow threads, as shown in some of the broken sporangia of Fig. 8.

It has been suggested that the lime is to be regarded merely as an excretion, a thing of which the organism desires to be rid in its actively living parts. Be it so or not, it is evident that the organism sometimes continues to make this substance subserve the useful purpose of support.

It is worth while to note the several ways in which the capillitium appears to be used to attain the same end—the maturing and disposal of the spores. Sometimes it is the untwisting of the hygrometric spiral hairs which disperses them (as in *Trichia*, Fig. 12); sometimes it is the uprising of the elastic pillow contained in the sporangium (as in *Arcyria*, Fig. 6); sometimes it is by the spreading branches of the capillitium that the spores are scattered over a wide surface, as in *Enerthenema;* sometimes they are inelastic and charged with lime, and are then used as beams to prevent the walls of the sporangium from falling in and so injuring the young spores (as in *Badhamia*, Fig. 2). This wealth of plan, this variety of scheme for effecting the same end, and with the same or nearly the same materials, is not unfrequently found in the works of Nature. One might suppose, if Nature were striving to do the one thing needful with the utmost economy, and in the very best way, that there would be one, and only one way which was the cheapest and best, and that this would, on the principle of the survival of the fittest, be found everywhere to prevail. But this is by no means always the case. Look at the vast variety of schemes by which, in orchids, insects are made to solve the problem of getting the pollen-masses out of the boxes into which they have been stowed away, and then of pollinating with them the stigmatic surface. Or look again at the vast variety of the forms of the peristomes in mosses (all varieties of the same elements and of the same fundamental idea), and the various ways in which they operate under the action of moisture. Or take again the insectivorous plants. Here the problem which Nature seems to have set herself is this—given a leaf, how to catch insects? And this problem has been solved by the use of different constituent parts of a leaf in almost as many ways as there are genera of insectivorous plants. Or, once more, take the case of birds fitted for subaqueous locomotion. Here the problem seems to have been—given wings and legs, how to drive the body through the water? and this has been solved, as we know, sometimes by using the wings, sometimes the feet, as paddles, and with a wealth of variation that is very remarkable. In all these cases Nature seems not to ask herself what is the single best way of using the instruments at command, but, given certain organs, how to attain the end in view with the greatest amount of variation!

The Opening of the Sporangia.—In some cases, as already mentioned, the sporangium opens by an indeterminate rupture, in other cases Nature differentiates it into two parts, the upper forming sometimes a lid, as in *Craterium*, sometimes falling away early, as in *Arcyria*. Just the same kind of difference prevails, it will be remembered, in the mosses, the sporangia of the clay mosses (*Phascum*) opening by a decay of their sides, the sporangia of most of the moss on the other hand having a regular dehiscence.

It is a beautiful sight to see through a microscope the opening of a sporangium of a myxie under the warmth of the sun. We have watched it in the *Trichia fallax*: sometimes there appears a small hole in the membrane towards the top, which enlarges into a chasm; sometimes the whole upper part seems lifted or pushed up. Then the closely-packed spores begin to start out—one after the other—falling at varying distances; then the whole surface of the mass of spores and elaters begins gently to heave and move, and the elaters sway about like the arms of a polype. These actions are, we presume, due partly to the elasticity of the hairs seeking to expand in every direction, and partly to the unequal thickness of the parts of the elaters and the consequently unequal action of the heat on the elaters themselves. They curl and twist because they are unequally expanded.

Spores.—The spore is another part of the structure which varies much. Spores vary in size; they vary in colour, sometimes violet or brown, or red or yellow; they vary in their surface, sometimes smooth, sometimes spinulous or covered with warts; sometimes covered with a kind of network or furnished with a border or band. All these variations are used as points of distinction in the classification of the myxies, and the presence of a dark violet colour in the species is found, as already mentioned, to be of high classificatory value.

Another curious point about spores is the tendency in some of them to gather into groups of a more or less definite number, whilst others exhibit no such tendency, but remain single or aggregated without law. The spores of *Badhamia utricularis* have a tendency to gather into groups of from seven to ten, whilst the spores of its nearest congener, *Badhamia hyalina*, often congregate in numbers as high as twenty, and in other closely allied forms the spores are free. But this character, though generally true, is not absolutely constant. The spores of *B. hyalina* are sometimes almost free, and the same tendency to variation has been observed in other species.

ELECTRICITY AS AN EXACT SCIENCE.

By Howard B. Little.

IV.—Experience, its Value, and its Danger.

Since electricity has become so great a factor in our daily lives, the experience of every man, woman, and child, throughout every civilized country in the world, has been enormously widened; or opportunities have been constantly given for such widening. Nor is this all; the far-reaching "fluid" is exercising a distinct influence on the savage. But it is sufficient for our present purpose merely to note this fact, without entering upon any discussion of it.

It will not be too much to assert that the popular use of electricity has introduced a new order, or class, of experience. This seems a painfully trite remark when one considers that every business or profession requires its own specially-trained workers; but what may be termed here "electrical experience" exhibits such a characteristic series of features that its consideration, besides being of interest, should also be profitable. To commence with, the idea of its being possible, by the motion of a relatively tiny lever here, to send messages to the Antipodes, seems to have opened up a new field of thought, which has in a manner been cultivated by the public's reception of such messages here, for the public is straining daily to live at a greater rate, to receive its news more rapidly, and to travel faster. To all this it is the electrician's business to attend. As typical instances of the kind of task he should set himself may be mentioned the attainment of a higher speed in signalling, and an increase in the number of messages which, at one time, may be sent through the same line. The latter consideration will, as a rule, resolve itself into a question of maintaining the absolutely synchronous motion of two instruments at opposite ends of the line.

Another point for his consideration is the maintenance of absolute regulation of supply to light and power mains. The question of fuel economy may very well be referred back to the mechanical engineer, because the efficiency of a good dynamo is generally some six or seven times as great as that of a good steam engine; in fact, as it has so often been pointed out, an enormous percentage of the fuel is wasted between the stoker's shovel and the pulley of the dynamo.

Unfortunately, man is not endowed with an electrical sense; he has to rely entirely on experience to ascertain the presence of electricity. And in some instances it is wonderful with what rapidity such experience can be brought into play. To quote a simple instance, and one of every-day occurrence. Suppose a house be "wired" and connected with an alternate-current station. The shock to be obtained from the fuse connections, or any similar points on the circuit, would be quite sufficient to startle anyone unaccustomed to such shocks, and should such an individual be at the time upon a ladder, it is quite possible that he would tumble off. Yet, to the electrician it is nothing, because, brief as the contact would in all probability be, he has yet had time to bring his experience to bear, before giving the involuntary jump.

Again, it is electrical experience alone which can enable us to rapidly grasp all the details of a system of electrical connections, which may involve the use of dozens or hundreds of connecting wires. And the ideas of self induction and mutual induction seem to the layman a complete upsetting of all his preconceived notions, while he is further appalled to learn that he will have to regard these as existing in definite quantities, under definite conditions; and in consequence subject to mathematical investigation. But, just as some "hyper-mathematical" minds have a conception of a fourth dimension, even so is this amongst electricians, in that to some these quantities assume a far more concrete entity than to others.

Turning now to quite another class of experience which the electrician must cultivate. He is called upon, more than any other scientist in these times, to explain to the non-scientific public. The less intelligent section of this latter community will, as a rule, be quite satisfied that they thoroughly understand the working of any apparatus if once they have been informed that it is electrical; and under certain circumstances it becomes the electrician's painful duty to undeceive them, and, with all the tact at his command, to insinuate that they really know nothing whatever about it. On the other hand, there is the individual who wants to know, and who will ask questions. In this connection the average electrician suffers more than all the members of any Foreign Office ever constituted, for two reasons; first, he is expected to make clear, to the class of questioner aforesaid, in the course of a few instants, what it may have taken him many years to arrive at a just appreciation and understanding of; and secondly, because the lay mind, having from childhood been familiarized with the phenomena of light, heat, and sound, never realizes that it has no information whatever as to what they are; consequently, by some curious process of reasoning, or want of reasoning, the impression prevails that any electrician who knows his business should be able to tell at once what electricity is. In this connection our esteemed contemporary "Mr. *Punch*" did us a great service many years ago, when, representing himself as having been asked to state what matter was, he replied somewhat in this way, "Matter, matter. Ah! yes, matter. Well, its—well, no matter." But "Mr. *Punch*" has many privileges to which the humble tramp toiling on the road of science is in no way entitled. Yet, seriously, it *is* a serious matter. Only a short while back I was asked, by a man whose intelligence I consider much above the average, "What are X rays? I want to make some." And there is yet another phase of this trouble. The "man in the street" clings to certain ideas, cherishes them, and absolutely refuses to part with them. For example, it is quite impossible to prevail on the majority to abandon their deep-rooted conviction that the phonograph is an electrical apparatus. In short, it will be noted that so far as these points alluded to are concerned (and indeed with reference to many others) the electrician requires, and must cultivate, a certain class of experience which is to a great extent unknown in other callings.

But nothing we can mention in this world is an unmixed blessing. While speaking of experience we must bear in mind that at times it may (under suitable conditions) become a distinct source of error. Reverting to first principles, under ordinary conditions of life we are justified in saying that where we can neither see nor hear nor feel the presence of anything, there is nothing present. We are so used to the ubiquity of the mixed gas air, that we do not trouble ourselves to mention it, and so we have such an expression as "an empty box." This is hardly to be regarded as contempt due to familiarity, but rather as an error, introduced by too wide an experience. Similarly, the student of electrical science has to be brought to realize that even though he cannot see, hear, or feel electricity, yet it may be present, and he has, as already pointed out, to look for its effects rather than for it.

While it is possible for electricians to learn a great deal from their failures, yet it frequently happens that the next undertaking of a similar nature to that which was not successful is approached with a distinct want of heart, and it will scarcely be too much to state that every electrical failure which comes to the knowledge of the public exercises a most pernicious effect upon them. Witness the trouble experienced in order to capitalize the earlier Atlantic cables, and note that the Royal Albert Hall, of which Londoners are justly proud, is not yet electrically lighted. Further, the public having noticed certain electrical failures have adopted the catch words "That shows the difference between theory and practice." For this there are two causes, they mis-apply the experience they have, and overlook the fact that any idea which works out satisfactorily on paper, but not in practice, had some essential point or points omitted in its theoretical consideration, or "on paper."

There exists a most unfortunate tendency to consider parrot, or monkey-like, imitation an exercise of experience, if not of the imitators at least of some constituted authorities. Also, there is great and serious liability to error from the fact that statements by such authorities are frequently very badly reported where things electrical have been spoken of. Speaking of imitation, it is almost amusing to observe that municipal bodies are now adopting very frequently a curious precedent with reference to electrical undertakings. Having decided to install the electric light, or to undertake the construction of an electrical tramway, the body in question will depute some two or three of its number to go and inspect the system or systems in use by other such bodies. Speaking gently of this practice one is bound to admit that it seems clumsy and expensive.

When the results achieved by Tesla, Röntgen, and Marconi were first announced the majority of electricians found that to become thoroughly conversant with their full import it was actually necessary to abandon many of their preconceived ideas, and even then, what they had been led to regard as well-founded conclusions, derived from past experience, still formed something of a stumbling block. Similarly, an electrician who has become thoroughly used to direct-current work will, if he suddenly find himself called to undertake investigations with reference to alternating currents, for some time to come find much of his past experience (though perfectly accurate in so far as it went) a decided nuisance to him, for the time being at least. It might be urged that these latter instances tend to show the danger arising from incomplete experience, rather than the danger of certain experience; but this contention cannot be allowed, for, returning to one of our previous illustrations, the error which usage permits in the expression "empty box" is not due to the fact that we have no experience *in vacuo*.

Perhaps of all the errors into which electricians as a body have ever fallen, solely on account of commercial-electrical teaching or experience, the one most widely spread was that which led them (well within the past ten years) to deride the teaching in schools of "frictional electricity." It used to be said that to teach a boy what would happen when silk, or sealing wax, or glass, was rubbed, was a mere waste of time, because it was not the electricity of commerce. It was pointed out that "frictional electricity" had but two commercial applications, for it was only made use of to de-electrify silk, when in the process of manufacture it became electrified, and hung together, with a tendency to become entangled, and to electrify the ink contained in the telegraphic syphon recorder. When, later on, this latter field for the remunerative use of the despised form of electricity was no more (owing to the introduction of a clockwork tapping apparatus which was found more convenient as a means of making the ink "jump" out of the tube), the electrician's tolerant smile at the "science master" became something painfully like a grin. But all that has been changed by the three men just mentioned (purposely in conjunction, though their work has been independent, and productive of widely different results). Before leaving this point, let me confess that I personally did my best to become one of the broadest grinners at the "science master." All I can say in extenuation is that, having cultivated a certain class of experience, I fell into the pit which I had dug unconsciously for myself, and, arrived at the bottom—well, I had good company there. Yet the value of experience must be by no means under-rated. Perhaps the plain statement of fact is best expressed by the assertion that amongst electricians, particularly, it requires great experience to arrive at a just appreciation of the value of experience, and a wide experience to make a proper use of experience.

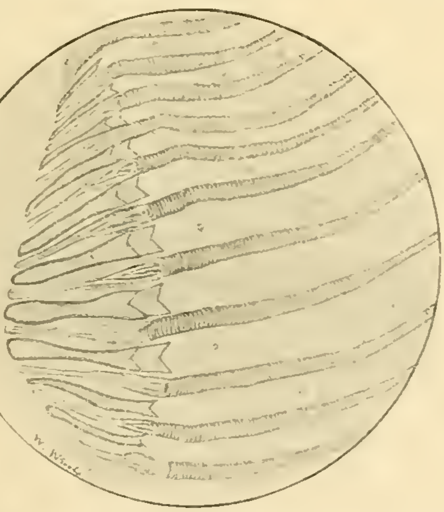
THE TEETH ON THE LABELLA OF THE BLOW FLY.

By WALTER WESCHÉ.

ONE of the most familiar objects that is mounted as a slide for the microscope, is the proboscis of the Blow Fly (*musca vomitoria*). Probably the most modest collection of objects contains a slide. It is used every day as a test for low powers, for flatness of field and sharpness of outline, and even familiarity has not diminished our wonder and admiration of this marvel of minute structure. But in the vast majority of cases, if a microscopist is asked to show the teeth, a denial of their existence would be received, probably coupled with an assurance (as I have been assured) that there were no teeth, but some minute hairs on the edge of the labella which had been mistaken for them. It is a curiosity of microscopy that often, unless it is known what to look for, it is quite possible to miss seeing a structure or detail, from the fact that its focus is at a different distance from some near, yet more prominent object. This is precisely the reason, coupled with the fact, that the proboscis is usually looked at with low powers, why these teeth escape observers; they lie at the base of the false or pseudo tracheæ, at a different focus, and the chitine of which they are composed being a light yellow and transparent, they are easily overlooked.

Like the teeth of the Dung Fly (*Scatophaga*), they were discovered by Mr. W. H. Harris, and figured in *Science Gossip*, in 1885, but the discovery seems not to have become known out of a small circle—as it is mentioned as fresh in the *Journal of the Royal Microscopical Society*, in July, 1898.

The teeth show between eleven of the false tracheæ, and six appear to be double, making a total of sixteen on each labellum. With the exception of one at the end furthest from the head, they have a cleft edge, thus securing two points to each tooth, and, one might suppose from this, are used for pricking or gently scraping a surface, possibly with the object of accelerating a flow of liquid. They are much thinner than those of the *Scatophaga*, and not round



Teeth of Blow Fly, magnified 170 diameters.

and tooth-like, but riband-like in appearance. The bases appear slightly rounded, and from these the teeth broaden and taper to a very thin edge—they might be compared to a row of chisels with cleft edges.

To see them a magnification of three hundred and fifty diameters is quite sufficient—a good quarter-inch power would do; the field at the back of the teeth is rather obscured by the chitinous support of the labellum, but if the bases of the false tracheæ are focussed, the characteristic edge of a tooth is probably seen, and that once found, the rest is easy. The length of the row of teeth is three two-hundredths of an inch.

Microscopy.

By JOHN H. COOKE, F.L.S., F.G.S.

The embedding of soft tissues requires considerable skill on the part of the operator. But frequently, notwithstanding the greatest care, failure results, either owing to the variable nature of the medium used, or because the processes of hardening have been too protracted. Those who have experienced these difficulties should try the white of an egg as the embedding medium. The process is as follows:—Make a small paper box, about a half-an-inch square, and fill it with the white of an egg. Eliminate all alcohol from the material which is to be mounted, and embed it in the albumen. Expose the box and its contents to heat, and when hardened place it again in alcohol. If the sections are passed through oil of cloves with balsam, the albumen will become clear and transparent.

An illustration of the pitfalls that confront science students is given by Dr. Martin Ficker, a German bacteriologist. Among various sources of error in work with bacteria is the glass of the vessel used, as different kinds of glass impart varying degress of alkalinity to water, and it is found that some bacteria, notably those of cholera, are favourably affected by alkalinity. This novel cause seems responsible for marked and important discrepancies.

Freshwater mites do not, as a rule, make satisfactory mounts. They shrink and fade, thus losing in the preserved state the beautiful symmetry and colourings which render them, when alive, such charming objects for observation and study. The difficulty is the mounting medium. No formula is known which will give perfectly satisfactory results, but the following, if carefully prepared, will enable the microscopist to preserve his specimens, for some years at least, from bleaching and collapse:—Prepare three mixtures of distilled water and pure glycerine in the proportions of twelve parts, ten parts, and eight parts of water, respectively, to one part of pure glycerine, and to the last add a small drop of carbolic acid. Place the specimens in the twelve-part mixture and leave them for twelve hours, after which place them in the ten-part mixture and leave them for a similar period. They may now be permanently mounted in the third mixture. Solid glass cells are preferable to built-up ones.

The preservation of labels of reagent bottles is a frequent source of trouble to the working microscopist. A good varnish for this purpose may be made by macerating the following substances, and thoroughly shaking the mixture until all are dissolved:—Sandarac, sixty parts; mastic, twenty-five parts; camphor, one part; oil of lavender, eight parts; Venice turpentine, four parts; ether, six parts; and alcohol, forty-four parts.

It is frequently desirable to supplement the records obtained by photographing micro-sections with a drawing, and it would probably be oftener done were it not for the difficulty that many experience when using either the neutral tint reflector or the camera lucida. With a vertical camera and suitable tracing paper this difficulty disappears, and it is possible, after a little practice, to acquire a creditable amount of dexterity in representing the salient features of all objects that do not require high-power objectives for their delineation. In making such drawings it is a great advantage to be able to do them direct from the microscope, so that no transference or copying is afterwards needed. For this purpose, the following recipe for making a tracing paper, which can be re-converted into ordinary drawing paper after the drawing has been made on it, will be found to be both simple and effective:—Immerse any ordinary drawing paper in a mixture consisting of one volume of castor oil and three volumes of spirits of wine, and hang it up to dry in a warm room for two or three hours. Place a sheet in the focussing screen of the camera and make the drawing, after which place it in a bath of spirits of wine and allow it to remain there until the oil has been dissolved out. The paper will resume its former state and appearance.

The isolation of the skeletons of siliceous organisms, foramens, and other small objects from rock specimens, may be readily effected by first drying the rock in air and then dropping it into a hot, saturated solution of Glauber's salts. On cooling, the processes of crystallization break up the rock mass.

Balsam mounts are apt to deteriorate, unless some means are adopted to prevent the access of air or moisture. They may be protected by running a ring of melted paraffin wax around the edge of the cover-glass, by means of the turn-table, and afterwards, when set, protecting this in its turn with a ring of finishing cement. A very beautiful and instructive preparation may be made by heating xylene balsam on a slide until the xylene has almost evaporated, and then adding a few crystals of sulphonal. The preparation should be gently warmed until the sulphonal melts and mixes with the balsam. The cover-glass is then put on. If perfect crystals are obtained this mount will show, with the aid of the polariscope, not only the most gorgeous colourings, but also perfect examples of the black cross.

An ocular pointer is a useful accessory for class demonstrations when it is desired to indicate any particular structure or object in the field of view. To make one, cut out a circle of cardboard of a size sufficient to fit easily in the ocular tube. Out of the centre of the circle punch a second circle, having a diameter slightly larger than that of the ocular diaphragm. Blacken this cardboard ring, and, with a little gum, fasten an eye-lash to edge of the smaller circle so that the *cilium* shall project halfway across the opening. Remove the eye-lens of the ocular, and drop the cardboard ring into the tube so that it rests on the diaphragm. The *cilium* is now at the level of the real image, and the specimen on the stage of the microscope can be so placed that the pointer will indicate exactly any particular portion to which it may be desired to draw attention.

Alcohol is used by many microscopists both for killing their specimens and for preparing them for the laboratory and museum. In the case of marine animals the use of alcohol in inexperienced hands is often attended with unsatisfactory results, and this for several reasons. On thick-walled animals, particularly those provided with chitinous envelopes, this reagent acts prejudicially on the internal organs, while in the case of the smaller crustacea it gives rise to precipitates in the body fluids which frequently prevent a satisfactory dissection of the parts being made. It has also been found in practice that alcohol tends to fix the salts of the sea-water contained in the organism, and thus, by forming a crust, prevents both the hardening and the staining fluids from penetrating the tissues. With proper precautions there are, however, few reagents which give better results. The method employed in the Marine Biological Laboratory at Naples is worth the attention of those whose efforts with alcohol have not always been so successful as they may have desired them to be. To kill, let us say, an annelid, the animal is transferred to a beaker containing sea-water. A few drops of alcohol are added, and this is repeated at short intervals until the animal expires. This tentative method of killing neither causes contraction nor distortion of the parts. The animal dies slowly, and, when dead, is so supple that it may be readily arranged in any desired position. The main point is to avoid the mistake, usually made, of killing in strong grades of spirit. After death the specimen may be passed through the various grades of alcohol in the usual way.

The popular theory regarding "honeydew" is that it is an excretion from aphides. Mr. H. W. Brice has recently made a microscopical examination of the substance, and has arrived at the conclusion that the popular theory is fallacious. Under the microscope some thickly-coated leaves of the lime and sycamore revealed not more than three or four insects per leaf. These insects were removed, and an hour afterwards the beads of honeydew were found to be more numerous and larger than when the leaves were first gathered. He concludes, therefore, that the leaves of some trees, under favourable climatic conditions, become surcharged with saccharine matter, and, the cells bursting, a copious exudation of "honeydew" takes place. The fact that "dew" gathered from the sycamore and the oak is much darker than that from the lime is held to prove that it partakes of the nature of the tree and not of the insect.

NOTES ON COMETS AND METEORS.

By W. F. DENNING, F.R.A.S.

SWIFT'S COMET.—In June this comet travelled in a direction which carried it rapidly away from the earth, and in July it will only be visible in powerful instruments. At the opening of the latter month the comet will be situated a few degrees S.E. of Arcturus. The following ephemeris is by Dr. A. Stichtenoth (*Ast. Nach.*, 3574) :—

Date.		R.A. h. m. s.	Dec.	Distance in Millions of Miles.	Brightness.
July 2	...	14 20 38	+ 19° 39·3′	117	0·13
„ 6	...	14 16 54	+ 17° 16·5′	129	0·11
„ 10	...	14 14 20	+ 15° 13·0′	140	0·08
„ 14	...	14 12 43	+ 13° 24·9′	152	0·06

The comet has shown some extraordinary fluctuations in brightness. On June 4th and 5th it was estimated one magnitude brighter than on June 3rd. The sudden increase was noted by Mr. T. H. Astbury, of Wallingford, and it is also referred to in *Ast. Nach.*, No. 3574, by Hartwig Schorr, Holetschek and Pokrowski.

TEMPEL'S COMET (1873 II.)—This object is now favourably visible and rapidly increasing in apparent brightness. It is, however, moving to the S.S.E., and will be somewhat low in the sky as observed from our latitude. Ephemeris by L. Schulhof:—

Date.		R.A. h. m. s.	Dec.	Distance in Millions of Miles.	Brightness.
July 3	...	20 18 43	− 10° 1′ 5″	40	2·77
„ 7	...	20 23 45	− 11° 38′ 27″	38	3·01
„ 11	...	20 28 41	− 13° 27′ 12″	37	3·23
„ 15	...	20 33 33	− 15° 25′ 46″	36	3·42
„ 31	...	20 52 41	− 24° 7′ 36″	35	3·67
Aug. 4	...	20 57 26	− 26° 14′ 6″	35	3·59

The comet will, therefore, be placed in the northerly region of Capricornus early in July.

HOLMES'S COMET.—This interesting body ought to come under observation in July if serious changes have not affected its appearance or orbit since its apparition of 1892. In *Ast. Nach.*, 3553, Zwiers gives the following sweeping ephemeris :—

Date.		R.A. h. m. s.	Dec.	Brightness.
July 3	...	1 51 41	+ 24° 7′	0·0374
„ 7	...	1 57 53	25° 17′	0·0382
„ 11	...	2 3 59	26° 26′	0·0390
„ 15	...	2 9 56	27° 34′	0·0398
„ 31	...	2 32 10	+ 32° 2′	0·0435

The brightness of the comet in 1892, November 8th, is adopted as 0·0747. On July 9th its position will be three degrees north of the bright star α Arietis, and its motion will carry it slowly to the north-east.

Since the above was written, information has come to hand that Holmes's comet was re-discovered on the morning of June 11th by Perrine, at the Lick Observatory, and that its position differed very little from that given in the ephemeris by Zwiers.

TUTTLE'S COMET.—This object is now invisible to observers in the northern hemisphere. During July it will travel rapidly to the south-east, and on the last day of the mouth will be in R.A. 10h. 10m. 14s., Dec. 30° 54′ south.

Fireball of 1899, *April* 4*th*.—In our notes for May reference was made to this object as observed at Birmingham and St. Anne's-on-Sea. It was also seen at Chester, and though the several observations are not in good agreement it is certain that the meteor was a brilliant Virginid, the radiant being at about 202° − 10°. The length of its real path was about one hundred and sixty miles from a height of sixty miles above a point ten miles west of Whitehaven to fifty-two miles above the north coast of Ireland.

Fireball of 1899, *June* 2*nd*.—In the strong twilight prevailing at about 8h. 47m. on June 2nd, a very fine meteor was observed from several places in the West of England. Few stars were visible at the time, so that the path of the object would not be exactly determined. Mr. Thomas Harries, of Llanelly, describes the meteor as rivalling Venus, and says its path was directed from Leo towards due west, extinguishing there at a point about thirty degrees above the horizon. The duration of flight was four seconds. At Bridgwater the object was seen by two persons, from whose description immediately afterwards Mr. Corder placed the beginning near β Leonis and the end close to the N.W. horizon. Its brightness was estimated as four times that of Jupiter. At Weston-super-Mare the meteor was seen as "a clear electric ball travelling quite slowly in a direction from east to west, and descending gradually until it seemed to go out." It was visible for two or three seconds, and appeared not very high in the heavens. It was also seen at Bristol and some other stations, but the descriptions are not very exact as regards details. It is certain, however, from a comparison of the various accounts of the meteor, that it belonged to a very well defined radiant of midsummer fireballs in Scorpio. It had a long and nearly horizontal flight (similar to that of the fireball of April 4th last), and beginning over the region of Totnes, Devon, it passed to north-west and disappeared over St. George's Channel after a course of about one hundred and seventy miles, during which it descended from sixty-one to fifty-one miles above the earth's surface. The radiant was approximately at 250° – 23° a few degrees north-east of Antares.

Large Meteors.—On 1899, May 27th, 8h. 53m., Mr. T. H. Astbury, of Wallingford, saw a fine meteor about three times as bright as Jupiter. Its path was from 246° + 26° to 252° + 16°. It moved swiftly and died out suddenly without an explosion. On 1899, May 28th, about 10h. 30m., a bright meteor, giving a flash at its disappearance, was noted by Mr. Corder at Bridgwater. It passed over κ Herculis and was directed downwards from half-way between β and ζ Herculis. Fine meteors were also seen on June 1st, 9h. 20½m., at Kettering, and on June 5th at Wallingford.

The great Perseid meteoric shower usually begins in the second week of July, and by the end of the month often becomes fairly prominent. During the years from 1869 to 1898, and periods from July 12th to August 20th, the writer at Bristol observed 6479 meteors, of which 2409 were Perseids, and the place of the radiant was determined on seventy-three occasions. An average of these was recently deduced, and indicated the position in July as follows:—

	°	°		°	°
July 13 ...	13·5	+ 48·6	July 25 ...	26·2	+ 52·8
„ 16 ...	16·6	+ 49·8	„ 28 ...	29·6	+ 53·6
„ 19 ...	19·7	+ 50·9	„ 31 ...	33·2	+ 54·4
„ 22 ...	22·9	+ 51·9	Aug. 3 ...	36·7	+ 55·2

It will be seen that in July the R.A. of the radiant nearly corresponds with the day of the month.

THE FACE OF THE SKY FOR JULY.

By A. Fowler, f.r.a.s.

The Sun.—On the **1st** the Sun rises at 3.49, and sets at 8.19; on the **31st** he rises at 4.23, and sets at 7.49. He is at his greatest distance from the earth on the **4th** at 9 a.m., his apparent diameter then being the smallest possible, namely 31′ 30·6.″

The Moon.—The Moon will be new on the **7th**, at 8.31 p.m.; will enter her first quarter on the **15th**, at 11.59 p.m.; will be full on the **22nd**, at 9.42 p.m.; and enter her last quarter on the **29th**, at 0.43 p.m.

The brightest star occulted during the month will be 7 Sagittarii, magnitude 5·4, on the **20th**; the disappearance takes place at 7.39 p.m., at 58° from the north point (80° from vertex), and the reappearance at 8.41, at 297° from north point (310° from vertex).

The Planets.—Mercury is an evening star throughout the month, being at greatest eastern elongation of 26° 59′ on the **22nd**, and at aphelion on the **27th**. In spite of this great angular distance from the Sun, however, the planet at greatest elongation will only remain above the horizon at London for about an hour after sunset, and the prolonged twilight will interfere with naked-eye observations. On the evening of the **25th** he will be a little more than 2° to the south of Regulus.

Venus remains a morning star, badly placed for observation. She rises little more than an hour before the Sun, and has an apparent diameter of only 10·3″. More than nine-tenths of the disc will be illuminated.

Mars has almost passed out of our view, setting very shortly after 10 p.m. at the middle of the month. On the **1st** he lies to the south-east of Regulus, and during the month describes a path towards β Virginis, a star which he very closely approaches on the evening of the **29th**. His apparent diameter is 4·8″ on the **15th**.

Jupiter remains an evening star, and will be found in Virgo, roughly midway between Spica and α Libræ. He will be in eastern quadrature on the **24th**. He crosses the meridian on the **1st** at 7.16 p.m., and on the **31st** at 5.24 p.m., setting about half-past eleven on the latter date. The low altitude of the planet, combined with long twilight, renders the position rather unfavourable. On the **15th** the polar diameter is 35·2″. At convenient hours the satellite phenomena are most interesting on the **7th**, **8th**, **13th**, **15th**, **16th**, **18th**, **25th** and **31st**.

Saturn remains in the southern part of Ophiuchus, between the stars η and θ of that constellation, and remains visible until after midnight throughout the month. He is due south at Greenwich on the **1st** at 10.33 p.m., on the **15th** at 9.35 p.m., and on the **31st** at 8.29 p.m. On the **15th** the polar diameter of the planet is 16·8″; the outer major and minor axes of the rings are respectively 41·9″ and 18·8″; while the axes of the inner bright ring are respectively 26·7″ and 12·0″. The rings are widely open and the northern surfaces are visible.

Uranus remains in Scorpio, almost midway between ν Scorpii and ρ Ophiuchi. He will be due south on the **1st** at 9.32 p.m., and on the **15th** at 8.36 p.m. The apparent diameter is 3·8″ and the movement is westerly.

Neptune is too near the Sun to be observed.

The Stars.—About 10 p.m. at the middle of the month, Perseus, Andromeda and Cassiopeiæ will be in the north-east; Cygnus and Pegasus in the east; Aquila in the south-east; Lyra nearly overhead; Corona, Libra and Virgo in the south-west; and Ursa Major in the north-west.

A favourable minimum of Algol will occur on the **13th** at 9.51 p.m.

Chess Column.

By C. D. Locock, b.a.

Communications for this column should be addressed to C. D. Locock, Netherfield, Camberley, and posted on or before the 10th of each month.

Solutions of June Problems.

(By W. S. Branch, Cheltenham.

No. 1.

1. B to B6, and mates next move.

No. 2.

Q to R8, and mates next move.

Correct Solutions of both problems received from J. K. M. (Repton), Capt. G. A. Forde, K. W., D. R. Fotheringham, H. S. Brandreth, N. B. Dick, W. Clugston, G. C. (Teddington), H. Le Jeune, N. M. Munro, J. Baddeley, many of whom have greatly admired these two problems.

Of No. 2 only, from Alpha, E. Servante, A. H. Doubleday, W. de P. Crousaz, W. Nash, A. T. Laster.

[Most of the above have given 1. B to B3 as the key of No. 1, overlooking that after 1. . . . R to B5ch, 2. K×R (dis. ch.), the Black Pawn can interpose.]

Alpha.—If it were not for the check!

E. Servante.—If 1. KtP×P, the Black Bishop moves.

Percival K. Hogg.—A little examination will convince you that none of your solutions to No 1 will quite work.

W. Nash.—Very glad to hear from you. You are in good company with "Alpha."

Rev. E. Cowley.—Thanks for the problem, which I have not yet had time to examine. If sound and good, it will receive early publication.

W. Clugston.—Thanks for the two problems, which shall be examined shortly.

J. K. M. (*Repton*).—Problem withdrawn as requested. The other two appear below.

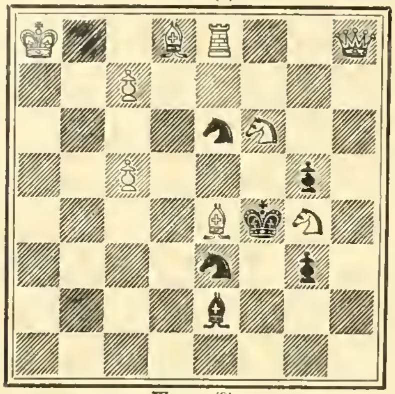
Towers.—In No. 2 the Black Pawn can cover. There is a solution to No. 1, as you will see above. It is difficult to apply the method of exhaustion to a chess problem, unless the process is absolutely complete.

PROBLEMS.

By J. K. Macmeikan.

No. 1.

BLACK (6).

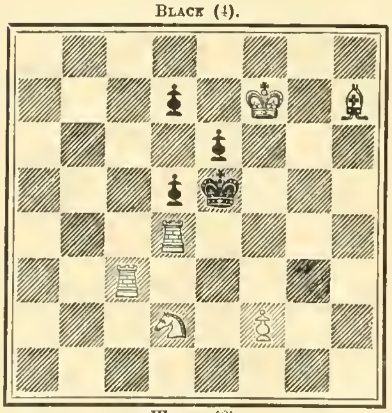


WHITE (9).

White mates in two moves.

No. 2.

BLACK (4).



WHITE (6).

White mates in two moves.

CHESS INTELLIGENCE.

The Kent Chess Association inaugurated a successful congress during Whitsun week. Messrs. Blackburne, Gunsberg, Lasker, Pillsbury and Tinsley, took part in simultaneous and blindfold displays, and in some consultation games, in which Mr. Pillsbury was both times on the winning side. The Kent Cup was won by Mr. P. Hart Dyke, the well-known Cambridge University expert, who from necessity plays *sans voir*.

Those insatiable opponents, M. Janowski and Mr. Showalter, have arranged yet another match to take place next October. Meanwhile both are playing well in the London tournament which commenced on May 30th.

The entries in the two-round tournament are not quite so representative as was hoped. Notable absentees are Dr. Tarrasch, M. Charousek, and Herr Lipke. Mr. Burn entered but declined to play. The competitors are Lasker, Janowski, Pillsbury, Maroczy, Cohn, Schlechter, Showalter—who are at present ahead of a trio of veterans consisting of Steinitz, Blackburne, and Tchigorin—the rear being brought up by Messrs. Mason, Tinsley, Bird, Lee, and Teichmann, the latter of whom has been compelled to retire owing to ill-health. Much may yet happen to change the present order, but it seems fairly certain that Janowski, Lasker, Maroczy and Pillsbury, will all be in the first six, and that the first three prizes will fall to three of these four. Steinitz will no doubt improve as he gets into better practice, but some of the Englishmen are evidently out-classed, and it is difficult to see why they were selected in preference to Herren Marco and Mieses, who, possibly from choice, are playing in the minor tournament.

Mr. F. J. Marshall, the new American master, who played at Board No. 8 in the recent cable match, at present holds the lead in the minor tourney. The other competitors are Messrs. E. M. Jackson, E. O. Jones, O. C. Muller, H. Erskine, T. Physick, and Dr. Smith, all of England; the foreign element being represented by G. Marco, J. Mieses, M. Tabountschikoff, J. Esser, and J. O. Klimsch. In this competition the English players are holding their own very well.

Result of the Minor Tourney:—1st, F. J. Marshall; 2nd and 3rd (equal), G. Marco and T. Physick; 4th and 5th (equal), E. O. Jones and J. Mieses.

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CONTENTS.

ON THE TREATMENT AND UTILIZATION OF ANTHROPOLOGICAL DATA.

By ARTHUR THOMSON, M.A., M.B.

IV.—HEIGHT.

THE question of height is one which requires careful consideration. Apart from the mere enumeration of measurements, and the averages deduced therefrom, we have to ascertain as far as possible the factors which determine those variations in stature. The height of the body depends not only on the length of the trunk and head combined, but also on the length of the lower limbs. We may have individuals possessed of trunks of the same proportions, but differing much in height, in such, the difference is due to the variation in the leg length. Common experience shows that it is a matter of difficulty to estimate correctly the individual height of a group of people seated round a table; it is only when they rise from their chairs that we gain a correct idea of their relative proportions.

In order to understand our increase in stature from childhood to the adult condition, the reader must be familiar with the mode in which the long bones grow. Each long bone is provided with a shaft and two extremities, and these several parts are each developed from independent ossific centres; thus the shaft, or diaphysis, grows from a single ossifying column, while the extremities, or epiphyses, are developed from one or several ossific nuclei. In consequence, the growth of the bone in length takes place in relation to each extremity, and so long as this growth is going on, we assume that the individual has not reached the stage of maturity.

A study of the statistics relating to growth has shown that there are periods in our life when development is taking place more quickly than at other times. Thus in the early years of infancy, increase in bulk takes place with great rapidity, succeeded by a period when growth is more slow and uniform. About the age of puberty, however, a fresh stimulus seems to stir the tissues, and hence we have at this time an increase in height often characterised by marked rapidity. As these changes must of necessity be associated with a great increase in the number, and it may be, in the size of the cells which constitute the tissues of our body, it is obvious that at these times of special activity the drain on the system must be great, and can only be met by the provision of suitable food, and surroundings congenial to health.

Here, then, we have very sound reasons for taking all possible precautions to provide a diet adapted to meet the requirements of the organism, for failing such it can be readily understood how the natural growth might be stunted for want of proper nutrition. But it is not merely a question of food, the surroundings are, in a way, almost as important. Statistics prove that those whose occupation keeps them out of doors are as a rule taller than those whose labours confine them to a closer atmosphere, and it is just at the age that the boys and girls of our manufacturing centres are turned into the factories that they are most likely to benefit by improved hygienic conditions. It is a matter for congratulation that recent legislation has to some extent improved the condition of the "half-timers."

But whilst errors in growth may be partly accounted for by modified nutrition and varying climatic and hygienic influences, the facts above stated are not sufficient to explain the circumstance that we meet with races living side by side displaying very different proportions. Just as in the case of the Italian greyhound we have a breed distinct from its near ally the English greyhound, so we have in mankind those races which are characterised by their small height as contrasted with the larger proportions of other members of the same stock, thus proving that heredity is a factor of no small importance. Considering the vast admixture of blood in most of the populations that are scattered over the surface of the earth, it is almost impossible to get satisfactory data as to permanency of type, yet recent experience in this country and in France has proved that evidence of a confirmatory sort may frequently be obtained in support of the migration and location of certain stocks. In what we call the English and the Scotch we have a mixed race, and though an average derived from all the measurements taken may be of service for comparison with the population of other countries, it must be pointed out that the resulting figure does not correspond to the height of the greatest number of people. In every race there are a certain number of individuals below or above what we may term the most common height; the smaller individuals may outnumber, balance, or fall short of the taller individuals, so that their inclusion in the average may, and often does, detract from the value of the result. For this reason the height of a race is best expressed by means of a binomial curve, as was first suggested by Quetelet and Galton. By the adoption of such a method we are at once able to recognize the standard of height attained by the greatest number of individuals, whilst the sides of the curve will illustrate the proportions of the various individuals who fall either short of, or exceed, the common standard. In this way we are more likely to obtain accurate information regarding what we may term the type height, and the range and numerical value of the variations. The mathematical method of Prof. Karl Pearson attains the same end, but in this simple case does not appear to possess any obvious advantage over the older method.

Unfortunately, the bulk of the observations placed at our disposal are in the form of averages, so that it is difficult in these cases to estimate the extreme of variation.

Amongst tall races are included those that measure 1 mètre 70 centimètres (5 feet 7 inches) and over. The races of medium height vary from 1 mètre 60 centimètres (5 feet 3 inches) to 1 mètre 70 centimètres (5 feet 7 inches), whilst the short races have a height of 1 mètre 60 centimètres (5 feet 3 inches) or under.

The tall include such races as the Patagonians, West African negroes, some Polynesians, some American Indians, Scandinavians, and Scotch and English. The short, among others, include the Malays, Lapps, Veddahs, Bushmen, Hottentots, Negritoes (or dwarf Asiatic negroes), the Negrillos—adopting the term suggested by Hamy—which include the Akkas, a dwarf form of African negro. It is these small or pigmy races to which, of late years, so much attention has been directed; their wide-spread distribution, as well as the fact that they are by many regarded as primitive types, lend an interest to their study quite distinct from their physical peculiarities. Additional importance has been imparted to the study of the pigmy races by Prof. Kollman's discovery, near Schaffhausen, of the remains of a race of pre-historic dwarfs, the bones of which were mingled with those of a much taller race with whom they must have lived, though, whether in a state of "peaceful harmony," as suggested by the distinguished professor, is another matter. The remains of four such neolithic pigmies were met with, and estimating their height from an examination of their leg bones, it was found that on an average, assuming their bodily proportions did not materially differ from those of living forms, their height did not exceed 1 mètre 42 centimètres (4 feet 8 inches), so that, as regards their stature, they correspond closely with the Negritoes inhabiting the Andaman Islands and the Bush race of South Africa.

Apart from the Lapps, whose height as a rule is about 1 mètre 53 centimètres (about 5 feet), we have other races of small people inhabiting different parts of Europe. According to Sergi, people of a height not exceeding 1 mètre 50 centimètres (4 feet 11 inches) are met with in Sicily and Sardinia, where, he states, they form quite fourteen per cent. of the population; and from observations made by the same anthropologist there appears little doubt that a correspondingly short race is met with in Central European Russia. This naturally gives rise to the question whether there may not be some association with the dwarf African peoples, as suggested by Sergi in his view of the diffusion of the Eur-African race along the Mediterranean shores.

Turning now to the consideration of the best known race of living pigmies, we find them located in the more or less inaccessible group of islands in the Bay of Bengal, called the Andamans. Though subjected to European influence since the year 1857, and rapidly undergoing physical and moral deterioration from their contact with civilization, yet a record has happily been kept of their physical proportions, as well as their social customs, arts, language, etc., by Mr. E. H. Man. Prof. Sir William H. Flower has described their skeletons, and, in discussing their affinities, has thrown out the suggestion that they are probably "the primitive type from which the African negroes on the one hand, and the Melanesians on the other, may have sprung." In appearance they resemble little negroes (hence the name Negritoes). Their average height for the men is about 1 mètre 42 centimètres (4 feet 8 inches), for the females about 1 mètre 37 centimètres (4 feet 6 inches). The hair is very fine, and curled in the form of short ringlets, so as to present a frizzy or woolly appearance. The colour of the skin is dark, whilst the features are a modification of the Negro type, displaying less projection of the jaws, and lips not so coarse and thick.

Closely allied to the Andamanese are the Aëtas, the dwarf races who inhabit the mountainous district in the interior of the Island of Luzon, whose height on an average is only 4 feet 8 or 9 inches.

Similarly populated are other islands of the Philippine group, and so also races of a corresponding type are met with in Formosa, the interior of Borneo, and in the Celebes, but curiously enough no trace of them has hitherto been found in Java. This is particularly interesting, as here Dr. Dubois made his most remarkable discovery of the Trinil skull, undoubtedly the earliest human remains yet found, all the facts pointing to the conclusion that it probably belongs to the younger Pliocene. Along with this skull a thigh bone was found, presumably a part of the same skeleton. Estimated from this, according to human proportions, the height of the individual to whom it belonged would be 1 mètre 65 centimètres to 1 mètre 70 centimètres (5 feet 5 inches to 5 feet 7 inches); considerably taller, it will be noted, than the stature of the Negritoes, and obviously upsetting the theory that the Negritoes are a survival of the primitive stock which peopled that part of the earth.

In Africa, the existence of pigmy races has long been hinted at. Aristotle, Heroditus, and Pliny all make reference to them, and in an interesting work entitled "Man transformed, or the Artificial Changling," published by John Bulwer, in 1653, a summary of the then state of knowledge is given, wherein reference is made to the occurrence of such races in Greenland, Lapland, Tartary, India, Africa, and Peru, the various authorities being quoted with much precision and show of critical acumen. To this subject the distinguished French anthropologist, Prof. Quatrefages, has recently directed attention in a work entitled "The Pigmies."* Therein the reader will find an interesting account of the distribution of these dwarf races and the conclusions derived therefrom.

The Bush race, which inhabits the southern portion of the African continent, has long been familiar to Europeans, averaging 1 mètre 40 centimètres (4 feet 7 inches in height); they agree closely with the Andamanese. In hair, however, they differ from the negro, for though extremely frizzy, it displays a tufted arrangement as if the scalp was covered with little woolly balls. In colour they are yellower than the negro, and display other physical peculiarities which serve to distinguish them from the other inhabitants of the continent. Though leading the life of degraded savages, they are not without their talents, for, as Mr. A. W. Buckland has pointed out,† their drawings and paintings will

* Translated by F. Starr. London: Macmillan & Co. 1895.

† "Anthropological Studies." London: Ward & Downey. 1891.

bear comparison with the Cavemen and Eskimo. The Bush race had probably at one time a much wider distribution throughout Africa and overflowed into Madagascar, where evidence of a dwarf population has been recorded by le Clerc, though whether or no they are the same stock as the other Negrillos found further north is still an open question.

Necessarily giving way before the more powerful Bantu races on the north, and harassed by the English and Dutch colonists from the south, they are fast going the way of all the weaker races in the struggle for existence. Their near neighbours, the Hottentots, though differing from the Bushmen in respect of height, are generally supposed to be a mixture of the Bush and Bantu races.

The recent exploration of Africa has done much to lift the veil of mystery surrounding the legendary dwarfs who dwell near the head waters of the Nile. Schweinfurth obtained one of these Akkas, as they are called, from the King of the Monbuttu, but lost him by death on his way to Berber. The Italian traveller, Miani, succeeded in bringing home to Italy two Akka boys, whom he obtained by barter. These little fellows were made much of, and finally became pages in the service of the Count Miniscalchi Erizzo. Similarly, Wissman, Stanley, and Emin Pasha, all refer to the same or allied races, and the latter explorer sent to the British Museum the skeletons of a male and female, which have been carefully described by Sir W. H. Flower. The result of the measurements of one of these skeletons was that the height of the female was determined at a little over 4 feet (1 mètre 21 centimètres). The other skeleton, the male, was not sufficiently complete from which to form an accurate estimate. On the whole, however, we may assume the average height of the males as 1 mètre 40 centimètres (4 feet 7 inches), that of the females as 1 mètre 30 centimètres (4 feet 3 inches). They are therefore a smaller race than the Andamanese. In respect of hair they are frizzy, and not tufted as the Bushman, and Emin describes them as covered all over the body by "a thick stiff hair, almost like felt." Their colour is lighter than most negroes, and their features display the negroid characters in marked degree—viz., pronounced prognathism, or projection of the jaws, together with full everted lips, in this respect contrasting with the Andamanese. In one point only do they differ in marked degree from the negro, that is in the form of the head, which is rounder and more spherical.

From what has been said regarding these dwarf races it will be apparent that though at present they survive only in the most inaccessible parts of the continents throughout which they are scattered, and are slowly succumbing to the influence of their more sturdy neighbours, none the less they are interesting as displaying a permanency of type, which is independent of climatic conditions, for we find the tall and short races dwelling side by side or in immediate proximity to each other, and it is for this reason that whilst an average may express the mean of the sum of the heights of the population of a country, it often conceals the fact that that population is made up of many individuals of tall stature intermingled with a certain proportion of people of smaller proportions. Apropos of this, Dr. Brinton remarks that "Since the intermingling of two races does *not produce a third race*, it is not likely that any of the existing races arose from a fusion of two others. The result of observation shows that after two or three generations the tendency in mixed breeds is to recur to one or other of the original stock, not to establish a different variety." It is for this reason then that we would lay special stress on a more detailed study of the heights of different populations, for just as we have seen that colour, hair, and bodily proportion are all of service in enabling us to trace the strain, so it would appear that height also is of service in assisting us to trace the influence of a parent stock. As yet we have not referred to the question of cranial form, the consideration of which must be discussed in future articles.

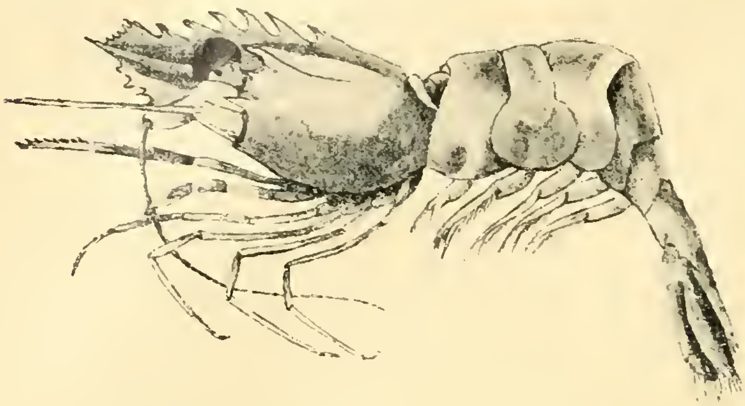
THE KARKINOKOSM, OR WORLD OF CRUSTACEA.—X.

By the Rev. Thomas R. R. Stebbing, M.A., F.R.S., F.L.S., F.Z.S., *Author of "A History of Crustacea," "The Naturalist of Cumbrae," "Report on the Amphipoda collected by H.M.S. 'Challenger,'" etc.*

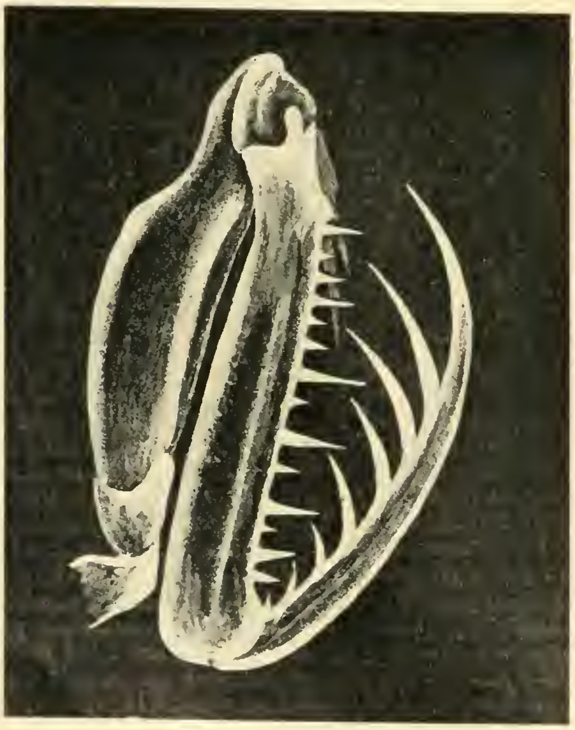
WEAPONS AND WILES.

Among the pictures of the year is one entitled "Wonders of the Shore." A delightful young lady, who has apparently been skirt-dancing, barefoot and alone, on the cool wet sands, is struck with astonishment at the sight of a Common Shore Crab (*Carcinus maenas*). Had she ventured to touch it with her naked toes, it might have added a new and truly impromptu figure to her dance. It is valiant exceedingly—far more valiant than polite. But it is not so much a wonder of the sea-shore as one of its commonest objects. At the beginning of this century vast numbers of this species were sold in London to the poor, who in those simple days esteemed them a great delicacy. At present, in England, for gastronomic purposes, there can scarcely be said to be more than one crab. Other crabs may be eaten, one alone is the "Eatable Crab." Thousands of persons consume it, in a heartless sort of way, without caring to know that its proper name is *Cancer pagúrus*. Occasionally they discover, without being carcinologists, that when alive it can inflict a painful pinch with the nipper of its mighty claw. There is, indeed, an old opinion that in proportion to its size this familiar crustacean is the strongest of all animals. Such a superiority might be difficult to establish if any obstinate person asked for the guarantee of calculation and experiment, tabulating the energy of mice and midges, crabs and crocodiles, in the common terms of horse-power or foot-pounds. Herbst genially endeavours to make the thing probable, not by these tedious methods, but by adducing the testimony of two reputable eye-witnesses, Minasi and Randazzo. The former had the good luck to see one of these crabs fight a stubborn battle with a black snake, without ever letting itself be caught in the coils or engulphed in the maw of the reptile. On the contrary, it so pinched and tore it that the snake, all flecked with gore and grievously abashed, now alarmed for its own safety, made way for its adversary to retire. Whereupon the crab, though still in fighting attitude, as much as to say "Come on if you dare," moved sideways to the water's edge, not folding its warrior arms till it sank into the sea. Randazzo, on his own estate, saw a like combat between a crab and a viper. Here, too, the venomous animal got the worst of it, finding its fangs of no avail upon its antagonist's carapace. In this instance, however, the cunning crustacean from time to time strengthened itself by eating marjoram, which grew on the field of battle, and then with heightened courage returned to the encounter with its proud (but less wily) opponent. In days of old sweet marjoram was a recognised remedy for drooping spirits and various other ailments. A modern crab no doubt takes other tonics, though it is surprising that its indisputable bravery should need them.

It is all very well for mankind to agree to put the sword into its scabbard and keep it there. In the case of several crustaceans the following of this pacific example would not be by any means easy. Crabs and lobsters, it is true, do sometimes cast off their formidable cutting and pinching chelæ of their own accord. But there is always a faint suspicion that they do this after they have had their fill of fighting, and when the mauled and battered weapons have become no longer serviceable to their owners. They speedily proceed to grow new ones, at first small and weak, as if only for the look of the thing, but in course of time their armature comes out as good as ever, or possibly a little improved.



Spirontocaris spinus (Sowerby). From Spence Bate.



Raptorial Claw of *Squilla raphidea* Fabricius. M. A. S.

When we turn to the prawns, we find many of them equipped in such a way as to put suppression of armaments out of the question. You cannot sheathe a sword that is an immovable projection from your own head. This part of a prawn's organization is called the rostrum. Its shape, its dimensions, the number and order of its teeth above and below, are seized upon by the naturalist for convenient specific characters. When they vary within the species, as they not unfrequently do, they become as specific characters very inconvenient. But all the prawn wants with them is that they should be characters inconvenient to his enemies. To fishes, such as are found sometimes with a small museum of fish-hooks inside them, the sword of a prawn may make no difference. Such a fish will swallow the prawn, sword or no sword. But the fact that we cannot defend ourselves against earthquakes and thunderbolts is not a reason for exposing ourselves defenceless to a multitude of smaller mischiefs. Probably the serrate rostrum of the prawn is not intended for attack, so much as to ward off objectionable advances, and, in the last resort, to induce a disgust for an other-wise much appreciated flavour by lacerating the gullet and stomach of small-sized aquatic epicures. The latter way of teaching them not to do it again must be expensive to both parties, and one may speculate whether it becomes efficacious by the extinction of the gourmands, or by some subtle spreading of experience throughout their tribe. In some prawns the rostrum is supplemented by another and a more dangerous-looking weapon. The plate attached to the second joint of the second antennæ, which is often broad, and has the function of a float or balancer, is in *Oplóphorus*, the Weapon-carrier, transformed into a sharp pike. Unlike the rostrum, which is almost always immovable, this bayonet-like organ can be turned about to give the enemy an oblique or sideways thrust, an uncomfortable dig in the ribs, well qualified to teach a small fish to control in future an unchastened appetite.

In the last chapter, the Squillidæ were referred to as a sort of pirates, lurking in their submarine tunnels—on the pounce. In this small, peculiar group, Nature shows no squeamishness. It is not for meek humility of self-defence, but evidently for rapine, that they are endowed with their raptorial claws. In the reckoning of appendages these correspond with the second maxillipeds, which are rather feeble mouth-organs in the crab, the lobster, and the shrimp. Far otherwise is it with their character in the Squillidæ, and in the great *Squilla raphidea* of the Pacific Ocean they attain a remarkable development. The two last joints, often spoken of as the hand and finger, may well arrest attention. The finger has its inner margin divided into eight sharp graduated sabre-like teeth, and in repose it shuts like the blade of a clasp-knife into a groove along the hand or handle. This groove itself is margined with several unequal spines at right angles to its outer edge, and three long ones making acute angles with its inner border. When the *Squilla* is pleased to close this piece of machinery with a sudden snap upon a passing object, only a very tough customer can hope to escape from that death-dealing labyrinth of teeth and spines.

However fierce and formidable a few of the crustacea may look, we need not attribute to any of them ambition, the desire of conquest, or the love of domineering for its own sake. All those virtues they leave to us, but for themselves they want food and offspring and personal safety. Unless these can be secured, it is of no use to say to them, "Down with your arms." They won't listen. Their otoliths, or earstones, will not vibrate in response to your appeal. But many of them are willing to obtain their ends by very quiet methods. Without venturing to affirm that in many positions they try to look as if they weren't there, or that they deliberately endeavour to wear an

Parthenope horrida (Linn.). From Guérin-Méneville.

unappetizing aspect, one may safely say that if they don't try they often succeed without trying. In the fauna of Great Britain and Ireland, we have some little crabs, which may be distinguished as Pennant's *Ebalia*, Bryer's *Ebalia*, Cranch's *Ebalia* and Norman's *Ebalia*, after the naturalists who either acted as their publishing agents, or who first brought their merits to light. These small crabs love the deep waters. They are not without some personal adornment, and there may be a season of their lives when they will run risks in order to display it, but in general they find their advantage in resembling little muddy rugged bits of stone. It is from stony ground that they are drawn to the unwelcome light of day by the merciless dredge or some exceptional storm. In cliffs and quarries, we often please ourselves by making out a human profile or perhaps the figure of a couching lion. Niobe and her children have been carved in the rock without the aid of a sculptor. There the accidental and the inorganic mimic the forms which we associate with living organisms. The Great Warty Crab (*Parthenope horrida*) makes an opposite appeal to our ingenuity. It sets its fellow-creatures the problem—though without the smallest desire that they should solve it—to find the living crab in what looks like a casual fragment of rock. From Guérin-Méneville's drawing, that might not seem to be a difficult puzzle. There are, however, certain points to be borne in mind. It was the artist's business to show as clearly as possible all the details of the organism. It is the crab's business to conceal them. It cares not a whit whether we can make out its specific characters, and would bear without a murmur the calamity of being referred to a wrong genus. It gathers up its arms and its legs into the smallest possible compass, inconsiderately making it quite difficult for any one to observe the shape of its external maxillipeds, or to see whether it has seven distinct joints in its tail as a *Parthenope* ought to have. The tail itself, usually so smooth a part in a crab, is here pitted and eroded like a weathered piece of sandstone. As for the tolerably symmetrical appearance, which the drawing displays, and which properly belongs to true crabs in general, no doubt a fish with an æsthetic eye might consider the circumstance suspicious. But this crab, though unversed in the biography of Sherlock Holmes, is not so weak as to expose such a clue. It tosses on a rag of seaweed here and there, in a negligent manner, so as to perfectly conceal the artfulness of its art. *Oreóphorus reticulatus* of Adams and White, as may be seen from the picture, is a crab which plays the same sort of game.

Oreóphorus reticulatus. From Adams and White.

Many crabs, and especially those of the tribe Oxyrhyncha, indulge in a highly elaborate costuming, about which much has been written of late. The improved and multiplied aquaria of recent times have given opportunities

Lambrus carinatus Milne-Edwards. From Adams and White.

for accurate observation of this strange procedure. It had, indeed, been long ago recorded that several species, which in youth had a smooth and shining carapace and legs but slightly tomentose, assumed in age a very different appearance. They seemed to become, as it were, "Half-suffocated in the hoary fell, and many-winter'd fleece of throat and chin," being all overgrown with the submarine fauna and flora among which they lay. In their fakir-like existence, they incurred the epithets of slow and sluggish, inert and languid, inactive and apathetic. When Leach discovered his *Inachus dorhynchus* from the Salcombe Estuary, he reasonably considered that this very circumstance of its being generally overgrown with marine matter had concealed it from earlier notice. Adams and White say of *Camposcia retusa*, from the Philippine Islands, that "as it advances in life, the carapace and legs become covered with a thick, woolly, yellowish-brown tomentum, and, in advanced age, the entire animal is concealed by a covering of Sponges, Corallines, Algæ, Actiniæ, and Alcyonia, beneath which it is impossible to recognise the species." Since crustaceans in general are subject during the larger part of their lives to periodical casting of the skin, it is evident that advancing age has very little to do with the forests upon them. These do not grow out of the crabs like the cherry tree out of Baron Munchausen's stag. They are under the control of the crustacean itself, to wear or not to wear, and can be adopted without any tedious waiting for their growth. The *Lambri*, which are numerous throughout the China Sea, living on submerged beds of broken shells and muddy gravel, suit themselves to their situation, many species, according to Adams and White, appearing "at first sight to be made up of a conglomerated mass of small stones and sand."

Our regard for all these animals must be heightened, now that we know more about their action and inaction. Neither the one nor the other is governed by vanity or superstition, or sloth. They know their own business and do it. Like naturalists, they find the absolute necessity of a quiet, retired life for carrying out their purposes. To secure this, they exchange the pomps and vanities of existence for a modest garb of mud and stones, or, availing themselves of their peculiar tubules and their uncinate and serrate spines, they deliberately plant upon their bodies a grove or tangle of such animals and vegetables as are suited to grow there. After all this trouble, it would be ridiculous for them to go scuttling around, and so to let all sorts of intruders and busybodies know their whereabouts, which they have been at so much pains to conceal. When they are forcibly transferred from one set of surroundings to another, they have an instinct which teaches them to change their dress to suit their new environment. This instinct, or faculty higher than instinct, is commended to the reader as a matter suggestive of many pleasing and interesting experiments.

A CONTRAST IN NOSES.

By R. Lydekker.

Of all the features of the human countenance none seems more prone to exhibit marked variations in size and shape than the nose. A broad and flattened nose is, for instance, characteristic of negroes and Australian natives, whereas the classic or Grecian nose is found only among the highest types of the Caucasian races of Europe. But while the nasal organs of the lower races of mankind differ in general from those of the higher peoples of Western Europe, yet it is among the latter that perhaps the greatest amount of variation in this respect may be noticed. And although even among these mixed Western nations a considerable amount of such nasal variability is evidently hereditary and distinctive of particular families or races, yet there are many instances in which it appears largely individual, although it may, of course, be due to reversion. Be this as it may, it will suffice for our present purpose to note that among European races a distinctly "snub-nosed," or "tip-tilted," type is not uncommon on the one extreme, while at the other we have what is commonly called the "long-nosed" type; the latter being broadly distinguished from the arched Roman, or aqniline, nose.

Now, it is a remarkable fact in natural history that whereas the great majority of the monkeys and apes of the Old World have noses of an ordinary pattern, that is to say, not very far removed from the type characterizing the nferior representatives of the human race, three of them have developed peculiarities in this respect which entitle them to be regarded as among the most extraordinary of all four-footed beasts. And not the least remarkable circumstance in connection with these nasal eccentricities is that the two extremes are found in members of a single group inhabiting widely distant and completely isolated areas.

Before referring to the species displaying these remarkable peculiarities, it will be well to briefly refer to their nearest relatives. These are most familiarly known by the sacred Hanuman monkey, or Langur, of India, which is one of a large group of species inhabiting most of the Oriental countries; one kind, the Himalayan Langur, being found at a considerable elevation in the outer hills of the mighty range from which it takes its name. And in winter, or early spring, these large grey monkeys may frequently be seen disporting themselves among pines heavily laden with snow. As distinctive features of the Langurs, reference may be made to their slim build, long hind legs and tail, and the absence of pouches in the cheeks for the storage of food. Their hair is long and coarse, and may be of any colour from slaty grey to bright foxy red or black. All have, for monkeys, fairly well-formed noses, of ordinary dimensions. Unlike the majority of the members of their order, they feed on leaves in preference to fruits; and, as showing how similarity of habit gives rise to similarity of structure (or, if the reader so please, *vice versâ*), it is interesting to note that the Langurs have complex stomachs, strikingly similar to those of sheep and ruminants in general; most other monkeys having simple stomachs of the normal type.

As already mentioned, the three species of monkeys which have gone in for eccentric nasal development are near relatives of the Langurs. The first of these, which has been known in Europe since 1781, is an inhabitant of Borneo, where, be it observed, there are also true Langurs with normal noses. As may be seen from our figure (1), which represents a male in the Natural History Museum, the Proboscis Monkey, as the species is called, is characterised by the inordinate length of the nasal organ of the adult male, which projects several inches in front of the line of the mouth, and gives to the whole physiognomy a most grotesque appearance. So remarkable, indeed, is the face of this monkey, that the first view of a stuffed specimen suggests to the beholder that it has been "faked," after the fashion of the "bogus" animals formerly manufactured by our Japanese friends. The nostrils are situated on the under surface of the tip of this ungainly proboscis, and are separated from one another by an extremely narrow partition. In the case of the female the degree of nasal development is considerably less; and in the young of both sexes the nose is comparatively short, with the nostrils visible from the front, instead of being directed downwards. In point of size the Proboscis Monkey is a comparatively large animal, the length of the head and body of the adult male being about thirty inches, and that of the tail some three inches less. Its colour is likewise conspicuous and striking, the upper parts, with the exception of a light band across the loins, being brilliant chestnut, and the face, which is fringed with long yellowish hair, a reddish flesh-colour.

Far more brilliant in colour is the first of the two Tibetan species which exhibit the opposite type of nasal eccentricity in the Langur group. But these snub-nosed monkeys, as they may be appropriately called, are fully as large as the Bornean species, and as they are of much stouter build, both as regards body and limbs, they look considerably bigger. Instead of a proboscis-like development of nose these two very peculiar monkeys have their nasal organs bent suddenly upwards at a sharp angle to

I.—PROBOSCIS MONKEY.

II.—SNUB-NOSED MONKEY.

A CONTRAST IN NOSES.

the line of the face, so that the nostrils are fully visible from the front; the whole aspect of the face being curiously piquant. The species here figured—the Orange Snub-nosed Monkey—was first made known to European science by the French missionary, Abbé David, who obtained specimens while travelling in the province of Moupin, in Eastern Tibet. Some of his specimens are preserved in the Zoological Museum at Paris; and the coloured plate of a female has long been the only figure available to naturalists. Thanks, however, to an energetic English naturalist resident in China, the Natural History Museum has recently acquired a pair of these hitherto little-known monkeys; our figure being taken from the male, which has been mounted for exhibition, and will form one of the most attractive specimens in the large monkey case. Since our photograph does not attempt chromatic effect, it is necessary to mention that the general colour of the upper parts is rich olive-brown, flecked with yellow and suffused with rufous, while the sides of the face, the lower part of the forehead, and the under parts are brilliant yellowish-orange, tending to full orange on the face, the naked portions of which are pale blue. Across the loins there is a light patch comparable to that of the Proboscis Monkey; the tail being proportionately rather shorter than in the latter, with a distinct tendency towards a club-shape. Altogether, the appearance of the animal is highly peculiar, both from the point of view of form and of coloration. The head, for example, in addition to its "tip-tilted" nose, is noticeable for its extreme massiveness, which gives an almost leonine appearance. And this general massiveness is equally observable in the limbs, which are relatively shorter than in the true Langurs; the feet being especially heavy and broad, with their toes almost concealed by long hair.

And here the attention of the reader may be directed to the circumstance that animals inhabiting cold countries (and Sze-chuan, where the British Museum specimens were obtained, can be very cold) are almost always much more heavily and substantially built than their relatives from warmer climes. An excellent instance of this phenomenon is afforded by the case of tigers in the same collection; the Bengal tiger being a long lanky beast, while its cousin from Mongolia is a heavily built creature, with extraordinarily massive limbs. Of course the longer hair of the Central Asiatic animal tends to exaggerate its general massiveness, which, however, would be perfectly apparent even without this extraneous aid. Possibly a stout and heavy build, especially as regards the limbs, may aid in protecting the circulatory system from the effects of extreme cold.

As regards the habits of the Orange Snub-nosed Monkey, our information is of the most meagre description. These animals are stated, however, to congregate in troops of considerable size, and to ascend the tallest trees (the part of Tibet they inhabit being more or less wooded) in search of fruits, which they much prefer to leaves. When pressed by hunger, leaves and the tender shoots of bamboo are said to form their staple nutriment. Bearing in mind this alleged partiality for fruits, it would be most interesting to determine whether the stomach of these monkeys is as complex as that of the true Langurs.

In view of the recent acquisition by the British Museum of the first specimens of the Orange species of Snub-nosed Monkeys ever seen in the country, it is not a little curious that it was last year that the professors of the Paris Museum were enabled to publish, with excellent coloured plates, the description of a new species of the same group, also coming from Tibet and the adjacent districts of North-western China.

This new species, which may be popularly known as the Slaty Snub-nosed Monkey, is fully as large as its more brilliantly-coloured relative, which it also resembles in the form of its nose. The tail is, however, much more bushy, and long-haired throughout. And while the colour of the upper parts and outer and front surfaces of the limbs is dark slaty-brown, the cheeks, under parts, and thighs are mostly pure white; the naked portions of the face being flesh-coloured.

The specimens of the slate-coloured species in the Paris Museum were obtained in the north-west extremity of Yun-nan, on the left bank of the River Mekong, in the neighbourhood of Yerkalo, and it seems evident that the species inhabits the crest of the long range separating the valley of the Mekong from that of the Yang-tsi-kiang. During the summer it is probable they frequent that side of the range which overlooks China, while their winter quarters would appear to be the side directed towards Tibet. The native name of *Tchru-tchra*, or snow-monkey, sufficiently indicates the severity of the climate of the region they inhabit. Probably the Blue River forms the line of division between the distributional areas of the slaty and the orange species, the latter being found in southern Kansu, northern Sze-chuan, and Moupin.

Despite their long isolation from the sphere of European science, one, if not both, of these peculiar monkeys seems to have been known to the Chinese from time immemorial, for in a work entitled *Shan-Hoi-King*, or "Mountain and Sea Record," which has been supposed to date from more than two thousand years B.C., a so-called man of the Heu Yeung kingdom appears, from its tip-tilted nose, to be one or other of the species under consideration.

In the foregoing remarks we have treated the three species of monkeys with eccentric nasal development merely as zoological curiosities. But it will be evident to every thinking mind that there must be a reason for such strange departures from the normal, and until we discover such reason we cannot be said to know anything worth knowing about these amimals. Unfortunately, those who have had the opportunity of seeing these monkeys in their native haunts have not assisted us in this matter; and as neither the Proboscis Monkey nor the Snub-nosed Monkeys have, we believe, hitherto been exhibited in confinement, there is an absolute lack of information in regard to this all-important point. And that the problem cannot be solved by guessing on the part of the stay-at-home naturalist may be regarded as practically certain. At the present day, owing partly to the anxiety to describe new species, and partly to the desire to obtain specimens of every animal for our museums, there appears a great tendency for intelligent explorers and travellers to degenerate from field naturalists into mere collectors. And the pity of this is too obvious to need more than mention. It is indeed often said that it is most important to obtain specimens of species before they become extinct; but the discovery of the *raison d'être* of the tip-tilted nose of the Tibetan monkeys, or of the proboscis-like organ of their Bornean cousin, would be a thousand times more valuable than the acquisition of untold specimens of either. And even the recently-acquired knowledge of the existence of the second species of Snub-nosed Monkey pales into unimportance when contrasted with the unsolved problem. By all means, then, let all those who have the opportunity put mere collecting into a very subsidiary place, and devote all their energies to the solution of problems of this nature (and their name is legion) before it becomes for ever too late.

After what has been said as to the necessity of actual observation to determine the reason for the peculiar nasal development of these monkeys, it would obviously be out of place to attempt to solve the problem in any other way. Attention may, however, be directed to the circumstance that the Chiru, or Tibetan antelope, has a remarkably swollen and puffy nose. And although the Saiga antelope, of the plains of Central Russia, has an equally remarkable nasal development, yet it seems highly probable that in the case of the Chiru, at any rate, the enlarged size of the nasal chamber and nostrils is correlated with the rarefied atmosphere of the elevated plateau on which that ruminant dwells. The Snub-nosed Monkeys, although living at a considerably lower elevation than the Chiru, are yet "well up in the world"; and since the shape of the nose in the former would appear designed to admit the passage of as much air as possible with the least impossible impediment, the suggestion that the habitat has something to do with the nose-structure may perhaps be suggested. As to the reason for the genesis of the ungainly proboscis of the Bornean monkey, we have not even the rudiment of a theory to offer our readers.

SOME SUSPECTED VARIABLE STARS.

By J. E. Gore, F.R.A.S.

There are many stars which have been suspected of being variable in their light, but which have not yet been admitted into the ranks of "known variable stars." The following are some of the most remarkable and interesting cases.

The brilliant star Capella (α Aurigæ) was suspected of variability by Struve, who, in a letter to Sir John Herschel in 1838, stated that he considered Capella was increasing in brightness, and Sir John Herschel agrees with him.* From observations made in 1855 by Mr. Benedict Ellner, of Bamberg, Bavaria, he found that Capella varied in brightness (1·0 to 1·9), and also in colour—from whitish-yellow to red. In the *Monthly Notices* of the Royal Astronomical Society for November, 1859, observations on the brightness of Capella are given by J. B. Kearney, of King's School, Canterbury. From February to April, 1858, he found Capella equal to Vega. Between November, 1858, and August 1859, Capella seemed rather brighter than Vega, but on August 19, 1859, "Capella was brighter beyond all possibility of doubt than either Arcturus or α Lyræ. At 10 o'clock Capella was magnificent, very far surpassing all its rivals. It flashed all manner of colours, blue and crimson being perhaps the most striking." On September 9th, 1859, he considered Capella *slightly* first, Arcturus a good second, and Vega, though *very* bright, third. My own observations, 1883 to 1886, make Capella sometimes brighter than Arcturus, and sometimes distinctly fainter. Capella was measured 0·08 at Oxford and 0·18 at Harvard, or nearly one magnitude brighter than an average star of the first magnitude.

Sir John Herschel found Arcturus brighter than Capella on April 14th, 1838.† It was measured 0·31 magnitude at Oxford (1882-1883), and 0·03 at Harvard. My own observations, as already stated, make Arcturus sometimes brighter and sometimes fainter than Capella, but the brilliancy of the stars and their distance apart render observations difficult and uncertain.

Canopus (α Argus).—This fine star—second only to Sirius in brilliancy—does not rise above the English horizon. In the Chinese Annals it is called Laou Jin, "the Old Man." Webb says, "It was thought, 1861, in Chili brighter than Sirius." Although it attained a meridian altitude of only seven degrees at my station in the Punjab, I observed it in 1874 to be very little inferior to Sirius. It was measured with the meridian photometer by Prof. Bailey at Arequipa, Peru, and found to be −0·96 magnitude, or about one magnitude brighter than the zero magnitude, that is about one magnitude brighter than Capella. As Sirius was measured −1·43 with the same instrument at Harvard, the result found by Prof. Bailey would make Canopus only about half a magnitude less than Sirius. It is certainly a splendid star, and may perhaps be variable to some extent, but owing to its great brilliancy suitable comparison stars are not available.

The star β Leonis, or Denebola, is almost certainly variable in light, but the period may be one of many years. It was rated 1st magnitude by Ptolemy, Al-Sufi, and Tycho Brahe, $1\frac{1}{3}$ by Flamsteed, $1\frac{1}{2}$ by Hevelius, but only 2nd magnitude by Lalande, Argelander, Heis, and others. In Schjellerup's translation of Al-Sufi's "Description of the Heavens" (tenth century) the star is thus described, "La 27 (β) de la première grandeur est la brillante et grande qui se trouve sur la queue; elle suit la brillante vingtième etoile située dans la reins. C'est celle que l'on marque sur l'astrolabe et que l'on nomme *dzana al âsad*, la Queue du Lion." Al-Sufi uses exactly similar words in describing Regulus (α Leonis), and, considering the great accuracy of all Al-Sufi's descriptions, it seems certain that in those days Denebola was fairly comparable in brightness with Regulus. The Arabians also called Denebola *al-sarfa*, "the vicissitude," possibly with reference to fluctuations in its light. Sir William Herschel, who made careful observations of the relative brilliancy of all the brighter stars in the Northern Hemisphere towards the close of the eighteenth century, rated Denebola as slightly less than γ Leonis, but slightly brighter than δ, or, in his notation 41 (γ), 94 (β) (denoting that γ was "the least perceptible difference" brighter than β). He says,* "this expression can certainly not be changed to 94, 41; much less can the order of three such stars as 20, 40, 39 Libræ admit of a different arrangement. If ever the state of the heavens should be such as to require a different order in these numbers, we need not hesitate a moment to declare a change in the brightness of one or more of the stars that are contained in the series to have taken place." Herschel's estimate of the relative brightness of β and γ Leonis is now certainly changed, as will be seen presently. Herschel says, further, with reference to β Leonis, "From the expressions of this catalogue, it is evident that the star is less now than it was thirteen years ago. The magnitude of this star given by Flamsteed is 1·2, but, as there is some ground to admit that this magnitude, even in this coarse way of reference, may be distinguished from what the same author seems to have taken for 2 mag., we conclude that this star has probably lost some of its former brightness." Again, he gives Beta 1·2 mag., and Gamma 2 mag. This notation seems to imply that Beta is larger than Gamma, which, not being the case, we have additional reason to suspect a change. De la Caille puts down Beta as 2 mag., though the difference between the notation of Flamsteed and the latter author can add little force to the argument for a change, as we have observed before, that a considerable allowance must be made for nominal variations in different authors. Nor can we draw any support from the magnitude itself, because the star will pass very well for one of that order when compared with other stars which are marked 2 mag. by the same author; but when De la Caille marks Beta 2 mag. and Gamma 3 mag., we may conclude that he estimated Beta to be larger than Gamma, though we do not know that he compared these stars

* "Cape Observations," p. 350. † *Ibid.*, p. 325.

* *Philosophical Translations of the Royal Society, 1796.*

together, because a whole magnitude in the second class cannot well be mistaken, coarse as is the type to which the reference is made." Sir John Herschel, while at the Cape of Good Hope (1834—1838), estimated β Leonis as 2·63 mag., and γ 2·34, or γ distinctly brighter than β. In recent years, β was measured with the "wedge" photometer at Oxford as 2·07, and with the meridian photometer at Harvard (U.S.A.), 2·23, γ Leonis being 2·12 at Oxford and 2·24 at Harvard. These results make the stars nearly equal in brightness; but my own observations show that β is now distinctly brighter than γ. The difference is conspicuous at a glance, and is unmistakable; and I can assert with confidence that if γ Leonis was ever brighter than β, as expressly stated by Sir W. Herschel, one of the stars is most certainly variable. In February, 1885, and March, 1887, I found β perceptibly brighter than γ; January 17th, 1889, β distinctly brighter than γ, and not very much inferior to Regulus—perhaps not more than half a magnitude; February 27th, 1889, β about a quarter magnitude brighter than γ, although β was at a lower altitude; April 14th and 17th, 1890, β nearly half a magnitude brighter than γ, although β was lower in the sky at the time of observation. At present β is distinctly brighter than γ. In February and March of the present year I found β, on several occasions, three or four steps brighter than γ, and my observations were confirmed by Dr. Kelly, of Blackrock, Co. Dublin—an experienced and accurate observer of variable stars.

δ Ursæ Majoris.—This is the faintest of the well-known seven stars forming the Plough, or Charles' Wain, and has been long suspected of variation, as it was rated of the 2nd magnitude by Tycho and the Prince of Hesse, while Sufi and Argelander give it 3-4 ($3\frac{1}{2}$), Bradley 3, and Heis 4-3. It was measured 3·41 at Oxford and 3·41 at Harvard. On December 7th, 1888, I found it equal to κ Draconis and slightly brighter than α Draconis. But α Draconis has also been suspected of variability, as it was rated 2nd magnitude by Tycho Brahe, Hevelius, Bradley and Flamsteed; 3rd magnitude by Ulugh Beigh, and only 3-4 by Ptolemy, Sufi, Argelander, and Heis. With reference to δ Ursæ Majoris, Schönfeld remarked, "Hinlänglish bestätigt, lange Periode." The period must be long, as it has not varied much in brightness for many years. Some of the other stars in the Plough have been suspected of variable light. Sir John Herschel, in 1838, thought that ϵ was the brightest of the seven, but in 1847 he found η *facile princeps*. Franks, in 1878, found ϵ decidedly the leader, and the sequence ϵ, η, ζ, α, β, γ, δ. According to the Oxford photometrical measures the sequence is η, ϵ, α ζ β, γ, δ. and according to the Harvard measures ϵ, α, η, ζ, γ, β, δ. On the evening of November 3rd, 1898 (6.45 p.m.), in a clear, moonless sky, I found, by a very careful estimate, the following sequence:—$\alpha = \epsilon$, ζ, η, β, γ, δ; but as the brightest stars of the set are so nearly equal in brilliancy, it is difficult to decide which, if any, are really variable.

α Hydræ.—This reddish star, called by the Arabians *al-fard*, "the solitary one," owing to its isolated position in the heavens, south of the sickle in Leo, was called "Choo'Neaon," the red bird, in the Chinese Annals, and is spoken of as red by Sufi. Sir John Herschel suspected variation in its light, and says ("Cape Observations," p. 349): "At the time I regarded the observations as satisfactory, and the results as sufficiently established; but the occurrence of a similar phenomenon with a period nearly identical in the case of α Cassiopeiæ, the period in each case being nearly a lunation, inclines me to distrust both conclusions, and to believe that the colour of the stars (in both cases verging to redness) has affected the judgment in the presence of moonlight differently from that of the stars of comparison." As, however, α Cassiopeiæ has since proved to be really variable, it seems probable that α Hydræ may be variable also. Gemmill observed it to be very bright on February 20th, 1882, and its red colour very conspicuous. He found it again remarkably bright on May 9th, 1883, when he thought it nearly equal to Pollux. It was measured 2·22 at Oxford and 2·02 at Harvard.

β Ursæ Minoris.—This star was rated of the second magnitude by Ptolemy, Sufi, Argelander, and Heis. In the "Cape Observations," Sir John Herschel gives observations of this star and concludes that it is certainly variable with a period of perhaps over ten years. From observations in 1881 and 1882, Espin thought it variable from 2·2 to 2·8 magnitude with a period of about 10·67 days. His observations were confirmed by Read, but the star has not yet been admitted into the ranks of known variables.

λ Draconis.—I have long suspected this star of variability, as my own observations, 1876 to 1891, show decided fluctuations of light. Sir William Herschel found it *exactly equal* to κ Draconis. On January 30th, and February 17th, 1876, I noticed that it was a little less than κ, and on the latter date I rated it 4th magnitude, and its colour orange. On January 12th, 1877, I found λ slightly *brighter* than κ, but on December 13th, 1878, I recorded it as a $\frac{1}{4}$ magnitude *fainter* than κ. Observations in subsequent years make it always less than κ, and on January 24th and 26th, 1889, I found it six steps, or about $\frac{3}{4}$ magnitude less than κ. On February 2nd, 1899, I found λ nearly one magnitude fainter than κ. Either λ or κ is therefore probably variable, and it seems more probable that λ is the variable, as its colour is orange and many of the reddish stars are known variables.

θ Serpentis.—This star was rated 4th magnitude by Ptolemy, Sufi, Ulugh Beigh, Lacaille, and Pigott; but 3rd magnitude by Tycho Brahe, Hevelius, Bayer, Flamsteed, Bradley and de Zach. Piazzi and Smyth made it $4\frac{1}{2}$, and Montanari called it 5. The Cordoba estimates vary from 4·1 to 4·6, and Dr. Gould thought there were strong indications of variability in one of the components (it is a double star). He gives the magnitudes as 4·5 and 4·7, but on one occasion at Harvard a difference of 1·4 magnitude was noted.

(*To be continued.*)

THE NEW ALGOL VARIABLE IN CYGNUS, +45° 3062.

An announcement is made in the *Astronomische Nachrichten*, Vol. 149, p. 271, that the star +45° 3062, R.A. = $20^h\ 2{\cdot}4^m$, Dec. = +45° 53′ (1855), magn. 8·6, is a variable star of the Algol type. Mme. L. Ceraski, of Moscow, found it abnormally faint on a photographic plate taken on May 20, 1898, and M. S. Blajko, after observing it visually for a long time, found it again at minimum on May 7, 1899. An examination was accordingly made of the Draper Memorial photographs to determine the nature of the variation. The region was covered by one hundred and ninety-five plates, one hundred and seventy of which showed the star at its full brightness, and twenty when it was below its normal brightness. From a discussion of these plates it appears that the minima they indicate, as well as the two minima found at Moscow, may be closely represented by the formula J. D. 2,411, $343^d{\cdot}605 + 4^d{\cdot}57294$ E. The period, therefore, is $4^d\ 13^h\ 45^m\ 2^s$, with an uncertainty which probably does not exceed one or two seconds. The variation in brightness of this star amounts to about three magnitudes, and, therefore, exceeds that of any Algol star hitherto discovered. Like all other Algol stars, its spectrum is of the first type.

The announcement of the discovery of this variable reached this Observatory on June 1. On June 3, the elements and ephemeris had been determined just in time to prepare for the minimum of that night. Accordingly, the star was followed all night by Prof. Wendell, assisted by Mr. Leon Campbell, and two hundred and seventy-two settings were made with the photometer attached to the fifteen-inch equatorial. From these it appears that at $16^h{\cdot}0$ G. M. T., it was 0·20 magnitudes brighter than the comparison star, $+45°$ 3067, while at $19^h{\cdot}9$ G. M. T., when observations were stopped by the dawn, it was 2·25 magnitudes fainter than the same comparison star, although it was still $1^h{\cdot}5$ before the predicted minimum. Observations by Argelander's method were also made all night by Mr. Wm. M. Reed, with the six-inch equatorial. Meanwhile, thirty photographic images were obtained by Mr. H. R. Colson, assisted by Mr. E. R. Cram.

Nearly a year would have been saved had the original discovery of the variability of this star been sent here for confirmation from the photographs, or had it been announced publicly. There is so little chance for error in a photograph that such cases are always examined here. Confirmation is not always obtained. A striking instance of this kind is furnished by a photograph, X 7524, taken at Arequipa with the thirteen-inch Boyden telescope on May 22, 1896, at $14^h\ 20^m$ G. M. T. Miss A. J. Cannon found that this plate shows the spectra of A. G. C. 17312, 17407, and 17453, magns. 7·0, 7·2, and 7·5 respectively, but fails to show the spectrum of the brighter star A. G. C. 17270, magn. 6·0. Apparently this is an Algol star observed at one minimum only. On one hundred and fifty-three other plates the star appears of its normal brightness. On a photograph, C 7354, taken at Cambridge with the eleven-inch Draper telescope on December 18, 1894, at $11^h\ 8^m$ G. M. T., the star, $+42°$ 4182, magn. 9·1, was found by Miss L. D. Wells to be absent, although stars two and a half magnitudes fainter were shown. On plate C 7353, taken twelve minutes earlier, and on two hundred and fifty-nine other plates, it appears of its normal brightness. An adjacent defect in the film of the first plate is perceptible, and perhaps explains the absence of this star.

Edward C. Pickering.

Harvard College Observatory,
June 10th, 1899.

[A minimum is predicted for the new variable 17^m before midnight on August 11th, and again 2^m before midnight on September 12th.]

British Ornithological Notes.

Conducted by Harry F. Witherby, f.z.s., m.b.o.u.

Mistle Thrush swallowing Droppings of Young.—I can endorse what Mr. East says about the Mistle Thrush. As in his case, a nest was built this year near my study window, easy of observation. There were three young ones, and, up to the time of leaving the nest, the old bird always swallowed the droppings. That she did not disgorge them, for some time at any rate, was evident, as she would often brood the young ones for several minutes before taking flight again. While she was sitting I noticed the cock bird pay her an occasional visit. She then perched on the edge of the nest, into which he disgorged some food and flew away. After eating at her leisure she resumed her duties.—George J. Chapman, m.a. (oxon.), f.z.s., Carlecotes, Dunford Bridge, Sheffield, June 20th, 1899.

All contributions to the column, either in the way of notes or photographs, should be forwarded to Harry F. Witherby, *at 1, Eliot Place, Blackheath, Kent.*

Science Notes.

Sir John Donnelly, who has just retired from the secretaryship of the Science and Art Department, and is succeeded by Sir George Kekewich, has during the forty years of his public service performed an amount of good work, the far-reaching effects of which will be better realised a generation hence, perhaps, than at present. Those who are best acquainted with his history do not hesitate to say that the present effective system of scientific instruction throughout this country is due almost entirely to Sir John's organizing ability and untiring efforts. A great friend of Gordon's from their student days at the Royal Military Academy, he was very near joining that hero in China when he commanded the "ever-victorious" army. When Gordon was Governor-General of the Soudan he invited his friend to join him, with a view to succeed him. All was settled to that effect, but, at the last moment, Sir John was induced to remain at home; the transference of his attention from military to civil problems has been a great factor in those innovations which have secured equal chances to all classes for the acquisition of sound instruction in Science and Art subjects.

The interesting collection illustrating the coinage and currency of the Chinese Empire, brought home by Lord Charles Beresford from his recent mission to China, has been generously lent by him to the Victoria and Albert Museum, South Kensington, and is placed in the Chinese Section in the Cross Gallery behind the Imperial Institute. It includes a series of silver taels in the form of cast ingots in the rough, with a pair of scales with brass and ivory weights for estimating the value, and some fragments used as small change. There is a set of dollars of different nationalities which pass in China, among them being the new British dollar, first issued in 1898 and coined in India. Among the copper coinage is a collection of ten thousand cash, strung together in bundles by means of the central hole which is a characteristic of Chinese copper coins, representing £1 in English money.

A novel camera, designed so as to admit of approaching quite near to any subject it is desired to photograph without betraying the purpose of the operator, has just been introduced by Messrs. W. Watson and Sons. It is in the form of a binocular field-glass. The photographer, ostensibly looking at an object in the direct line of vision through dummy object glasses, really operates on unsuspicious people at right angles—to the left or right—by means of intercepting prisms which divert the incident rays round a corner, as it were. Very good results can be obtained, and the action is instantaneous.

Obituary.

Sir William Flower, whose death, we regret to record, occurred on Saturday, the 1st July, was much and justly esteemed by scientific men the world over. Born at Stratford-on-Avon in 1831, after a course of study at University College, London, he entered the Army, and served in the Crimea as Assistant-Surgeon, becoming on his return home, Demonstrator of Anatomy in the Middlesex Hospital, and a year or so later, Curator of the Hunterian Museum of the Royal College of Surgeons, then Hunterian Professor of Comparative Anatomy and Physiology, and, in 1884, succeeded Owen as Director of the Natural History Museum at South Kensington. He was elected a Fellow of the Royal Society in 1864, and received from that learned body a Royal Medal in 1882. In 1879 he became President of the Zoological Society, and presided over the anatomy section of the International Medical Congress which met in London in 1881; from 1883 to 1885 he served as President of the Anthropological Institute, and was President of the British Association in 1889, having previously acted as president of the biological section in 1878 and of the department of anthropology in 1881. Oxford and Cambridge both conferred honorary degrees upon him, and the Institute of France appointed him one of its corresponding members. In the Jubilee year, 1887, he received the honour of C.B., and in 1892 he was knighted. Sir William's best-known work is, perhaps, "The Horse: a Study in Natural History," although several other works emanated from his pen—"An Introduction to the Osteology of the Mammalia;" "Diagrams of the Nerves of the Human Body;" "Fashion in Deformity," and "Mammalia," in the "Encyclopædia Britannica," as well as many minor articles on zoological subjects in that ponderous work of reference; but a large portion of his writings remains entombed in the proceedings of the Royal Society and other learned bodies. Morphology was, however, enriched by the "Memoirs on the Brain and the Dentition of the Marsupialia," which he published in 1865 and 1867, and his papers on the "Characters of the Cranium in the Carnivora" and on the "Evolution of the Cetacea" constitute valuable acquisitions to scientific literature. Sir William stedfastly urged the importance of museums as instruments for the advancement of knowledge in two ways—by affording facilities for scientific research, and by providing the means for popular instruction; these views he put in practice during his reign at the Natural History Museum, and the innovations he introduced were attended with excellent results.

Letters.

[The Editors do not hold themselves responsible for the opinions or statements of correspondents.]

HONEYSUCKLE FLOWERING IN A STRANGE PLACE.

To the Editors of Knowledge.

Dear Sirs,—In a beautiful garden at Uckfield, I saw the other day a sight that rather surprised me. A dead branch had fallen from a tree into a lake. From this branch an arm stood some four feet straight out of the water. On the top of this arm has now appeared a honeysuckle, trailing some inches down. The seeds of this plant were no doubt deposited by a bird, but how does it obtain sufficient moisture to be in the healthy condition it is? Is it capillary attraction, or are long suckers shot down by the plant into the water?

Jos. F. Green.

THE DISTRIBUTION OF THE STARS.

To the Editors of Knowledge.

Sirs,—The subject of Dr. Burns's article in your July issue is one on which I have bestowed a good deal of attention. My earliest articles on it appeared in *The Sidereal Messenger* for 1888. In the first of them, I inferred that if the stars of the nth magnitude were all placed on the surface of a sphere, those of the $n+1$th would be placed on the surface of a sphere with a radius 1·585 times greater, and would, therefore, on the hypothesis of uniform distribution, be 2·512 times as numerous. I discovered and corrected my mistake before any other contributor did so, but the curious circumstance is that the wrong figure accorded much better with observation (based on photometric measures) than the right one. It was indeed somewhat too low, but the right figure was considerably too high.

Argelander's magnitudes cannot be regarded as based on the ratio of 2·512 for one magnitude, and 9·5 being the lowest magnitude mentioned in his tables, he has included under that head stars of the 10th magnitude and even below that magnitude. Our only real guide is that afforded by photometric measures, in which Pogson's scale was adopted. The various publications of the Harvard Observatory contain the best and most extensive tables at present available. But I should doubt the correctness of any measures as low as the 17th magnitude, and am not at all surprised at the apparently discordant results arrived at by Dr. Burns from an examination of them.

In my recent little book "An Introduction to Stellar Astronomy," I summarised briefly the results of my previous investigations thus: "So far as I have compared photometric measures of stars, I think the theoretical proportion of four to one for the numbers of stars of two successive magnitudes is rarely, if ever, realized. If all stars are of equal intrinsic brightness, and light varies as the inverse square of the distance, a thinning-out commences at (comparatively speaking) no great distance from the earth or sun" (pp. 38–9). And I go on to point out that if the theoretical ratio were even approached in the case of very faint stars, the total sky-light would be vastly greater than it is. Let me illustrate this by comparing the total light of stars of the 5th and the 105th magnitudes on the hypothesis of uniform distribution. The light of each star is diminished in the proportion of $1{\cdot}585^{200}$, but the total number of stars is increased in the proportion of $1{\cdot}585^{300}$ to 1. The total light is, therefore, greater in the proportion of $1{\cdot}585^{100}$ or 10^{20} to 1. Written in figures, this would be represented by 100,000,000,000,000,000,000 to 1. The collective light of the stars of the 105th magnitude would, on this hypothesis, be much greater than that of the sun, and the change made in the total amount of sky-light by the rising and setting of the sun would become utterly insignificant.

W. H. S. Monck.

THE NEBULA N.G.C. 2237-9 MONOCEROTIS.

To the Editors of Knowledge.

Sirs,—The remarkable photograph of the above object, to be found at p. 132 of the June number of Knowledge, must, I think, impress every one who sees it with the great skill of the photographer, Dr. Isaac Roberts, and the perfection to which he has reduced the portrayal of the nebulæ. But there are other considerations which have struck me while looking at this picture. The first is the enormous extent of the nebulous matter. If we assume the parallax to be, say 0·5″, which is probably far over the mark, and consequently the real distance under estimated, the diameter, or greatest linear extent (perpendicular to line of sight) of that portion of the nebula situated in the N.P. part of the whole system, comes out about two hundred and sixty-seven thousand millions of miles; or, in other words, at least forty-eight times the diameter of Neptune's orbit. But *all* the separate nebulosities shown in this picture would seem to be undoubtedly connected; and we find that the greatest extent of the whole system exceeds one hundred and twenty-seven times the diameter of Neptune's orbit. Such figures convey absolutely no idea of their reality to our minds; yet unless any one can show that the nebula is very much nearer to us than the generality of the stars, it must be conceded that our figures are much under rather than over the mark. Mr. Maunder remarks* it is hard to understand how we can have gaseous masses of such enormous extent. They beggar our solar system in dimensions, and instead of a very few bodies of comparatively small size and condensed nature, must occupy an amount of solid space which we are quite unable to grasp.

The second feature to which I would call attention, and which Dr. Roberts in his description of the photographs specially refers to, is that of the dark rifts or lanes occurring in the nebula, especially the N.P. portion. They are sharply defined and clearly cut. How are we going to explain these dark rifts, which Mr. Maunder and others have alluded to? The breadth of one of these sharp rifts is about 1 mm., which on Dr. Roberts' scale = 24″. If the nebula is homogeneous and with a thickness in the line of sight approximately the same as that perpendicular to it, we are driven to the conclusion that this rift must be a hole, perforating the nebula from one side to another, with a length which must exceed its breadth by at least fifty times. This, as in the case of a bullet hole in the case of a terrestrial object, we might perhaps allow, if the aperture were circular; but when we come to have several of these rifts with an irregular, yet sharply-defined outline, the probability is very enormous against their being apertures extending through the nebulous matter to an extent corresponding to that of the whole system, in the line of sight.

I believe it has been suggested that such a phenomenon as these rifts may be due to the interposition of solid dark masses of matter between us and the nebula. But in the present state of our knowledge, and on scrutinizing the photograph under consideration, I cannot bring myself to believe that this is the correct explanation. The rifts do, to me, certainly appear as real vacuities, showing the blackness of space between or amongst the nebulous matter.

I can only account for them by the infinitely complicated character of this nebula. I suppose it to consist of streams and wisps, and projections of gas, bending, twisting in all directions, and by no means homogeneous when considered over the whole angular space which the nebula seems to occupy. In that case, a hole or rift is not so difficult to understand when we consider that it pierces a portion of nebula small in comparison to the whole system. Some cause or other, at present totally unknown to us, may tend to draw away or attract the nebulous fluid from certain definite but comparatively small localities and produce these gaps. The explanation, I fear, is a lame one to a certain extent, but who can offer a better? Those who have studied the writings of Proctor on this subject will probably trace his influence in this attempted explanation. He it was who said that "the constitution of the sidereal universe is too complex to be at present ascertained," and I think this remark would apply very largely to the particular nebula I have been considering. We must not think this nebula to be of the same nature as the regular spherical or elliptical ones, or the globular clusters of stars. In such I do not think such a thing as a dark vacuity exists.

It is possible that photographs taken at some future time, on a much larger scale, when the art has been greatly improved, may show these gaps or rifts to be partially occupied with, perhaps, comparatively tenuous nebular matter, just as increase in magnifying power of a (visual) telescope brings out details unexpected before. Meanwhile the rifts must remain a very remarkable feature, showing, I think, the very complicated nature of the detail which go to make up one of these irregular nebulæ. The curdlings and streaks, etc., in the great nebula in Orion are, I think, a phenomenon of an analogous order, although the general character of that nebula may differ from the one particularly under consideration.

E. E. Markwick, Col.

* Knowledge, February, 1896, p. 38.

THE ORIGIN OF FLINT.

To the Editors of Knowledge.

Sirs,—I find that, in an article on "Flint" in Knowledge for June, 1899, I have omitted mention of a comprehensive paper by Prof. Rupert Jones, F.R.S., on "Quartz, Chalcedony, Agate, Flint, Chert, Jasper," in the *Proceedings of the Geologists' Association*, Volume IV. (1876), p. 439. Prof. Rupert Jones provides an admirable historical account of the various opinions that had been held as to the origin of flint, and strongly supports the view (p. 450) that the silica is deposited as a pseudomorph of limestone. So much had been written on the subject in a more or less extravagant vein, that this paper, twenty-three years ago, produced a very salutary impression.

Grenville A. J. Cole.

THE DISTRIBUTION OF STARS IN SPACE.

To the Editors of Knowledge.

Sirs,—With reference to Dr. Burns' interesting paper on this subject in the July number of Knowledge, I find, in going through the recently published volume of measures made with the photometer at Potsdam Observatory (zone +20° to +40°), about one hundred cases in which the photometric magnitudes differ from those in the *Durchmusterung* by one magnitude and over. With only one exception in the hundred, the magnitudes given in the *Durchmusterung* are brighter than those found by the photometer. Thus, a 7·0 magnitude in the *Durchmusterung* is 8·0 or less in the Potsdam Catalogue, a 7·3 magnitude in the *Durchmusterung* is 8·3 or less. and a 7·5 magnitude star in the *Durchmusterung* is only 8·5 or less when measured with the photometer. This tends to confirm Dr. Burns' opinion that the fainter stars in the *Durchmusterung* are estimated too bright. Only stars down to 7·5 magnitude in the *Durchmusterung* were, however, measured at Potsdam.

With reference to the stars composing the Milky Way, it seems very improbable, I think, that the faintest stars lie at the distance indicated by their magnitude. For, taking stars of the 16th magnitude, their distance would be one thousand times—$(1{\cdot}585)^{15}$—that of an average star of the 1st magnitude, and with Dr. Elkin's mean parallax of 0·089″ for stars of the 1st magnitude, the parallax of a 16th magnitude star would be only 0·000089″, or a "light journey" of about 36,600 years! Placed at this distance our sun would be reduced in brightness to a star of magnitude 19·8, which no telescope yet constructed would show. I find by Pogson's formula that to *glimpse* a star of 19·8 magnitude, a telescope of 132 inches, or 11 feet, in aperture would be required.

To reduce the sun to a star of the 16th magnitude it should be removed to a distance of 398,100,000 times its present distance from the earth. This would imply a parallax of 0·000518″, and a "light journey" of over 6000 years! But the stars composing the Milky Way may very possibly be much smaller than the sun and intrinsically brighter (Sirian type), and, therefore, much nearer to us than the above calculation would indicate.

Dublin, July 10th. J. E. Gore.

Notices of Books.

An Introduction to Stellar Astronomy. By W. H. S. Monck, M.A., F.R.A.S. 1899. (London: Hutchinson & Co.) Mr. Monck has been unfortunate in his choice of a title. A more appropriate one would be "Facts and Fancies of Stellar Astronomy," and this, besides expressing more truly the nature of the essays that Mr. Monck has here reprinted in book form, would have been more likely to attract the attention of those readers to whom it would appeal. These readers should be "scientists," whom Mr. Monck in his preface distinguishes from "observers," good, bad or indifferent; and from the style of the book itself we should judge that by "scientist" he means what in the Middle Ages would have been called a "philosopher" and in the present day a "metaphysician." Still the "Introduction to Stellar Astronomy" will form a volume of comfortable reading for a philosopher in a hammock slung in a cherry orchard, if he is well acquainted with all the methods, and most of the facts and a few of the theories in stellar astronomy—or is content to remain ignorant of the first two. There is one theory, however, which we cannot pass over. It is not new, indeed, having been advocated for many years, by two or three paradoxers under the simpler term of "the sun a cold body." It is that "all loss or gain of heat," and presumably all forms of energy, is "an interchange between bodies in space, and on the whole the amounts lost and gained by these bodies would be equal." In other words, the sun only shines where there is anybody to receive its rays. We have always been ready to deplore the gross extravagance that is rife in the universe—and perhaps since economy should be practised, the sun and stars in fact take as their motto "no waste"—yet we do not see how Mr. Monck can ever hope to advance any evidence, not to say proof, on the point, since even if he could turn "somebody" into "nobody," and send it out as an immaterial spirit into the void of space, it would still be a moot question whether the lack of evidence it brought back would tend to establish that "nobody" had no eyes to see or senses to perceive, or that the sun had no rays to give forth to space.

The Internal Wiring of Buildings. By H. M. Leaf, A.M.I.C.E., M.I.M.E. (Constable & Co.) Illustrated. 3s. 6d. This is a really useful book, containing a number of minor errors which must not appear in the next edition. In speaking of the first of these errors, we would (in order to avoid a pun) suggest that Mr. Leaf should take two pages out of his book. These pages are the ones upon which definitions of the electrical units are given. It is clear in this connection that the author has attempted to break away from stereotyped expressions, and the results are not particularly happy. For example, the ampère is defined as the unit of quantity; so that one is led to ask, "What then is the coulomb?" The definition of the volt again gives no idea of electro-motive force. Yet clumsy as these definitions are, they will, we trust, do no great harm, though for Mr. Leaf's sake, it is a pity they occur so early in the book. We should like, too, to see the term C^2R spoken of sometimes as the watts lost by heating. Amongst the many interesting points brought out, we note that while many people object to the idea of bunching mains (even of like polarity) in wood casing, yet it is quite usual to draw both positive and negative leads into the same metal tube, and further, owing to the better mechanical protection afforded by such a tube, the insulation is frequently made lighter. Now all this is actually done in practice, as Mr. Leaf says, but the absurdity of it is obvious. There is a good detailed specification given, which might be copied almost verbatim (save in the matter of quantities, of course) by anyone wishing to apply it to a particular "job." Finally, while the book has its faults they are not serious, and regarded as a whole it is better than the most of those we know dealing with the subject. It is up to date, too, containing in the appendix the Institution wiring rules; also, the get-up of the book is good, but when will publishers give up printing the name of a work at the top of every page, instead of some useful sub-heading, or the chapter's title?

A Text-book of Botany. By J. M. Lowson, M.A., B.SC. (London: W. B. Clive.) 6s. 6d. This book is the latest addition to the well-known series issued from the University Correspondence College for the use of students preparing for examinations in general and those of the London University in particular. Mr. Lowson, consequently, has not had a free hand, and has not, in our opinion, done himself justice. There is no fault to be found on the score of inaccuracy; the book is well and clearly printed and also profusely illustrated; yet as a whole there is a lack of attractiveness. One cannot on a single page forget the examination. The alternation of clarendon and italics unconsciously sets one thinking—"Is this likely to be set next time?" The attention, instead of being fixed, is distracted. Then, too, the explanatory words attached to the well-drawn and instructive illustrations call up, willy nilly, the flag labels which the undergraduate associates with Burlington Gardens. What is to become of the romance of flowers and the poetry of the garden when plants are treated in this way? It is unavoidable, perhaps, that the primrose should be regarded as a dicotyledon, which is an excellent instance of heterostyly, but even the mortal who aspires to the honour of Bachelor of Science or Bachelor of Medicine might be taught, even while trying to assign it to its proper order in a system of classification, to regard a flower to some extent from the æsthetic point of view. We are finding no fault with Mr. Lowson, it is abundantly evident that he is an accomplished teacher. Under his care the candidate need have no fear of being "plucked." We complain of the examination spectre, and wonder what will be left to poor ordinary cultured beings who care nothing for titles but everything for the flowers of the field.

A History of Physics. By Florian Cajori, PH.D. (Macmillan.) 7s. 6d. net. We have histories of chemistry, astronomy, and biology—subjects which are sufficiently specific to lend themselves fairly well to historic treatment. Foundation stones are required for these literary structures, and they are all delved out of the mines of heterogeneous learning of the Greeks. Anyone who has indulged in this sort of intellectual diversion knows how the several sciences grow out, so to speak, from a main stem—the beginning of each history is almost identical in each case, and it is only after repeating the same old story that the subject begins to acquire individuality. Dr. Cajori, of course, resorts to the same sources as all the others, but his subject instead of developing into a distinct personality, as it were, becomes a kind of a many-headed monster—sound, light, heat, electricity, magnetism, mechanics, meteorology, atomic theory, and the evolution of physical laboratories. We ourselves are at one with Professor Ostwald where he says:—"Eminent and far-sighted men have repeatedly been obliged to point out a defect which too often attaches to the present scientific education of our youth. It is the absence of the historical sense, and the want of knowledge of the great researches upon which the edifice of the science rests." True, but we want something approximating to continuity in the history of, say, sound; to read one or two pages of matter concerning the progress of a subject during the sixteenth century, followed by similar scraps on many other subjects, to form a chapter for that particular period, and then repeat the same process for each succeeding century is a kind of scientific switchback railway which is more depressing than exhilarating. It is remarkable, too, that this book should have ever seen the light at all in its present condition—so thoroughly incommensurate with the magnitude of the project; the author, it is fair to say, appears to be conscious of this defect, but here it is nevertheless—not even a good skeleton for future clothing, at any rate according to our way of thinking. Here are from sixty to seventy thousand words in the book, and with this slender expenditure of printed matter "it is hoped that the survey of the progress of physics here presented may assist in remedying this defect so clearly pointed out by Professor Ostwald."

A New Astronomy. By David P. Todd. (Sampson, Low, Marston and Co., London.) Prof. Todd's leading thought in preparing this attractive little manual has been that it is possible to teach much of the principles and a good many of the facts of astronomy by what may be termed "laboratory work," that is to say, by practical work of a kind that is within the reach of nearly everyone. It is this principal that justifies Prof. Todd in calling his book a *New* Astronomy, for it differentiates it from the great majority of manuals dealing with the same general subject. The idea is an excellent one, and it has been admirably worked out with much ingenuity and freshness of thought. Lowell's work on Mars and Venus, Hale's spectroheliograph, Deslandres' discoveries in the spectrum of Altair, Lockyer's Meteoritic Theory, Chandler's Wandering of the Pole, and other recent developments, are all noticed, so that the book is fully up to date. For so small a book, indeed, it is very remarkably complete, and the explanations of principles or difficulties, though brief, are usually very clear. Lastly, especial pains have been taken with the illustrations, which are very numerous and good. Many of these are decidedly novel and striking. Thus in the two illustrations of the chief circles of the horizon equator and ecliptic systems, the different lines and curves are not lettered or numbered for reference, but are most distinctly labelled. So, too, with the telescopes. We must, however, object to the picture of the zodiacal light on p. 351, as utterly unlike the subject it professes to represent, whilst on p. 308 he has fallen into the inexcusable mistake of representing the eclipsed moon as 5° in diameter.

Smithsonian Institution. Report by S. P. Langley, for the year ending June 30th, 1898. Since the establishment of the Smithsonian foundation at Washington, in 1846, scientific research in America has progressed steadily, and the long series of publications issued have been the chief means of spreading the fame of the institution, the buildings of which are fine, and contain the national museum, and a good library, as well as the Library of Congress. In this report, Prof. Langley gives us an outline of the operations of the institution during the year ending June 30th, 1898, including the work placed under its direction by Congress in the United States National Museum, the Bureau of American Ethnology, the International Exchanges, the National Zoological Park, and the Astrophysical Observatory. The permanent funds of the Institution are as follows :—

Bequest of Smithson, 1846		$515,169·00
Residuary legacy of Smithson, 1867		26,210·63
Deposits from savings of income, 1867 ...		108,620·37
Bequest of James Hamilton, 1875	$1,000·00	
Accumulated interest on Hamilton fund, 1895 ...	1,000·00	
		2,000·00
Bequest of Simeon Habel, 1880...		500·00
Deposits from proceeds of sale of bonds, 1881 ...		51,500·00
Gift of Thomas G. Hodgkins, 1891		200,000·00
Portion of residuary legacy, T. G. Hodgkins, 1894		8,000·00
Total permanent fund . .		912,000·00

The first grant made by the Institution for scientific exploration and field research was in 1848, to Spencer F. Baird, of Carlisle, for the exploration of the bone caves and the local natural history of south-eastern Pennsylvania. In recent years a vast amount of such work has been carried on by the bureaus —a work made possible by Congressional appropriations for this purpose. The works published and circulated during the last fifty years form a library of about two hundred and fifty volumes. In 1887 the institution sent out seventy-one tons of documents, and had two thousand one hundred and sixty-five correspondents at home and seven thousand three hundred and ninety-six abroad; during the past year it transmitted one hundred and fifty-one tons, and had six thousand nine hundred and fifteen correspondents at home, and twenty-two thousand five hundred and forty-three abroad. Indeed, the system of international exchanges is the most powerful factor of the Smithsonian Institution for carrying out efficiently the beneficent purpose of its founder—to diffuse knowledge among men.

The Essex Naturalist. Edited by Wm. Cole, F.L.S., F.E.S. (Essex Field Club, Buckhurst Hill, Essex.) 6s. per annum. We have before us the parts of Vol. X. of this excellent publication, a work which is almost wholly local, *i.e.*, devoted to the elucidation of the natural history, geology, and pre-historic antiquities of the county of Essex. The Essex Field Club is about nineteen years old, and has already published some eighteen volumes of "Transactions" and "Special Memoirs." As might be expected, the subjects dealt with touch on every phase of the outdoor world as seen in the county of Essex—boring in search of coal, food of oysters, notes on the Epping Forest species of mycetozoa, floral aspects of the forest, fungi and how they should be represented in the local museums, fresh-water algæ, protection of birds, tides on the coast, ancient defensive earthworks, soils and subsoils, and so on. Indeed, whatever can in any way contribute to the economic or social welfare of the county is assured of a place in this little magazine, which is occasionally very well illustrated.

Researches into the Origin of the Primitive Constellations of the Greeks, Phœnicians and Babylonians. By Robert Brown, Junr., F.S.A., M.R.A.S., &c., &c. Vol. I. (Williams & Norgate, London, Edinburgh and Oxford.) 1899. Mr. Robert Brown, Junior, is George Eliot's Mr. Casaubon with a difference. The "Key to all the Mythologies" never took concrete form within the covers of a printed volume. Mr. Brown is more energetic than his fictional prototype, and his version of the "Key" reaches its fifteenth *avatar* in the present volume. But the scholarship, the industry, the essential and ostentatious pedantry and the complete obsession of the man by a single theory are characteristic equally of the real as of the imagined writer. Yet with all this, it is beyond dispute that Mr. Brown's books, and the present one in particular, have a very high value. In spite of page after page filled with matter which is really irrelevant, and which seems to have been simply introduced in order to impress the reader with a proper sense of the amazing learning of the author; in spite of continual repetitions which confuse rather than help, and of an arrangement far from well considered, the present book stands out as the most serious and scientific attempt yet published to trace the old constellation figures back to their origin. Mr. Brown traces the primitive constellations of the Greeks—those, that is to say, that are described for us in the *Phainomena* of Aratos—back to the early inhabitants of the Euphratean Valley, and particularly to the Akkadians, from whom the Greeks derived them through the Phœnicians, the Hittites, and the later (Semitic) Babylonians. This opinion Mr. Brown has set forth again and again in his earlier books, but though his details and repetitions are wearisome and often wholly unnecessary, there can be little doubt that, so far as there is evidence at present available, he proves his point. The question is different when he enters on the signification of the constellations. Here only one answer is regarded as admissible. Every constellation, without exception, is simply a special case of the great solar myth. So sweeping and so simple an explanation is self-condemned, and indeed we find that most of his interpretations of the signs of the zodiac assume that they were mapped out when Aries was the equinoctial sign, yet he is careful to point out (p. 327) that the present arrangement was adopted when the sun still entered Taurus at the vernal equinox. The fact is that many of the myths with which Mr. Brown deals were clearly originated at a relatively late date in order to account for the signs, the origin of which had then been forgotten, instead of the process being the reverse. It would be unjust, however, to enlarge too much upon the faults, glaring though they may be, of a writer who has made a real advance in a difficult subject. But we cannot conclude without a reference to the perversity with which Mr. Brown forces his ideas of the correct orthography of familiar proper names upon us at every turn. One single page supplies us, beside five synonyms for Babylon, with the following: Dârayavaush, Nabukudurra-utsur, Qarth-Hadasth, which we are kindly informed either here or elsewhere are meant to represent Darius, Nebuchadnezzar, and Carthage, and we are tempted to exclaim with honest old Hugh Evans, "The tevil and his tam! what phrase is this? why it is affectations."

Stonyhurst College Observatory: Results of Meteorological and Magnetic Observations for 1898. Father Sidgreaves' Report presents its usual neat and clear appearance, and as an ardent meteorologist he has the happiness on this occasion of establishing a record, the month of January being the warmest January in the Observatory annals. The appendix, which gives the meteorological observations taken at St. Ignatius' College, Malta, furnishes a less pleasant record for October. No readings of the ground thermometers were taken in that month from the 20th to the 30th inclusive. The reason for this omission is not expressly stated, but a suggestive account of a hailstorm on the 19th, with hailstones as large as hen's eggs, which crashed through wooden venetians, and pierced through corrugated roofs, is appended in a footnote. A useful little table of dates of magnetic disturbances is given on p. 50, but Father Sidgreaves concludes that there is at present no clear law connecting the magnetic disturbances with the sunspot areas of the year.

The Scientific Roll and Magazine of Systematized Notes, conducted by Mr. Alexander Ramsay. This work is to be completed in sixteen numbers. It embraces (1) a *bibliography*, classified according to subjects arranged (*a*) under year of publication, and (*b*) alphabetically as to authors, and each item has its number for reference purposes; (2) an *index*, which, although arranged alphabetically, is classified in groups more than is usually the case, the object being to render it possible, at some future time, to amalgamate the various subject-matter indexes into one general index; (3) a *systematized collection of facts*, grouped with reference to their relation to each other. The aim of the whole is to enable any person engaged in scientific research to find the information he seeks with a minimum expenditure of time. The information does not extend to science in general, but is confined to Climate and "Baric condition."

Rousdon Observatory, Devon; Variable Star Notes. No. 4: R Cygni and χ Cygni. As is well known, Sir C. E. Peek makes the observation of variable stars his speciality, and in this, the fourth issue from his Observatory in Devonshire, he gives the observations and curves of R and χ Cygni. The inspection of the curves brings to light the remarkable coincidence—it can be no more—that the light variations of the two stars seem complementary. The mean curve of the two stars indeed would be very nearly a straight line.

Curious Epitaphs. Compiled and edited, with notes, by William Andrews. (Andrews & Co.) 7s. 6d. This is a reprint, with some important additions, of the interesting collection of epitaphs first published by Mr. Andrews some years since. In terseness, wit, and perspicuity, it is hard to beat Jerrold's anticipatory epitaph on Charles Knight, the distinguished historian: Good Knight.

Coleridge's Table Talk. The Bibelots. Vol. I. Edited by J. Potter Briscoe. (Gay & Bird.) 2s. 6d. We do not recall a more elegant and altogether dainty little volume. Beautiful types and good paper, embraced in embossed calf, with gilt edges, make up an exquisite possession for the book lover.

The International Directory of Booksellers and Bibliophile's Manual, 1899. Edited by James Clegg. (Rochdale: Aldine Press.) 6s. This unique compilation should bring the book-buyer and the bookseller into touch all round the world, seeing that the editor has penetrated to the most remote districts, and Trinidad is put into communication with Tonquin or Rhodesia. An invaluable book of reference.

BOOKS RECEIVED.

A Glossary of Popular, Local, and Old-fashioned Names of Birds. By Chas. Louis Hett. (Simpkin.) 6d.

Insects: Their Structure and Life. By Geo. H. Carpenter. (Dent.) 4s. 6d. net.

The Cambridge Natural History.—Insects. Part II. By David Sharp, M.A. (Macmillan.) Illustrated. 17s. net.

The Soluble Ferments and Fermentation. By J. Reynolds Green, F.R.S. (Cambridge University Press.) 12s.

Physics: Experimentat and Theoretical. By R. H. Jude, M.A., D.SC. (Chapman & Hall.) 12s. 6d. net.

Curiosities of Light and Sight. By Shelford Bidwell, F.R.S. (Sonnenschein) Illustrated. 2s. 6d.

Darwinism and Lamarckism Old and New. By Frederick Wollaston Hutton, F.R.S. (Duckworth.) 3s. 6d.

Rambles with Nature Students. By Mrs. Brightwen, F.E.S. (Religious Tract Society.) Illustrated.

The Modern Chess Primer. By Rev. E. E. Cunnington, M.A. (Routledge.) 2s.

Anatomical Diagrams for Art Students. By James M. Dunlop. (G. Bell & Sons.) 6s. net.

Report of Proceedings of the Museums Association. Edited by Herbert Bolton. (Dulau.)

Impressions of America. By T. C. Porter. (Pearson.) 10s. 6d.

Bacteria: Especially as related to Economy, Industrial Processes, and Health. By Geo. Newman. (Murray.) Illustrated. 6s.

The Commonwealth of the Body. By G. A. Hawkins-Ambler. (Scientific Press, Limited.) 1s. 6d.

Chats about the Microscope. By Henry C. Shelley. (Scientific Press, Limited.) 2s.

Kinetic Theory of Gases. By S. H. Burbury, F.R.S. (Cambridge University Press.) 8s.

The Indian Eclipse, 1898. Edited by E. Walter Maunder, F.R.A.S. (British Astronomical Association.) 5s.

The Principles of Mechanics. By Herbert Robson. (The Scientific Press.) 2s. 6d.

The Studio for July. 1s.

Wild Life in Hampshire Highlands. By George A. B. Dewar. (J. M. Dent & Co.) Illustrated. 7s. 6d. net.

The Birds of Breconshire. By E. Cambridge Phillips. (Brecon: Edwin Davies.) 7s. 6d.

TWO MONTHS ON THE GUADALQUIVER.

By Harry F. Witherby, F.Z.S., M.B.O.U.

III.—REEDS AND RUSHES.

OUR second encampment in the *marismas* was surrounded by somewhat different country from that described in Knowledge, for March, 1899. Instead of scanty verdure, dry mud and shallow *lucias*, we had stretches of marshy land covered with fairly luxuriant grass, and great lakes, shallow but deeper than *lucias*, and thickly overgrown with rushes. This country, separated from the other only by the river, was inhabited by quite a different set of birds—a fact made more apparent when we re-visited the place later on after the birds had commenced to breed.

Instead of the larks and stone curlews of the dry plains, and the flamingoes and migrant waders of the *lucias*, on the borders of these rush-grown lakes were hundreds of stilts and redshanks,* while the lakes themselves were inhabited by many colonies of whiskered terns† and black terns.‡ Many other interesting birds had also located themselves here and there in reedy dykes and on patches of raised and dry ground.

The first of these lakes we visited extended over several square miles, and was completely overgrown with rushes; at a distance it looked like a great field of deep waving green, over which flitted and hovered in little companies thousands of graceful marsh terns, appearing sometimes dark and sometimes bright as they twisted and turned in the sunlight.

We hastened through the marshy ground, disturbing as we did so stilts and redshanks, which flew round us uttering loud alarm notes. Soon we were brushing aside the rushes, which were shoulder high, and wading up to our knees, and often to our waists, through the tepid water.

Fig. I.—Floating Nest of Whiskered Tern.

We came upon a colony of terns; some rose from their nests and flew round us much agitated; others, their nests not yet completed, flitted past with mouths full of grass; while, again, some, their beaks at right angles, hovered over the water searching for prey, which they dashed down upon with a graceful plunge, captured, and had eaten almost before the water had run off their sharp wings and elegant body in a glittering spray.

* *Totanus calidris.* † *Hydrochelidon hybrida.* ‡ *H. nigra.*

Terns may be counted as among the most graceful of birds, and to watch the varied motions of a colony of whiskered or black terns is indeed a delight. Both these terns build, floating upon the water, nests of grass and rushes, but the black tern, judging from the many nests which we examined, although making a smaller nest, builds it much more compactly and raises it higher from the water than the whiskered tern. In the middle of May we found the nests in all stages. Many contained eggs, many were half finished, and several were merely foundations of a few pieces of rush placed across each other on the water.

Frogs abounded in this marsh, and many storks were wading often breast-high in the water in search of the savoury reptiles, or were flying high overhead clapping their beaks with a cŭp-cŭp-cŭp-cŭp, that resembled the sound of frogs croaking.

We waded on some two or three miles, passing many a colony of terns, and once more reached the shallow water, where noisy stilts and redshanks began again to assert themselves.

Redshanks are so abundant on our home marshes that it is not necessary for me to say anything about them. Stilts are much like redshanks in many of their habits. They are exceedingly noisy, especially when their nests are approached, and although we admired them much and watched them often we hated them on occasions when we were seeking better game and our presence was made known to everything within many yards by the "querep-querep" of the stilts overhead.

When feeding, stilts have also much the same action as redshanks, especially in the way in which they continually jerk their heads backwards and forwards. We found a great many of their nests, and noticed that those placed in swampy ground were built substantially, whereas those on dryer ground were much less so, while several found on quite dry ground were composed of nothing but a few pieces of grass placed in a "scoop." The birds became very much agitated when their nests were approached. They flew over us calling loudly, and repeatedly settled within a few yards of us, seeking to attract our attention by running about and jumping into the air as if they were dancing, then rapidly quivering their wings and with gaping beaks chattering softly and continually. While watching these birds we witnessed a curious little neighbours' quarrel. A long-legged stilt was making little rushes and dabs at a couple of redshanks, which looked so short and quaint compared with their tormentor, and all the time the three were uttering soft, but imprecatory noises (swear words we imagined) at each other.

The marsh was full of life. There were numerous tortoises, difficult to find amongst the weeds, and the whole place was infested with myriads of dragon flies, every rush being covered with its share of them. Once I gave one of our men, who seemed to have nothing to do but smoke the delicious *cigarillo*, a net, and showing him a dragon fly told him to go and catch as many as he could, as I wanted some for a friend. He went off delighted, and stayed away three hours and came back with one butterfly! Cigarettes and the sun were too much for him when he had once sat down out of sight.

On one occasion as we were watching some stilts and ducks a peregrine falcon suddenly appeared circling over their heads. The birds gradually became more and more frightened, until at last they rose from the water and took a short flight. Down came the falcon like a stone and knocked a duck on to the water, and there he left it floating keel uppermost. The ducks and stilts settled again, but the falcon still circled overhead until the now terrified birds rose again. This time he singled out a stilt, struck it in a flash, and left it like the duck floating on the water. Apparently he was only practising or having some sport, for he swept right away and left his victims limp and dead. But a dead body is not left for long in this country where hungry kites and birds of prey abound. One afternoon we shot and lost a duck and a slender-billed gull;* the next morning we visited the spot again, and on the edge of the marsh were two little heaps of feathers—one brown, the other a delicate pink—all that was left of the duck and the beautiful gull.

On the dry ground some distance from the marsh, or perhaps raised above it, many interesting birds were nesting, and all betrayed their anxiety as we approached. This they did in different ways, the pratincoles† with their strong swallow-like flight whirled round our heads and made as much noise and fuss as the stilts. They often settled very near us, but instead of dancing like the stilts they crouched, and spreading their long wings to the full extent rested them upon the ground. When they wish to rise from this position and fly they invariably close their wings, possibly because their legs are too short to raise the wings sufficiently, but they run fast with their wings closed. The eggs of this bird, two or three in number, are laid side by side in a little scoop in the dry mud. They are handsomely marked and mottled, but as their shape and colour are similar to a stone or a piece of mud at a short distance they are not easily discovered. There were other birds nesting in this dry mud near the water. Black and white avocets laid their four brown eggs in a hollow in the mud, usually adorned by a feather or two—often a bright pink one from a flamingo. In one spot we could stand still and touch five separate nests with a gun, and our horses sometimes trod on the eggs, so plentiful were they. Avocets do not annoy one like stilts and pratincoles; when their eggs are approached they fly round complaining for a few minutes, and then go away to stand and await developments at a distance; and so do the lesser terns‡ and Kentish plovers, the eggs of which we also found on this mud.

Fig. 2.—Stilt's Nest strongly built in Wet Ground.

Besides many patches of tall reeds here and there in the marsh, there were several long dykes very thickly grown with reeds as high as small trees. These dykes resounded with the hoarse and incessant croaking of great reed warblers —small brown birds with loud harsh voices. As mentioned

* *Larus gelastes.* † *Glareola pratincola.* ‡ *Sterna minuta.*

in my first article these birds are difficult to see. Although bold enough when in cover—for they will cackle into one's ear at a yard's distance—they leave their retreats only to flit out and in again, and it is impossible to do more than catch a passing glimpse of them when amongst the waving reeds. We managed to beat some of them out and so get specimens, and we also found their beautiful nests, made of the flower of the reed and woven round four or five stems. Fastened in this way on the reeds they sway with every gust of wind, but the cup of the nest is so deep that the eggs are safe from falling out.

Whilst exploring one of these dykes in search of the great reed warbler, we saw a little bittern,* a black and creamy-white bird rather larger than a waterhen, run into a thick mass of reeds. We surrounded the spot, and eventually managed to drive the bird from its hiding place, but it ran past us like a rat and was up the bank of the dyke before we could move. We rushed to the top just in time to see it flying across to a reedy swamp, and thither we quietly followed it. Just as we reached the reeds another little bittern flew out. We shot at it but only succeeded in wounding it. The bird flew a short distance and then perched on a reed, gripping it firmly with one foot above the other. As we approached, the bittern pointed its bill straight up into the air, and stretched up its neck and body until it was long and attenuated and resembled a reed. This attitude is commonly employed by the bitterns for purposes of concealment when hard pressed. A brown-coloured bittern is exceedingly difficult to find in a reed bed when in this position, and so is a little bittern where the reeds are thick and the light broken up, but in the present case the pied plumage of the bird was very conspicuous in the more or less open place which it had chosen. The bird, however, seemed to consider itself quite invisible, for it remained stiff and motionless although we went within a few yards of it. By wading quietly through this reed bed we put up several more of these birds, and we had also the good fortune to find one of their nests made of dry pieces of reed, and carefully concealed. The nest contained five eggs of the purest dull white.

As mentioned in my first article, a small portion of the *marismas* is dotted over with pines and cork oaks, and overgrown with a very dense and tall undergrowth, composed of tamarisk, gorse, cistus and other shrubs, sometimes growing almost to the size of trees. This part of the *marismas* is near the sea, from which it is protected by miles of sand dunes. These are increasing so rapidly in height and breadth that many trees, and even whole woods, have been covered and eventually stifled to death by the shifting sand. In riding across these sand hills one actually passes over the tops of many a tall dead tree hidden under the sand, or guides one's horse amongst the topmost branches of some big pine, which is still living and fighting the irresistible sand that will eventually smother it. The sight of a grove of these trees buried up to their "necks" in sand and yet still living, is not to be forgotten.

We approached this country from the river, and as our boat neared the shore we noticed that the mud of the river bank was thickly studded with what looked like small stones, but no sooner had our boat grounded than all these "stones" disappeared as if by magic. We landed and found that the mud was bored in every direction with holes, and on going a little distance off and remaining quiet, the "stones" appeared again in thousands, and we soon discovered that they were really small brown crabs. The crabs seldom stray far from their holes, so that it was by no means easy to catch any of them. If surprised suddenly, and not being able to reach his own home, a crab would dart into a neighbour's hole, but only to be chased out by the owner, and thus he could be captured before going to ground again. Some curlew† and whimbrel‡ were running about on the edge of the river at a little distance away from us, and with our glasses we could see that every now and again one of the birds would make a rush, and catching a crab by a leg would drag it from its retreat. The bird would then walk off with its captive to the hard ground, and after breaking the crab's shell against the stones, as a thrush does a snail, make short work of its soft inside.

Of the many interesting birds such as eagles and kites to be found in the wooded part of this country I hope to write in a subsequent article. Occasionally amongst the tamarisks there is a small lake often with an island, sometimes covered with reeds or rushes, sometimes with tamarisk. Many kinds of herons breed on these islands in colonies. Owing to the dry spring of 1898, water, and hence food for the birds, was scarce, and consequently they began to breed much later than usual. Up to the 7th of May, no herons, excepting the purple heron, were to be found at their breeding places. However, we had ample opportunities of watching these beautiful birds, which were always to be seen feeding in the marshes bordering on the wooded land. A most striking and beautiful sight is that of a flock of buff-backed herons,‡ looking a dazzling white in the sunlight, attending on a herd of black bulls or a group

Fig. 3.—Stilt's Nest slightly built on Dry Ground.

* *Ardetta minuta.*

* *Numenius arquata.* † *Numenius phoeopus.*

‡ *Ardea bubulcus.*

of horses. Some walking by the side of the cattle are constantly stretching out their beaks to the horses' head or jumping up to its belly, in order to snap off a fly or tick which they have spied; others perched on the backs of the beasts relieve them of many an enemy. All the while the cattle never flinch, but seem to know perfectly well

FIG. 4.—Avocet's Eggs in a Scoop in the Mud.

that the birds with their graceful movement and delicate peck are doing them a service.

Squacco herons,* with reddish-brown backs, were also in these marshes, as well as many flocks of that most beautiful of all the heron tribe—the little egret.† The entire plumage of this lovely bird is of a pure snowy white, its beak and legs are black, and its eyes yellow. Like all the herons it has long plumes on the head and breast, and growing from the middle of its back, and drooping over its wings, are those filamentous wavy feathers so exquisitely beautiful on the bird—so artificial and unsightly on a woman's bonnet.

* *Ardea ralloides.* † *Ardea garzetta.*

SECRETS OF THE EARTH'S CRUST.

By GRENVILLE A. J. COLE, M.R.I.A., F.G.S., *Professor of Geology in the Royal College of Science for Ireland.*

IV.—A CALDRON OF THE ROCKS.

THE phenomena of volcanoes, so full of mystery, so fraught with perilous excitement to those who dwell upon their flanks, have been disguised in a haze of erroneous statements, and in much poetic imagery, born of astonishment and fear. To this day, such expressions as "the smouldering of subterranean fires," or "vast clouds of incandescent gas," are by no means confined to the daily press, or the pages of sensational magazines. Sir William Hamilton,* the well-known Envoy of His Majesty at the Court of Naples, may be said to have set the example, so far as English observers are concerned, in systematic observation, day by day, of what actually goes on in a volcano. His views on the structure of volcanic cones anticipated those of Scrope,† and his researches, in a large degree, preceded those of his Italian contemporary, Spallanzani. In later years, our ideas have been kept, as it were, from wandering, by the successive editions of Scrope's memorable works, and by the series of papers from the pen of his successor, Prof. J. W. Judd.‡ Prof. Judd, in his book on "Volcanoes,"§ has summarised a long series of observations; while Sir A. Geikie|| has recently called attention to the debt we owe to the great French geologists in the early years of the present century. The latter author has also added, in his history of volcanic action in our islands, to the large debt we owe to his own writings.

If the elucidation of the visible phenomena of volcanoes still remains a subject for discussion, far greater difficulties are sure to be experienced when we try to realise what is going on beneath the surface. What happens in the great underlying lava-basin, in this unseen caldron of the rocks? What evidence have we as to its nature? How can we hope to make any actual observations?

In the venerable, but highly erroneous diagrams that may still be found in atlases of physical geography, a section of the earth's crust may be seen, in which the whole stratified series is piled up, like a sloping row of books, and resting at one end upon a primitive mass of granite. The high antiquity of granite, and its eminently fundamental character, are conceptions which date back to the last century, and which were not then to be lightly called in question.

Yet, when James Hutton,¶ in 1785, made his famous discovery in Glen Tilt, and showed that granite sent off veins into the surrounding rocks, its supposed fundamental character was successfully assailed. The theory of the deposition of all crystalline rocks from the waters of a primitive ocean was at one time widely accepted, and was held by some Italian geologists down to very recent years. Yet, from Hutton onwards, observation after observation showed that such rocks were intrusive in others at their margins, and were at times, therefore, of later date than Mesozoic or Cainozoic rocks.** If, as was thus generally proved, granites and their kindred were at one time in a state of fusion, with what type of igneous phenomena were their features most nearly allied?

The modern volcano does not erupt granite, or diorite, or gabbro, or any material in a highly crystalline condition. The fused and viscid lava, when it consolidates, may even form a glass, imperfect, it is true, but certainly glassy to the eye. The surface of highly siliceous lava-flows, like the Rocche Rosse of Lipari, resembles the broken refuse of a bottle-factory; while the smoother and

* "Observations on Mount Vesuvius, Mount Etna, and other Volcanoes," 1772; Second Edition, 1773; also the superbly illustrated folio on the Campi Phlegræi, 1799.

† "Considerations on Volcanoes," 1825.

‡ "Contributions to the Study of Volcanoes," *Geol. Mag.*, 1875.

§ *International Scientific Series*, 1881.

|| "Ancient Volcanoes of Great Britain" (1897), Vol. I., preface.

¶ *See* Lyell, "Principles of Geology," Vol. I. (1830), p. 62; Hutton, "Theory of the Earth," Vol. III., now first published in 1899.

** *See*, for instance, KNOWLEDGE, Vol. XXI., p. 124.

basaltic rock of Kilauea, in Hawaii, has also a coating of some two inches of black glass. Occasionally, as in the wonderful valley near Hlinik, in north-west Hungary, or at Obsidian Cliff, Yellowstone Park, huge rock-masses may be seen, consisting throughout of natural glass. In most cases, however, the inner portion of the lava-flow is dull and partly crystalline, while the centre may reveal no glass, even when seen in section under the microscope. A dense mass of felted crystals has arisen; the fused rock has passed through its glassy stage while at a high temperature; the heat has been maintained sufficiently long for the molecules of the silicates to creep together; and a stony lava is the result. The mass has *devitrified*, as glass-workers say; and all the stages, as Sir James Hall showed long ago, may be successfully imitated by experiment.

In the dykes, which are exposed where portions of a volcanic cone have been broken down, matters may have proceeded farther. These wall-like masses of rock represent lava that has cooled in fissures; and they have probably been exposed at no point to the open air. A glassy film may appear on their edges, where the lava was first chilled by contact with the surrounding rock; and their thin veins or offshoots may easily be vitreous throughout. But the central portions of a dyke will in general be more crystalline than any portion of a lava-flow of similar composition. They will, in fact, approximate to the structure of granite and its allies.

The microscope, indeed, shows that the approximation is a very good one. The minerals that have developed are, with very few exceptions, similar to those that occur in coarsely crystalline rocks of the same chemical composition. Their mode of grouping in the rocks of the dykes is again and again paralleled in sections cut from coarsely crystalline materials. The structures seen in lavas are, then, to be found in the outer portions of dykes; those of granite and its allies occur in the central portions. The scale may be more minute, and that is all.

Certain types of mineral-aggregation may appear in the intermediate regions of the dykes, or throughout dykes of only moderate thickness, which at first sight seem peculiar to these masses. These structures are found, however, to be intermediate in character between those of ordinary lavas and the coarser type of igneous rock; and they are repeated, moreover, in the heart of massive lava-flows. One is forced to correlate these modes of aggregation of the minerals, and the presence or absence of a glassy groundmass, with the conditions of temperature and pressure under which the rock consolidated.

It may, then, be fairly conceded that very slow cooling underground, under considerable pressure, has produced the crystalline characters of granite. The water that escapes so freely as steam from lava-flows at the surface may be imprisoned in deep-seated masses, and may have its effect on the order of crystallisation of the constituents, and even on the nature of the minerals themselves. Yet, when we examine the offshoots of a granite or a gabbro—*i.e.*, the dykes which have arisen along the margin of these masses—we find that the links are complete with the dyke-rocks of our present-day volcanoes. We must allow for the weathering of some constituents, and for the superior freshness of rocks formed in our late Cainozoic epochs; but, with this proviso, the comparison can be carried out down to minute structural details.

Lavas, again, whether they cool in dykes or flows, frequently contain what are called "porphyritic" crystals. These are larger than those in the general groundmass, and give the rock the character of the "porphyry" of the Greeks and Romans. They float, as it were, in the ground, and are frequently broken and eaten into, showing that they have not developed under the conditions that prevailed during the flow of the molten mass. They must have separated out in quieter times, and doubtless under greater pressure. May they not be the relics of a stage of consolidation which set in far below the surface? This stage was interrupted by renewed fluidity being given to the mass, through reheating, or by access of water,* or, perhaps, by mere relief from pressure as the mass rose towards the surface; and the crystals already formed were carried upward in the lava. Many of them were remelted in the process; many remained to tell the tale. The latter form the "crystals of the first consolidation," the importance of which has been so fully urged by M. Lévy, in his critical studies of the structure of igneous rocks.

Here we are getting some glimpse of the features of our underlying caldron of the rocks. We may well ask, what would have happened if the slow crystallisation had gone on, if no subsequent movement had occurred? Surely a completely crystalline mass would have arisen, coarser in all its features than the materials examined by us at the surface. Granite and the lava known as rhyolite have precisely the same chemical composition; diorite is similarly related to the lava andesite, gabbro to the well-known lava, basalt. Where, then, we have rhyolite, andesite, or basalt at the surface, should not granite, diorite, or gabbro, be respectively forming underground?

The transition seems easy to us when put in this form; but the argument at one time was beset with difficulties. The peculiar Teutonic aptitude for classification rather than comprehension obscured the issue with a flood of papers which were intended to prove the essential dissimilarity of ancient and modern igneous rocks. Granites and gabbros and such like, our German friends urged, are all of ancient date. Abandoning the theory that such rocks were truly primitive, an arbitrary line was drawn at the close of Mesozoic times, and every igneous material now forming was supposed to differ in some way from those produced in Cretaceous or earlier days. It was vain for such workers as the late Mr. S. Allport,† who ranks as one of our foremost pioneers in microscopic work, to urge that decomposition during long ages was responsible for such mineral and structural differences as could be observed; or for Mr. F. Rutley‡ and others to show that slow secondary devitrification would account for the absence of true glasses among ancient volcanic lavas. The German classifications had been based upon a theory sustained by hand-specimens and microscopic slides. The appeal from an orderly collection to the rude disorder of external Nature was repugnant to the careful mind; and even the great French authors were drawn into the net, and were enfolded in the meshes of the text-books.

Prof. Judd, in his papers on the "Secondary Rocks of Scotland," and on the "Volcano of Schemnitz,"§ laboured hard to prove that highly crystalline igneous masses arise naturally in connexion with volcanoes. We cannot usually trace the actual passage from one type of product to the other, since a long lapse of time is necessary before the caldron itself can be laid bare. In the Western Isles of Scotland, however, the coarse gabbros and well-developed granites were proved to be of Cainozoic age; and the same fact has been admitted with regard to other masses, where denudation has been sufficiently severe to

* *See* Judd, "The Natural History of Lavas," *Geol. Mag.*, 1888, p. 9.

† *Geol. Mag.*, April, 1870; and *Quart. Journ. Geol. Soc.*, Vol. XXX. (1874), p. 565.

‡ "Devitrified Rocks from Beddgelert and Snowdon," *Quart. Journ. Geol. Soc.*, 1881, p. 407.

§ *Quart. Journ. Geol. Soc.*, 1874 and 1876.

reach down into the volcanic core. The elaborate proofs, moreover, afforded by the mine-shafts of Nevada,* destroyed any belief in America as to the structural distinction of Cainozoic and older igneous rocks. Highly crystalline rocks, regarded previously as ancient, were found to be in continuity, in sections three thousand feet in depth, with the lavas that had been described as Cainozoic.

Finally, the authors of rock-classifications based on geological age retreated step by step, as Von Buch and the Wernerians had done before them; and we may now seek to read, without opposition, the history of a modern volcanic caldron in one of our old deep-seated masses.

The dykes and veins sent off at the margins of such masses seem natural enough; the rocks have cracked and yielded round about the igneous invader. But the actual position of this invader raises many difficult problems; and the huge mass of the caldron or reservoir is often astounding, compared with anything that we see in volcanic action at the surface. When, however, we consider the extent of what Prof. Judd has called volcanic provinces—areas over which similar volcanic rocks are simultaneously erupted—we may well see that one caldron may have to serve vents scattered over thousands of square miles. Many caldrons, moreover, may remain unconnected with the surface, and may fulfil their period of activity in merely attacking their surroundings.

Whether connected with a true vent or not, how does the reservoir arise? Its frequent nearness to the surface, considering the great thickness of the solid crust, makes it improbable that it remained as a liquid mass from the first consolidation of the globe. Evidence of the intrusion of the liquid, moreover, is again and again forthcoming; yet how was space found for it in the tightly packed material of the crust?

A tempting theory, current from Hutton's time down to about 1860, was based on the assumption that sedimentary or other rocks could be metamorphosed into a highly crystalline state *in situ*, while still retaining at their margins traces of their former structure.† What may thus be called progressive metamorphism provided an easy escape from the difficulties of an intrusive theory. The granite or gabbro merely represented the mass that was there before crystallisation set in. A partial melting might then account for the offshoots at its margins. Case after case, however, broke down upon investigation; and the modern tendency has been to refer one metamorphic rock after another to an igneous origin, rather than to allow any igneous rock a metamorphic origin. It can hardly be denied that sedimentary materials have from time to time become melted up since their first appearance on the globe; but this implies a complete change in their character, and the cycle of events may be very rarely traceable.

Seeing that igneous rocks can have little inherent power to force open cavities for themselves, we are apt to fall back on earth-movements to explain the position of our caldrons; and we may reasonably suppose that rocks which were once in contact may become bent apart during the severities of folding. Such separations take place in the experiments that have been devised to imitate mountain-structures; and, in nature, any molten material would at once be forced into the hollow as it formed. External pressure on this material, and the expansion of the water contained in it, would account for its intrusion.

It is not surprising, then, that what have been called

* Hague and Iddings, *Bull. U. S. Geol. Survey*, No. 17 (1885).

† *Cf.* Portlock, "Geol. Report on Londonderry, &c.," 1843, p. 507.

"laccolites"* occur, where one series of strata has been pushed up in a dome, like a great bubble, over the surface of the underlying beds, the cavity being filled, step by step, by intrusive igneous matter. It is generally believed that the igneous rock, acting under earth-pressures, is itself the cause of the local uplift and of the formation of the dome. Here we have our caldron formed progressively. Any fissures that open above it may lead to volcanic action at the surface.

Given the caldron, however, can we conceive it to have no action, beyond mere metamorphism, on its surroundings? Almost every crystalline mass, when worked over in the field, shows signs of local variation. The subject has been recently discussed, in its broad aspects, by Sir A. Geikie,† and absorbs the attention of petrologists in every land. The same rock-mass—our consolidated caldron—may be extremely rich in silica in one part, and may consequently have given rise to granite or quartz-diorite; while in another part it may be poor in silica and rich in magnesia and iron. Extreme types of igneous material may thus be found in association, and pass by degrees into one another. Where movement has taken place, two kinds of material may have become streaked out together, so that a banded gneissic rock results, truly igneous in origin, but implying differences in constitution in the original magma of the caldron.

How have these differences been brought about? Elaborate theories have been devised, whereby it is shown that a mixed mass of silicates will naturally tend to divide itself into magmas of varying composition. On the other hand, we have striking examples of igneous masses, extending over thirty or fifty linear miles, in which very little variation can be traced. It must be admitted, however, that in such cases the differentiated portions may lie far away below our feet, or may have been already removed by denudation.

When we view, in a fortunate locality, the edge of a great igneous mass against a series of stratified rocks, we must be struck with the extent to which blocks of the latter are picked off and lie scattered through the invader. But these disappear as we retreat from the contact-zone, and sometimes do so with surprising rapidity. Can it be that the caldron has attacked its surroundings for a distance of fifty or sixty feet, but was powerless to effect further destruction?

If we examine the included blocks themselves, we find them altered in various degrees; many of the smaller ones are penetrated throughout by the igneous material, and have become completely crystalline. Shales and slates have thus come to assume the aspect of basic igneous rocks. By intermixture of the materials, and by partial absorption of the sediment in the igneous invader, new rocks have been actually formed. If these fragments have happily survived the extremes of change, how many more may have been completely dissolved in the great caldron? Is it not probable that vast masses of sediment, penetrated by the insidious magma along all their cracks and crevices, have been cut up into detached portions, and have entirely melted and disappeared?

But such absorption must have influenced the chemical composition of the invader. In many cases, the bulk of the latter is so great that little change has been effected in it. In other cases noticeable differences have arisen. Can we not explain many supposed cases of "magmatic differentiation" by such local phenomena of absorption?

* G. K. Gilbert, "Geology of the Henry Mountains," 1877, p. 51, &c.; also Whitman Cross, "Laccolitic Mountain Groups," *14th Ann. Rep. U.S. Geol. Survey*, p. 236.

† "Ancient Volcanoes of Great Britain," Vol. I., p. 90, etc.

The phenomena of mixture exhibited when one igneous rock penetrates another have led Prof. Sollas* to question the potency of differentiation; and his general conclusions may be supported in many other areas than the one selected by him. Probably the French geologists are at present most active in showing the extent to which an igneous caldron may react on the surrounding rocks. M. Barrois,† to take one excellent example, finds that the granite of Ménez-Bélair, in Brittany, has eaten its way along the strike of a series of tilted shales and sandstones, but has penetrated the former to a far greater distance than the latter. Bands of quartzite remain as ridges in the granite area, and represent the undissolved layers of the sandstone. This example of selective absorption should go far to explain the position of many intrusive igneous masses. Our caldrons do not merely occupy hollows prepared for them by earth-movement; they extend at their surfaces by absorption, and the igneous mass becomes increased in bulk, and at the same time modified in composition. Provided that the absorption is on an extensive scale, materials may be imported of such differing character that a sort of average composition may be reached. In such cases a uniform type of igneous rock may be arrived at, not far different from those highly siliceous masses that fill most of our solidified caldrons at the present day. Persistent absorption and melting imply a return of the sedimentary materials towards the igneous rocks from which they came. The cycle is, indeed, that pictured by Hutton and the old geologists, though the process is shortened by the direct refusion of the sediments, instead of their progressive metamorphism.

It may be observed, in conclusion, that M. Stanislas Meunier,‡ bold in his generation, is prepared to derive all the water required for volcanic action from the absorption of water-logged superficial rocks by the igneous layers underneath them. Without making such large demands, we may yet see in our familiar igneous rocks the result of a series of mixtures, refusions, and interpenetrations; while down below, in still more mysterious caldrons, lie the purer magmas which rarely reach us unalloyed.

* "The Relation of the Granite to the Gabbro of Barnavave," *Trans. R. I. Acad.*, Vol. XXX (1894), pp. 502—510.

† "Le Bassin du Ménez-Bélair," *Annales de la Soc. Géol. du Nord*, Tome XXII. (1894), pp. 223, 231, 342, etc.

‡ "La Géologie Expérimentale" (1899), p. 266.

NOTES ON COMETS AND METEORS.

By W. F. Denning, F.R.A.S.

Swift's Comet (1899a).—This object is now exceedingly faint, and in the early part of August will be only one-fiftieth as bright as it was at the time of its discovery early in March. But its apparent brightness varies suddenly and unaccountably. The following estimates by Holetschek, of Vienna, exhibits the remarkable changes it underwent in June last.

	Mag. of Nucleus.	Mag. of Comet.
June 1	9·5	5·5
„ 2	9·5	5·7
„ 3	—	6·0
„ 4	7·5	5·3
„ 5	7·0	4 5
„ 6	8·0	4·7
„ 8	9·5	6 (?)
„ 9	9 0	5·7

Tempel's Comet (1873 II.).—This comet is now practically invisible to observers in this country owing to its low position in the sky. For the benefit of southern observers we give its place on one moonless night in each of the next four months.

Date.	R.A. h. m. s.	Dec.	Distance in Millions of Miles.	Brightness.
Aug. 4	20 57 26	− 26° 14′ 6″	35	3·59
Sept. 5	21 38 29	− 35° 59′ 37″	47	1·89
Oct. 3	22 19 17	− 34° 7′ 1″	67	0·80
Nov. 4	23 8 29	− 26° 31′ 7″	100	0·29

Holmes's Comet should be favourably visible during the first half of August, moving slowly to N.E., in the region between the constellations of Aries and Perseus. The following are its positions on three nights.

Date.	R.A. h. m. s.	Dec.
Aug. 4	2 36 50	+ 33° 4′
„ 8	2 41 43	+ 34° 9′
„ 12	2 46 24	+ 35° 14′

Coddington's Comet.—Mr. C. F. Merfield (*Ast. Nach.*, 3577) thinks that this object may just possibly continue to be visible in August. Its position on August 3rd is R.A. 5h. 11m. 34s., Dec. + 0° 47′, and on August 31st, R.A. 5h. 21m. 1s., Dec. + 1° 19′. Its distance from the earth on August 3rd and 31st is four hundred and twenty-eight and four hundred and sixteen millions of miles respectively. The comet will appear to be very nearly stationary during the month of September.

Barnard's Comet (1892 V.).—A sweeping ephemeris has been computed by Coniel, but the re-detection of this faint object must be undertaken by an observer having the use of a large instrument such as that at the Lick or Yerkes observatory.

Klinkerfues's Comet (1854 IV.).—The definitive orbit of this comet has recently been determined by Drs. Buschbaum and Steiner. About two hundred observations were obtained between September 12th and November 14th, 1854. The computers find that the comet moved in an elliptical orbit with a period of 1088·78 years, with a possible error of seventy years.

Aerolite of March 12th.—The *Bulletin de La Société Astronomique de France* (June, 1899) contains some interesting accounts both of the flight of this luminous bolide and of the descent of the solid material comprising it. The object is described by observers in Sweden, and others in Livonia and the N.W. parts of Russia. At Borgo, in Finland, there took place something like an earthquake, and it was there that the aerolite fell on the frozen sea surface, producing a hole nine metres in diameter. The stone must have been a huge one, probably weighing one thousand kilogrammes. At several different places in Sweden the colour of the fireball as it sped down the sky was described as similar to that of an electric lamp, and its light surpassed that of the full moon. Prof. Herschel has examined the various accounts, and concludes that the radiant point was probably in about 105°—20°. The meteor nearly crossed the zenith at Dorpat and Wesenberg, and after passing over the Gulf of Finland, fell to earth at or near Borgo, on the south coast of Finland. It probably began over a point about fifty miles east of Walk, in Livonia, and was eighty miles high when over Wesenberg, its motion above the earth's surface being directly towards N. by W. A Reuter's telegram, dated Helsinfors, May 26th, says: "The collected pieces of the aerolite which fell at Burgo have been sent here and placed in the Geological Museum. The largest piece is said to weigh two hundred and six Russian pounds, while all the parts together weigh eight hundred and fifty pounds."

Meteoric Fireball of June 1st.—A very brilliant meteor was observed at 9h. 20m. p.m. by observers at Kettering, Dewsbury, Manuden, near Bishop Stortford, and other places. At Dewsbury the lustre of the object was estimated as four times as bright as Jupiter. The various observations are not, however, sufficiently full to admit of the derivation of very precise results, but it appears probable that the radiant point was approximately in or near the zenith (at about 208° + 51°), and that the meteor terminated its luminous flight at a height of thirty miles above King's Lynn, in Norfolk. There is a well-defined radiant near θ Boötis (No. 164 of my General Catalogue in *Memoirs of the R.A.S.*, Vol. LIII., p. 263) which conforms very nearly in position and date with this fireball radiant.

The Great Perseid Shower.—A favourable opportunity will be presented this year for recording the progress of this shower during the first half of August, as there will be very little moonlight. It seems desirable to direct special attention to the following points connected with the display, viz. :—The date and hour of maximum; the horary rate of the Perseids, and the exact situation of the radiant point on each night of observation.

In 1898 the maximum occurred on August 11th, and it is certain that for some time in the future the shower will be at its best on a similar date and not on August 10th, as hitherto. The fact that 1900 will not be leap year favours this conclusion.

The position of the radiant will be as follows :—

Date.	α	δ	Date.	α	δ
Aug. 3 ...	36·7°	+ 55·2°	Aug. 12 ...	47·5°	+ 57·5°
„ 6 ...	40·2°	+ 56·0°	„ 15 ...	51·3°	+ 58·2°
„ 9 ...	43·8°	+ 56·8°	„ 18 ...	55·2°	+ 58·9°

The accuracy of these positions should be tested by further observations.

Microscopy.

By John H. Cooke, F.L.S., F.G.S.

According to Nocht, the success of the nucleus stain of Romanowsky, a mixture of eosin and methylene blue, depends upon the presence of certain impurities in the methylene blue. To obtain the best results the use of polychromic methylene blue is suggested, as the essentials for the formation of the nuclear stain are more frequently met with in this than in any other. Before using, its alkaline reaction should be neutralized with acetic acid, and the solution should then be mixed with ordinary methylene blue until it is clear and blue. Finally dilute the fluid with a one per cent. aqueous solution until a reddish tinge is apparent near the edges. Macerate the preparations in this for some time, and if too much stain is taken up decolourize with dilute acetic acid.

The causes of the colouring of leaves in autumn has formed the subject of a series of investigations by Mr. E. Overton. The leaves that turn red he classifies under two heads, those which remain throughout the winter, and those that fall soon after their change of colour. Microscopic examination show that in both cases the palisade cells, and the cells that line the air-chambers of the leaf, are charged with a red cell sap of the nature of glucosides. The cultivation of *Hydrocharis morsus-ranæ*, of *Utricularia*, and many other land plants, in a weak solution of glucose, confirmed his deductions. In each case the leaves assumed a rich reddish-brown tint.

For general botanical work the most useful killing and fixing agents are solutions containing chromic acid. In the last issue of the *Journal of Applied Microscopy*, Prof. C. J. Chamberlain, of Chicago University, discusses the results of his experiments with the chromic acid groups, in the course of which he gives some valuable notes on the strengths of the solutions used. For spirogyra, fern prothallia, and similar objects, he suggests a solution made up of chromic acid, two grammes ; acetic acid, one cubic centimetre ; and water, ninety-seven cubic centimetres. If plasmolysis takes place, weaken the chromic, or strengthen the acetic, since the chromic has a tendency to produce contraction, and the acetic to cause swelling. Too large a proportion of acetic acid, however, may cause distortion, and hence it would be better to weaken the chromic acid.

Referring to the time that should be allowed for the fixing of tissues in chromic solutions, Prof. Chamberlain has found that twenty-four hours should be the minimum even for the most delicate objects. It is well known that zoologists allow fixing agents like Müller's fluid and Erlicke's fluid to act for weeks before the material is passed on to the next stage, and it is therefore questionable whether the time which is usually allowed by microscopists when using chromic acid solutions is not much too short. Sixteen to twenty-four hours is the time usually allowed ; but Prof. Chamberlain's experiments show that the material is better able to withstand subsequent processes if it has been kept in the fixing solutions for two or three days. More rapid penetration, and consequently more immediate killing, can be secured if the reagent is kept at a temperature of from thirty degrees to forty degrees Centigrade.

Wickersheim's Preserving Fluid is a valuable reagent, but it is not commonly used owing to the poor preparations that have been put on the market. Animal and vegetable bodies impregnated with it retain their form, colour, and flexibility in the most perfect manner. The objects to be preserved are placed in the fluid, and left in it for from six to twelve days, after which they are dried in the air. The ligaments remain soft and movable, and the animals or plants remain fit for anatomical dissection and study for long periods. The formula for the fluid is as follows:—Dissolve one hundred grammes alum, twenty-five grammes common salt, twelve grammes saltpetre, sixty grammes potash, ten grammes arsenious acid, in three thousand grammes boiling water. Filter the solution, and when cold add ten litres of the liquid to four litres of glycerine and one litre of methyl alcohol.

For the preservation of arachnids and myriapods the following mixture is recommended :—Glycerine and Wickersheim's fluid one and a-half ounces each, and distilled water three ounces, the whole to be shaken and thoroughly mixed and added to thirty ounces of ninety-five per cent. alcohol. He considers that alcohol that has been previously used for preserving mites and spiders is preferable to pure alcohol, as the former already contains some of the fats dissolved out of the specimens. This liquid preserves the colouring of the specimens, and keeps them flexible.

For five months Dr. Marsson concentrated his attention on the study of the variations of the animal and plant life of the plankton of the Leipsig ponds, one result of which has been the discovery of many new and interesting—though anomalous—facts. Two ponds, separated only by a road, never contained the same forms. *Volvox aureus* was found in abundance in the pond on the south side, but not a single specimen could be found in that on the north. *Synura uvella* was found in the one, in September, in great quantities, and none at all in the other. Both ponds afforded similar conditions of depth, character of soil, light, and plant growth, and swans and other water birds frequented both. On the 20th May, *Tintinidium fluviatile* made its first appearance in a pond, and on the 26th it formed the largest constituent of the plankton, after which it disappeared and did not return. In April, *Codanella lacustris* appeared in this same pond, then it disappeared entirely, and was first found in other ponds in August.

To many microscopists the terms "one quarter inch," or "one half inch," as applied to their objectives, convey the idea that, when in focus, the object is at a distance of a quarter inch, or a half inch, from the front lens. They confound the equivalent focal length of the objective with the working distance. As a matter of fact, the latter is always considerably less than the former. The determination of the working distance of an objective is a point of considerable importance, and therefore all microscopists should make themselves familiar with the method of calculating it. The following simple device will be found useful for estimating the working distance of objectives that are not higher than one-twelfth inch. Make a long thin wooden wedge, ten centimetres in length along the base, and twenty millimetres in perpendicular height. Focus a diatom on a glass slip without a glass cover, and then carefully push the wedge along the glass slip until it touches the objective. The thickness of the wedge at the point of contact will represent the working distance of the objective.

Prof. Leroy gives, in the *Journal of Applied Microscopy*, the results of his experience in the use of picro-carmine as a counter-stain for bacteria in tissues. As a rule this reagent is somewhat uncertain in its effects, and it is therefore suggested that, to obviate risk of failure, the tissues should be first treated with logwood picro-carmine, and finally stained by Gram's method of bacterial staining. As a counter-stain, alum carmine alone gives only a nuclear stain and leaves the cytoplasm practically untouched. Better results can be obtained by first staining in alum carmine or borax carmine, then carrying the section through the regular Gram process, and lastly leaving the section for half a minute in a solution of sodium sulp.-indigotate 0·1 gramme, and carbolic acid, five per cent. aq. sol. one hundred cubic centimetres, after which follow on with alcohol, creasote, and balsam. By this method the nuclei will stain red, the cell bodies apple green, and the bacteria purple (if gentian violet be used in the Gram's solution).

THE FACE OF THE SKY FOR AUGUST.

By A. Fowler, F.R.A.S.

The Sun.—On the **1st** the Sun rises at 4.25, and sets at 7.47; on the **31st** he rises at 5.12, and sets at 6.48. Spots are still occasionally to be seen.

The Moon.—The Moon will be new on the **6th**, at 11.48 A.M.; will enter the first quarter on the **14th**, at 11.54 A.M.; will be full on the **21st**, at 4.45 A.M.; and enter the last quarter on the **27th**, at 11.57 P.M.

The brightest star occulted at a convenient time during the month is f Sagittarii, magnitude 5·1, on the **18th**; the disappearance takes place at 10.28 P.M., at an angle of 50° from the north point (44° from the vertex), and the reappearance at 11.34 P.M., at 267° from the north point (251° from the vertex). Other occultations are:—19 Piscium, magnitude 5·2, on the **23rd**, from 3.1 to 4.8 A.M.; τ^2 Arietis, magnitude 5·2, on the **27th**, from 12.5 to 1.5 A.M.; υ^1 Tauri, magnitude 4·6, on the **28th**, from 4.20 to 5.19 A.M.; η Geminorum on the **30th**, from 4.9 to 5.25 A.M.; ζ Geminorum on the **31st**, from 2.59 to 3.58 A.M.

The Planets.—Mercury moves westwards towards the Sun until the **19th**, when he will be in inferior conjunction. He will afterwards be a morning star, and at the end of the month will come into a very favourable position, a few degrees west of Regulus. The greatest westerly elongation, of 18° 2′, will occur on the morning of September **5th**.

Venus is unfavourably situated for observation. She is approaching superior conjunction, and the apparent diameter is therefore small (9·8″ on the **15th**), and the disc nearly full.

Mars sets so soon after the Sun this month that he may be considered not observable. He is near β Virginis at the beginning of the month, and moves in a south-easterly direction.

Jupiter remains an evening star, low down in the south-west, soon after sunset. His apparent polar diameter at the middle of the month is 32·2″. The satellite phenomena are not very numerous during the short periods available for their observation. At 8.43 P.M., on the **3rd**, there will be egress of the shadow of the second satellite; on the **10th**, at 8.51 P.M., transit egress of the second satellite; and on the **24th**, at 7.56 P.M., an eclipse reappearance of the first satellite.

Saturn may be observed until nearly midnight during the early part of the month, low down in the south or south-west. He is between η and θ Ophiuchi, and traverses a westerly path until the **21st**, when he will be stationary, and during the rest of the month an easterly path. The rings are widely open, and their northern surfaces are presented to us. On the **3rd**, the apparent polar diameter of the planet is 16·4″, and the outer major and minor axes of the outer ring are respectively 40·9″ and 18·5″.

Uranus is also an evening star, but like Jupiter and Saturn can only be observed for a comparatively short time after sunset. He is in Scorpio, a little less than half-way from ν to 19 of that constellation. At the middle of the month the planet sets shortly before 11 P.M.; is stationary on the **12th**, and in eastern quadrature on the **27th**.

Neptune cannot be observed this month.

The Stars.—About 10 o'clock at the beginning of the month, Perseus and Cassiopeia will be in the north-east; Pegasus, Andromeda, Aries, and Pisces towards the east; Aquarius and Capricornus in the south-east; Cygnus and Lyra nearly overhead; Aquila due south; Hercules and Ophiuchus towards the south-west; Corona and Boötis in the west; and Ursa Major in the north-west.

Favourable minima of Algol will occur on the 2nd, at 11.31 P.M., and on the 25th, at 10.1 P.M.

Chess Column.

By C. D. Locock, B.A.

Communications for this column should be addressed to C. D. Locock, Knowledge Office, 326, High Holborn, W.C., and should be posted by the 10th of each month.

Solutions of July Problems.

(By J. K. Macmeikan.)

No. 1.

1. Kt to B2, and mates next move.

No. 2.

1. R to B8, and mates next move.

Correct Solutions of both problems received from Alpha, E. Servante, G. A. Forde (Capt.), N. M. Munro, G. J. Newbegin, H. S. Brandreth, J. Baddeley, A. H. Doubleday, G. C. (Teddington), W. de P. Crousaz, H. Le Jeune, H. H. Thomas, K. W., W. d'A. Barnard, D. R. Fotheringham, K. R. B. Fry (Cheltenham College), T. Frampson. Of No. 1 only, from W. H. Jones, W. Grimshaw.

A. H. Doubleday.—Variations are quite unnecessary in two-movers.

W. Grimshaw.—After 1. P to B4ch, K×R; there is no mate.

Alfred Osborne.—Your solution of No. 2 (June) is correct, but arrived too late for acknowledgment.

G. A. Forde.—Some of our solvers object to sui-mates. Nevertheless their indignation shall occasionally be braved if a good specimen, in two or three moves, is sent in.

Henry Bristow.—We gladly notice your booklet next month.

W. H. Jones.—If 1. R. to Q3, the Black King escapes.

N. M. Munro.—Your problem is not sound; there appears to be only one "threat" and there are several defences to it. Can you revise it? Your other question has been answered in the daily press.

A. P. M.—The solution of No. 1 (June) is quite correct. In the variations you mention the White King retakes the Pawn or Rook, discovering check-mate from the White Rook.

I. M. Brown (Bradford).—Change of address noted.

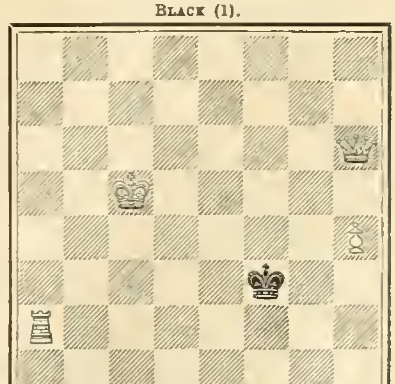
E. Servante.—I should recommend you to write to Dr. Hunt, 101, Queen's Road, Dalston, N.

PROBLEMS.

No. 1.

By Rev. E. Cowley.

Black (1).



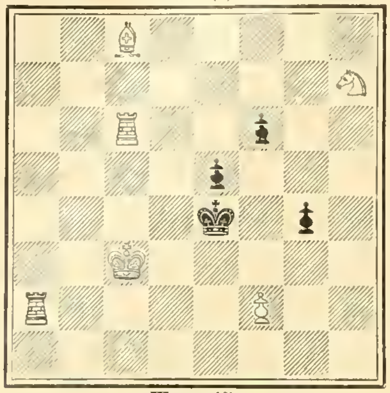
White (4).

White mates in three moves.

No. 2.

By W. Clugston (Belfast).

Black (4).



White (6).

White mates in two moves.

[Will correspondents kindly notice the alteration of address mentioned at the beginning of this column.]

CHESS INTELLIGENCE.

The London International Tournament was brought to a conclusion on July 10th, with the following result:—

	1st Round.	2nd Round.	Total.
Lasker	11	$11\frac{1}{2}$	$22\frac{1}{2}$
Janowski	$9\frac{1}{2}$	$8\frac{1}{2}$	18
Pillsbury	$9\frac{1}{2}$	$8\frac{1}{2}$	18
Maroczy	10	8	18
Schlechter	$9\frac{1}{2}$	$7\frac{1}{2}$	17
Blackburne	$8\frac{1}{2}$	7	$15\frac{1}{2}$
Tchigorin	8	7	15
Showalter	$6\frac{1}{2}$	6	$12\frac{1}{2}$
Mason	5	7	12
Cohn	8	$3\frac{1}{2}$	$11\frac{1}{2}$
Steinitz	$6\frac{1}{2}$	5	$11\frac{1}{2}$
Lee	4	$5\frac{1}{2}$	$9\frac{1}{2}$
Bird	4	3	7
Tinsley	3	2	5

The prize list is as follows:—

E. Lasker, first	£250
M. Janowski — second, third, and fourth	115
H. N. Pillsbury — second, third, and fourth	115
G. Maroczy — second, third, and fourth	115
C. Schlechter, fifth	65
J. H. Blackburne, sixth	50
M. Tchigorin, seventh	40
J. W. Showalter, eighth	30
J. Mason, ninth	20

Mr. Teichmann was also a competitor, but retired owing to ill-health after playing four games, his score then being two.

A comparison of the prize list with the July number of Knowledge will show that our prediction as to the ultimate first four did not err on the side of rashness. Mr. Lasker's performance was a remarkably fine one. He lost one game only out of twenty-seven, seven being drawn, and has more than justified his claim to be considered the finest living player. M. Janowski was leading for some time, but fell off slightly; no competitor drew fewer games. Herr Maroczy, on the contrary, drew ten games, and lost only four to M. Janowski's seven. Mr. Pillsbury invariably played to win, and ran many risks throughout. Nevertheless he won two games less than M. Janowski, and drew twice as many. Herr Schlechter drew eight games, a very small number for him. Mr. Blackburne, after a rather poor start, played up excellently; he was the only player who defeated Mr. Lasker. M. Tchigorin also improved after the first week or two, as also did Mr. Mason, but Mr. Showalter fell off after a good start. Herr Cohn also started capitally, but fell all to pieces in the second round. Of Mr. Steinitz we do not know what to say, except that he has never in his long career failed so unaccountably. Mr. Lee did fairly well to win six games and draw seven in such company. The other two Englishmen made poor scores.

Two of the best-known English chess-players joined the majority last month. One, the Rev. G. A. Macdonnell, was one of the finest amateurs in the days of Staunton, Boden and Buckle. He was for many years Chess Editor of the *Sporting and Dramatic News*, and was the author of "Chess Life Pictures," and "The Knights and Kings of Chess." Mr. Macdonnell had been in failing health some time before his death at the age of 69. The other, Mr. Edmund Thorold, of Bath, is best known as the inventor of the variation of the Allgaier Gambit, which has superseded all others, and which will bear his name as long as chess lasts. He was a most brilliant player, and took part in many of the meetings of the Counties Chess Association, and in the International Tournaments at Bradford and Manchester in 1888 and 1889. Mr. Thorold's name will be always associated with three others—Skipworth, Ranken and Wayte. Of these four Mr. Ranken is now alone left.

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CONTENTS.

SOUND REFLEXION AND REFRACTION.

By the Rev. John M. Bacon, M.A., F.R.A.S.

More than one recent disaster at sea, still unexplained, has pointed to the necessity of reconsidering certain accepted dogmas relating to the transmission of sound waves, and official reports of a disquieting nature from look-out stations have called once and again for serious investigation of the anomalous behaviour under special conditions of such sound signals as are commonly in use at sea. In particular it has been insisted on that the hearing of the syren and fog-horn is apt to prove uncertain and that, on occasions at least, there are to be found areas or zones of silence where their warning will unaccountably fade or else cease altogether to be heard.

It would appear, however, that this peculiarity is not by any means confined to the signals of those instruments of which the syren is the type. The writer has had special opportunities of experimenting with explosive signals of many kinds, and has on three separate occasions, and under very different circumstances, carried out systematic trials on the penetration of the service cotton-powder cartridge fired at different heights from balloons whilst travelling over diversified open country as also over populated districts including London itself. These trials have drawn records from a large number of independent observers, whose statements, when carefully analysed and compared, have proved beyond all reasonable doubt that even the most powerful and deservedly well trusted form of modern explosive signal is sometimes fickle in its character, failing or fading in unexpected quarters without obvious cause.

It will probably be readily conceded that the explanation of these facts must be sought not so much in any peculiarities in the sounds themselves as in the condition of the medium through which they are propagated, and it is here that the views expressed perhaps too confidently a generation ago may need to be modified. Certain conclusions as to states of atmosphere commonly affecting the passage of sound waves have perhaps remained too long unchallenged.

Thus Professor Tyndall states that while conducting experiments with sound signals at the South Foreland there were present always and in all weathers invisible acoustic clouds which returned echoes from the instruments and cannon planted on the summit of the cliff overhead. Hundreds of cannon-shots, he states, were fired, and were always followed immediately by a rumbling which the Professor asserted must have come only from out of the empty air. If this were so, then we must conceive that there was constantly present in the air some form of obstruction that not only impeded but reflected back the waves of sound that were being emitted.

It is with regard to this point that some results recently obtained may be deemed instructive. In the first place, although during the experiments in which I have been concerned some scores of cotton-powder signals have been fired from balloons under very different meteorological conditions, nothing of the nature of an aerial echo has ever been suspected, and the dead silence aloft has always been absolutely unbroken after each report until, after an interval of several seconds, the earth itself has replied with a burst of sound which has reached the car even at the height of a mile with all the intensity and reverberation of a thunder-clap. This striking result, invariably the same, appears highly significant, and would point to the conclusion that the initial report immediately consequent on a lightning flash is, like the fog-signal bursting below the car, comparatively speaking only a trivial sound, while the great uproar of sound must practically be wholly due to echo, which is presumably largely off the ground. In support of this I would state that when one of the signal cartridges already described is fired, say, 150 feet above the ground, in moderately open country, an observer below hears a series of extremely powerful echoes which he can easily trace to each clump of trees or building around, and several seconds after this elapse before the subsequent conflict of reverberations ceases. Further, when such a rocket signal has been fired over a wide extent of quiet common terminating at some distance in an abrupt decline, it has awoke surprising and unexpected echoes from woods lying in the valley, although these have been completely out of sight and sheltered from the ear by a considerable stretch of intervening level ground. In this case both the incident and reflected waves of sound had clearly been defracted or bent over the shoulder of the hill which hid the woods from view.

I would then submit, first, that a condition of atmosphere causing aerial echoes is by no means the normal condition, and, secondly, that the return of sound which Professor Tyndall, when stationed under the cliff, appeared to hear almost instantly from the offing may in actual fact have been defracted from cliffs and headlands hard by but out of sight.

That aerial echoes are sometimes heard I would, as the result of my own experiences, very readily admit, and I would regard the condition of atmosphere favouring this phenomenon as one probable cause of that failure of sound at certain spots which has been already referred to.

But some other dogmatic statements which have already done service full long respecting the reflection of sound waves may well be questioned. Take the well-known example attributed to the Whispering Gallery of St. Paul's. Here, as I have pointed out elsewhere, the transmission of a whisper around the circular wall is obviously not due to reflection in the ordinary sense, as anyone may convince himself by testing the phenomenon in quiet night hours. Or, again, if on a calm day a smooth crescent-shaped surface similar to a segment of the Whispering Gallery be constructed in the open—as may be readily done by means, say, of a length of continuous stout brown paper stretched on battens—an experimenter will find that the Whispering Gallery effect can be produced under circumstances where reflection from an opposite surface is impossible. A whisper communicated either by the mouth or suitable instrument against such a curved surface appears to *course round* in close contact with the surface.

I would note that the description given by Sir John Herschel of the peculiar phenomenon of the Whispering Gallery, which has been copied and re-copied into every text-book, is obviously incorrect, and so also, as I am prepared with due permission to point out, is that relating to the echoes at Woodstock. From which I would gather that neither Herschel nor those who have quoted his words have ever investigated the phenomena in question.

In connection with echoes a very noteworthy result has presented itself in the course of the acoustic ballooning experiments in which I have been engaged—namely, that the echo from earth of exploding signals has been always and uniformly retarded. This result has been obtained and verified very many times by independent observers using carefully corrected instruments, and no doubt has been entertained of its truth. Whether, however, this retardation be due to a diminution in the rate of sound travelling vertically through the atmosphere or to any "dwell" or "lag" in the actual reflection of sound I am not at present prepared to state.

As suggesting a further cause possibly operative in the occasional local failure of sound signals, I would call in evidence certain experiences of my own with regard to the effect on sound of fog or cloud. Professor Tyndall insists that fog has no sensible power to obstruct sound, while air associated with fog being, as a general rule, highly homogeneous is favourable to the transmission of sound.

I am able to assert that this view is very far from being generally accepted by practical men employed on look-out stations, and it is entirely opposed to the statements of Stevenson and other eminent authorities. My own observations gathered in balloon voyages, and also during a sojourn of several days and nights, generously granted me by Trinity House, on the Maplin Lighthouse in thick weather, go to show that whereas a condition of still and settled fog may aid the travel of sound, compacted cloud-heaps or wreaths, and masses of rolling mist are capable of refracting and diverting sound waves in a manner that will deceive the most practised ears. For example, the warning of neighbouring light-ships' foghorns as heard from the Maplin are influenced in a far greater measure by the circumstances and qualities of intervening fog than by a gentle wind; moreover, a horn which had been nearly quenched by interposing mist has been observed to sound with far more than normal intensity as soon as the fog had rolled away behind, forming a background to gather and reflect the sound wave.

I would call attention to the fact that many accepted statements that have done duty in the past with regard to the travel of sound waves seem to have been based on the results of experiments conducted in the laboratory, and I would submit that a more unfavourable place for satisfactory experiments on sound could hardly be chosen, inasmuch as the six bounding surfaces must surely cause reflections seriously endangering the truth of results obtained. Conducting experiments of this kind must often rather resemble such a feat as trying to project lantern pictures in a room where walls, floor, and ceiling are all faced with brilliant mirrors.

THE MYCETOZOA, AND SOME QUESTIONS WHICH THEY SUGGEST.—V.

By the Right Hon. Sir Edward Fry, D.C.L., LL.D., F.R.S., and Agnes Fry.

ABERRANT FORMS.—Having thus given some description of the various parts of the Endosporous Myxies, we shall now revert to the aberrant forms which have hitherto been left out of consideration—viz., the Exosporous Myxies and the Acrasieæ, the position of which in the classification may be learned by again referring to the table given in an earlier paragraph.

Exosporeæ.—The Exosporeæ, or Myxies which carry their spores on the surface and not in the inside of the sporangium, consist of one genus—*Ceratomyxa*—and of two species, or, according to other authorities, of one species only with one variety. Of this small organism a drawing will be found in Fig. 15. Its first describer, Micheli, called it *Puccinia ramosa* (in 1729). In 1805 it was called *Ceratium hydnoides* by Albertini and Schweinitz. It was described as *Ceratomyxa mucida* by Schrater in 1889, and, as that name is adopted by Mr. Lister, whose works are the most convenient for the English reader, we have thought it best to follow him. But we have given the synonyms to prevent our readers from being misled by the puzzling and lamentable variety of names.

Fig. 15.—*Ceratomyxa mucida*. Magnified. (After Famintzin and Woronin.)

The *Ceratomyxa mucida* is by no means uncommon on rotten wood, and might at first sight be mistaken for a white or pale-coloured fungus. It consists of an aggregation of finger-like projections from a common base, and presents somewhat the appearance of a minute piece of white coral. When the surface of these projections is examined, it is found to be marked off by delicate lines into polygonal spaces, from the centre of each of which rises a delicate white stalk, and on the summit of this an equally delicate and white egg-shaped spore.

The development of this little organism has been elaborately studied by two Russian botanists, and it is sufficiently interesting to demand a few minutes' attention.

Its plasmodium emerges from the wood in points about the size of a pin's head, and is found to be differentiated into two elements—(1) a transparent motile jelly, and (2) an irregular network of opaque plasma embedded in the transparent jelly. These two parts are shown in Fig. 16. Gradually little prominences are developed on the surface of the plasmodium, and as these grow into the finger-shaped projections, the network of opaque plasma appears just below their surface, the translucent jelly of the interior passing through the strands of the network and forming a very thin external coat. The next step is taken when the strands of this network thicken so as to occupy nearly the whole surface of the projection and then break up into polygonal plates, each furnished with a nucleus; from each of these plates there grows a pedicel supporting a ball which is the future spore; into this the opaque plasma of the plate passes. This state of things is shown in Fig. 17. When the spores have fallen off, the rest the plant withers and disappears.

Fig. 16.—*Ceratomyxa mucida.* Plasmodium showing superficial transparent jelly, and opaque strands. (After Famintzin and Woronin.)

Each swarm spore, according to these authors, often shows amœboid movements; divides into two equal parts, which assume a cross-like posture in their greatest length, the one lying on the other; then each of the two parts divides into two other parts and again each of the four divides into two parts, so that the original swarm spore is now represented by eight protoplasts all lying together; these then separate, develop cilia, and act as free swarm spores. Fig. 18 represents the eight protoplasts lying crosswise together, before their final separation. We are bound to add that this peculiar process has not been noticed by Mr. and Miss Lister in their numerous observations on *Ceratomyxa*, nor by ourselves in our more limited ones, and the matter appears therefore to require further enquiry.

Fig. 17.—*Ceratomyxa mucida.* Development of Spores × 160. (After Famintzin and Woronin.)

Fig. 18. — *Ceratomyxa mucida.* Eight Protoplasts before their final separation. (After Famintzin and Woronin.)

Acrasieæ.—We have already indicated the existence of a small group of organisms differing from the ordinary myxies in the fact that the swarm-spores, though they gather together and act together, never fuse into a single mass or constitute a true plasmodium.

Three species have been studied and described with some care, and their history is so curious that we hope our readers will not weary if we dwell upon it a little.

The swarm spores are like those of true myxies, and have the same amœboid movements, but without the dancing movement with flagellæ. These swarm-spores meet and, as if by common consent, set up a centre of attraction, towards which they tend, the long arms or straggling parts of the original gathering coming more and more to the central point.

The course of growth in *Acrasis granulata* (one of the organisms in question) has been described by Van Tieghem. When the swarm cells have gathered together, they touch one another, and form a cellular mass. This mass grows upwards in a conical shape. The cells of the axis, somewhat longer than they are broad, assume a cellular membrane, and constitute a foot, buttressed up by other cells. The exterior cells move upwards on this foot, clothe themselves with a cellular membrane, heap themselves together at the summit of the structure, and thus form a chaplet of spores.

Fig. 19.—*Dictyostelium mucoroides.* Section. *a*, Crown of Spores; *b*, Stalk; *c*, Remains of Membrane broken by growth of the Sporangium. (After Brefeld.)

In *Dictyostelium mucoroides* a very similar course of growth has been observed. The mass which collects at the central point differentiates itself into a column, a membraneous veil to the column, and a residual mass surrounding the column. As the column grows upward this residual mass does the same, and thus withdrawing its lower part from the ground it wanders up the stalk and forms a cap or crown which turns into spores without a trace of capillitium. Fig. 19 shows in section the nearly adult form of this organism.

A still more singular history is presented by a third species, the *Polysphondylium violaceum.* Here the early stages correspond with those already described, the plasmodium, or more accurately the pseudo-plasmodium, gathers itself towards a central mass as shown in Fig. 20; the central mass again differentiates itself into a column and a surrounding mass of protoplasm which clings round the attenuated central column, as shown in Fig. 21; it then begins to narrow in at intervals along this column, and breaks up into discontinuous lengths with intervening nodes, as shown in Fig. 22 (*a*). From these discontinuous pieces of protoplasm there are subsequently developed in the top of the column a terminal head, and on the successive lower stages of the column, successive whorls of stalks, each carrying a lateral and smaller head, as shown in Fig. 22 (*b*); each of these heads finally ripens and breaks up into spores.

The life-history of all these *Acrasieæ* presents many very curious points; it seems to bring before us the fact that separate protoplasts, without ever uniting into a plasmodium or ever becoming part of a single organism, may nevertheless acquire as it were the social instinct and live for the good not of themselves but of the whole organism, and for that purpose may submit to a division of labour;

for whilst some of the protoplasts assume the function of only supporting their fellows, the others avail themselves of the support, raise themselves from the level of their original surface, and devote themselves to the function of reproduction. And, moreover, certain aberrant and sessile

Fig. 20.—Pseudo-plasmodium of *Polysphondylium violaceum*. (After Brefeld.) × about 25.

forms of the *Dictyostelium* seem to show that this elevation of a portion of the protoplasm is not necessary to reproduction, though it may well be that the greater exposure to the ripening influences of the atmosphere and the sun may render it beneficial to the organism, and so more than compensate for the withdrawing from the function of reproduction of a certain part of the protoplasm, and applying it to the purposes of support alone.

Unicellular Organisms.—Leaving now the subject of classification, and of the aberrant forms of myxies, we return to the principal group. We have already dwelt upon the fact that the myxies show all their vital powers and all their capacity for development without the formation of a true cell-wall, or undergoing division by septa formed in cells. It seems scarcely possible for organisms living in the air to attain any considerable size or complexity of form without the support of cell-walls, and without the formation of vessels which assist the transfer of nourishment from one part to the other.

But with plants inhabiting the water—a medium of nearly the same specific gravity as the plant—and drawing their nourishment directly from this medium, the case is different, and the possibility of such organisms attaining considerable proportions and complexity of outward form is shown by a considerable group of *Algæ*, for which there has recently been formed a class called *Multinucleatæ*, which includes four orders with considerable differences amongst themselves, but which all agree in possessing no cell-walls, and, under ordinary conditions, no septum dividing one part from the other. Each organism is thus a single protoplast. These unicellular organisms, as they are often called, show a capacity for developing a vast diversity of forms, many of them very beautiful, and many of them strangely mimetic of the forms of higher plants—of the mosses, the lycopods, the conifers, the cactus tribe, and the hymenomycetous fungi. Some of these organisms reproduce sexually, others asexually; some attain very considerable size—as in the genus *Caulerpa*, a beautiful form of marine alga. "Nature," says Mr. Geo. Murray, speaking of *Caulerpa*, "appears to have executed in the form of this genus a *tour de force* in exhibiting the possibilities of the siphoneous thallus—in showing that it is possible for a unicellular organism to display the varied beauties of outward form characteristic of highly organised types, to attain by means of a lattice-work of cross beams within the cell body that mechanical support effected by transverse septa and separate differentiated cellular structures for other algæ and for the higher plants."

A consideration of these structures impresses the mind very forcibly with the vast inherent capacities of protoplasm. Nature had two courses open to her, if we may so speak, as to the mode of dealing with protoplasm—endowed as it is with its varied capacities—each of which she has pursued to a certain extent. In the one course of development the single protoplast has remained a unit, and has in this undivided condition performed all the needful work of the plant. In the other course, the protoplasm has been broken up into detached parts by the cell-walls, and thus a division of labour has been brought about or promoted which has led to the highest results, and left the unicellular organisms far in the rear. The former course of development is seen in the myxies, and, as we have shown, reached a great development both as regards size, form, and function, in such algæ as *Caulerpa*. The other course of development is seen of course in nearly all the other members of the vegetable kingdom, and reaches its highest results in such vast and complex organisms as our forest trees.

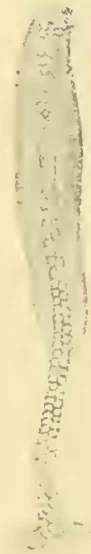
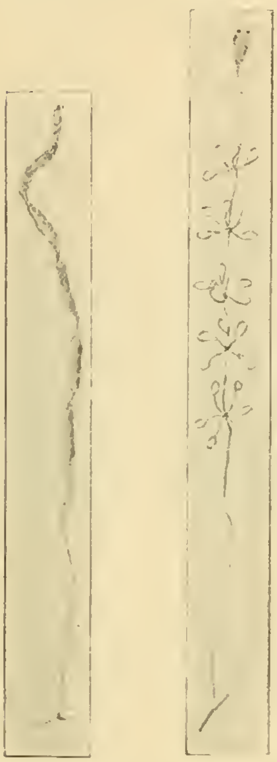


Fig. 21.—Immature Sporangium of *Polysphondylium violaceum*. (After Brefeld.)

One other observation naturally arises from the consideration of these unicellular forms. We are wont to trace the origin of the differentiation of parts—of the branches and leaves and so forth—to the divisions of the cell of the growing points in plants. We now see a differentiation of parts arising without any such cell to divide, and without any septa to mark off the future organ. The protoplasm is the master: the cell-walls are its humble servants, and we have another illustration of how the contents are apt to rule the containing structure, and the soft to rule and mould the hard. The divisions of the cell-walls are a secondary and subordinate phenomenon.

Isomorphism.—We crave our readers' leave to return to the fact already mentioned, that unicellular organisms have a tendency to imitate the forms of cellular organisms, and that whereas we have in the series and chain of cellular plants such marked outward forms as those of the moss, the lycopod, the conifer, the cactus, &c., we have in the chain of unicellular plants very similar outward forms, so that we seem to have two chains branching off from one another, with links here and there which closely correspond with one another. This phenomenon is one found frequently to present itself to the attention of the philosophical systematist, and like all the phenomena of Nature is well worth pondering. It has been stated very forcibly by Mr. Brady, in respect to the *Foraminifera*, a group of organisms deeply studied by him:—"A purely artificial classification is ill-adapted to the conditions presented by a class of organisms like the *Foraminifera*, largely made up of groups of which the modifications run in parallel lines. This 'isomorphism' . . . . . exists not merely between a single series in one of the larger divisions, and a single series in another, but often amongst several series, even of the same family. It not unfrequently happens that a member of one group presents a greater similarity to its isomorph in another group with which it has no relationship than it does to any other member of its own group. Take a familiar illustration: suppose the fingers of the two hands to represent the modifications (species) of two such parallel types of *Foraminifera*: the thumb of one hand resembles more closely the thumb of the other hand than it does any other of the fingers of its own."



a b

Fig. 22.—*Polysphondylium violaceum.* *a* and *b* successive stages in ripening of Sporangium. (After Brefeld.)

A comparison of the marsupial quadrupeds of Australia and South America with the placental mammals of the rest of the world presents another series of these isomorphs. There are certain Marsupials which seem set over against the Carnivora, others against the Rodents, and so forth. Mr. Murray, in his "Geographical Distribution of Mammals," has figured on the same page two animals, one a small placental mouse, and the other a small marsupial mouse, and their outward forms are almost indistinguishable; and yet the common parent of the two forms must be sought, according to our present notions of phylogeny, before the separation of the two great groups of Quadrupeds.

Another instance of isomorphs occurs in the two parallel groups of the *Irideæ* and the *Liliaceæ*. Every one knows how closely similar in outward appearance are the purple crocus of the spring and the purple colchicum of the autumn; and yet the crocus is more nearly related to the yellow iris than to the colchicum; and the colchicum is more akin to the garlic or the Butchers' broom than to the crocus.

It seems as if when two lines of development started from a common point, they sometimes carried *in gremio* the necessity of development along the same lines, and the production of like form at corresponding points in the divergent courses.

FAIRY RINGS.

By A. B. Steele.

The green circles, or parts of circles, in pastures, popularly known as fairy rings, have given rise to many curious beliefs and sayings, and their marvellously rapid growth has struck the uncultivated as a supernatural phenomenon. The prevalent belief was that they were caused by the midnight dancing and revelry of the fairies; and Shakespeare speaks of the elves—

> "Whose pastime
> Is to make midnight mushrooms."

In the west of England these rings are called "hag's tracks." In the myths and folk-lore of Sweden they are said to be enchanted circles made by fairies. The elves perform their midnight *stimm*, or dance, and the grass produced after the dancing is called *ailfexing*. A belief prevails in some parts of this country that anyone treading within the magic circles either loses consciousness, or cannot retrace his steps. Many absurd theories have been propounded as to the cause of these rings. Aubrey, who wrote the "Natural History of Wiltshire," in the seventeenth century, says that they are generated from the breaking out of a fertile subterraneous vapour, which comes from a kind of conical concave, and endeavours to get out at a narrow passage at the top, which forces it to make another cone, inversely situated to the other, the top of which is the green circle. Another remarkable theory by a writer, quoted in Captain Brown's notes to White's "Selborne," attributes these rings to the droppings of starlings, which, when in large flights, frequently alight on the ground in circles, and are sometimes known to sit a considerable time in these annular congregations. It was also thought that such circles were caused by the effects of electricity, and for this belief the withered part of the grass within the circles may have given foundation. Priestley was a strong advocate of the electric theory, and was supported by many eminent men of his time.

> "So from the clouds the playful lightning wings,
> Rives the firm oak, or prints the fairy rings,"

says Dr. Darwin, and appends a note that flashes of lightning, attracted by the moister part of grassy plains, are the actual cause of fairy rings. Archæologists suggested that they might be the remains of circles formed by the ancient inhabitants of Britain, in the celebration of their sports, or the worship of their deities. Naturalists formerly came to the conclusion that the rings were caused by the underground workings of insects, and a few years ago a writer in the "Transactions of the Woolhope Club" attempted to prove that they were the work of moles.

These so-called fairy rings, which have long puzzled philosophers, are caused by a peculiar mode of the growth of certain species of fungi, the peculiarity being their tendency to assume a circular form. A patch of spawn arising from a single seed, or a collection of seeds, spreads centrifugally in every direction and forms a common felt from which the fruit rises at its extreme edge; the soil in the inner part of the disc is exhausted, and the spawn dies or becomes effete there while it spreads all round in an outward direction and produces another crop, whose spawn spreads again. The circle is thus continually enlarged and extends indefinitely until some cause intervenes to destroy it. This mode of growth is far more common than is supposed, and may be constantly seen in our woods, where the spawn can spread only in the soil or among the leaves and decaying fragments which cover it. In the fields this tendency is illustrated by the formation of circles or parts of circles of vigorous dark green grass. To get at the cause, however, of the rank growth of the grass composing these rings, is not without its difficulties still. It is known that fungi exhaust the soil of plant-food and store it up in their own substance. In the case of these fairy rings they take up from the soil organic nitrogen which is not available to the grasses, and in some way become the medium of the supply of the soil-nitrogen to the grasses forming the circle. How exactly the nitrogen, one of the most important plant-foods, is fixed by these fungi, has not yet been discovered; but the grasses immediately following the fungi have been analysed and found to contain a larger proportion of nitrogen than the herbage in the neighbourhood.

Fairy rings are sometimes distinctly visible on a hillside from a considerable distance, many of them being years old and of enormous dimensions. One recorded from Stebbing, in Essex, measured 120 feet across, the grass all over it being very coarse and dark green in colour, chiefly of the cock's-foot species. Rings found in pasture lands are composed of several species of fungi, all of which are edible. They are most frequently observed to be formed by *marasmuis oreades*, a little buff mushroom which most people know under the name of champignons or Scotch bonnets. It is abundant everywhere. For several months in the year it comes up in successive crops in great profusion after rain, and continually traces fairy rings among the grass.

Another and very delicious mushroom, *agaricus prŭnŭlŭs*, sometimes called the plum agaric, and known in America as the French mushroom, occasionally succeeds a crop of champignons which had recently occupied the same site. It is sometimes found throughout the summer, but autumn is the time to look for it. The only other good edible fungi to be found in any quantity forming rings are the horse-mushroom, the giant mushroom, and St. George's mushroom. The first two are excellent eating, and to be had in the late summer and autumn; but the last are reproduced in rings in spring every year—the circle continuing to increase till it breaks up into irregular lines. The continuity of the circle is a sign to the collector that there will be a plentiful harvest next spring, while the breaking up is conclusive proof that it is going to disappear from that place. Spring is the only time it makes its appearance and the proper place to look for it is the borders of woodlands. It is one of the most savoury of mushrooms, and difficult to be confounded with any other, as it appears at a time when scarcely any other kinds occur. Like the champignon it has an advantage over the common mushroom in the readiness with which it dries, and is largely employed in the preparation of ketchup. It is called St. George's mushroom on account of its appearing about St. George's Day, the 23rd of April, and among the peasants of Austria is looked on as a special gift from that Saint. In Italy a basket of early specimens is a favourite present among all classes.

BEN NEVIS AND ITS OBSERVATORY.—I.

By William S. Bruce, f.r.s.g.s., *formerly in charge of the Observatory.*

(Illustrated by photographs taken by the Author.)

BEN NEVIS, the highest mountain in the British Isles, along with the northern Carn Dearg, forms an irregular semilunar-shaped mass, the concavity of which faces the north-east, and the convexity the south-west. The lower north-western half of this mass is the Carn Dearg, and the loftier south-eastern half, Ben Nevis. Ben Nevis itself, rising in the south as a rather steep slope from Glen Nevis, drops perpendicularly towards the north as a precipice varying in height from one thousand five hundred to two thousand feet. To the west it continues as the north-westerly lying Carn Dearg; to the east it runs into a north-easterly ridge which unites it to the Carn Mhor Dearg.

The summit of the mountain is an elongated plateau, more than one mile in length, averaging about seventy yards in width, and is nearly eleven acres in extent. The Ordnance Cairn lies almost exactly half-way between the two extremities; the Observatory rests close to, and to the south of the Cairn. The broader and more regular portion of this plateau, to the east of the Observatory, may be termed *East End:* the portion divided into three parts by two great gullies, *West End.* These two gullies are known as the *First Gorge* and *Second Gorge* from their respective proximities to the Observatory. Passing from the Observatory to the First Gorge, we find a small building situated on the southern edge of this plateau. Here, during the summer months, visitors to the summit are supplied with refreshments at a moderate cost by some enterprising Fort William purveyors.

Just beyond the southern edge of the summit, lying to the south-south-east of the Observatory, flows a small spring, Wragge's Well, sixty-six feet below the Ordnance Cairn. During a rainless season this spring runs dry, since it is fed solely by rain falling or snow melting upon the summit. Excepting this small spring, where a tank holding a hundred and fifty gallons of water was placed in 1896, there is no other water until, travelling westward, we reach Buchan's Well, at an elevation of three thousand six hundred feet, and even its supply is scanty. Lower down, at three thousand three hundred and fifty feet, is the Chrystal Well, also scantily supplied. The Red Burn has a fair supply of water at two thousand three hundred feet. Below the contour of two thousand feet, nearly two miles from the Observatory, is a fairly large lake. Small streams flow from the south-west side into the Nevis, and at the base of the great northern cliff is a burn containing a considerable volume of water at two thousand five hundred feet. We may safely say that there is no substantial amount of water above two thousand five hundred feet.

Ben Nevis rises as a pink granite mass through the Dalradian crystalline schists. In the centre of this granite is a plug of dark porphyry. For the lower three thousand feet or so of the ascent one traverses this pink granite, the higher portions of which are more finely grained than the lower. After the granite comes the dark porphyry, of which about the last thousand feet of the mountain is entirely composed.

The ordinary unobservant individual would say that the last two thousand feet of the Ben was devoid of vegetation; but, on examination it is found that there is scarcely a rock which is not more or less covered with one or more species of lichens, whilst there are also numerous mosses growing wherever there is a suitable nidus. This is true, even on the summit plateau, where the disjointed masses of porphyry, with their strangely brecciated surfaces, form so striking a feature. In some places round the edges of the cliff these mosses grow quite luxuriantly, as well as one or two phanerogams.

As in the case of vegetation, so it is in that of animal life the ordinary visitor would not note much. Yet, in fine weather, the mountain top is swarming with insects. There are spiders and snow-fleas, coleoptera, diptera, hymenoptera, and many others, etc. Snow buntings and ravens are there for nearly the whole year; now and again ptarmigan or a golden eagle may be seen. Curiously enough, voles have been captured on the summit, even in midwinter, about the Observatory, and foxes, stoats, and mountain hares are not unfrequently seen.

The first question most people ask when they reach the summit of Ben Nevis during the summer months is:—Why do you take observations on the top of a mountain, and what is the use of such observations? Let us regard our atmosphere as an ocean, only, instead of being an ocean of water, four or five miles deep, let us remember that it is an ocean of air manifold deeper—that it is, in fact, an "atmosphere," instead of a "hydrosphere." Like star-fish, sea-spiders, and other deep sea denizens, we creep about at the bottom of this ocean of air and know little or nothing about the conditions which exist in the upper atmosphere. And it is our true scientific instinct that leads us to sound, as it were, upwards, and to explore into the upper reaches of the atmosphere just as we sound downwards and explore at the bottom of the sea. There are various ways of doing this: we can study, for instance, the height of clouds, their speed, direction and constitution, and learn a good deal regarding temperature, winds, and so forth. This can be done by careful eye observation from below, but how much more satisfactorily can it be done if we actually ascend into those upper strata of the air by a balloon, or by climbing to the top of mountains, which rise up like islands from the lower into the upper atmosphere!

Fig. 1.—Ordnance Cairn and Observatory on the Summit of Ben Nevis showing the Great Cliff: Summer.

In 1875, Mr. Thomas Stevenson proposed to establish from the top to the bottom of some mountain a series of stations, in order to find out what was occurring in the atmosphere at different levels. It was pointed out that Ben Nevis, of all places, was most suitable.

First.—Because it was the highest mountain in the British Isles, rising to four thousand four hundred and six feet.

Secondly. — Because its summit was in close horizontal proximity to a sea-level station at Fort William.

Thirdly.—Because it was situated in the track of the south-west storms, which influence so greatly the weather of Europe, especially in autumn and winter.

It was urged that these observations would have important bearing in forecasting storms; for, unlike the Americans, who can track the course a storm is taking across their continent by means of their meteorological stations, we are unable to do so on account of the wide extent of the Atlantic Ocean, where we can have no permanent stations with telegraphic communication. Indeed, it is hardly possible to foretell that a storm leaving the American coast will reach our shores.

To Mr. Clement Wragge, now Government Meteorologist to Queensland, we owe the first actual series of observations. From June till October, 1881, without the break of a single day, he climbed the Ben, and took observations on the summit, while Mrs. Wragge took synchronous observations at Fort William. He made similar observations on an extended scale with two assistants during 1882; and during 1883 similar observations were carried on by Messrs. Whyte and Rankin, who had previously assisted Mr. Wragge. On account of the high importance of these observations, which were so ably discussed by Dr. Buchan, an appeal was made to the public for funds, and under the auspices of the Scottish Meteorological Society, four thousand pounds were soon collected in amounts varying from two hundred pounds to a penny; every class was represented, from Her Majesty downwards.

On the 17th October, 1883, Mrs. Cameron Campbell, who granted the site, opened the Observatory on an ordinary Ben Nevis winter day, amidst wind and driving snow. At the same time Mr. C. Livingstone started observations at the public school at Fort William.

It was intended to take twenty-four hourly observations during the day, reading the barometer and thermometers,

Fig. 2.—Observatory from South: Summer.

and making notes of wind, cloud, rainfall, and so on. But before two or three feet of snow were covering the summit, great drifts were piled up round the building, and as no arrangement for keeping the doorway clear had been made, constant digging was required. As long as the weather was fine this was easily accomplished, but when the wind rose the snow drifted in much faster than it could be dug out, and it had to be left to drift up. All observations were stopped for some hours until it had again become calm. Then two or three hours' spade drill would clear the passage through the snow. "This," writes Mr. Omond, "was good exercise, no doubt, but a kind of work not usually included in the routine of an observatory." When the snow reached its winter depth of ten or twelve feet, the work became stupendous, and even as late as May, 1884, the continuity of outside observations was broken from this cause. By next winter the building had been added to and improved, by having an office and a tower erected. The result was the lessening of the labour of observations. There is now a door at the top of the tower by which exit can be made at any time during the whole winter.

Since then—that is, for nearly sixteen years—hourly observations have been taken without a break, except on one or two occasions, when, for a few hours, wind and snow-drift rendered it impossible to stand or see the thermometers outside. Any ordinary gale can be faced if the observer is protected by oilskins and keeps his lantern to leeward, but sometimes the wind rises above one hundred miles an hour, carrying with it drift and solid pieces of ice ripped off the snow surface, which are sufficient to break the plate glass windows of the Observatory if the latter do not happen to be buried beneath the snow. I do not wish you to imagine that you always have gales of this description blowing; it is an occurrence, perhaps, once or twice a year, although gales of not so violent a character are not infrequent. But now there is no need to break the continuity of temperature observations, since a special louvred screen has been devised to be read from within the Observatory tower. And this, even when the wind is blowing with great force, is very fairly correct.

"The whole building is of a most substantial character. It is all on one story, except the tower, and consists of double wooden walls covered with felt and surrounded by dry stone walls, varying in thickness from four feet, in the less exposed parts, to ten feet at the base of the tower; the windows are all double and the roof is covered with lead overlaid with snow boarding. The strength of the whole has been frequently tested by gales of a severity and duration never experienced at lower levels."

(*To be continued.*)

SOME SUSPECTED VARIABLE STARS.—II.

By J. E. Gore, F.R.A.S.

ι ANDROMEDÆ.—This star was rated a bright 4th magnitude by Sufi, 4 and 5 by Lalande, 6 by Harding, 4 by Argelander and Heis, 7 by Piazzi, and 3-4 and 7 by d'Agelet. It was measured 4·56 at Oxford and 4·30 at Harvard. My own observations, 1875-1884, show well-marked fluctuations in its light to the extent of about half a magnitude. It is sometimes distinctly brighter than its neighbour κ Andromedæ, and sometimes quite as distinctly fainter. The observations, however, do not seem to show any regular period.

ϵ Pegasi.—This star, which is usually rated about $2\frac{1}{2}$ magnitude, was found by Schmidt unusually faint in a perfectly clear sky on November 5th, 1847. Signs of variation were also found at Cordoba. Seidel from photometric determinations believed it to be variable, and Schwab's observations indicate a variation with a period of about twenty-six days.

83 Ursæ Majoris.—This star, which lies near ζ Ursæ (in the Plough), was seen by Birmingham as bright as δ Ursæ in August 1868. Birmingham says: "This star, which is ordinarily of the 6th magnitude, I saw as large as δ Ursæ, between 3 and 4 magnitudes, on August 6th, 1868. It was smaller on the next night, and slowly diminished to its usual magnitude." It was rated 6-5 by Argelander, and 5-6 by Heis, and was measured 5·10 at Oxford, and 4·83 at Harvard. On January 28th, 1878, I found it brighter than Alcor (the naked eye companion to ζ), but on February 7th, 1884, it was distinctly fainter than the same star.

ζ Virginis.—This star, which lies about two degrees south of Spica (α Virginis), and is usually about the 6th magnitude, was seen by Schmidt between the 4th and 5th magnitude on June 6th, 1866. It was then considerably brighter than 68 (i) Virginis, which lies between it and Spica. It gradually diminished in brightness, but even on June 19th it was still visible to the naked eye in moonlight. Schjellerup, in his translation of Al-Sufi's "Description of the Heavens," identifies the star with one marked 19 of Virgo, by Sufi, and thus described by the Persian astronomer, "La 19 est la méridionale du côté postérieure du quadrilatère, après *al-simak* (Spica) s'inclinant vers le sud; elle est des moindres de la cinquième grandeur; Ptolemée la dit absolument de cinquième, mais elle est plus près de la sixieme. . . . Avec *al-simak* et la 17me. (76 Virginis) elle forme un triangle isoscèle, cette étoile etant au sommet." From this description it is absolutely certain that Sufi's star is identical with the one seen by Schmidt. Observations at Cordoba, 1871-73, vary from 5·7 to 6·3 magnitude, and the star would seem to be certainly variable, although it has not yet been admitted into the list of known variables. In 1879, Burnham discovered that the star was a very close double, the components being 6·2 and 6·5, and separated by less than half a second of arc.

65 Ophiuchi.—This star is supposed to have disappeared, as it was duly observed by Flamsteed on May 6th, 1891, and the observation was regularly reduced by him. No such star is now to be found in the sky. It was looked for at Greenwich, but without success. There is no star in Flamsteed's position in Argelander's southern zones, or in the Washington zones, nor is it in Lalande's Catalogue or Harding's Atlas. It has been suggested that Flamsteed may possibly have observed a so-called "new" or "temporary star."

37 Leonis Minoris.—Smyth (in his "Celestial Cycle") says that Piazzi called this star "by its old name Præcipua, as the *lucida*, or principal star of Leo Minor, registered of the 3rd magnitude by Hevelius and continued so by Bode. Mr. Bailey, however, in his recent edition of Flamsteed has rated it $5\frac{1}{4}$ in lustre under the following plea. "This star," he says, "is marked as of the 3rd magnitude in the British Catalogue, but in the *original* entries it is designated three times as of the 6th, once of the 4th, and once as $4\frac{1}{2}$, but nowhere greater. I have taken the mean of the whole." Schmidt adds, "I have never seen it but as given above from Piazzi" (4th magnitude). It was rated 5-4 by Argelander and Heis, and was measured 4·87 at Oxford, 4·76 at Harvard, and 4·90 at Potsdam.* On April 29th, 1886, I estimated it two steps less than 31 (β).

ζ Piscis Australis.—This star was rated 5th magnitude by Ptolemy, 5-6 by Sufi, 6 by Ulugh Beigh, $6\frac{1}{2}$ by Lalande, 6 by Lacaille and Harding, 6-5 by Behrmann, and 5-6 by Argelander and Heis. Gould found it 6·6, or 6·7 from observations at Cordoba. It was measured 6·62 at Harvard.

* The standard star, Polaris, is in the Oxford photometry 2·05, in the Harvard 2·15, and in the Potsdam photometry 2·34.

From a consideration of the various recorded magnitudes, C. H. F. Peters came to the conclusion that the star is probably variable with a long period. The fact of its having been seen at all by Sufi proves beyond reasonable doubt that it must have been brighter then than it is at present. I estimated it about 7th magnitude in August, 1877, and November, 1882.

η Crateris.—This star was rated 4-3 by Ptolemy, 5-6 by Sufi, 4 by Ulugh Beigh, Tycho Brahé, and Hevelius, 6 by Argelander and Heis, 5·4 by Gould, and only 6-7 by Houzeau. It was measured 5·01 at Harvard. The star seems certainly variable to a considerable extent, but the period may be very long; otherwise, it seems impossible to explain how a star which was seen only 6⅓ magnitude by Houzeau—or barely visible to the naked eye—should have been rated fourth magnitude by Tycho Brahe, who was a very accurate observer.

"The Story of θ Eridani" has been already told in a most interesting paper in Knowledge (July, 1893) by Dr. Anderson, the discoverer of Nova Aurigæ. I fully agree with Dr. Anderson that θ Eridani is certainly identical with the "Last in the River" of Ptolemy, and the Achernar of Sufi, and that consequently the star has undoubtedly faded from the first magnitude to about the third since the tenth century. It is one of Sufi's thirteen first magnitude stars, and his clear description of its position places its identity beyond all doubt. In recent years the star has been suspected of variation in its light. It is a splendid double star—one of the finest in the heavens.

We will now consider some telescopic objects. The famous variable star Algol has several faint companions. One of these was discovered in 1787 by Schroter, who strongly suspected it to be variable. Sadler thought it variable from 10th to 14th magnitude in some short period. A writer in *Nature* (February 20th, 1879) stated that he failed to see any trace of the star on several fine nights in the early part of 1874, using a seven-inch refractor, but on September 9th of the same year he saw the companion very distinctly with the same instrument. It was measured by Talmage at the Leyton Observatory on October 2nd, 1874, and estimated 11-12; and in 1878 by Burnham, who found three other fainter companions, one not far from Schroter's companion and forming with it a wide double star. Franks found it "easy enough" with an eleven and a-quarter inch reflector on January 11th, 1885, and about two magnitudes brighter than Burnham's faint companion. If variability is confirmed it will be very interesting, as a variable companion to a known variable star would be a rather unique object. There is, however, a somewhat similar case in the star S (15) Monocerotis, which is supposed to be a short period variable. A distant companion to this star was rated 8½ magnitude by Main in 1863, but only 12 magnitude by Sadler in 1875. Observations by Mr. Tarrant in March and April, 1888, showed a variation of 1½ magnitude in about three weeks. On March 28th, 1889, observing with a three-inch refractor, I found the suspected variable about one magnitude brighter than another companion a little to the west of it.

ζ Ursæ Majoris.—In *Comptes Rendus*, Vol. XIII., p. 438, Mädler states that he found the companion to this bright star invisible on April 18th, 1841. About an hour afterwards it was again visible, and he suggests that the companion is variable "comme Algol, mais probablement avec une période beaucoup plus longue." His account leaves it uncertain whether Alcor or the closer companion is referred to, but as he seems to have been using a telescope at the time, probably the close companion is meant. The naked eye companion Alcor has also been suspected of variation in brightness.

γ Virginis.—The components of this famous binary star were considered by Struve to be alternately variable in brightness. His observations in the years 1851 and 1852 show that sometimes the component stars were exactly equal in brilliancy, and that sometimes the Southern star—the one generally taken as the primary star—was from 0·2 to 0·7 magnitude brighter than the other. There seems to be little doubt that some variation really takes place in the relative brightness of the pair. This is clearly shown by the measures of position angle. For example, in the year 1886, Prof. Hall recorded the position angle as 154·9°, evidently measuring from the Northern Star as the brighter of the pair; while in 1887, Schiaparelli gives 334·2°, indicating that he considered the Southern Star as the primary or brighter of the two. Burnham found 153·4° in 1889, and Dr. See 332·50° in 1891. The period of variation would seem to be short, for O. Struve found the Southern Star half a magnitude brighter than the other on April 3rd, 1852, while on April 29th of the same year he found them "perfectly equal." He thought the variation was about 0·7 of a magnitude, but that the climate of Poulkova, where he observed, was not good enough for such observations. The variation is very interesting, and the question should be thoroughly investigated with a good telescope.

Pollux (β Geminorum).—Admiral Smyth measured two faint and distant companions to this bright star, and says (Bedford Catalogue, p. 187): "A, 2, orange tinge; B, 12½, ash-coloured; C, 11½, pale violet; and it has a minute *comes* to the *s. p.*, which, though unnoticed in former registers, is certainly now (1832) as bright as C; these companions form a neat triangle." And he adds in a footnote: "While this is in the press, the Rev. W. R. Dawes has shown me an exact diagram which he made of the object, January 1st, 1829, with a three and a-half foot achromatic, charged with a Huygenian eyepiece magnifying two hundred times. With this instrument he saw the three companions very distinctly, although two only were visible, and that but on remarkably fine nights, in Sir James South's seven foot equatorial, with an aperture of five inches." In the *Monthly Notices*, R. A. S., for April, 1861, the Rev. T. W. Webb says that with his five and a-half inch object glass the third star appears "as much inferior to B, 12m., as B is below C; and as Sir James South's equatorial of five inches had shown but two companions some years before the date of the Bedford Catalogue, there is, perhaps, grounds to suspect a variation in its light." Burnham, in 1879, rated Smyth's star C as 9th magnitude, and the third star 9½. In 1878 he called B 10th magnitude. On January 30, 1880, observing Pollux with a three-inch refractor and power one hundred and thirty-three, I found C quite plain and B tolerably so, with Pollux in the field of view; D, Smyth's third star, only seen with Pollux just out of the field; C about one magnitude brighter than B, and B one a-half or two magnitudes brighter than D, which was very faint. To my eye C seemed about 10th magnitude (Smyth's scale), B 11th magnitude, and D about 12½. On March 31st, 1881, I again examined the star with the same instrument and power, and found C brighter than B, and D very faint, hardly visible. D was not visible with a power of eighty-three. If D was ever equal to C, as expressly stated by Admiral Smyth, it must certainly be variable.

There are many other telescopic objects which have been suspected of variable light, and some of these I may deal with in a future paper.

CLOUDS.

By E. M. ANTONIADI, F.R.A.S., and G. MATHIEU,
of the National Agronomical Institute, Paris.

THE application of photography to the study of meteorological phenomena enables us to investigate with great advantage the form and height of the various clouds, the appearance of water-spouts, rainbows, halos, coronæ, etc., as well as to record the fugitive sinuosities of the lightning flash.

Nor does this mode of enquiry require any modification of the camera. A good large-angle object-glass with an ordinary shutter is all that is needed. For clouds, however, floating about the zenith a moveable-headed foot will be found of use.

The simultaneous photography of the same cloud from two different stations will give its height above the earth's surface. At his private observatory of Trappes (Seine-et-Oise), M. Léon Teisserenc de Bort utilizes for this purpose two photographic theodolites of the type adopted by Her Majesty's Government in India. The instruments are separated by a distance of one thousand three hundred and eighteen mètres, while they are united by a telephone, destined to ensure the simultaneity of the operations. In this way, M. de Bort has secured results of permanent value.

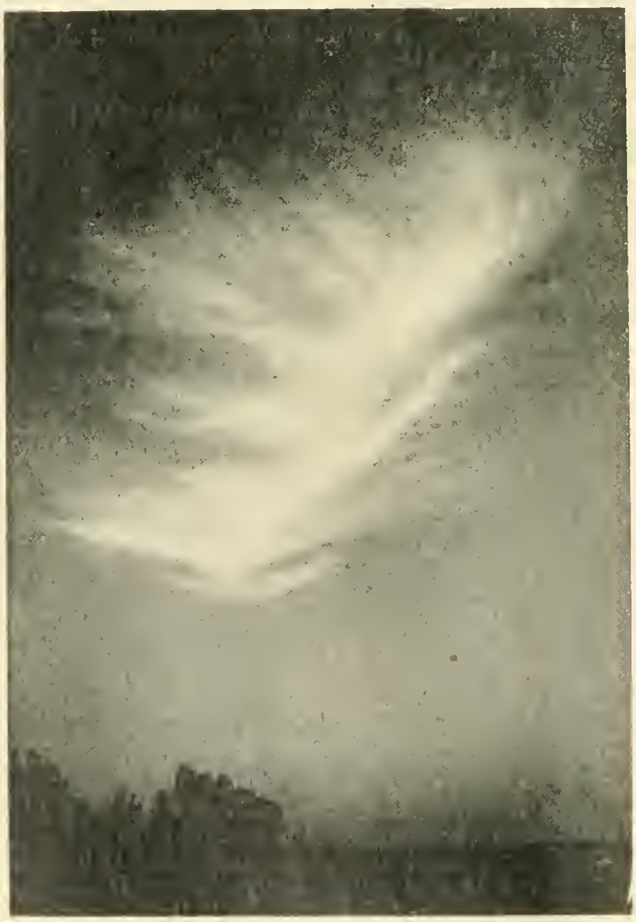


FIG. 1.—"Mare's Tail" Cloud, 6d. 2h. 25m. local time, photographed on 1899, May.

If we look at the sky through a spectroscope, we see all the colours of the spectrum, though blue is the predominant colour; but it is only the reflected light that is blue, the transmitted light is orange or red. The action, therefore, of the particles of our atmosphere on sunlight is apparently dichroitic. A careful consideration of these phenomena led the late Prof. Tyndall to the statement that our gaseous envelope behaves exactly as if it were laden with extremely small particles, impinged upon by the minute waves of ether. And, as "in the case of water, for example, a pebble will intercept and reflect a larger fractional part of a ripple than of a larger wave," similarly the small particles of the air would exert their most conspicuous action upon the smaller waves, a predominance of blue in the scattered light being the consequence. By his classical experiments on "actinic clouds," Prof. Tyndall brought to light * the brotherhood existing between the blue colour and polarization of skylight and the phenomena observed on exceedingly fine precipitates. But the sifting action exerted by these particles on the constituents of white light being solely a product of their exiguity, an increase in the diameter of the particles must necessarily entail a whitening of the diffused light; and as the dimensions of these bodies vary inversely as their height above the earth's surface, the sky ought to appear, and actually *does* appear, whiter near the horizon than about the zenith.

FIG. 2.—"Mackerel Sky," 1898, September, 21d. 4h. 51m.

Thus much with the blue reflected light. The red hue of the transmitted light is accounted for, in this theory, by the assumption that "through its successive collisions with the particles, the white light is more and more robbed of its blue constituents."

The predominance of violet rays in the reflected skylight is, in the large majority of cases, a perpetual drawback in cloud photography, since the photographic action of blue light is almost identical with that of white light. Hence the necessity of devising some means to quench the violet of the sky, while preserving the light of the clouds. To this end various methods have been devised.

Prof. Riggenbach has utilized the polarization of skylight. The maximum of polarization being observable at

* "Fragments of Science," Vol. I., Chapters on "Artificial Sky" and "The Sky."

FIG. 1.—Large Thunder-Storm Cumulus, photographed on 1898, August, 23d. 1h. 20m.

FIG. 2.—Light Cirro-Cumulus in the Upper Regions, with Stratus in the Foreground. 1897, September, 16d. 4h.

PHOTOGRAPHS OF CLOUDS.

an angle of ninety degrees from the sun, if the heavens are scrutinized in the proper direction through an analyzer (Nicol or black mirror), a large proportion of the rays emitted by the blue of the sky will be quenched, while the intensity of the clouds will not be very considerably attenuated. This enhances contrast, and gives fine views.

Fig. 3.—Stratus, 1898, November, 2d. 4h. 15m.

Another method of the same physicist's consists in simply photographing the sky with a small diaphragm and short exposure. This gives next to nothing after development; but an energetic intensification of the negative with bichloride of mercury and sulpho-antimoniate of soda, seems to give fair results.

The most practical way, however, of quenching the blue of the sky is that of placing in front of the objective a yellow glass or solution contained in a cell with parallel sides. This is the method adopted, after many trials, by MM. Hildebrandson, Angot, and Teisserenc de Bort, and, invariably, by the present writers.

Exposures in cloud photography are usually very short. According to M. Angot, of the Bureau Central Météorologique, who is a past master on the subject, a long exposure is usually preferable to a short one, because, after development and fixing, it is easy to give a long-exposed negative the necessary intensity by dipping it in hyposulphite of soda dissolved in water at ten per cent., to which should be added a solution saturated with red prussiate of potash. The action of this liquid on the image is a reducing one, by which the intensity of the negative is diminished. A prolonged washing ought to follow. By this means M. Angot drew excellent results from over-exposed plates, while the intensification of under-exposed ones gave him only bad negatives.

Having undertaken at Juvisy, at M. Camille Flammarion's suggestion, and under his superintendence, a continued photographic study of the optical phenomena of our atmosphere in general, and of the various forms of clouds in particular, the writers thought it might interest the readers of Knowledge to give them a brief account of the work done here in this line since the summer of 1897.

The apparatus used is an ordinary seven-inch by five-inch camera, to which can be adapted either an "orthoperiscopic" object-glass by Derogy, 1·42-inch aperture, or a smaller glass by Lévy, 1·04-inch only, but giving a wider field of view. Various coloured screens have been utilized here: (*a*) a yellow glass; (*b*) yellow gelatine; and (*c*) a solution of bichromate of potash contained in a cell with rigorously parallel sides. It is not difficult to make yellow glasses. Fixing with hyposulphite of soda a thin, unexposed, photographic plate, and then dipping it into chrysoidine dissolved in water, the film will be tinted with the most exquisite yellow. The intensity of the colouring will, of course, entirely depend on the quantity of chrysoidine used.

Convenient as the interposition of a mere coloured glass is, the use of a yellow solution in a glass cell has been found more advantageous. The varying intensity of clouds requires different shades of yellow. Thus, very light cirri on a milky sky will not print their delicate filaments on the plate without a *strong yellow* screen, while a bright cumulus, projected on a dark blue sky, might be advantageously photographed through a very light yellow only.

But, however efficient the coloured screen, contrast will be rendered still more prominent by the use of isochromatic plates. The panchromatic plates of Messrs. A. Lumière et ses Fils, of Lyons, have been invariably used by the present writers.

The photographs accompanying this paper exhibit the chief forms of clouds, by giving Luke Howard's three primary types and their compounds.

A cirrus of the "feather" or "spray" type is shown in Fig. 1. A glance bestowed on this photograph will give an idea of the action of the yellow screen; the cloud was so delicate to the naked eye, that its ramifications could barely be discerned from the bright bluish-white background of the sky, and yet its slightest filaments can be detected on the negative, where the contrast with the sky is most marked. The cirrus in question was the first

Fig. 4.—Small Cumuli during fine summer weather, 10d. 1h. 5m., 1898, September.

cloud of the day, coming after a spell of very fine weather. Borne by a north-easterly wind, it was gradually drifting to the south-west. Other cirri then followed, while a few cumuli put in an appearance towards four o'clock in the afternoon. The sky became finally overcast, and 0·13 in. of rain fell on the morrow.

FIG. 5.—Rain-Clouds, 1898, May, 12d. 3h. 30m.

In Fig. 1 of the accompanying Plate we have a fine cirro-cumulus texture, with clouds at the lower level (stratus) crossing the sun, as if "brushed up" from the south-west.

A coarser cirro-cumulus is shown in Fig. 2. Here we note heavier cumuliform masses, bordering on what is termed *Alto-Cumulus* on the Continent. In the upper part of the photograph, the small clouds are separated along curious, definite, and nearly parallel straight lines. The formation of these cirro-cumuli was preceded and followed by fine weather, though it coincided with a slight barometric depression.

Fig. 3 is a view of a bank of stratus above the valley of the Seine, east of Juvisy. These clouds had given rise to foggy, overcast weather a few days previously. On the photograph, contrast is deficient, and the outlines are vague.

FIG. 6.—Scud drifting before a grey sheet of Cirro-Stratus, 1898, July, 19d. 3h. 50m.

But Mr. Scott, of the Meteorological Office, says that stratus cloud is "not in any way consolidated into a definite form."*

The cumuli of Fig. 4 are of those peaceful little clouds, following, accompanying, and forecasting fine, warm, summer weather. The perspective grouping of the clouds near the horizon, to the right, shows an appearance of *Roll-Cumulus*, while the upper cloud, passing in the vicinity of the sun, shows a dark body with golden fringes.

One is struck by the flatness of the base of the cumulus. Such horizontality is due to the fact that the base marks the height above the earth's surface, at which the ascending vapours, chilled by expansion, reach the dew-point. Another interesting feature about cumuli is their remarkable appearance of solidity:—"The hills and white valleys at our feet," says M. Flammarion, in one of his balloon ascents, "appear so solid as to invite us to leave the car and step on them. What a surprise, were we to yield to this temptation!"

But cumuli do not always assume this serene, benignant appearance. They easily swell into menacing mountains, with silvery white crests, and sombre, thundering bases. This is particularly the case during a thunderstorm (Fig. 1 of the accompanying Plate), where the proud masses, scaffolded by an uninterrupted supply of vapour from below, roll confusedly over each other, heaping themselves into pyramidal figures of fantastic appearance.

FIG. 7.—A Photograph of the Rainbow, taken at Juvisy after a violent storm, on 1898, June, 2d. 5h. 20m. local time.

The nimbus of Fig. 5 was taken during a showery day of the spring of 1898. Rain is falling on the horizon, towards the right-hand side of the picture. It should be remembered that it is to the successive reflections and consequent exhaustion of the light falling on the water droplets that rain-clouds owe their darkness, and that the light is scarcely quenched here by true absorption.

"Light scud-clouds driving across heavy masses," says Admiral Fitzroy, "show wind and rain." Such are the small clouds of Fig. 6, drifting in the foreground of

* "Instructions in the Use of Meteorological Instruments," 1888, p. 67.

a dull cirro-stratus cloak (M. Poey's *Pallium*) during a storm.

On the 2nd of June, 1898, the writers were enabled to secure the photograph of the rainbow shown in Fig. 7. Exposure $= \frac{1}{10}$ second. Diaphragm on the Derogy objective $= \frac{1}{15}$. It will be seen that the bow produced on the negative the effect of a luminous arch projected on darker background. It was obviously the shorter waves which proved the most efficient in the impression of the meteor. The bow can be traced in the reproduction down to the landscape, especially in front of a row of poplar trees bordering the right bank of the Seine. The altitude of the sun at the moment being some twenty-one degrees, the top of the arch was raised some twenty degrees only above the horizon.

The photograph is interesting as showing the inner space of the bow to be much brighter than the outer, an appearance which is not always noticeable to the eye. This is due to the fact that whereas no light is sent to the observer from the back of the drops situated outside the first, and as far as the secondary bow, the drops inside the primary do reflect light from their back, which in spite of its enfeeblement through divergence, suffices to vaguely illumine the inner segment. This is the region of the "supernumerary bows" unexplained by Descartes and Newton, but to which the illustrious Thomas Young, with the intuition of genius, applied his discovery of the law of interference of light. The condition necessary for the appearance of the supernumeraries is that the drops shall all be of nearly equal sizes. Otherwise, as in the case of the photograph, we have a confused superposition of the various colours, which are thus blended into white light.

Letters.

[The Editors do not hold themselves responsible for the opinions or statements of correspondents.]

THE RESOURCES OF THE SEA.

To the Editors of Knowledge.

Sirs,—I notice in your issue of July 1st a somewhat guarded review of Prof. McIntosh's new work on "The Resources of the Sea."

The points at issue between the author and the Scottish Fishery Board are, though interesting in themselves, of minor importance compared with the opinion freely expressed in several places throughout the work, namely that no restrictions should be placed on any method employed or any area of our sea fisheries. Thus, at p. 228, the author says :—

"So little can be done by man in the way of altering Nature's laws in the sea that it might be more prudent to leave the adjustment of the supply and the demand in her hands."

Again, at p. 231, he writes :—

"Yet so far as history and so far as observation at the present time go there is no ground for alarm in regard to the permanence of the food fishes."

The matter is put more specifically on p. 229 :—

"The grave and permanent deterioration of our in-shore and off-shore fisheries has been dealt with in the foregoing pages, and by a practical and unbiassed examination of the areas themselves and of the statistics of fishes caught in them, the condition is shown to be one that inspires confidence and not alarm."

Permit me then to point out, Sirs, what those statistics consist of. They are records of certain hauls of the trawl net, by various vessels of greatly varying tonnage, extending over periods varying from ten to two years, made in certain closed areas around the Scotch coast. When practical men are told that in certain tables—"barren hauls are omitted" (p. 104), that trawls with beams varying from ten to fifty feet, with nets of varying mesh were used, and that the trawling was "for the most part carried on by daylight" (p. 105), such statistics will be appreciated at their true value.

But, Sirs, the records of the fish markets and the newspapers are and have proved conclusively that the fishing grounds around our coasts are no longer producing our fish food supply, and are indeed depleted ; and, further, that our trawlers are now busy at the same work in Icelandic and Biscayan waters, despite the strenuous opposition of the coast authorities.

The author does not deny this, for, at p. 95, he writes :—

"To commence with the most northerly, viz., Aberdeen, at which trawling has made great progress since the former date (1884), it is found that, whereas the chief supplies were brought fresh from the adjoining sea by the older paddle ships, or from the Moray Firth by the more powerful vessels, much of the supply of the present day comes from the Great Fisher Bank or from Iceland."

Again, speaking of the Government returns, he says :—

"While, therefore, the present statistics show no serious diminution, it may be truly said that the total is kept up only by supplies from Iceland, Faroe, and the Great Fisher Bank."

Surely, Sir, no "scientific observer" such as described on p. 223, of whom it is said "the welfare of the fisheries as a whole is his aim," can look on, while Hewitt's Short Blue Fleet is shut down because the North Sea grounds no longer yield a profit, and the British steam trawler is daily seized and fined for fishing in Danish territorial waters, without drawing some practical conclusion therefrom. Men do not abandon large and old established businesses, or run the risk of getting hundreds of pounds worth of goods confiscated without some reason ; and that reason is plain to the intellect of even the unscientific, namely, that the fish in the old fishing areas are no longer caught profitably. This means to us :—

1. That another food stuff has to be brought from abroad ;
2. That thousands of hard-working fisher folk are being ruined ;
3. That the fishermen-seamen counted upon by our experts to help man the Navy, are being reduced in numbers by leaps and bounds.

One can only hope that this cleverly written book by one of our highest authorities, with its bald and unconvincing conclusions, will not tend to delay still further the reform of our fisheries until it is too late.

Charles S. Patterson, M.B., M.R.C.S., F.Z.S.,
Hon. Sec. British Sea Anglers' Society.

THE SUN'S RADIANT HEAT.

To the Editors of Knowledge.

Sirs,—A point touched on by your reviewer seems to me worth discussing on its own account, and I hope some of your able correspondents will be able to throw light upon it. For my own part I have not adopted any theory on the subject. The question is this, What becomes of the radiant heat of the sun ?

According to the ordinary view the sun is constantly radiating heat in all directions, and, I think, it is generally supposed that it is only a small portion of this heat that encounters material bodies at any distance however great. If so, the question arises what becomes of the residue ?

Physical research leads us to believe that heat cannot be destroyed but only transformed; yet many persons seem to think that this heat vanishes like a ghost without transformation and without producing any effect. This may be so, but it is so much opposed to physical analogies that we should be slow to accept it unless on the basis of definite observations which, I think, it will be admitted are not at present forthcoming. Nor can we confine the question to the sun. The loss of radiant heat must (on the theory which I am now considering) extend to all the stars. A larger portion of the heat of some of them is no doubt intercepted by other bodies, but some of it must escape—vanish. The whole universe is losing heat; or at least it is losing motion, for the supply of heat may be temporarily kept up by the conversion of motion into heat (as, for example, by a bombardment of meteorites). But that a good part of the radiant heat vanishes, thus lessening the total amount of force—of heat and its equivalents—in the universe, seems to be a common opinion. This theory, however (for of course everything on the subject is theory), will strike many of your readers as unsatisfactory for physical, not metaphysical or theological, reasons. But if this heat be not lost, what becomes of it?

If the sun's rays and those of the stars always met with some material body, however great its distance might be, the problem would be solved; there would be no loss of heat to the universe. The sun may at present be radiating more than it receives, and, consequently, cooling; but in travelling through space it may reach other regions in which these conditions will be reversed. But it seems plain that if this be the case, the greater part of the bodies which encounter the solar heat are dark bodies, or else that there is an absorption of light in passing through the ether. Such an absorption of light and heat by the ether —as maintained, I believe, by the great observer Struve— would equally solve the problem; for the light and heat thus absorbed could not be lost, and would probably be given back by the ether to material bodies in some manner not yet traced. Otherwise, it would change the properties of the ether.

A third possible alternative is that radiation, like gravitation, only acts between material bodies, and that, though, like gravitation, it acts on a material body in any direction and follows it in all its movements, there is no expenditure of force in the directions in which no material body is encountered. On this theory also there would be no loss of heat. There would only be an interchange of the same kind as if every heat-ray ultimately encountered a material body.

KNOWLEDGE since its foundation by Mr. Proctor has always distinguished itself by its readiness to discuss questions of this kind. Mr. Proctor was indeed more of a theorist than an observer, and his spirit has not died with him; and I trust that the pages of KNOWLEDGE will continue to be open to the theorist as well as to the observer.

W. H. S. MONCK.

DARK RIFTS AND LANES IN NEBULÆ.

To the Editors of KNOWLEDGE.

SIRS,—The dark rifts and lanes which are visible in Dr. Robert's splendid photograph of the Nebula N.G.C. 2237–9 Monocerotis are most remarkable, and, as Colonel Markwick points out in your issue for this month, it is very difficult to explain their cause. The idea that they are holes right through the nebula, so that we are able to see through them the dark space beyond, is open to very serious difficulties. A possible explanation which occurs to me, and which I don't think has yet been suggested, is that the darkness is caused by patches of cool gas being on the outside of the nebula and between us and the incandescent gas beyond. This layer of cool gas would be quite opaque to the light coming from the bright portions of the nebula, and would thus cause a dark patch. The spectrum of the nebulæ is of such a simple kind, consisting of only a few bright lines, that the light coming from a star situated beyond the nebula would shine through one of these dark patches, and the only change in its light would be caused by a few dark lines in its spectrum, which would lie in the same position as the bright ones in the spectra of the nebula. If these dark patches are caused, as I suggest, in this way, it is, I think, possible that they may be more clearly seen in the photographs of nebulæ than when they are examined visually, as the ultra violet end of the spectrum would be more affected by the absorption of the cool layer.

We know yet so very little about the nebulæ, and have so few solid bases to build upon, that I merely offer this as one possible explanation of these curious dark rifts.

W. E. WILSON.

Obituary.

We regret to record the death of Prof. Robert Wilhelm Eberard Bunsen, which took place at Heidelberg on the 16th August. As most students of science know, Bunsen for more than half a century past exerted a profound influence as a preceptor on a large proportion of leading chemists of the day. Born at Göttingen in 1811, after studying in the university of his native place, he amplified his attainments at Paris, Berlin, and Vienna, and then became professor of chemistry in Cassel, Marburg, Breslau and Heidelberg in succession. At the latter place he built a grand laboratory, and made it one of the best schools of its kind in Europe. Among his discoveries are the burner which bears his name, the electric pile, mode of producing magnesium on a large scale, and, in conjunction with Kirchoff, spectrum analysis, which in the hands of chemists has added so much to our knowledge of the elements, and under the control of astro-physicists has given birth to the new astronomy—a branch of practical science opening up new vistas in celestial space and evolving a simple, yet wonderful, means of deciphering the hieroglyphics of the stars. Many lives have been saved by his discovery of hydrated oxide of iron as an antidote to arsenic poisoning. Perhaps the most striking of his contributions to science is that of 1861, when he proved the presence of rubidium and cæsium in a few drops of mineral water from Durkheim by the aid of the spectroscope, and his evaporation of several tons of the water to obtain a sufficient quantity of the new metals to experiment with. Among his chief works are: "On a New Volumetric Method," "A Treatise on Gas Analysis," and "Chemical Analysis by the Spectroscope."

Sir Edward Frankland, a famous pupil of Bunsen, died in Norway on the 10th August. Born at Churchtown in 1825, he was educated at Lancaster Grammar School, and afterwards studied chemistry under Dr. Lyon Playfair in the Museum of Practical Geology, working away at chemistry for a twelvemonth in a laboratory fitted up in the cellar kitchen of a house in Duke Street, Westminster. He then went, in company with Tyndall, to the laboratories of Liebig and Bunsen at Giessen and Marburg. Frankland was appointed Professor of Chemistry in Owen's College in 1851; St. Bartholomew's Hospital in 1857; the Royal Institution in 1863, and the Royal College of Chemistry (now the Royal College of Science), in 1865. He is author of "Researches on the Isolation of the Radicals of Organic Compounds," receiving for the same a gold medal from the Royal Society in 1857; also "On the Manufacture and Purification of Coal Gas"; "On the Influence of Atmospheric Pressure on the Light of Gas, Candle and other Flames," and "On Researches connected with the Atmosphere of the Sun." An epitome of his work may be found in the "Fifth Annual Report of the Normal School of Science and Royal School of Mines, Session 1884—85," the year of his retirement as professor in that institution. Sir Edward was the first president of the Institute of Chemistry in 1877, received the honour of K.C.B. in 1897, and his merits as one of the most brilliant of our experimental chemists were duly recognized at home and abroad by the bestowal of unstinted honours from many universities and learned bodies.

Notices of Books.

The Indian Eclipse, 1898. Report of the Expeditions organised by the British Astronomical Association to observe the Total Solar Eclipse of 1898, January 22. Edited by E. W. Maunder, F.R.A.S. (London · Hazell, Watson, & Viney. 1899.) Illustrated. 5s. The British Astronomical Association very justifiably takes a pride in the achievements of its eclipse expeditions to India, and the report now issued may be regarded as one of the most valuable of its publications. Beautifully printed and illustrated, ably written and edited for the most part, the volume is one which we found ourselves unable to put down before reading it throughout. There is much that is interesting without being strictly astronomical, much that is instructive on matters connected with eclipses, and a fair proportion of the book deals with the scientific results of the expeditions. The story of the eclipse of 1898 has already been in part made familiar to our readers. Two stations were occupied by the Association; one at Talni by Mr. and Mrs. Maunder, Mr. Evershed, Mr. Thwaites, and others; the other at Buxar, on the Ganges, by the Rev. J. M. Bacon's party. The troubles and pleasures of travel, and the novelty of camp life, are lightly touched upon in the general narratives of the two expeditions by Mr. Maunder and Mr. Bacon respectively, and both writers refer to the interest of watching the new astronomical conditions as the voyage southwards was performed. The camp at Jeur, occupied by Prof. Campbell, Prof. Naegamvala, and others is described by Mr. Cousens, and another chapter is devoted to brief descriptions of photographs of various places of historical or other interest visited by members of the expeditions after the eclipse. One of the most serious chapters is that entitled "Spectroscopic Observations." This opens with an admirable introduction to the special questions and conditions involved in eclipse work, which we commend to all who require a simple explanation of these matters. Mr. Evershed follows with an account of his spectroscopic work, which is illustrated by copies of some of his numerous photographs taken with the prismatic camera, his most valuable contribution to science being, in the judgment of the writer, his splendid impressions of the ultra-violet part of the flash spectrum. Unfortunately, his report breaks off where the real interest for many readers will perhaps commence—that is, in the bearing of the results on solar theory. Mr. Maunder's experiences with the prismatic opera glass will be very valuable to future observers who may employ this exceedingly portable and comprehensive instrument, the possibilities of which were described in the *Journal of the British Astronomical Association* for 1896; the chief result agrees with that obtained from photographs taken at Viziadrug—namely, that the distribution of coronium corresponds with the inner corona and has no obvious connection with the great streamers. Visual and photographic impressions of the corona occupy a considerable part of the volume, and here an attempt is made by Mr. and Mrs. Maunder to discuss the results, which seem to them to indicate a close connection between cometary and coronal phenomena. A full account is given of the wonderful photographs taken with a very modest camera by Mrs. Maunder, showing great extensions of the corona, and the corona itself a considerable interval after totality. The absence of a description of the Buxar animatograph, of reference to its object, and the subsequent misfortunes of the film, leave a curious feeling of incompleteness in this section. Among the miscellaneous observations, described by various contributors, the subject of shadow bands is not the least interesting. It so happens, however, that all the observations were made on a horizontal plane alone, so that they cannot be utilised in some of the inquiries which suggest themselves, and little or no new light is thrown upon their origin. Suggestions for future work enhance the value of the report. We hope to have made it clear that the report is at least very instructive and full of interest. What is badly wanted now is a successor to the late Mr. Ranyard, who would undertake to co-ordinate recent eclipse work in a companion volume to the well-known Vol. XLI. of the *Memoirs of the Royal Astronomical Society*. Until this is done it will be difficult to correctly estimate the value of many observations published in this and other eclipse reports.

In the Australian Bush and on the Coast of the Coral Sea. By Richard Semon. xv. + 536 pp., with eighty-six illustrations and four maps. (London: Macmillan & Co., Limited.) 21s. net. Not every biologist anxious to study oviparous mammals, marsupials and ceratodus, can do as Dr. Semon did in June, 1891. He started from Jena with the intention of spending two years in the Australian bush, in order that, in the first place, he might thoroughly investigate the life-history, and follow the various stages in the embryology, of ornithorhynchus, echidna, and ceratodus; and secondly, if possible, add to the existing knowledge of Australian fauna in general. But, thanks to Dr. Semon's skill in photography, and to his trained powers of observation, to say nothing of his industry since his return to Europe, every zoologist who wishes to extend his acquaintance with the old world forms named above, can, if he will take this handsome volume as a guide, become transported to a completely new environment, and in the company of a charming companion enjoy all the pleasures of a visit to the Antipodes. "In the Australian Bush" is not only a book of thrilling adventure, but, what is far more valuable, it is a well-stocked storehouse, in which new facts concerning animals of unique interest to the student of zoological classification are presented in a scholarly yet eminently readable manner. Dr. Semon regarded his work on the monotremes and that representative of the almost exterminated class of Dipnoi or lungfish, ceratodus, as his principal task. Taking these animals in the same order in which the author deals with them, the duck-billed platypus must be first introduced. The water-mole, as the colonists call it, will be best known to many readers by its scientific name *Ornithorhynchus anatinus.* It is only represented by this single Australian species, and exists nowhere else in the world. For its food it is restricted to the water, and is able to keep under the surface for some time, but not to breathe there, its lungs being as unfit for water breathing as those of all other

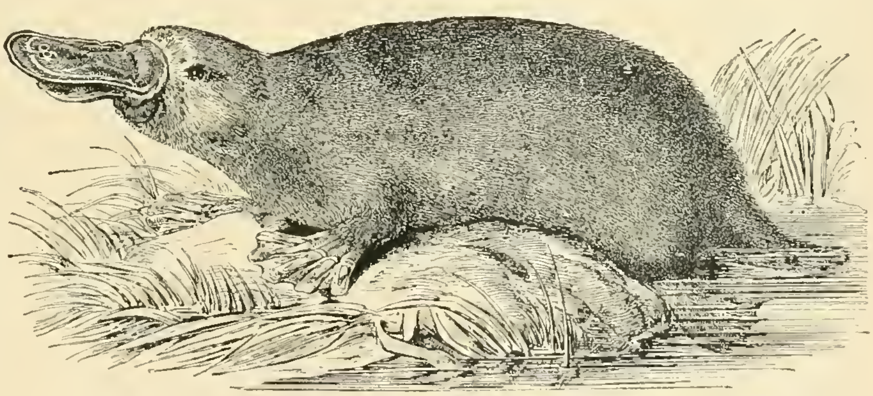


Figure of Duck-billed Platypus (*Ornithorhynchus anatinus*), from "In the Australian Bush." (Macmillan.)

mammals. It generally remains asleep during the day in its self-built holes within the river banks. When feeding in the mire of a river it rakes up the mud with its flat duck-like beak, or it hunts for grubs, worms, snails, and mussels. These it stows away in its cheek-pouches for future consumption. It is a toothless animal, like echidna. Its thick horny jaws which take the place of teeth are well adapted for cracking mussels and similar food. During the warmer season the ornythorhynchus exclusively uses the nights for its visits to the river in its neighbourhood, and sleeps in its burrows during daytime.

Dr. Semon had to exercise great patience in his search for ceratodus and its eggs. His method of catching the animal,

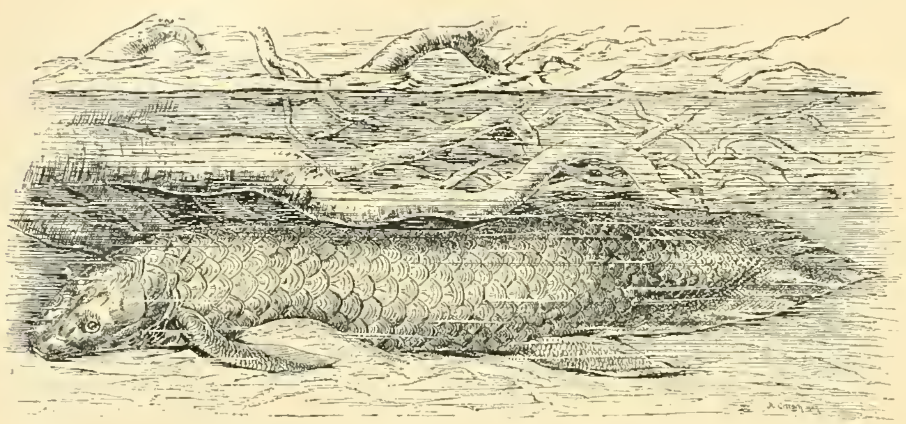


Figure of the Lungfish (*Ceratodus Forsteri*), from "In the Australian Bush." (Macmillan.)

as well as subsequent dissection, completely disproves what has hitherto been believed about the vegetarian proclivities of the Australian lungfish. It limits itself to fresh water. In its general behaviour ceratodus resembles a newt. It has an ally, *Protopterus annectens*, in tropical Africa, which differs from ceratodus, however, in taking a long summer sleep, having first protected itself in a sort of cocoon made out of its own slime. In dealing with echidna, the other oviparous mammal, the author summarises what is known about this member of the monotremata. It is well to remember that its distribution is by no means so limited as that of ornithorhynchus. The brain of echidna is conspicuous for its size, considering the lowly position of the animal in the zoological scale. The animal is itself most remarkable for its excessive shyness, a fact which makes it appear dull and stupid in captivity. Enough has been written to show that the author of this book is justified in hoping that it may prove "a friendly companion to a reader wishing to wile away the leisure hour." We have spent many hours with it, and heartily recommend it to the notice of all who are interested in biology.

My Tour in Palestine and Syria. By F. H. Deverell. (Eyre & Spottiswoode.) Illustrated. "My," in the title of this work, is a word which, to the author, represents a brilliant triumph—the realization of a dream of youth. To read works of travel in the Holy Land was not sufficient for Mr. Deverell ; his religious environment in early life led him to regard a visit to Palestine as "the crowning visit of all possible visits," and we have here a beautiful setting of all his experiences charmingly illustrated with photographs of excellent character. The journey out to Jaffa commenced on the 21st March, 1895, and from thence Jerusalem, the central point of interest, was reached direct by train—a distance of fifty-four miles which occupied four hours ; altogether, the tour extended over a period of about two months, and "the journey has, I believe," says the author, "tended to deepen rather than to destroy my previous conception of Palestine's place in universal history, and the Bible's place in universal literature." Being a perfectly independent production, embodying the impressions of a mind deeply imbued with scriptural subjects and written in a tranquil and unvarnished style, the book presents a very realistic picture of the places visited and the people now occupying the country which is of such unparalleled interest to all mankind. Some scientific readers will find matter of value in the meteorological and other natural phenomena observed by the author during his tour and here incorporated.

A Retrospect of Eight Decades. By Rev. Edward L. Berthon, M.D., F.R.A.S. (George Bell & Sons.) Illustrated. 5s. Mainly autobiographical, this book gives us glimpses of many phases of life and the transformations which applied science have effected during the last eighty years. The author, born in 1813, was intended for the medical profession, and ultimately became a clergyman ; but, judging from his inventive proclivity, it is probable he would have made a more imposing figure as an engineer. In his book, the main fault of which, if we may term it such, is its brevity, he gives us a vivid impression of a bygone age—the age which preceded steam and electricity, and all those innovations which, taken together, form such a conspicuous line of demarcation between the Victorian era and the centuries, separating us from the ancient civilisations of Greece and Rome. A keen and strictly scientific observer, the astounding stories he tells of surgery as practised in the first half of the century are well calculated to make us thankful for the more rational system which now prevails. Mr. Berthon, among other things, has invented the screw propeller, collapsible boats and pontoons, and portable hospitals.

Early Work in Photography. By W. E. Henry, C.E. (Dawbarn and Ward), has reached a second edition. It is a text-book for beginners, and treats in a very lucid manner the first steps in photography, even introducing an actual positive and negative on celluloid, to aid the tyro in his efforts. The price is 1s. net.

The Journal of the Society of Comparative Legislation. (John Murray.) 5s. The second volume of the new series is remarkable for some short memorial articles on the late Lord Herschell, which have been contributed by Mr. Victor A. Williamson, Lord Davey, Lord James of Hereford, and two others. Of these, the most interesting is the brief appreciation by Lord James of a colleague with whom he served in the arduous work of the Parliament of 1880–85, when Herschell was appointed Solicitor-General, and Sir Henry James, as he then was, became Attorney-General. "Full confidence he gave me—a confidence that enables me to declare that never has a public man more strenuously striven a true part to play and fully his duty to do than did Farrer Herschell." We cannot too highly commend the object of this important periodical in comparing and contrasting the problems of civil and criminal law and procedure as they appear to legislatures other than our own ; and the urgent importance of gathering together such material is apparent when we reflect upon the fact that "no fewer than a hundred legislatures in English-speaking countries alone are engaged in experiments more or less instructive."

Our attention has been directed to a new "look-out" telescope, fitted with terrestrial and astronomical eye-pieces, as well as a dark glass for observing the sun, just put on the market by Messrs. Newton & Co. The instrument is provided with a very good three-inch object glass mounted in a forty-two inch brass tube, which is carried on a tripod five feet high. The metal cradle bearing the telescope projects outwards at an angle which admits of a free sweep in altitude, and there is an adapter for rough adjustment of distance, with a rack motion for final focussing. Altogether it is an admirable piece of work. We notice that this firm has opened a new factory in Little James Street.

BOOKS RECEIVED.

Rapport Annuel sur L'etat de L'Observatory de Paris pour L'Année 1898. Par M. M. Loewy.

Forty-sixth Report of the Department of Science and Art, 1899. (Eyre & Spottiswoode.) 1s. 7d.

Remington Typewriter Manual. By R. T. Nicholson. (Pitman.)

On the Physiological Perception of Musical Tone. Boyle Lecture. By John Gray McKendrick. (Frowde.) 1s.

Remarkable Eclipses. By W. T. Lynn. (Stanford.) 6d.

Bird Life in an Arctic Spring. By Dan Meinertzhagen. (R. H. Porter.) Illustrated. 4s. net.

The Studio. August, 1899. 1s.

The Röntgen Rays in Medical Work. Second edition. By D. Walsh. (Baillière.) Illustrated. 10s. 6d. net.

Proceedings of the Society for Psychical Research. Part XXXV., Vol. XIV. (Kegan Paul.) 5s.

National Competition, 1899—List of Students Rewarded, with the Report of the Examiners.

The Yorkshire Ramblers' Club Journal. Vol. I., No. 1. (Unwin.) 2s.

Introduction to Zoology. By B. Lindsay. (Sonnenschein.) Illustrated. 6s.

The Romance of Wild Flowers. By Edward Step, F.L.S. (Warne.) Illustrated. 6s.

The Photo-Miniature. No. 4. July, 1899. (Dawbarn & Ward.) 6d.

Modern Cremation. Third Edition. By Sir Henry Thompson. (Smith, Elder & Co.)

Arithmetic of Electrical Measurements. Seventh edition. By W. R. P. Hobbs. (Murby.) 1s.

Ajax Loquitor, or the Autobiography of an Old Locomotive Engine. By Robert Weatherburn. (Crosby Lockwood.) Illustrated. 2s. 6d. net.

Journal of the Society of Comparative Legislation. New Series. No. II. (John Murray.) 5s.

Bacon or Shakespeare? An Historical Enquiry. By E. Marriott. (Elliot Stock.) 1s. net.

A Guide to Chamonix, and the Range of Mont Blanc. By Ed. Whymper. (Murray.) Illustrated. 3s. net.

A Guide to Zermatt and the Matterhorn. By Ed. Whymper. (Murray.) Illustrated. 3s. net.

Molesworth's Pocket Book of Engineering Formulæ. Twenty-fourth Edition. (Spon.) 6s.

LONDON SUMMERS NEAR SUN-SPOT MINIMA.

By Alex. B. MacDowall, M.A.

Three stages might perhaps be distinguished in meteorological science:—First: observation and record of phenomena. Second: elucidation of those phenomena, as regards their proximate, terrestrial causes (explaining, *e.g.*, the physics of cyclones, thunder, dew, &c.). Third: reference of weather to periodic changes of the sun or the moon, or perhaps some other outside influences.

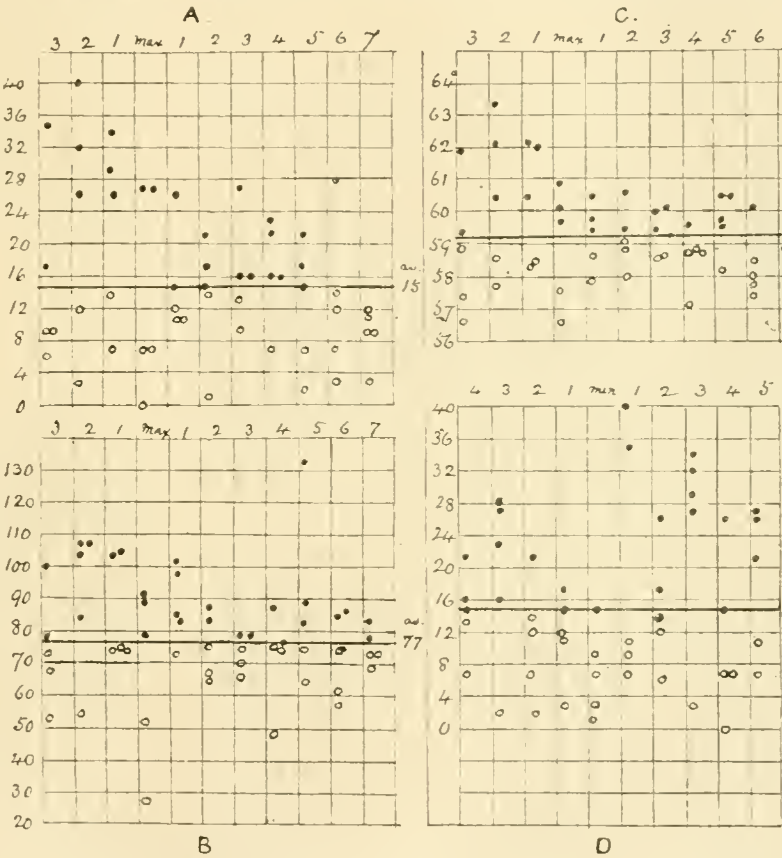
If a beginning may be said to have been made in this third stage of "cosmic meteorology," the amount of undisputed gain to knowledge is not, thus far, perhaps, so extensive and definite as to be of great practical use. Thus it probably occurs to few at present to ask what part of the sunspot cycle has been reached, with a view to getting some clue to the weather of approaching years. Such inquiries may in time, however, prove to be not wholly useless.

The last sunspot maximum occurred in 1894 (by one estimate), and we are now on the downward slope, and probably nearing a minimum. The exact time of this minimum cannot be fixed, but if we consider these dates of minima since 1841—viz., 1843, 1856, 1867, 1879, 1890—we shall probably be not far wrong in looking for a minimum in or about 1901.

Do our summers give any indication of sunspot influence? And does our past experience of summer near sunspot minima give any hint as to what kind of summer weather we might expect near this next minimum? These practical questions we may briefly consider.

The heat of our summers might be measured in various ways. Thus we might count, in each year, the number of days on which the thermometer reached or exceeded a certain limit, say eighty degrees. We might do the same with a lower limit, say seventy degrees. Greenwich supplies tables of such data from 1841, and we shall employ both series. Again, we might find the mean temperature of summer proper—that is, of June, July, August; or do the same with four or five months, including (with summer) May or September, or both. We shall, in a third method, use the mean temperature of the four months, May to August.

In the rough diagrams herewith, A relates to summers as measured by the number of days with the thermometer going up to or beyond eighty degrees. Summers are here "pigeon-holed," so to speak, in eleven columns, according as they fall in a sunspot maximum year, or the year before or the year after, or the second year before or after, and so on; the series extending from the *third* year before to the *seventh* year after, in accordance



A. Summers measured by number of days with thermometer 80° or more (max. sunspot group).

B. Summers measured by number of days with thermometer 70° or more (max. sunspot group).

C. Summers measured by mean temperature of May to August (max. sunspot group).

D. Same as A (min. sunspot group).

with the average course of the sunspot cycle (four years of growth, seven years of decrease). Each mark (dot or small o) stands for a summer season, and the distance of each mark from the average line (fifteen days) shows how hot the summer is (dots), or how cool (small o's); that is, how much *more* than the average number of days with thermometer up to or above eighty degrees it had, or how much *less*. Five summers are thus represented in each column, according to the five sunspot maximum years dealt with.*

Now, we may here be struck by the fact that the hottest summers cluster in the *earlier* years of the series, that is to say, about the time of *growth* and maxima of the spots.

Suppose we draw a line at twenty-four, and call every summer season with more than twenty-four of those days *very hot*. We find twelve such summers, and ten of these are in the first five columns (3, 2, 1, maxima, 1). In the years after maxima are passed, the dots cluster nearer the average line; the summer heat, in fact, is moderated. Coming to the end of the series, *i.e.*, near sunspot minima, we find (6, 7) a large preponderance of *cool* summer seasons.

The same general view seems to be borne out by the diagrams B and C; in the former of which seventy degrees is taken as the thermometric limit, instead of eighty degrees; while in the latter we consider the mean temperature of May to August.

Thus, in the case of B, we find *ten* summers which, having more than ninety days with thermometer up to or over seventy degrees, might be called *very hot*. Of these, as many as *nine* are in the first five columns, and *one* only in the remaining six. True, that one (1865) is the hottest summer of the whole, from the present point of view (with one hundred and thirty-two days), and so presents a curious anomaly. The details of C may be worked out, similarly, by the reader.

Comparing these three diagrams, we may further notice, I think, in years following maxima, a *constriction* (so to speak) of the space covered with marks, from *below* as well as from *above*, towards the average line. In other words, the summers in those years apparently tend to be less extreme in *coolness* as well as in *heat*. (Consider the columns 2, 3, 4, after maxima, in B and C especially.)

Reverting to A, it may be useful to specify those twelve hot summers (as measured); they are 1846, 1847, 1857, 1858, 1859, 1868, 1870, 1876, 1884, 1887, 1893, 1895. The hottest is 1868 (forty days). The seasons 1876 and 1887 form the exceptions to the rule.

Now, the above mode of classification (starting from maximum sunspot years), though adequate as far as it goes, does not quite exhaust the summers since 1841, and slightly fails in regard to minima; it is well, therefore, to supplement it by another, in which we start from *minimum* sunspot years, counting forwards and backwards.

In the fourth diagram, D, we are enabled, taking the same measure of summer heat as in A, to compare the five years *ending* with sunspot minima, with the five years *following* those minima. The result is very much the same—few very hot summers in the former group, and in the latter part of this period of spot decline, a large preponderance of cool summers. But once the minima are passed, and the spots are growing, a number of very hot summers.

It is in accordance with these results that we generally find, in regard to summer rainfall at Greenwich, a preponderance of wet summers in the five years ending with sunspot minima, and a preponderance of dry summers in the five years following minima.

The practical view, then, to which these inquiries point (and it is offered without dogmatism as to sunspot influence, or affirmation of an unvarying law), is that we are at present at a time when cool summers are to be looked for rather than hot ones, and that only after the next sunspot minimum is passed (say 1901, but not certainly), need we prepare for recurrent times of thorough and persistent broiling!*

* That is, 1848, 1860, 1870, 1884, 1894. As there are only four summers since 1894, I have made use of the summers 1842, 1843, 1844, being the fifth, sixth, and seventh after sunspot max., 1837.

* Up to 19th August, there have been this season, I think, sixteen of these very hot days, eighty degrees and over.

THE STORY OF THE ORCHIDS.—II.

By the Rev. ALEX. S. WILSON, M.A., B.SC.

THE butterfly orchises, *Habenaria bifolia* and *H. chlorantha*, are also fragrant; they have greenish-white flowers with very long spurs. The greater butterfly orchid is perhaps the deepest of all our native flowers; its nectary sometimes attains a length of one and a half inches. Its fertilizers are sphinx moths, which alone of all our native insects have a proboscis sufficiently long to remove the nectar. The pale colour of the flower and the absence of markings are also indicative of nocturnal or crepuscular visitors. The rostellum differs from that of the orchids already considered; the two viscid disks are separate and placed at the sides of the entrance to the spur. In this position they may adhere to the moth's proboscis, or to the sides of its head; not unfrequently they are observed attached to its eyes.

FIG. 4.—1, *Habenaria*; 2, *Epipactis*; 3, *Listera*.

In the fly orchis, *Ophrys muscifera*, the rostellum is also divided, each disk being lodged in a separate cup. The front view of this orchid presents a remarkable likeness to a fly; from this circumstance it gets its name. But the name is appropriate for another reason, for the flower seems to be adapted to carrion flies. The labellum is not spurred, but secretes minute drops of fluid which are gathered by the visitors; the latter as they move upwards come against the rostellum and remove one or both pollinia. Two black shining bodies at the base of the lip are believed by Müller to be pseudo-nectaries intended to deceive certain classes of visitors.

The twayblade, *Listera ovata*, is another orchid frequently met with in woods and pastures. It has yellowish-green flowers, which, as in the previous case, curiously resemble one of its most frequent visitors—a beetle, *Grammoptera levis*. The bilobed labellum hangs down in front; it has no spur, but honey is secreted in a longitudinal furrow. Besides the above-mentioned beetle the twayblade is visited by ichneumon flies. As they creep upwards, licking the honey in the groove, the rostellum is touched and a drop of fluid exudes which instantly hardens and cements the pollinia to the head of the visitor. At the same time the scale-like rostellum bends downwards and protects the stigma from self-fertilization; later on the scale becomes again elevated so that the stigma is once more exposed. The bird's-nest orchid is fertilized in an analogous manner.

Another of these orchids with greenish-yellow, not particularly attractive, flowers is the Helleborine, *Epipactis* *latifolia*, remarkable as being visited almost exclusively by wasps. There is no spur, but the concave labellum contains a copious supply of nectar. The square stigma is surmounted by the rather small rostellum; the pollinia, which have no stalks, are both attached to one disk, and are removed together by visitors very much as in the orchids just described. *Orchis pyramidalis* also has but one disk; it is saddle-shaped, and clasps the visitor's proboscis; the curving of the disk causes the pollen-masses attached to it to diverge, whereby they come more readily in contact with the stigmas of the next flower. Self-fertilization occurs extensively in the fly and bee orchises.

A singularly interesting group, the Cypripedinæ, is represented in this country by the lady's-slipper orchid, which occurs (unless it has been recently extirpated) in the north of England. Many species of Cypripedium are cultivated for the sake of their flowers, which are much larger than any of our native orchids, though as a rule they are produced singly, and not in clusters or spikes. Cypripedium differs from the common orchid in several respects. The pollen grains are not combined into pollinia; instead of only one, it has two perfect stamens which belong to the inner whorl, and correspond to the two little swellings at the sides of the fertile stamen of the orchis. The latter is represented in Cypripedium by a large flattened staminode, which partly closes the opening of the lower lip. The lip itself is hollowed out into a kind of pouch in front of the flower. Its upper edges are incurved in such a way that an insect cannot escape by the opening through which it entered. The visitor is consequently forced to crawl up inside the labellum, and squeeze itself through one of the two little holes higher up, where the labellum arises from the column.

FIG. 5.—*Cypripedium barbatum.*

To reach either of these apertures the visitor must first creep under the stigma. Should there be any pollen on the bee's back this will be transferred to the stigmatic surface. Above each little opening one of the anthers is so placed that the pollen is brushed off by a bee as it makes its escape. This pollen the departing guest will not fail to carry with it when it enters the labellum of Cypripedium. Sand bees have a special liking for this flower, and large insects are occasionally found dead in the labellum, from which they have been unable to escape. The flowers are of various colours — shades of white, yellow, crimson, and pink—according to the species, but the prevailing tint is chocolate brown. A species common in America, with large nodding blossoms of pale crimson colour, is known as the mocassin-flower. The genus has recently been re-arranged into a number of sub-genera, and many species have been re-named.

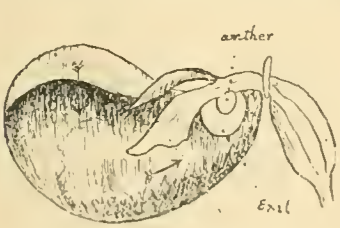


FIG. 6.—Section through Labellum of Slipper Orchid.

One of the Australian orchids, *Pterostylis longifolia*, has a sensitive labellum which acts as a spring trap. When an insect alights it instantly flaps up, and the unwary visitor is entrapped in the flower. There is only one opening above by which escape is possible, and, as happens in Cypripedium, the stigma and anther are encountered on the way out. An irritable labellum also occurs in species of Megaclinium, Bolbophyllum, Drakea, and others. In the vanilla orchid, the pods of which supply the well-known flavouring, an arrangement of hairs, somewhat resembling the mouse-trap hairs of the birthwort, induces visitors to enter and depart in the manner most favourable to cross-fertilization.

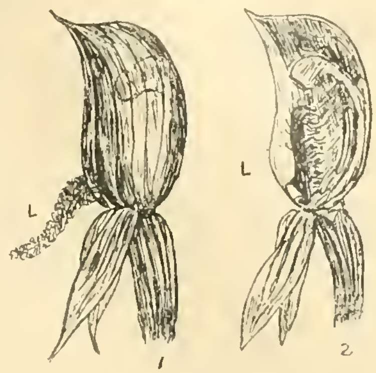


FIG. 7.—(1) *Pterostylis*: (2) with Labellum folded.

ELECTRICITY AS AN EXACT SCIENCE.

By HOWARD B. LITTLE.

V.—ELECTRICAL REASONING AND INCONTROVERTIBLE ELECTRICAL FACT.

SINCE mathematical reasoning and logical truth are the same, all the world over, and in every walk of life, it follows at once that no extraordinary form of reasoning should have been introduced by electrical workers, unless they wished to forfeit their science's claim to be considered exact. A consideration of all electrical laws (and all legitimate deductions therefrom), will render it quite clear that electrical reasoning is, as it should be, no more than the application of the soundest reasoning we know to the immutable laws of the science.

Consider the simplest law that occurs at the moment, "The sum of the currents flowing to a point is equal to the sum of the currents flowing from that point." The "casually inclined" student might perhaps smile, and even say "obvious." And there would be a certain amount of excuse for him in this instance (but bear in mind that a simple rule was purposely selected). Apply Euclid's definition of a point, "That which has no parts and no magnitude." Can any change occur in such a position, when the word position does not imply space? Mathematically, then, it is a statement which may be regarded as an axiom. But the law thus enunciated becomes of real importance when we have to consider that portion of a circuit where one conductor divides into many branches. Here the law of shunts comes in, and we find that the current flowing in each branch or shunt may be represented by a number which is inversely as the resistance of that particular branch, or proportional to the conductivity, where this latter quantity is, of course, expressed as the reciprocal of the resistance.

Once having clearly realised that every electrical quantity is subject to some more or less direct form of measurement, we see that all such quantities may be represented by numbers, these numbers being in their turn regarded as the representatives of so many units. The conception of positive and negative quantities is not so easily arrived at, because we (for some occult reason) adhere to the unfortunate expressions positive potential, and negative potential. These phrases imply to the beginner that there is a difference in quality between the two potentials thus referred to. Nothing of the kind is, however, the case. It has already been pointed out that the potential of the earth is conventionally assumed to be zero. Why not then bring this to the recollection of the beginner by the use of the complete expression, thus: "The potential of the body is positive with reference to the earth, because, on joining the body to earth, the current would flow from it to earth." We are really compelled to this convention with reference to the earth's potential, and in most cases it is useful, yet here, unless carefully applied, confusion will all too often be the result.

The importance of the algebraic sign must under no circumstances be neglected. A suggestion which I threw out some years ago makes this evident; assume that we wish to measure the resistance of a small part of a circuit, from A to B. We may use a Wheatstone's bridge, or an ammeter and voltmeter. Arrived at the result in ohms, how do we know whether we have been measuring the small portion from A to B, or the remainder of the circuit, which (to preserve our idea of direction) we call B A? Had we wished to measure this latter quantity which we are supposing much greater than A B's resistance, we might have connected up in precisely the same way. Obviously the answer is, consider the signs of the potential difference introduced. This suggestion, calculated to appal the majority of students who have not long been acquainted with the bridge and its use, may be developed. How can one tell that the result is not the resistance in parallel of the two parts of the circuit, modified by the existence of P D's in that circuit, before the bridge was connected? And so on, till it may be made a positive nightmare tending to negative all hope of rest till it be cleared up.

It has been urged that "Reason is the life of the law," and that "Nothing is law that is not reason," yet nearly all unreasonable practices which are widespread amongst electricians in their work are the direct outcome of attempts at legislation concerning matters electrical. While it would serve no useful end to draw attention to specific instances in the past of sheer reasoning power having been brought to bear on some electrical difficulty, yet it cannot be denied that a great amount of thought and subtle reasoning have been required not merely for the perfection of apparatus whose results should be as nearly as possible true mathematically, but also upon systems of electrical generation and distribution which in themselves have formed the life-studies of many vigorous intellects. It is, by the way, more than unfortunate that we should retain as a common expression "generation of electricity," and that we should constantly speak of generators. There is a growing tendency in this direction; in a recent issue of the *Pall Mall Gazette*, a contributor, under the heading "Science Notes," gravely asserts that Joule invented the conservation of energy. But to continue, while all this mental energy, of an order distinctly above the average, has been actually necessary to bring apparatus to its present condition, it must not be forgotten that much of the apparatus in question is used daily in a far more intelligent manner than formerly. To the lay mind one of the most striking instances of the results achieved by electrical reasoning is the fact that should a fault occur on a telegraph line it can be "found" or located from one end of the line, although it may be hundreds of miles away from the individual making the test. And not only can the actual position be fixed, but a good description of the fault can be given by an intelligent operator, and, while remaining perhaps a hundred miles away from the scene of the trouble, he will be able to state, with certainty, that there is a "dead earth," a "partial earth," or a leak, or a break, as the case may be. This must be regarded as a distinct advance, due exclusively to a development in electrical reasoning, because, not more than a few years since, the only known method of finding faults was a search along the line, and the present condition of things must not be referred to improved apparatus, because ten years back, or even twenty, instruments were common which would have enabled the operator to adopt the systems now in use; only, these systems had not yet been thought of.

We have a common saying to the effect that "facts are stubborn things," and scientists who have the courage of their own opinions should be stubborn. Hence, scientific fact has two claims, which may be spoken of as well founded and to be stubbornly incontrovertible. It seems childish to insist that a fact is incontrovertible, but unhappily the necessity exists. So long as a single exponent of the somewhat exclusive science of perpetual motion remains alive, or while the inventor of a primary battery continues to aim at the sale of the said battery to the unfortunate public, for no better reason than that it will cause the filament of a glow-lamp to become incandescent, it is actually the duty of everyone who has made a speciality of scientific study to insist that fact cannot be contradicted, with any hope of success. If upon every housetop in London one were stationed, for eight hours a day, to yell "*ex nihilo nihil fit*," it is yet conceivable that were those words expressed in every language ever heard of, there would remain some who would never hear, and some who would never heed, and some who would contradict.

If we wish to establish the claim of any style of thought, or school of teaching, to be considered scientific, there is one rigorous test which we can apply; ask ourselves, Does such thought and such teaching lead to, and ultimately enunciate, facts which reasoning individuals must admit to be *universally* true? And, do these facts conform with what reasoning beings have already admitted the truth of? To such questioning, electricians can answer boldly, "We are governed in our investigations by laws which it would be actually futile to dispute; and under the guidance of these laws we have been able to contribute largely to the spread of knowledge throughout the civilized world. In our turn, permit us to ask what you would have us do to establish the claim of our study to be considered exact and scientific? Let us also request that the deliberate untruths which are told about us and our work be rigorously suppressed. To ignorance gentle treatment may well be applied, but let those who profess to have attained to an exalted standard of wisdom and popularity (?) keep silent, unless they are prepared to strive honestly for the spreading of truth.

But the Millenium is not yet. When Carlyle was impudent enough to say "Mostly fools," someone whispered "*Tu quoque*," or, if not, someone neglected a distinct duty, and it might have been better to shout. Reverting to those stubborn things which in this connection one is called upon to produce. The telegraph has an existence, so that we get news within a day that would otherwise have taken weeks or months to reach us. We can travel distances in hours which would otherwise take days or weeks. Suppose all the telegraph lines and cables were cut to-morrow. The idea seems appalling, for with the cutting of these lines at first stagnation almost everywhere would result, yet, electricians would be particularly lively, and in something like an hour the majority of the lines would be at work again! If, however, with the cutting of the lines the electricians all died? Well, the world would no doubt stand still for a day or two. And the infant has accomplished all this, just as it would bring into existence a new race of electricians at almost lightning-like rapidity. Further, as the child *must* be growing up, the new edition would in all probability be a distinct improvement. And when the infant arrives at the hobbledehoy stage, who is going to protect us from his antics? Might it not be wise, for the sake of the community, to legalize infanticide in this particular instance? Already the brat is said to be spoiling the appearance of entire districts, and this because he is past the crying stage. We must protect ourselves.

Perhaps the most striking fact that can with justice be introduced as absolutely electrical is that now "opaque" bodies can be seen through. In this respect, if no other, the child has distanced all the elder members of the family. But why dwell upon this? Our police force must be regarded (like Mr. Meagles' family) as being constituted of "practical people," and they would be amongst the very first to assert that it was quite impossible for them to work if the wires all remained cut.

Endeavouring now to sum the matter up in a more becoming spirit, this much may be asserted, absolutely without fear of contradiction—if suddenly we were to be deprived of everything electrical, our lives would at once undergo a complete change, and this change would, upon the whole, be very much for the worse. Again, and with all possible deference, referring to Democritus, we may glance at a fact which no one hoping to preserve their own reputation for sanity dare dispute; water power where available may be converted into electrical energy, which in its turn may be made use of for the production of light, and the energy dissipated, or allowed to undergo a form of change useless to man, need not be much more than ten per cent. of the amount which must still be considered as having been available. In conclusion, since I am doing my utmost to represent facts quite literally in the latter part of this paper, let me ask for a statement of fact from all who care to give the matter their serious consideration. In what way, other than electrically, can man manipulate any natural force, and, making it subservient to his will, show such an efficiency as this? Finally, the subject in hand is difficult to leave, there is so much that clamours for mention, and it would be absurd to pretend that anything but an arbitrary selection had been made here.

NOTES ON COMETS AND METEORS.

By W. F. Denning, F.R.A.S.

Swift's Comet (1899a).—This object will be situated, in September, near the Equator in the extreme north-east part of Virgo, but will be exceedingly faint, the computed brightness being only 0·006—.

Tempel's Comet (1873 II.).—This comet is now invisible to European observers, though it may still be seen from places in the southern hemisphere. It was well seen at Bristol on July 16th and 29th, when it was a fairly conspicuous object in a ten-inch reflector with powers of forty and sixty. The nucleus was placed on the S.S.E. side of the nebulosity, so that it preceded in the direction of motion.

Holmes's Comet (1892 III.) is now well situated, but is scarcely an object for ordinary telescopes. When re-discovered by Perrine on June 11th, it was estimated to be no brighter than the 16th magnitude, and since the date alluded to there has been little increase in its apparent brightness. Its light is far more feeble than that computed from its observed appearance in 1892, and Prof. Barnard's idea that the comet owed its origin to some "celestial accident" and would not be seen again has been partially confirmed. Quite possibly its conspicuous and sudden apparition in 1892 was really due to a catastrophe, which imparted a temporary lustre to the object, so it is highly probable that after this return it will have to be relegated to the list of "lost comets." The following is an ephemeris by Zwiers for several days in September :—

Date.	R.A. h.	m.	s.	Dec. °	′	″	Distance in Millions of Miles.
September 5 ...	3	5	53	+ 41	13	30	172
„ 9 ...	3	7	39	+ 42	9	25	170
„ 13 ...	3	8	52	+ 43	3	34	167
„ 30 ...	3	7	29	+ 46	26	25	159

On September 2nd the comet will be about half a degree east of the variable star β Persei, but the lustre of the star will probably obliterate the feeble light of the comet.

The August Meteors (Perseids).—The weather was very clear at about the time of the maximum, and a large number of observations have been made. The shower was not unusually rich, nor were the individual meteors of special brilliancy, but the display was fairly conspicuous, and none of those who witnessed it will have cause to complain of scanty results. From the reports already to hand it appears that both August 10th and 11th furnished many meteors (about forty per hour for a single observer), but it is difficult to say when the maximum was attained. Prof. Herschel at Slough, and Mr. T. H. Astbury at Shifnal, Salop, found meteors decidedly more numerous on the 10th than on the 11th, while the writer at Bristol considered the two nights equally productive. But M. Antoniadi, at Juvisy, observed more meteors on the 11th than on the 10th, his comparative numbers being :—

Aug. 10—9h. to 14h. 30m. G.M.T. 104 meteors, 19 per hour.
„ 11—9 to 14 30 „ 138 „ 25 „

In 1898 the maximum occurred on the 11th, and that date certainly furnished a richer display than was observed on any night in 1899. During the recent shower some brilliant Perseids were recorded. At Juvisy, on August 10th, at about 12h. 8m., a magnificent fireball, estimated five times as brilliant as Venus, exploded in Cepheus. At Bristol, meteors rivalling Venus were seen on August 9th, 12h. 7m., August 10th, 10h. 14m., and August 12th, 12h. 1m. The latter left a streak for three and a-half minutes amongst the stars in the northern region of Pegasus. On August 10th, 10h. 31m., Mr. T. H. Astbury at Shifnal, Salop, recorded a Perseid which must have been quite as bright as Sirius, for it gave a very brilliant flash at the end of its flight, and left a streak for twenty seconds.

A preliminary examination of the results sent in by several observers shows that a considerable number of the brighter Perseids have been observed at more than one station. The real paths of all these will be computed as soon as further observations have come to hand and rendered the list more complete.

The minor showers usually contemporary with the Perseids are as interesting as they are numerous. The radiant points of several of these were clearly indicated during the recent display of Perseids, and the most prominent of them, as observed at Bristol, appeared to be as follows :—

Radiant.	Meteors.	Radiant.	Meteors.
16° + 31°	4	315° + 79°	11
40° + 21°	5	332° + 27°	8
277° + 70°	10	339° − 11°	8
293° + 60°	8	345° ± 0°	9

These and the other secondary streams of the epoch occasionally furnish very conspicuous meteors, and some of them were observed during recent observations at Bristol. Thus on August 12th, at 12h. 31m., an exceedingly slow, yellow meteor of about first magnitude sailed down the northern sky, and occupied about seven seconds in its descent. On August 13th, at 10h. 41m., a meteor about equal to Jupiter passed slowly along the eastern sky, from $29\frac{1}{2}° + 27\frac{1}{2}°$ to $353° + 3\frac{1}{2}°$, and left a bright streak. Its radiant was at $61° + 37°$, and proves the meteor to have been an early member of a well-known September shower.

Large Meteors.—Prof. Barnard has kindly sent me an account of a large detonating meteor seen at Nashville, Tennessee, on March 6th, 1899, at 17h. 45m. G.M.T. Observers describe the meteor as blinding in the intensity of its light. It appeared slightly to the west of the zenith, and moved through a short path to the west or north-west, where it exploded with a terrific noise which shook the city like an earthquake.

Fireball of August 4th.—M. Antoniadi sends a very interesting account, accompanied with a diagram, of a fireball, about five times more brilliant than Venus, which he observed at Juvisy, on August 4th, 9h. 46m. G.M.T. It travelled from

$241\frac{3}{4}° + 23°$ to $218\frac{3}{4}° + 25°$ when it exploded, and finally became extinct in $208° + 22\frac{1}{2}°$. The path, carried far back in the same direction, brings us to the radiant of the July–August Aquarids, and there is little doubt that this brilliant meteor derived its origin from that well-known stream.

Microscopy.

By JOHN H. COOKE, F.L.S., F.G.S.

Canada balsam, one of the most useful of resinous media, is usually slightly acid. In some cases this is a drawback, but for mounting sections stained with carmine, or injected with carmine gelatine, or Berlin blue gelatine, it is advantageous. The balsam may be neutralized by mixing a little carbonate of soda with the thinned solution before it is thickened. The soda settles after a few days and leaves the balsam clear and neutral. Carmine will diffuse, and blue will fade in the neutral balsam.

Thin mica plates are suggested as making good covers for such objects as fish's eggs, frog's eggs, &c. On account of the flexibility of the mica, the egg is less liable to be crushed than with a glass cover, and if the effects of pressure on the development of the egg are to be studied, the mica cover may be easily manipulated.

The preparation of a bone section so as to show the lacunæ, canaliculi and deep seated cells, may be quickly effected by the following method:—Take a fresh bone, and with a strong, sharp knife cut off a thin shaving. Immerse the section in carmine dissolved in ammonia, the ammonia being first neutralized by acetic acid. The walls of the vessels which penetrate the lacunæ and canaliculi are by this means stained crimson, and the true structure of the bone is thus rendered visible.

A solution of gum-dammar in xylol is more suitable than Canada balsam as a mounting medium for rock sections.

To render micro-photographs self-luminous soak them in castor-oil to make them transparent, and dust them over with powdered sulphate of baryta or sulphite of lime. When dry mount them on cardboard of a suitable size with starch paste. The phosphorescence of the salt lights up the photograph.

Drying oils in every form, such as gold size, paint, etc., becomes hard by oxidation, and not, as is generally supposed, by evaporation. The drying process is frequently a long one. Where time is an object, as in class demonstrations, it may be expedited by placing the slides in a small chamber (a porcelain dish answers admirably) and passing over them a stream of oxygen obtained by the decomposition of potassium chlorate.

A saturated solution of bichloride of mercury, to which has been added one per cent. acetic is an excellent medium for killing specimens of the protozoa on the slide or cover preparatory to mounting. In some cases a hot solution is useful, as being more rapid in its results, and producing little or no deformity of the cells.

It is a pity that amateur microscopists do not more fully recognize the necessity of recording, to some uniform and convenient scale, the dimensions of the microscopic objects that they make their study. This want of uniformity not only detracts from the value of the work done, but it also renders the work of comparison of the drawings of the objects laborious and unreliable. By operating on some object of known size it is easy to ascertain what arrangement of the microscope, and of its objectives and ocular, is necessary to obtain an image with the camera lucida of any required size. Having determined on a given amplification it should be adhered to, and a scale be made corresponding to this amplification. The actual dimensions of the object might then be readily ascertained by applying this scale to the various parts of the image or drawing. The value of some such uniform method as this is self evident.

To prevent sand grains and other loose objects from being forced out from under the cover-glass when mounting, Mr. H. C. Sorby recommends that the objects should be well mixed with weak gum and water, the gum to be of such a consistency as to make it easy to separate the grains and spread them uniformly over the space which will afterwards be covered by the cover-glass. The water is then allowed to evaporate slowly. Much of the gum may collect around the margin, but by properly regulating the quantity originally added, enough will remain under the larger grains to hold them so fast that they will not be squeezed out in the excess of balsam.

Dr. Marpmann, of Leipsic, has recently published the results of his microscopical examinations of sixty-seven samples of ink used in schools. Most of these inks were made with gall nuts, and contained saprophytes, bacteria, and micrococci. Nigrosin ink taken from a freshly opened bottle was found to contain both saprophytes and bacteria. Red and blue inks also yielded numerous bacteria. In two instances he succeeded in cultivating from nigrosin ink a bacillus which proved fatal to mice in four days. This ink had stood in an open bottle for three months, and the inference to be drawn from the enquiry is that ink used in schools should always be kept covered when not in use.

The current issue of the *Transactions of the American Microscopical Society* contains *inter alia* a valuable article on "Freshwater Investigations during the Last Five Years," by Dr. H. B. Ward, of Nebraska. It includes a bibliography of every article, however small, that has been published on plankton work since 1893, and it is therefore of great practical value to those who have taken up this field of work.

In the same publication, Dr. T. E. Oertel describes a convenient method for preparing nucleated blood in bulk for class demonstration. No book on microscopical technique has given details of preparing blood so as to yield absolute uniformity in results. "Smears" are not as a rule satisfactory by reason of the agglutination or crenation of the corpuscles, excess of serum, and the formation of fibrin. Dr. Oertel's contribution is therefore of considerable practical value, inasmuch as it obviates all of these defects. His method is, briefly, as follows:—Select a large frog, chloroform it, open the thorax, puncture the aorta and allow the blood to flow directly into a small glass jar containing a one per cent. aqueous solution of osmic acid in the proportion of one of blood to fifty of the solution. Allow the cells to settle, decant the supernatant fluid and add distilled water. Repeat this process, after which add Böhmer's hæmatoxylin diluted one-half with distilled water. After a few moments' staining, filter; wash filtrate from the paper and pass through the various grades of alcohol, beginning with seventy per cent. and finishing with absolute. Clear in carbol-xylol, and after drawing off as much of the liquid as possible add thin xylol balsam. Keep in a well-stoppered bottle, and when required for use transfer a drop with a glass rod to the slide, and super-impose a cover-glass. A neat and permanent preparation is the result.

THE FACE OF THE SKY FOR SEPTEMBER.

By A. FOWLER, F.R.A.S.

THE SUN.—On the **1st** the Sun rises at 5.14, and sets at 6.46; on the **30th** he rises at 6.0, and sets at 5.40. He enters Libra, and autumm commences, at 6 o'clock on the morning of the **23rd**.

THE MOON.—The Moon will be new on the **5th**, at 3.33 A.M.; enter first quarter on the **12th**, at 9.49 P.M.; will be full on the **19th**, at 12.31 P.M.; and enter last quarter on the **26th**, at 3.3 P.M. Two or three days before and after full the Moon rises nearly at the same time, thus giving us the well-known phenomena of the Harvest Moon.

The sixth magnitude star, 39 Ophiuchi, will be occulted on the **12th**; the disappearance will take place at 8.47 P.M., at 28° from the north point (2° from the vertex), and the reappearance at 9.26 P.M., at 318° from the north point (287° from the vertex). The Moon sets at 9.33 P.M.

THE PLANETS.—Mercury is a morning star throughout the month, and during the first part is very well placed for observation. He will be at greatest westerly elongation at 7 A.M. on the **5th**, but as the planet is at perihelion on the **9th**, the angular distance from the Sun only amounts to 18° 2′. Still, the apparition is specially favourable for our latitudes because of the great inclination of the ecliptic to the horizon near the time of sunrise at this time of the year, as shown in accompanying diagram. At the most favourable time, on the **5th**, he rises something like an hour and three-quarters before the Sun; about an hour before

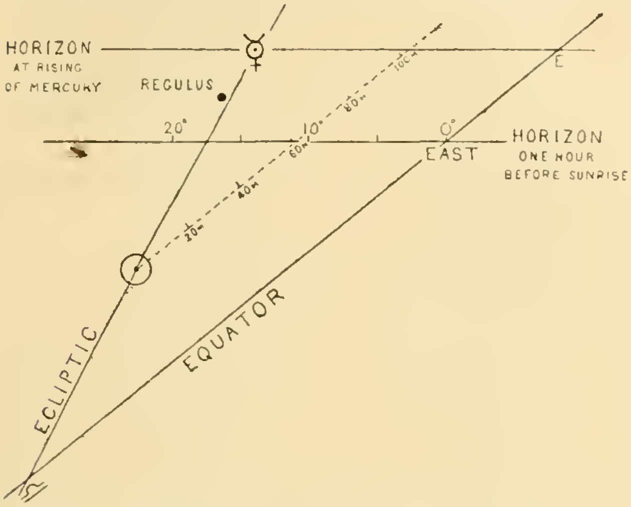


Diagram to illustrate favourable conditions for seeing Mercury as a morning star on September 5th. The dotted scale represents intervals before sunrise, and the horizontal scale shows amplitude north of east.

sunrise the planet will be some 14° north of east, and between six and seven degrees above the horizon. On the morning of the **3rd** he will be at or near the same altitude as the crescent Moon, and only about 4° to the left, a circumstance which may assist in identifying the planet.

Venus is badly placed for observation. She is a morning star until the **16th**, when she will be in superior conjunction with the Sun.

Mars is an evening star in Virgo, but he sets too soon after the Sun, and is too far away, for useful observation.

Jupiter is also an evening star, but is too near the Sun and too low to be easily observed. It is only under specially favourable conditions that any of the satellite phenomena can be observed this month. The planet is between Virgo and Libra, in the west, in the early evening.

Saturn is still in the southern part of Ophiuchus, and may be observed in the early evening low down in the south-west. He will be in eastern quadrature on the **10th**. About the middle of the month he sets shortly before 10 P.M.

Uranus is not observable.

Neptune may be picked up in the eastern sky by diligent observers. He is in western quadrature on the **20th**, and stationary on the **30th**. His path lies in the Milky Way, in the eastern part of Taurus, and the difficulty of identification is, therefore, considerable, especially as he is near a stationary point. He is about 15m. following, and 1° 3′ north of ζ Tauri.

The Stars.—About 10 P.M. at the middle of the month, Auriga and Perseus will be in the north-east; Taurus low down a little north of east; Aries, Andromeda, and Cassiopeia towards the east; Pisces a little south of east; Cetus low down from east to south-east; Pegasus south-east; Aquarius and Capricornus nearly south; Cygnus almost overhead; Aquila and Lyra nearly south-west; Hercules in the west; Corona and Boötis to the north of west; and Ursa Major nearly due north.

A conveniently observable minimum of Algol occurs on the **17th** at 8.34 P.M. A maximum of Mira Ceti is due in the early part of the month.

Chess Column.

By C. D. Locock, B.A.

Communications for this column should be addressed to C. D. Locock, Netherfield, Camberley, and should be posted by the 10th of each month.

Solutions of August Problems.

No. 1.

(By Rev. E. Cowley.)

Key Move—1. Q to Kt7.

If 1. . . . K to K6. 2. Q to Kt4, etc.
1. . . . K to K5. 2. R to KB2, etc.
1. . . . K to B5. 2. R to KB2ch, etc.

No. 2.

(By W. Clugston.)

1. B to Kt7, and mates next move.

Correct Solutions of both problems received from Alpha, E. Servante, G. A. Forde (Capt.), W. de P. Crousaz, G. C. (Teddington), A. H. Doubleday, H. S. Brandreth (Cauterets), K. R. B. Fry, K. W., H. Le Jeune, N. M. Munro, J. Baddeley.

Of No. 1 only, from W. H. Jones (variations incorrect).

Of No. 2 only, from Charles Savage, F. B. L. (Devonport), and W. H. Wesley.

W. H. Jones.—After 1. R to QB4ch, K to B6; 2. B to QKt7ch, the Black Pawn can interpose.

G. D.—No qualification is necessary for solving the Chess problems in Knowledge. Those sent by you this month are unfortunately incorrect. In No. 1, 1. K to Q5 is met by 1. . . . K to Kt6, not Kt5, in which case there is a mate in two moves by 2. R to R3 as you suggest. Nor will 1. B × P solve No. 2, on account of the subsequent interposition of the Black KP.

P. G. L. F.—Thanks for the problem; it appears below.

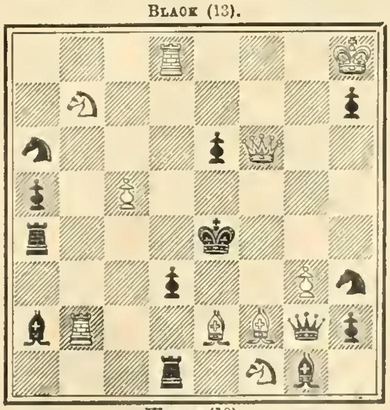
Gustav v. Bröcker.—We regret that the programme is not intelligible to us.

PROBLEMS.

No. 1.

(From *Chess Miniatures*, by H. Bristow.)

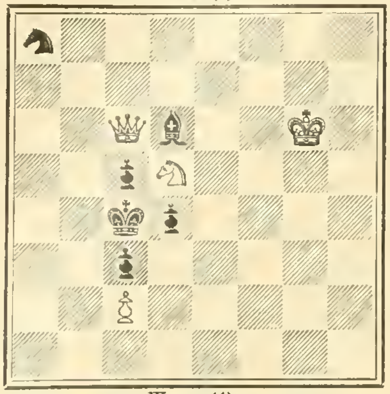
Black (13).



White (10).

White mates in two moves.

No. 2.
By P. G. L. F.
BLACK (6).



WHITE (4).
White mates in three moves.

CHESS INTELLIGENCE.

"Chess Miniatures" is the title of a collection of fifty two-move chess problems by Henry Bristow. Some of Mr. Bristow's problems have appeared in this column before this. Though occasionally a little too exuberant in the matter of forces, they are always full of point, and generally exhibit considerable originality. The booklet, which is "the first production of an amateur printer," and, as such, certainly very creditable, may be obtained from the author, 16, Wesley Terrace, Hyde Park Road, Mutley, Plymouth. The price, post free, is 1s.

The British Chess Company, Stroud, Gloucestershire, offer to supply, gratis, to any chess club or reading room a copy of the rules of the British Chess Code, mounted on linen (about twenty inches by sixteen), suitable for hanging on the wall.

Messrs. George Routledge and Sons are the publishers of the "Modern Chess Primer," by the Rev. E. E. Cunnington, M.A. (Price 1s. 6d. boards, or 2s. cloth.) This is an extremely useful handbook for beginners. The feature of the book lies in the fact that the writer has succeeded in looking at the game from the standpoint of the beginner, and not, as is too often the case, from his own point of view. The writer takes the whole of chess for his province, and the three hundred and fifty pages are most usefully filled. The moves of the men, and the various notations are first explained; then numerous examples of check-mates are given, including both standard ending check-mates, and mates of the kind likely to occur during the middle-game in actual play. Pawn play is next considered, and there in an instructive chapter on traps and stratagems. The openings occupy about thirty-five pages; then follow general hints, annotated games and end games, and about thirty problems. A brief history of chess and chess literature leads to the British Chess Code at the end. Perhaps the most useful novelty is the chapter on easy check-mates in two or three moves. We ourselves recently composed a collection of "Check-mates on a Castled King," showing the most likely ways of bringing the middle game to an abrupt termination. Some of Mr. Cunnington's mates are naturally the same, or similar; but some of them strike us rather as ordinary problems, the Black King often being in the centre, than as mating positions likely to occur in actual play. The games are very well annotated for beginners, the objects of the various moves being clearly explained. On the whole, the book strikes us as the best introduction to chess which has yet appeared.

Game played in the London Tournament.
"Queen's Gambit Declined."

WHITE. (Janowski.)	BLACK. (Maroczy.)
1. P to Q4	1. P to Q4
2. P to QB4	2. P to K3
3. Kt to QB3	3. Kt to KB3
4. B to B4	4. B to Q3
5. B to Kt3	5. Castles
6. P to K3	6. P to QKt3
7. R to Bsq	7. B to Kt2
8. P×P	8. B×B
9. RP×B	9. P×P
10. B to Q3	10. P to KR3
11. P to KKt4	11. R to Ksq
12. P to Kt5	12. P×P
13. Kt to B3	13. P to B4
14. Kt×KtP	14. P×P
15. R to R8ch	15. K×R
16. Kt×BPch	16. K to Ktsq
17. Kt×Q	17. R×Kt
18. Kt to Kt5	18. P×P
19. Kt to B7	19. P×Pch
20. K×P	20. Kt to B3
21. Kt×R	21. B×Kt
22. Q to R4	22. Kt to K4
23. B to B5	23. Kt to K5ch
24. K to Ktsq	Resigns.

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CONTENTS.

ON THE TREATMENT AND UTILIZATION OF ANTHROPOLOGICAL DATA.

By ARTHUR THOMSON, M.A., M.B.

V.—CRANIAL FORM.

HITHERTO we have confined our remarks to questions relating to colour, hair, proportions and height. We must now direct our attention to the consideration of the head. For various reasons this is the part of the human frame which has been most thoroughly studied, though it must be admitted that the vast amount of labour which has been expended on its minute and careful examination has not hitherto been productive of commensurate results.

The form of the head and the type of features naturally commend themselves to us in our attempts to analyse racial characteristics, for they are the parts of the body most exposed to our observation, and though it is a matter of great difficulty to secure all the bones of a skeleton, especially if a considerable time has elapsed since the interment of the individual, there is not much trouble involved in picking up a skull. Consequently, whilst the material at our disposal, so far as it relates to the complete skeleton, is meagre, there is no lack of skulls wherefrom to draw conclusions. It is beyond the scope of these articles to enter into all the detail and minutiæ with which the expert alone can be expected to be conversant, it is rather our intention to point out the features which appear to be of value in enabling us to determine with some approach to accuracy those distinctions in structure and form which may be considered racial characteristics.

The skeleton of the head, called the skull, includes those bones which form the protective covering for the brain and those which support and surround the various structures lodged within the cavities of the face. The only movable bone of the skull is the lower jaw; for this reason it is apt to become separated from the other bones and, in consequence, lost. To a skull from which the lower jaw is absent we apply the term cranium. Owing to the fact that the remaining bones of the face are apt to be destroyed in the process of decay, we often meet with specimens in which they are broken away; in this case the bony envelope of the brain, which is called the calvaria, alone remains. Stress must be laid on these details, as when in cataloguing skulls we make use of the terms skull, cranium, and calvaria, we imply thereby certain definite structures.

The appearance of the head in the living depends upon the relative proportions and forms of the calvaria and the bones of the face; it will be necessary therefore to refer to these in detail. The size of the calvaria is subject to great variation, both as regards capacity and form. As it is this part of the skull that contains the brain, an organ which in man attains its highest proportionate development, it will be obvious that the size of the calvaria must be correlated with the amount of brain substance contained within it, for, generally speaking, the osseous case is closely moulded round the great central nervous mass, so that its contours correspond roughly to the form of the encephalon. The exceptions to this rule will be especially referred to hereafter. But whilst no doubt the size of the calvaria is largely dependent on the development of the brain, it must be pointed out that its shape is to some extent controlled by its association with the lower jaw. This depends on the fact that one of the most powerful muscles which moves the lower jaw—*i.e.*, the temporal muscle—arises from the side of the skull, and according to its size and the extent of its attachment leads to variations in the form of the calvaria which are quite characteristic.

As will be readily understood from what has been said, it is a matter of no great difficulty to estimate approximately the size of the brain from the examination of a calvaria; if the capacity of the cranial cavity be gauged it will conform generally with the amount of nervous matter lodged within it during life. The cranial capacity may be measured in a variety of ways, but before doing so it is necessary to prepare the skull for this method of examination. Bones which have for centuries lain in their places of burial are apt to become exceedingly brittle owing to the disappearance of the organic matter which binds together the earthy salts. Such specimens are liable to crumble away when handled, and means must be taken to preserve them from further disintegration. Of these, none is better than that of making a warm solution of thin size into which the bones are placed and retained for some time. After being taken out of the fluid they are allowed to drain, and after being dried will be found to have lost all their brittle qualities, and can be now freely handled and measured.

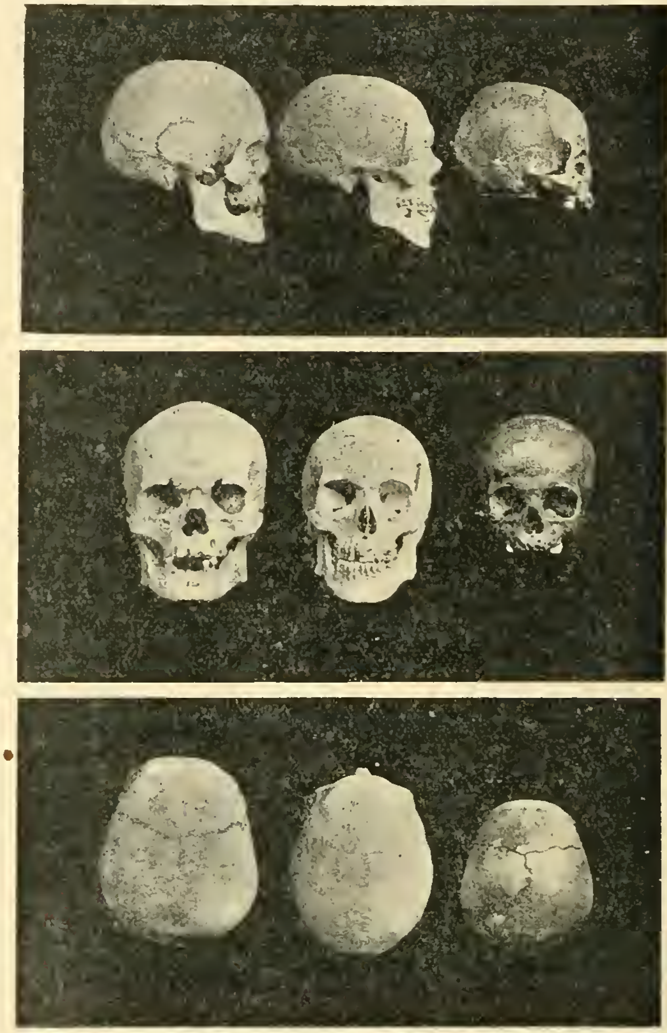
A further precaution necessary before proceeding to take the cranial capacity is to block up the various clefts and holes which open into the interior; cotton wool or modelling clay may be used for this purpose.

A variety of methods have been adopted to determine the cranial capacity. They all have certain advantages and disadvantages. The ideal method, of course, would be to fill the interior of the calvaria with fluid introduced through the foramen magnum, and then measure the amount of liquid contained: but this is open to grave objection on account of the difficulty of making the skull water-tight. Of recent years, an ingenious way of overcoming this difficulty has been introduced. A fine bladder is introduced into the inside of the calvaria, and into this the fluid is poured. We are unable, however, to speak from experience as to whether this arrangement is satisfactory or no. Of other plans adopted, the most common are those in which small shot (No. 8 for preference), small glass beads, or fine seeds of various kinds are used. Simple though it appears to measure skulls in this way, by pouring in shot and then pouring it out again, and taking its cubage, it requires very considerable experience before any degree of accuracy can be attained. The utmost care must be taken to use the same measures and funnels into which and through which the shot is poured. The height from which the shot is poured must always be the same, and precisely the same manipulations must be employed in "packing" the shot in each case, else very considerable differences in the measurements will be the result. Adopting some such method, and it is of advantage to use that most commonly employed, viz., that recommended by Broca, as the results are then comparable with other observations, it has been found that the cranial capacity in man ranges from 1000 cubic centimètres to 1800 c.c. Comparing this with what we observe in apes, we find that the man with the lowest capacity, viz., 1000 c.c., has a capacity twice that of the highest apes, for in gorillas we find a capacity of only 500 c.c. or thereabouts, whilst orangs and chimpanzees are considerably lower, with capacities of 430 c.c. and 420 c.c. respectively, though one must not overlook the fact that their body weight is much less than that of the gorilla.

For convenience of classification, calvaria are grouped according to their capacities. Those with a capacity below 1350 c.c. are termed microcephalic, those between 1350 c.c. and 1450 c.c. are mesocephalic, whilst those of 1450 c.c. are called megacephalic.

The first group (microcephalic) include Australians, Tasmanians, aborigines of India, Veddahs, Bushmen, Hottentots, Andamanese, Akkas, and other pigmy races. The mesocephalic comprise Malays, American Indians, and African Negroes; whilst the megacephalic races are composed of Europeans, ancient Egyptians, Mongolians, mixed Polynesians, Eskimo, Kaffirs, and Zulus.

In considering the question of cranial capacity the matter of sex must not be omitted. The average difference between the male and female capacities is 150 c.c.—the male having the advantage. The fact, however, must not be overlooked that women are not so tall as men, and therefore we would not expect them to have such large heads; but even making allowance for the difference in height the female capacity is still relatively less than that of man. The average weight of man's brain is about fifty ounces, that of woman about forty-five ounces. This difference between the sexes is less marked in savage than in civilized races, and is apparently explained by the fact that in the higher races more attention is paid to the education of the male than the female, and, consequently, the brain is stimulated to increased growth. It will be interesting to note whether in view of the recent developments in the education of women she will be able to equalise matters as regards her fair share of brains. It is hardly necessary to point out that quantity is no criterion of quality, and though the brains of many distinguished



A. B. C.

Fig. 1 displays the differences in size and cranial capacity met with in Skulls. A is a large English Skull, with a cranial capacity of 1680 c.c.; it is, therefore, megacephalic. B is a German Skull, with a cranial capacity of 1400 c c.; it is, therefore, mesocephalic. C is the Skull of an Andaman Islander, with a cranial capacity of 1040 c.c.; therefore microcephalic.

men have weighed much above the average (that of Cuvier weighed sixty-four ounces), there are abundant examples of equally weighty brains the possessors of which were not characterised by wits above the common herd. For our part we would rather that women remained as they are, for a small and shapely head is a feature of feminine beauty, and what they lack in quantity they may well make up in quality.

But apart from the mere size of the cranium we have to consider its shape. If a number of skulls be taken and placed on the floor so that we can look down upon them, we will at once realize that they display a great diversity of form, provided always that we are dealing with mixed groups; some are long and narrow, whilst others are broad and rounded. We hardly need to make this observation to bring the fact home to us, it is only necessary to remind the reader how easily he recognises his own hat by the accuracy of its fit.

For descriptive purposes the long heads are called dolichocephalic, the round head brachycephalic.

It is noteworthy that this peculiarity is not confined to man. Of the anthropoid apes the gorilla and chimpanzee are dolichocephalic, the orangs and gibbons brachycephalic, and it has been pointed out as an interesting coincidence, if nothing more, that the races of men corresponding to the geographicical distribution of these apes have the same peculiarities of head form. But whilst much stress was formerly laid on this difference in head form as a racial characteristic, the trend of modern opinion seems to be that too much reliance must not be placed on this distinction. As we have said, the size, and to some extent the form of the calvaria, depends on the development of the brain, at the same time we hinted that the shape of the brain case was to some extent correlated with the masticatory apparatus, for in those cases where we have large teeth and big jaws we necessarily require powerful muscles to act upon them, and these by their size and development necessarily react on the surfaces to which they are attached. As a rule in brachycephalic skulls the fossæ for the attachment of the temporal muscles are low and shallow, whereas in dolichocephalic skulls they are high and deep.

Another factor which determines the shape of the calvaria must not be overlooked. As Virchow has pointed out, the form of the skull depends to some extent on the order in which the sutures or joints which unite the several bones become closed, compensation always taking place in the direction of the suture, thus if one of the longitudinal sutures, the sagittal, for instance, becomes early synostosed the skull tends to grow long and narrow; if, on the other hand, one of the transverse sutures becomes ossified the skull can no longer increase in length, but expands transversely, forming a round and broad head. Apart from the question of heredity, which no doubt exercises a powerful influence, any one of the foregoing causes may determine remarkable individual variations of form.

For scientific purposes these differences in shape are recorded by the use of what is termed the cephalic index. This expresses the proportion of the width of the skull to its length, taking the latter as equivalent to one hundred; thus, supposing a "round" skull was strictly circular, its width would be equal to its length, *i.e.*, one hundred. On the other hand, if the width of the skull was only half its length, *i.e.*, fifty, the form of the calvaria would be an elongated oval, that is to say, long headed. Such extremes as those above mentioned are not met with in practice, but the example stated may serve to illustrate the method. As will be seen, this plan of grouping skulls is to some extent a compromise, and is open to certain grave objections. We assume that the length of the skull is the constant and the width the variable, whereas we might with equal reason adopt the transverse diameter of the skull as the constant and the antero-posterior length as the variable. Furthermore, though the index expresses the proportion of the width to the length, it by no means follows that it enables us to map out with any accuracy the outline of the skull; it merely enables us to say that we could place the skull within a cube the length and width of which correspond to the proportions expressed by the index, just as if we were making a box in which to pack the skull. The accompanying diagram illustrates this; both skulls have the same cephalic index though their shape is entirely different.

It will thus be seen that the cephalic index merely indicates the proportion of width to length, and fails to convey any accurate impression of contouring. Were we able to locate with precision the point of greatest width in relation to the length of the skull, the results would be more valuable, but unfortunately any such attempt would be beset with considerable difficulties.

In practice, the cephalic index is obtained by the following formula:—

$$\frac{\text{Breadth} \times 100}{\text{Length}} = \text{Cephalic Index.}$$

The results are grouped as follows:—Skulls with a proportionate width of eighty or over are termed *Brachycephalic.* This group includes, among others, some Mongolians, Burmese, American Indians, and Andamanese.

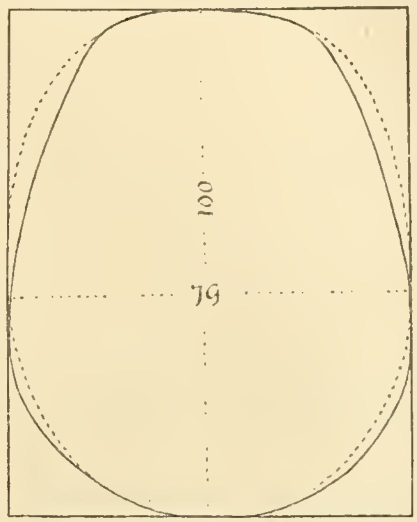
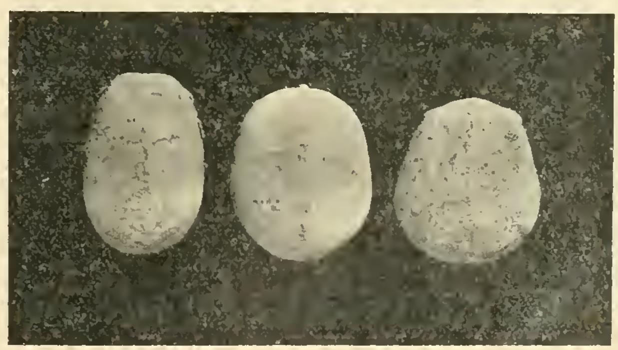


FIG. 2 represents two Skulls having the same cephalic index—viz., 79—yet displaying very different forms.

Skulls of which the index lies between seventy-five and eighty are *Mesaticephalic*, comprise Europeans, Ancient Egyptians, Chinese, Japanese, Polynesians, Bushmen, &c.

Whilst skulls with a proportionate width below seventy-five are *Dolichocephalic*, and are more or less typical of Veddahs, Eskimo Australians, African Negroes, Kaffirs, Zulus, &c.

The accompanying illustration shows three typical



A. B. C.

FIG. 3 shows examples of three varieties of Skull form. A. Extremely dolichocephalic Skull of Veddah, index 64; B. Mesaticephalic Italian Skull, index 79; C. Brachycephalic Swiss Skull, index 88.

examples of the variety of form characteristic of the three groups above mentioned.

SIR MICHAEL FOSTER'S PRESIDENTIAL ADDRESS TO THE BRITISH ASSOCIATION,

September 13th, 1899.

IN an address of singular literary grace, Sir Michael Foster, at Dover, last month, reminded us that some of the most fruitful advances effected in chemistry, geology, and electricity, were made at the very close of the eighteenth century, and that the concrete achievements of the present are the translation into fact of the purely intellectual efforts of Lavoisier and Priestley, of Galvani and Volta, of Hutton and of Cuvier.

Sir Michael said "the Association has seen pass away the men who, wise in their generation, met at York on September 27th, 1831, to found it; it has seen other great men who in bygone years served it as presidents, or otherwise helped it on, sink one after another into the grave. Each year, indeed, when it plants its flag as a signal of its yearly meeting, that flag floats half-mast high in token of the great losses which the passing year has brought. This year is no exception; the losses, indeed, are perhaps unwontedly heavy.

The eyes of the young look ever forward; they take little heed of the short though ever-lengthening fragment of life which lies behind them; they are wholly bent on that which is to come. The eyes of the aged turn wistfully again and again to the past; as the old glide down the inevitable slope their present becomes a living over again the life which has gone before, and the future takes on the shape of a brief lengthening of the past. They who study the phenomena of living beings tell us that light is the great stimulus of life, and that the fulness of the life of a being or of any of its members may be measured by the variety, the swiftness, and the certainty of the means by which it is in touch with its surroundings. I do not propose to weary you by what in my hands would be the rash effort of attempting a survey of all the scientific results of the nineteenth century. It will be enough if for a little while I dwell on some few of the salient features distinguishing the way in which we nowadays look upon, and during the coming week shall speak of, the works of Nature around us—though those works themselves, save for the slight shifting involved in a secular change, remain exactly the same—from the way in which they were looked upon and might have been spoken of at a gathering of philosophers at Dover in 1799. And I ask your leave to do so.

In the philosophy of the ancients, earth, fire, air, and water were called "the elements." It was thought, and rightly thought, that a knowledge of them and of their attributes was a necessary basis of a knowledge of the ways of Nature. Translated into modern language, a knowledge of these "elements" of old means a knowledge of the composition of the atmosphere, of water, and of all the other things which we call matter, as well as a knowledge of the general properties of gases, liquids, and solids, and of the nature and effects of combustion. Of all these things our knowledge to-day is large and exact, and though ever enlarging, in some respects complete. When did that knowledge begin to become exact? Let me ask you to picture to yourselves what confusion there would be to-morrow, not only in the discussions at the sectional meetings of our Association, but in the world at large, if it should happen that in the coming night some destroying touch should wither up certain tender structures in all our brains, and wipe out from our memories all traces of the ideas which cluster in our minds around the verbal tokens, oxygen and oxidation. How could any of us, not the so-called man of science alone, but even the man of business and the man of pleasure, go about his ways lacking those ideas? Yet those ideas were in 1799 lacking to all but a few. Although in the third quarter of the seventeenth century the light of truth about oxidation and combustion had flashed out in the writings of John Mayow, it came as a flash only, and died away as soon as it had come. For the rest of that century, and for the greater part of the next, philosophers stumbled about in darkness, misled for the most of the time by the phantom conception which they called phlogiston. It was not until the end of the third quarter of the eighteenth century that the new light—which has burned steadily ever since—lit up the minds of the men of science. The light came at nearly the same time from England and from France. Rounding off the sharp corners of controversy, and joining, as we may fitly do to-day, the two countries as twin bearers of a common crown, we may say that we owe the truth to Cavendish, to Lavoisier, and Priestley. If it was Priestley who was the first to demonstrate the existence of what we now call oxygen, it is to Lavoisier we owe the true conception of the nature of oxidation and the clear exposition of the full meaning of Priestley's discovery, while the knowledge of the composition of water, the necessary complement of the knowledge of oxygen, came to us through Cavendish and, we may perhaps add, through Watt. The date of Priestley's discovery of oxygen is 1774. Lavoisier's classic memoir "on the nature of the principle which enters into combination with metals during calcination" appeared in 1775, and Cavendish's paper on the composition of water did not see the light until 1784. During the last quarter of the eighteenth century this new idea of oxygen and oxidation was struggling into existence. How new was the idea is illustrated by the fact that Lavoisier himself at first spoke of that which he was afterwards—namely, in 1778—led to call oxygen, the name by which it has since been known, as "the principle which enters into combination." What difficulties its acceptance met with is illustrated by the fact that Priestley himself refused to the end of his life to grasp the true bearings of the discovery which he had made. In the year 1799, the knowledge of oxygen, of the nature of water and of air, and, indeed, the true conception of chemical composition and chemical change was hardly more than beginning to be, and the century had to pass wholly away before the next great chemical idea, which we know by the name of the atomic theory of John Dalton, was made known.

If there be one word of science which is writ large on the life of the present time, it is the word "electricity"; it is, I take it, writ larger than any other word. The knowledge which it denotes has carried its practical results far and wide into our daily life, while the theoretical conceptions which it signifies pierce deep into the nature of things. At what time did this bright child of the nineteenth century have its birth? He who listened to the small group of philosophers of Dover, who in 1799 might have discoursed of natural knowledge, would perhaps have heard much of electric machines, of electric sparks, of the electric fluid, and even of positive and negative electricity; for frictional electricity had long been known and even carefully studied. Probably one or more of the group, dwelling on the observations which Galvani, an Italian, had make known some twenty years before, developed views on the connection of electricity with the phenomena of living bodies. Possibly one of them was exciting the rest by telling how he had just heard that a professor at Pavia, one Volta, had discovered that electricity could be produced not only by rubbing together particular bodies, but by the simple contact of two metals, and had thereby explained Galvani's remarkable results. For, indeed, as we shall hear from Professor Fleming, it was in that very year, 1799, that electricity as we now know it took its birth. It was then that Volta brought to light the apparently simple truths out of which so much has sprung. And even Volta's discovery might have long remained relatively barren had it been left to itself. When, however, in 1819, Oersted made known his remarkable observations on the relations of electricity to magnetism, he made the contact needed for the flow of a new current of ideas.

Of all the various branches of science, none, perhaps, is to-day, none for these many years past has been, so well known to, even if not understanded by, most people as that of geology. Its practical lessons have brought wealth to many; its fairy tales have brought delight to more; and round it hovers the charm of danger, for the conclusions to which it leads touch on the nature of man's beginning. In 1799 the science of geology, as we now know it, was struggling into birth. There had been from of old cosmogonies, theories as to how the world had taken shape out of primeval chaos. The brilliant Stenson, in Italy, and Hooke, in our own country, had laid hold of some of the problems presented by fossil remains, and Woodward with others, had laboured in the same field. In the eighteenth century, especially in its latter half, men's minds were busy about the physical agencies determining or modifying the features of the earth's crust; water and fire, subsidence from a primeval ocean and transformation by outbursts of the central heat, Neptune and Pluto, were being appealed to, by Werner on the one hand, and by Desmarest on the other, in explanation of the earth's phenomena. In 1783, James Hutton put forward in a brief memoir his "Theory of the Earth," which in 1795, two years before his death, he expanded into a book; but his ideas failed to lay hold of men's minds until the century had passed away, when, in 1802 they found an able expositor in John Playfair. The very same year that Hutton published his theory, Cuvier came to Paris and almost forthwith began, with Brongniart, his immortal researches into the fossils of Paris and its neighbourhood. And four years later, in the year 1799 itself, William Smith's tabular list of strata and fossils saw the light. It is, I believe, not too much to say that out of these geology, as we now know it, sprang.

In another branch of science, in that which deals with the problems presented by living beings, the thoughts of men in 1799 were also different from the thoughts of men to-day. It is a very old quest, the quest after the knowledge of the nature of living beings, one of the earliest on which man set out; for it promised to lead him to a knowledge of himself, a promise which, perhaps, is still before us, but the fulfilment of which is as yet far off. Yet in the past hundred years, the biologic sciences, as we now call them, have marched rapidly onward. We may look upon a living body as a machine doing work in accordance with certain laws, and may seek to trace out the working of the inner wheels, how these raise up the lifeless dust into living matter, and let the living matter fall away again into dust, giving out movement and heat. Or we may look upon the individual life as a link in the long chain, joining something which went before to something about to come, a chain whose beginning lies hid in the furthest past, and may seek to know the ties which bind one life to another. As we call up to view the long series of living forms, living now, or flitting like shadows on the screen of the past, we may strive to lay hold of the influences which fashion the garment of life. Whether the problems of life are looked upon from the one point of view or the other, we to-day, not biologists only, but all of us, have gained a knowledge hidden even from the philosophers of a hundred years ago. Of the problems presented by the human body viewed as a machine, some may be spoken of as mechanical, others as physical, yet others as chemical, while some are, apparently at least, none of these. In the seventeenth century, William Harvey, laying hold of the central mechanism of the blood stream, opened up a path of inquiry which his own age and the century which followed trod with marked success. The philosopher of 1799, when he discussed the functions of the animal or of the plant involving chemical changes, was fain for the most part, as were his predecessors in the century before, to have recourse to such vague terms as "fermentation" and the like; to-day our treatises on physiology are largely made up of precise and exact expositions of the play of physical agencies and chemical bodies in the living organism. He made use of the words "vital force" or "vital principle" not as an occasional, but as a common explanation of the phenomena of the living body. During the present century, especially during its latter half, the idea embodied in those words has been driven away from one seat after another; if we use it now when we are dealing with the chemical and physical events of life we use it with reluctance, as a *deus ex machina* to be appealed to only when everything else has failed.

During the latter part of the present century, and especially during its last quarter, the analysis of the mysterious processes in the nervous system, and especially in the brain, which issue as feeling, thought, and the power to move, has been pushed forward with a success conspicuous in its practical, and full of promise in its theoretical, gains. We now know that what takes place along a tiny thread which we call a nerve-fibre differs from that which takes place along its fellow-threads, that differing nervous impulses travel along different nerve-fibres, and that nervous and psychical events are the outcome of the clashing of nervous impulses as they sweep along the closely-woven web of living threads of which the brain is made. We have learnt by experiment and observation that the pattern of the web determines the play of the impulses, and we can already explain many of the obscure problems not only of nervous disease, but of nervous life, by an analysis which is a tracking out the devious and linked paths of nervous threads. The very beginning of this analysis was unknown in 1799. Men knew that nerves were the agents of feeling and of the movements of muscles; they had learnt much about what this part or that part of the brain could do; but they did not know that one nerve fibre differed from another in very essence of its work.

If we pass from the problems of the living organism viewed as a machine to those presented by the varied features of the different creatures who have lived or who still live on the earth, we at once call to mind that the middle years of the present century mark an epoch in biologic thought such as never came before, for it was then that Charles Darwin gave to the world the "Origin of Species." That work, however, with all the far-reaching effects which it has had, could have had little or no effect, or, rather, could not have come into existence, had not the earlier half of the century been in travail preparing for its coming. For the germinal idea of Darwin appeals, as to witnesses, to the results of two lines of biologic investigation which were almost unknown to the men of the eighteenth century. Darwin, as we know, appealed to the geological record; and we also know how that record, imperfect as it was then, and imperfect as it must always remain, has since his time yielded the most striking proofs of, at least, one part of his general conception. In 1799 there was, as we have seen, no geological record at all. All or nearly all the exact knowledge of the laboured way in which each living creature puts on its proper shape and structure is the heritage of the present century. Although the way in which the chick is moulded in the egg was not wholly unknown, even to the ancients, and in later years had been told, first in the sixteenth century by Fabricius, then in the seventeenth century in a more clear and striking manner by the great Italian naturalist Malpighi, the teaching thus offered had been neglected or misinterpreted. At the close of the eighteenth century the dominant view was that in the making of a creature out of the egg there was no putting on of wholly new parts, no epigenesis. It was taught that the entire creature lay hidden in the egg, hidden by reason of the very transparency of its substance, lay ready made but folded up, as it were, and that the process of development within the egg or within the womb was a mere unfolding, a simple evolution. Nor did men shrink from accepting the logical outcome of such a view—namely, that within the unborn creature itself lay in like manner, hidden and folded up, its offspring also, and within that again its offspring in turn, after the fashion of a cluster of ivory balls carved by Chinese hands, one within the other.

I have said, I trust, enough to justify the statement that in respect to natural knowledge a great gulf lies between 1799 and 1899. That gulf, moreover, is a two-fold one; not only has natural knowledge been increased, but men have run to and fro spreading it as they go. Whoever, working at any scientific problem, has occasion to study the inquiries into the same problem made by some fellow-worker in the years long gone by, comes away from that study humbled by one or other of two different thoughts. On the one hand, he may find, when he has translated the language of the past into the phraseology of to-day, how near was his forerunner of old to the conception which he thought, with pride, was all his own, not only so true, but so new. On the other hand, if the ideas of the investigator of old, viewed in the light of modern knowledge, are found to be so wide of the mark as to seem absurd, the smile which begins to play upon the lips of the modern is checked by the thought—Will the ideas which I am now putting forth, and which I think explain so clearly, so fully, the problem in hand, seem to some worker in the far future as wrong and as fantastic as do these of my forerunner to me?"

TWO MONTHS ON THE GUADALQUIVER.

By Harry F. Witherby, f.z.s., m.b.o.u.

IV.—SCRUB AND WOOD.

A WOODED portion of the *marismas* was briefly referred to in my last article (Knowledge, August 1899), and as this part of the country is interesting from several points of view, a more detailed description of it and of its wild inhabitants may prove acceptable.

Our first day's work in this scrub and wood was as novel to us as had been our first day's stalking behind the *cabestro*. We were fortunate in having as headquarters a large rambling old house, from which we set out accompanied by two keepers and a boy, all on horseback—an imposing cavalcade, surely, for a bird-nesting expedition. But to have a smaller escort in Spain would be considered *infra dig*, while to walk when there are horses to ride would be altogether out of the question. We were loth to depart from the customs of the country, and, therefore, consented to this arrangement. As we rode in single file along narrow pathways, through a growth of tamarisk, gorse, and other plants, as high as our horses' heads, and, in many places, quite impenetrable, or as we spread out in different directions to search for birds' nests, we began to understand the advantage of the Spanish system of bird-nesting. From horseback we could see over the high cover, and so guide our way to the most likely looking spots. On a horse, too, one can cover more ground in a day than on foot, which is a great advantage in a big country with a burning sun; and, again, one feels more comfortable on a horse when suddenly confronted by a fierce-looking wild sow with her litter—at all events, such was our experience. Dotted about here and there in the midst of the tamarisk were small groups of cork oak trees, and to the exploration of these we devoted our first day. Every tree contained a bird or a nest, and in many cases several birds were breeding in the same tree. We discovered many nests of both the red and black kites, and found another use for our horses in climbing up to them. The lower part of a tree is generally branchless, and so the most difficult to climb. By standing up on your saddle a bough is generally within reach, and thus the difficulty is overcome, provided the horse does not move away at the critical moment. Most of the red kites at this date (April 22nd) had young ones, clothed in dull white down and with beaks and legs apparently many sizes too big for their strength and age. The few eggs of the red kite which we found were much incubated, whereas those of the black kite were all fresh.

The first red kite's nest found was near the top of a cork oak tree. It was about the size of a rook's nest, but much flatter, and was built of sticks and lined with dung. It was swarming with ants which had climbed the tree, and contained three young birds, one of them covered with a half-eaten rat, while the others were nestling against the remains of a couple of small rabbits. The nest was decorated with bits of newspaper and dirty rags and strips of old linen, some of which, hanging down from projecting sticks, fluttered like pennants in the breeze.

Other nests contained by way of larder the remains of snakes and coots. All were not lined with dung, but every one was adorned, even in places far from any human habitation, with the "lesser linen," which Shakespeare bids us look to when the kite breeds. The black kite's nest differs little from that of its relation, except that it is less ornamental and sometimes contains no rags at all.

Green woodpeckers,* of a species very nearly allied to that found in England, were abundant amongst the cork oaks, as were jackdaws,† while now and again a brilliant blue roller‡ would glide up into a thick tree, or a golden oriole,§ always shy, would give us a glimpse of his glorious black and gold as he dipped away into another tree to resume his mellow piping. An occasional view of these brilliantly coloured birds amongst the trees, and the bee-eaters,‖ with their gorgeous rainbow hues, flying round like swallows in the open, gave the whole place quite a tropical aspect. But without the brilliant sun the metallic blues and greens of the bee-eater are dull and brown, and it is only when the sun is shining full upon it that one sees all the gorgeous colouring of the bird as it hovers and floats and turns in the air. It seems a sin that a bird should be destroyed simply because of its beauty; but so it is—fashion demands it—and thousands of bee-eaters are annually snared and roughly skinned by the Spanish natives who sell them to the milliners in Paris. We saw a bee-eater going through the most extraordinary antics in the air and then perch on a tree to gasp for breath. We shot the bird, and found round its neck a horsehair noose attached to a small peg. Bee-eaters lay their eggs in a tunnel which they are at some pains to bore into a bank or into flat ground. The natives place nooses, fastened to a peg driven into the ground, over these nesting holes, so that when the bird emerges it is caught and strangled. The bird which we shot had evidently loosened the peg and flown away with a burden from which nothing but death could release it.

* *Gecinus sharpii.* † *Corvus monedula.* ‡ *Coracias garrulus.* § *Oriolus galbula.* ‖ *Merops apiaster.*

But notwithstanding this wealth of colour, melody was not wanting, for everywhere nightingales* poured forth their songs, although certainly not such full-toned ones as we have in England. Now and again we heard a soft "hoo-hoo," and an occasional hiss, and found the performer a hoopoe,† strutting about, proudly raising its beautiful crest.

Amongst others of the many birds we saw were several little owls.‡ One of these comical little birds allowed us to ride right up to it, as it sat in a small tree. We stared hard at it, and it stared hard at us, with its yellow eyes. I almost touched the bird with the muzzle of my gun, whereat it flew off to another tree, and proceeded to hurl screeches and whoo-whoos at us.

We did not always ride about this country; indeed, we found a long lonely walk often a great relief, and a great advantage, for one cannot observe small birds from horseback, besides which, our horses, although hobbled at night, would sometimes be driven by flies and mosquitoes to a worse torment—a leech-infested marsh—and, as a consequence, would appear in the morning only fit (as the keepers remarked) for the bull ring.

One of these lonely walks may be worth recording. I had been forcing my way through the thickest cover for some miles without seeing anything but a stag or two (where wild boars are common, the crash of a stag, as it jumps up within a yard of one, is rather disconcerting), when I came upon a clump of cork trees. I crept cautiously up to them. The first tree contained nothing, but near the top of the second there sat a great griffon vulture. I coveted his skin, although I had no wish to skin him myself, as those who know what a griffon vulture is will understand. However, I fired, and down fell a very mountain of flesh and feathers. He was not dead, so I put a charge of small shot into his head, at which he sank down, and apparently died. But it is even easier to kill a cat than a big vulture. I was sitting down with my back to the vulture, eating lunch, and considering how I could carry him home, when I heard a great rustling, and there was my "dead" bird hobbling off, drooping its broken wing. I leisurely picked up my things and was proceeding to follow the vulture when it disappeared into the thickest part of the scrub. It seems incredible that one could lose a badly wounded bird as large as a turkey in scrub however thick. Nevertheless I did lose that bird, and was never able to find it again, notwithstanding many hours of diligent searching. My search, it is true, was somewhat distracted, firstly, by a large eyed lizard,§ about two feet long, which was sunning itself on a little patch of bare sand, from which it made off on my approach with an ungainly gallop, like a young crocodile. Then I heard a harsh noise going on behind me. I turned and saw a serpent eagle‖—a small light-coloured eagle—hovering over a tree from which sounded a shrill "tic-tic-tic." Suddenly it closed its wings and went down into the tree like a stone. Presently it rose again and flew away, while the "tic-tic-tic" again sounded from the tree. I crept forward and out flew another eagle from a nest in the tree. The nest was compactly made of stout twigs, and had for a lining a number of acorn cups and a long clean backbone of a snake, but there were no eggs. On visiting this nest again some days afterwards it was still empty, and the snake's skeleton had disappeared.

The griffon vulture was not the only bird that came to life again, so full of surprises to us was this strange country.

* *Daulias luscinia.* † *Upupa epops.* ‡ *Athene noctua.* § *Lacerta occellata.* ‖ *Circaetus gallicus.*

We were sitting one evening "picking oakum," not from inclination but from necessity, having run short of tow wherewith to fill up our bird skins, when a kite, which had been shot some hours before, and was just about to be skinned, suddenly got up from the floor, and flew round the room. Verily the ornithologist requires strong nerves.

We made several expeditions amongst the sandhills bordering on the sea. The markings on the surface of these sandhills are well worth studying. Everywhere the tracks of cows, horses, deer, and rabbits are to be seen. Look a little closer at the sand, and you will find that its whole surface is covered with smaller tracks, crossing and re-crossing each other. You can decipher those of birds of different kinds, lizards, large and small, as well as tortoises, but there still remain to be accounted for a vast number of intricate dots, lines, marks, and trails, which may have been made by mammals, birds, reptiles, or even insects. Here and there amongst the sandhills is a pine wood, which still holds out against the all-embracing sand. In these stunted pine trees we found kites' nests, as well as those of ravens,* not more than twenty feet from the ground. The raven is well known as a very early breeder in England, often having eggs in the beginning of March, but in Spain, although so many miles further south, we found fresh eggs on April 26th, and slightly incubated ones as late as May 11th. It is possible, of course, that the bird has two broods in Spain, but I think it unlikely, as we never saw any young ravens about.

As we were riding one day across these sandhills, a great black eagle—the Spanish Imperial eagle†—rose in front of us and flew away with a big straggling mass of white in its claws. We followed it, anxious to discover what was its prize; and we were not the only being who watched the great bird with interest. No sooner had it settled again than four kites and two ravens flew down and stood near at hand, whilst several more kites swooped round and round in the air. The eagle, rending and devouring his prey, took no notice, but the kites and ravens watched his every movement, afraid to attack, but still expecting a share of the booty. At last we fired a shot from our hiding place. The eagle was so surprised that he dropped his quarry and soared away on high in giant circles, while the kites and ravens disappeared as if by magic. The straggling white mass was a half-eaten spoonbill, a bird nearly as big as the eagle itself.

There are two kinds of magpies in Spain, our common magpie‡ and the Spanish or azure-winged magpie.§ We found many nests of the common magpie. They were all built in low bushes, and none of them had the dome, which is the chief characteristic of the magpie's nest in England, as well as, I believe, in every other country it inhabits. Why the magpie should build a roofless, unprotected nest in a country swarming with egg-eating and chick-stealing birds is a puzzle towards the solution of which I have no suggestions to offer.

The Spanish magpie occurs only in the Iberian Peninsula, and is even there very locally distributed. We met with it in considerable numbers amongst pines and wild olives some long way from the riverside. Of a most delicate blue in general colouring, with a velvety jet-black head and a long elegant tail, it is one of the most beautiful birds. In habits it reminds one much of the jay, especially in the way in which the birds go about in small parties chattering loudly, always keeping just ahead of one, and out of sight in the tree tops. We had many opportunities, however, of surprising the magpies when feeding on the ground.

* *Corvus corax.* † *Aquila adalberti.* ‡ *Pica rustica.* § *Cyanopica cooki.*

Like the fieldfare and other birds they are very sociable, and if one nest is found several others will be discovered in neighbouring trees. All the nests we saw were built in small pine trees, and were made of a silvery flower interwoven with twigs of pine, the inside being lined with red cows' hair—a beautiful nest for a beautiful bird.

It would weary the reader to be told of all the charming and interesting birds that we saw in this wonderful country, but I cannot refrain from telling of an eagle and its nest.

We were riding home after a hard day's work, when we spied a large black bird sitting near the top of a cork tree some distance off. The keepers proclaimed it a *cuerbo* or raven, but a glance through our binoculars told us it was something better. Accordingly, we made a wide circuit until we had placed the tree between ourselves and the bird. Then we dismounted and crept as quietly as possible through the cover until we were under the tree. Here an unforeseen difficulty presented itself. The tree was so thick that we could not at first see the bird. At length we caught sight of it sitting all unconscious above our heads. We fired, and down it dropped, not to ground but into a great nest which we had not seen just below it.

It did not take us many seconds to reach that nest. It was just a flat platform, some six feet across, and was made of green boughs. In it was the great bird we had shot lying stone dead—a Spanish Imperial eagle—while near the old bird were two young ones clad in soft white down, and a little distance from them a great round dirty-white egg. There was room in the nest for a couple of sheep, but the eagle's larder contained nothing more than a few rabbits and the legs of a coot.

A good idea of the wild character of the country may be gathered from the fact that this nest was within a mile of the house in which we were staying, and yet the keepers had no suspicion that one of the most deadly game destroyers had taken up its quarters there.

THE KARKINOKOSM, OR WORLD OF CRUSTACEA.—XI.

By the Rev. Thomas R. R. Stebbing, M.A., F.R.S., F.L.S., F.Z.S., *Author of "A History of Crustacea," "The Naturalist of Cumbrae," "Report on the Amphipoda collected by H.M.S. 'Challenger,'" etc.*

TASTE AND TRY.

A BOY gathering limpets on the shore in Devonshire, being questioned about them, remarked that they were "very good raw, but better boiled." That is a maxim which will not fit all the mollusca in either of its alternatives, and only fits the crustacea in one of them. For while unsophisticated aquatic animals find crustaceans very good raw, human beings exhibit a quite unwonted unanimity in fancying them better boiled.

The unanimity of mankind seldom runs to excess. Foreign nations often presume to have customs different from ours. They have the temerity, for example, to use for food many species from the karkinokosm which are quite unknown to the English public. As, however, one object of these papers has been to inform and widen the taste for a neglected class, some mention ought to be made of the species deemed palatable in other climes.

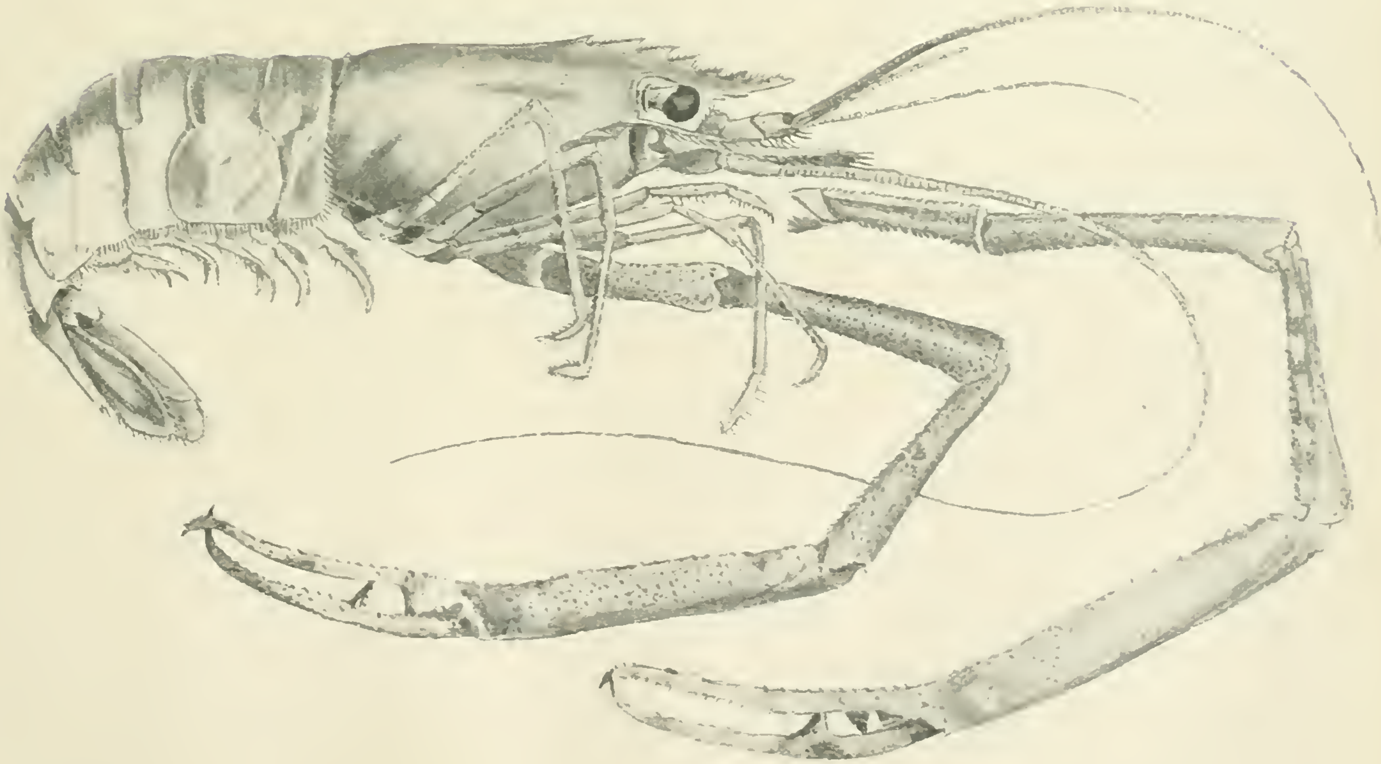
The Thyrostraca, or Cirripedes, discussed in a previous chapter, might seem a group as unlikely as any to supply specimens to tempt the appetite of mankind. Notwithstanding their extreme abundance on and about our own coasts, there are no purveyors of them for the home market. Yet *Balanus psittacus*, Molina, is eaten and relished in South America. It is an acorn barnacle, not unlike the sorts common with us, only monstrously big by comparison. But then the rule with crustaceans for table is, the bigger the better, you can't have too much of a good thing. At any rate we are told that from Peru to Patagonia people eat the big *Balanus* and find it delicious, when cooked. Those, therefore, among ourselves who are in search of a new sensation or a new flavour have an encouraging precedent for trying what is to be got out of boiled barnacles.

There are few records which speak in favour of Entomostraca as comestibles. Curiosity has tasted them, and perceived in them a fairly acceptable reminiscence of shrimps. But, like the child who thought the making of flies must be fiddling work, the consumers of Copépoda appear to find them fiddling food. It takes many to make a mouthful. Some of them are excessively oily. We may be content to let them fatten our herrings and other useful fishes, we ourselves in this way more conveniently devouring them at second hand, like those august oriental potentates who drink the kava prepared by the mouths of their menials.

For more substantial banquets we must have recourse to the Malacostraca. Still among these what may be called the lower orders, the sessile-eyed groups, enter very little into an Englishman's calculation of food supply. The Isopoda may be said to be quite out of it, although woodlice, such as the Slaters (*Porcellio*) and the Pill-Millepeds (*Armadillidium*), were once of much repute in medicine. In the latter genus the animal faces danger by rolling itself up into a ball. Here, then, was a little shining pill, evidently moulded by Nature for curative purposes. Modern human prejudice rejects the useless remedy with disgust, whereas the better informed barndoor fowl eats this small game with avidity, not as a medicine, but as a substitute for the unattainable lobster. The Amphipoda have won rather more appreciation as food for man. Thus Risso, in 1826, describing the curious *Phrosina semilunata*, remarks of it that the flesh is tender and well-tasted, and that it might well supply a dish to those who dwell on the shores of the Mediterranean, where it occurs in abundance. Risso does not say that either he himself or any one else ever had such a dish, but, for all that, an English author subsequently cites him as affirming that "these crustacea are eaten as a luxury, and, moreover, serve as an article of food to the inhabitants on the shores of the Mediterranean." It would be a tempting improvement to declare that those inhabitants never eat anything else. It is more to the purpose to repeat the Prince of Monaco's recommendation to the shipwrecked, not to neglect the species of *Hyperia*, which may be obtained from jelly fishes in the open sea. That the great amphipods, which abound in Arctic waters, would pleasantly satisfy man's appetite on an emergency can scarcely be doubted. The indiscriminating seal swallows them whole, as we know by specimens recovered in good condition from the seal's stomach. The amphipods, in revenge, if they meet with a dead seal, make short work of its carcase—a devouring crowd compelled by the nature of their jaws to savour and enjoy every morsel of the much-divided feast.

Passing on to the stalk-eyed group, we find a general recognition of the culinary merit contained within it, though few know how great is the number of extremely different species over which that merit is diffused. In Great Britain we never get a chance of tasting any of the Squillidæ. To an uneducated eye, a dish of them might look rather repellent, and an uneducated ear might be horrified at an invitation to eat Stomatópoda. That order comprises the single family of the Squillidæ. One at least of

ARCTIC SHRIMP, Natural Size. *Sclerocrangon ferox* Sars. From Sars.



ORIENTAL RIVER PRAWN, Natural Size. *Palæmon lar* Fabricius. From Spence Bate.

the species, *Squille mantis*, is abundant in the Mediterranean, nor can there be any doubt that among the border tribes of that favoured lake it is commonly eaten, and its meat considered uncommonly good.

In the case of the Crustacea Macrura, qualms are less likely to arise. There is so great a general resemblance among numerous species respectively of shrimp or prawn or lobster that ignorance raises a barrier against repugnance. All unawares we might be tricked into eating a *Pandalus montagui* in mistake for a common prawn. Against practical jokes of this kind, the only true defence is a diligent study of the karkinokosm. Even in England prawns and shrimps of several species are sold without distinction, so that the heedless may at any time be mixing up *Leander serratus* (Pennant) and *Leander squilla* (Linn.) "in their midst" without knowing it. On the Continent they have a prawn which is neither a *Pandalus* nor a *Leander*, but a *Penæus*. This is affirmed to be of much finer flavour than the common lobster or crayfish. As the names just quoted indicate, prawns belong to more than one genus. By many names men call them, in many seas they dwell. They are, in fact, so divided up into genera and species that none with a light heart can hope to know them all, each clearly apart from the rest. They do not all live in the ocean, but many in fresh waters. They are not all of one size, but some large as lobsters. Some have three pairs of their legs fashioned into chelipeds, some only two. In some the chelipeds of one pair are enormously elongated. Some have the eyes boldly prominent. In others, as *Alphéus*, the eyes are beneath, just gleaming through, the semi-pellucid carapace. The great river prawn of tropical America, *Palæmon jamaicensis* (Herbst), is freely eaten. In regard to Colima, in Mexico, Miss M. J. Rathbun quotes the statement that this prawn "is offered in the market there as a choice article of food, especially on Fridays and Sundays." From this one may infer that it serves equally well for fasting and feasting. Shrimps also have their grades and distinctions. It would be unmannerly to confound the common shrimp, *Crangon vulgaris*, with *Sclerocrangon boreas*, an Arctic species of noble proportions and prominent armour. They have in common the first pair of legs subchelate, that is, as before explained, with the finger closing down upon the palm margin of the hand instead of closing against an opposable thumb. But in spite of this obvious sign of near relationship the *Sclerocrangon* may disdain the shrimp of commerce on account of its own superiority in size and strength and armature. On the other hand, to humble its pride, we learn from Kröyer that when his party at Spitzbergen, in 1838, found it so abundant that they began to use it for food, in consequence of a specially rank flavour it met with no approbation.

Phrosina semilunata, Risso. (Magnified.)

On the crayfishes and their distribution over the fresh waters of the world, let the writings of Erichsen and Huxley and Hagen and Faxon be consulted. Then a man will know where to go for the large or the small sorts, and having ascertained the branchial formula and the true name of each, he will be able to eat with a good conscience and a well ordered mind. Nay more, he will be able to supply the information about which those authors have not been sufficiently thorough, as to whether the most enjoyable repasts can be made of *Cambarus* or *Potamobius*, of *Cheraps* or *Engaeus*, of *Astacoide* or another. For the last named he must go to Madagascar. *Cheraps* he will find in New Holland. He can dig for *Engaeus* in Tasmania.

Of lobster-like animals in Great Britain, we eat the river crayfish, the common lobster, the Norway lobster, and the rock lobster or crawfish. The last of these differs very obviously from the first three by the great size and stiffness of its second antennæ, and by the comparative feebleness of its first legs which do not form nippers or chelipeds. Among the other three, which all and severally have three pairs of chelipeds, the graceful Norway lobster is easily distinguished by the much ridged and denticulate character of its long and slender front pair. A correspondent tells me that this crustacean is sold in Edinburgh at a shilling a dozen, and that he has seen the shores of the Firth of Forth strewn with them after a storm. As to the common lobster and the crayfish, in addition to the great difference in size and to the fact that one lives in salt water and the other in fresh, there are distinctions easy to observe in the rostrum and the second antennæ. In the latter, the exopod or outer branch attached to the second joint is proportionally much larger in the crayfish than it is in the lobster. Huxley, after explaining minutely the structure of the crayfish, especially recommends the student to compare a lobster with it in the various points which he has been discussing. So far as most of the points are concerned the student may eat both crayfish and lobster before commencing the comparison. He will pass with an increase of zest from the meat to the mechanism. Should he still need encouragement, he may have recourse to Dr. Herrick's valuable work on the American lobster. Not only is that a cousin-german to our own, but specimens of it are sometimes delivered alive in the markets of London and Paris. The New World may well have a few to spare, since, according to Herrick, "about three million lobsters are said to be taken in the British Isles in the course of a year, while the total number captured on the North Atlantic coasts of America has undoubtedly in some years reached close to one hundred millions." Though, however, the true lobsters are so prolific in individuals, they are content with an exceedingly modest number of genera and species. In this respect they differ from the crayfishes and the crawfishes which have many of both. Of the crawfishes several are very handsomely coloured, of large size, extensively distributed, and very numerous. One well-known species, *Jasus lalandii* (Lamarck), is said to afford abundant food for the poorer classes at the Cape of Good Hope, besides keeping a factory at work for tinning and exporting it. Including the antennæ it is generally about three feet long and it is sometimes longer.

Hermit crabs do not look as if they could ever be inviting diet, yet an aberrant member of the group, the *Birgus latro* or Cocoanut crab, is a celebrated dainty.

Of the common crab it is needless to sing the praises. Rather is it to be lamented that no enterprising person will try to acclimatise amongst us, in favoured situations such as Cornwall or the Isle of Wight, the river-crab of the Continent, *Potamon fluviatilis*, said to be a tempting delicacy. The not less admired land crabs of the West Indies might not take kindly to our wilful temperature, and must be content to be eaten in their native haunts. The large spider-crab, *Maia squinado*, sometimes very plentiful in the South of England, is eaten apparently, as some jokes are laughed at, only out of compassion. The poor creature is perhaps maligned by a misnomer, for when Mr. Thomas Bell, the carcinologist, asked a little girl, who had some ready cooked for sale, whether they ate those crabs, she replied, "They ben't crabs, sir, them's spiders." Concerning another member of this family, Tilesius, in 1812, relates that it occurred very plentifully in Kamtchatka in a bay deriving its name from the abundance of the crabs, and that "the sailors of the Niva eagerly sought after the species, finding it to be very delicious as food." But on this point, as on one or two others, mankind speak not all with one mouth. In the United States of America the blue crab, *Callinectes hastatus*, is the common edible crab, and it is most esteemed just after exuviation, in what is known as the soft-shelled condition. It has recently received the alternative name of *sapidus*, the tasty one. *Lupa pelagica*, prized among us as a specimen for its striking form and beautiful colouring, is the common edible crab of Sydney in Australia.

Without further exemplification, then, it is evident that the generous globe in every zone, from sea or river or land, offers man some delectable crustacea to embellish his meals. Some of them may not be suited for our food. Some of us may not have gastric arrangements suited for feeding on them. But in being generally wholesome and generally palatable, few large groups either of animals or vegetables surpass the crustacea, and, in any case, they eat up things that we do not want, and are eaten up by things that we do, thus by a happy transmutation of species supplying blubber to the starving Eskimo, sealskin to the luxurious European, and all sorts of fish to all sorts of people all over the world.

Letters.

[The Editors do not hold themselves responsible for the opinions or statements of correspondents.]

S. S. CYGNI.

To the Editors of Knowledge.

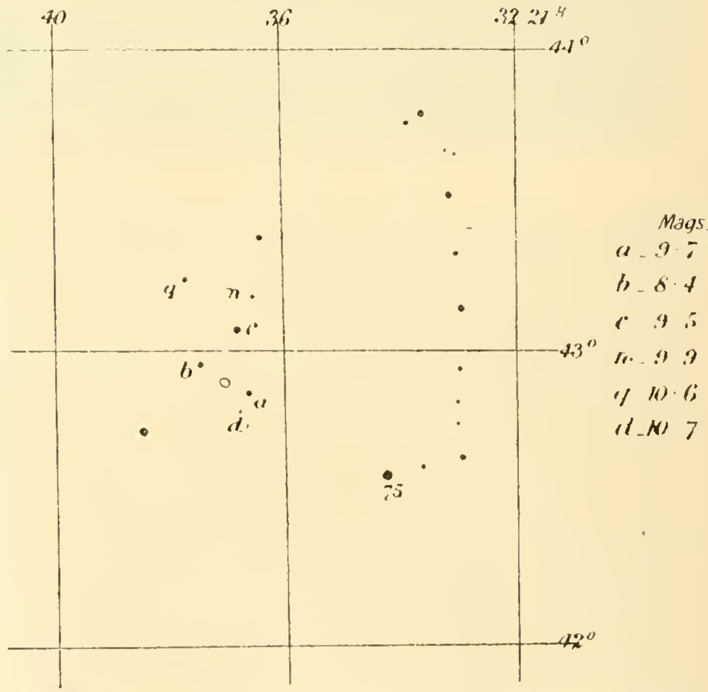
Sir,—As Dr. Hartwig, at the last European Conference, called attention to the variable star S. S. Cygni, which seems to be designated as R^3 in "The Companion to the Observatory," the following ephemerides may be of interest to your readers. Its period is irregular.

1898.		Mag.
July 19	(invisible)	
" 20	...	8·75
" 22	(maximum)	8·25
" 23	...	8·25
" 24	...	8·55
" 25	...	8·90
" 27	..	10·05
" 28	(invisible)	
Sep. 5	...	8·41
" 7	...	8·31
" 8	...	8·14
" 9	...	8·18
" 13	(maximum)	8·13
" 14	...	8·13
" 15	...	8·23
" 17	..	8·95
" 18	...	9·67
Nov. 10	(cloudy)	
" 11	...	8·35
" 12	(cloudy)	
" 13	...	8·4
" 13	(later maximum)	8·25
" 14	...	8·35
" 15	(cloudy)	
" 16	...	9·35
" 17	...	9·50
" 18	...	9·95

1898.		Mag.
Nov. 19	(invisible)	
1899.		
Jan. 6	(7.30 p.m., invisible)	
" 6	(8.00 p.m., very faint)	
" 6	(8.40 " less than 10·00	
" 7	...	8·65
" 8	...	8·35
" 10	(about maximum)	
	Bad weather till	
" 14	...	8·35
" 16	...	8·8
Mar. 13	...	8·7
Maximum three or four days earlier.		
July 1	(invisible)	
" 2	...	8·30
" 3	...	8·30
" 4	(cloudy)	
" 5	...	8·40
" 6	...	8·35
" 7	(cloudy)	
" 8	(maximum)	8·20
" 9	...	8·52
" 10	...	8·75
" 11	...	9·60
" 12	(barely visible)	10·20

These are the means of several observations the same night.

S. S. CYGNI.



My observations of U. Orionis at its last appearance are as follows:—

1899.		Mag.
Jan. 29	..	9·00
" 31	..	8·7
Feb. 1	...	8·6
" 7	...	8·3
" 8	...	8·2
" 23, 26	...	7·5
" 27, 28	...	7·45
Mar. 28	...	6·65
" 29, 30	...	6·60
Apr. 1	(maximum)	6·60
" 2, 4, 7		6·60
" 8	...	6·5
" 9, 10, 11	...	6·7

1899.		Mag.
Apr. 12	...	6·8
Mar. 2	...	7·85
" 3	...	7·7
" 6	...	7·5
" 7, 8	...	7·25
" 9	...	7·30
" 10	...	7·2
" 11, 12	...	7·35
" 15, 16	..	7·00
" 19	..	6·95
" 21	...	6·4
" 22	..	6·45
Apr. 13	...	6·9

1899.	Mag.	1899.	Mag.
Apr. 15 ...	6·8	Apr. 30 ...	7·65
„ 16, 17 ...	6·7	May 7 ...	7·60
„ 18, 20 ...	6·8	„ 8, 9 ...	7·75
„ 23 ...	7·15	„ 10 (lost behind trees).	
„ 25, 26 ...	7·4		

The weather in the second and third weeks of February, aided by the moon, made observations and estimates difficult and unsatisfactory.

Memphis, Tenn., U.S.A., David Flanery.
29th June, 1899.

THE DISTRIBUTION OF STARS IN SPACE.

To the Editors of Knowledge.

Sirs,—With reference to Mr. Gore's letter in your issue for August, I quite agree with his remarks about the Milky Way. It appears to me very improbable that the galactic stars are of the same order of brightness as our sun. There can be no reasonable doubt that many stars of the 6th magnitude, and even brighter, belong to the system of stars composing the Milky Way. I believe very few astronomers now consider it likely that there is any great difference in the distance of the stars in this system; but if stars of the 6th and 16th magnitude are at the same distance, the 6th magnitude stars must be ten thousand times as bright as the 16th magnitude stars. With equal intrinsic superficial luminosity, this implies a difference of volume of a million to one; if, therefore, we assume the 16th magnitude stars in the Milky Way to equal our sun in size, it follows that the 6th magnitude stars in the Milky Way must be a million times as great. If it is considered, that, of the stars concerning whose mass we knew something, none is more than forty times the mass of our sun, it must be admitted that the existence of stars of a million times the size is very improbable. It is far more likely that the brighter stars in the Milky Way are of the same order of brightness as our sun, and that the fainter stars are much smaller.

The following table gives the results of some of my own gaugings in the region of the Milky Way compared with similar gaugings in other parts of the heavens:—

	Number of stars visible.	Number of additional stars visible with each increase of aperture.			
Aperture.	¾-in.	1¼-in.	2¼-in.	3-in.	3¾-in.
Sum of 22 gaugings in various parts of the Milky Way ..	61	174	301	306	198
Sum of 100 gaugings in various parts of the heavens, excluding the Milky Way ..	118	348	457	559	342
Relative density of the stars in the Milky Way	3·8	3·6	4·8	4·0	4·2

In taking gaugings in the Milky Way, I found it impracticable to use a field of the same area as in other cases, owing to the large number of stars to be counted. The area of the field was about ·625 of the area used in the one hundred gaugings of the stars generally, and this difference of area has to be taken into consideration in making a comparison of the results. The last line of the above table shows that the Milky Way, as far as these observations go, is about four times as rich in stars as other parts of the heavens. It will be noted that the increase in density is distributed among stars of various magnitudes, with some approach to uniformity. This fact certainly suggests the conclusion that galactic stars are at about the same distance as other stars.

One result of my investigations in this subject is a conviction that the assumption frequently made of the magnitude of a star depending chiefly on its distance is not justified by facts. My belief is that real difference in actual brightness, and not difference in distance, is the more important element in determining the apparent magnitude of a star. Gavin J. Burns, b.sc.

[In other words, the *range* in actual brightness is greater than the square of the *range* in distance. The conclusion is one of great importance, but I think Mr. Burns is justified by the facts which he has adduced, and by the general trend of discovery, in adopting it.—E. Walter Maunder.]

SOME SUSPECTED VARIABLE STARS.

To the Editors of Knowledge.

Sirs,—In his paper on this subject, Mr. Gore does not appear to have considered the effect of "personal equation" in colour between different observers. In the case of β Leonis (p. 176), a bluish star, being compared with γ, which is yellow, the difference of colour will affect their apparent relative brightness. The Harvard observers made yellow stars distinctly brighter, relatively, than I do, and it is probable that the difference is even greater between them and Mr. Gore.

There is also the question, which has recently been so much discussed, of "position angle" to be considered and allowed for; the correction being probably variable for different observers. Therefore it seems to me hardly correct to say that if γ Leonis be seen distinctly brighter than β, that is certain proof of the variability of one of them.

I do not, however, on the whole, dispute Mr. Gore's conclusion; to me the relative brightness of the two stars undoubtedly varies, sometimes one and sometimes the other being the brighter, though it is difficult to decide which is the variable.

Sunderland, T. W. Backhouse.
September 16th, 1899.

TREE STRUCK BY LIGHTNING.

To the Editors of Knowledge.

Sirs,—One of your readers, in a letter subscribed "A. C." (Knowledge, January, 1899), desires to have an answer to the question: "What actually takes place when a tree is struck by lightning?"

This certainly is a question of general interest, and I have had the occasion to observe the effects of lightning several times in different countries. Before all, I must say that the result of a lightning-stroke on a tree may be of very different character, and depends firstly on the species to which the tree belongs, and secondly, on the condition in which the tree is at the time it is struck.

If lightning strikes a tree after a long period of heavy rain, when the whole surface of the tree is damp, it generally does very little harm to the tree, and often none at all. On the other hand, if a tree is struck when its surface is dry, it is more severely damaged, because then the electric spark will descend by a line of lower resistance along the damp wood under the bark of the tree. In this case the heat of the spark instantly produces steam of very high pressure under the bark, and the latter is generally blown up in a long band.

In such cases, pine trees, and other trees of that kind, are much less damaged than other trees, because the wood of the pine is much more dry, and contains a greater percentage of isolating resin. In a leaf-tree there is no isolating substance, and if the whole interior of the tree is damp, it often happens that a large quantity of steam is produced, and thus the tree is quite destroyed by the lightning. A very old tree with a hole in its interior, if very dry, can even be set on fire by lightning, and burned down.

In all these cases it is certainly always water-steam of a very high pressure which is the principal cause of the destruction.

An interesting proof of the correctness of this explanation was afforded by the destruction by lightning of a monumental column in Gatchina, one of our Imperial summer residences, fifty kilomètres south of St. Petersburg. From the beginning of this century there stood a column nearly fifteen mètres high, named the "Connetable." It was of stone, and contained in its interior a series of iron angles, which held together the stones. After a period of rainy weather, it seems that much water had got among the stones into the interior of the monument. Then lightning struck it, killing the sentry on guard, and in the same moment the whole column disappeared from its place, blown up as by an explosion. Its fragments were thrown around in all directions, and some of them were found at a distance of more than one hundred and fifty paces. The column was completely destroyed, and only the pedestal, nearly three or four mètres high, remained. In this extraordinary case there is no doubt that the lightning spark, retained by the intervals between the iron angles, instantly produced a great quantity of steam of very high pressure in the interior of the damp column, and the latter was actually blown up by its explosion.

In the year 1896 I saw a very curious case in Lapland, where the lightning had struck a *Pinus sylvestris*. In this tree the fibres of the wood form a spiral around the trunk. The spark had taken the same direction, and had blown up the bark on the corresponding spiral line.

Baron N. Kaulbars
(*Lieutenant-General, Member of the Military Scientific Committee*).
St. Petersburg,
August 26th, 1899.

MEMORY WITHOUT REASON.

To the Editors of Knowledge.

Sirs,—Case 1.—A cart mare, kept for breeding but used for farm work when not maternally employed, was for several years turned into a grass field with her foal for the summer. In this grass field was an elm tree, with a low spreading branch on a level with the mare's back, and, much to the gratification of herself and to the amusement of the lookers on, the mare contracted a habit of standing in a certain spot transversely to the bough, and swaying herself backwards and forwards, thus getting an agreeable scratch-back, apparently in a rational manner. During one winter the bough was cut off in the absence of the mare, but when she was turned into the field again after some six months, I was surprised and amused to see her for some days separately, at intervals, stand in the old spot with the same backward and forward sway, without any apparent reason and without any satisfactory result.

Case 2.—A cart mare, with a foal loose in a grass field, got out of her depth in mud in a pond, and had to be dragged out in a very mired condition, with the characteristic pond-mud smell. Another mare that had been lying with the bedraggled mare all the summer, on getting the wind of her, became frantically excited, and was with difficulty kept away by four men and the bedraggled mare's heels, which were very active. Other mares in the same field and within scent took no notice. The explanation is that the frantic mare's foal had died about a month before, and a few days before its death it had been stuck in the same pond and had been dragged out, carrying the same smell. I have no doubt that the bereaved dam, deceived by the smell and perhaps partly by the circumstances being the same, thought (?) that her foal had again come out of the pond, and the sight of the mare, some sixteen hands high, could not persuade her to the contrary.

These two cases go to show how little horses depend on sight, or use their eyes, as compared with ourselves.

Kitchen End, Hampshire, C. Crouch.
Sept. 3rd, 1899.

Obituary.

On the first of August there passed away, at Great Cotes, Lincolnshire, in the person of John Cordeaux, one of the best types of the field naturalist. By ornithologists, especially, his loss will be keenly felt. For many years Cordeaux was a regular contributor to the ornithological columns of the *Field*, the *Zoologist*, the *Naturalist*, and many other natural history journals, as our own pages will testify. It was chiefly in connection with the migrations of British birds that his name as an ardent worker, as well as an authority on the subject, will be best known. John Cordeaux was the chief instigator of the formation, in 1880, of a committee of the British Association which held such an elaborate and exhaustive investigation into the subject of bird migration as observed on the coasts of Great Britain and Ireland. For nearly twenty years Cordeaux carried out the arduous duties of secretary to this committee, which did such valuable work. In 1873 he published a volume on "The Birds of the Humber District," while just before his death he issued "A List of Birds belonging to the Humber District." In this last work the information regarding the birds of his district is brought down to date, and the list contains the extraordinary number of three hundred and twenty-two species. He was a well-known member of the British Ornithological Union, president of the Yorkshire Naturalists' Union, and first president of the Lincolnshire Naturalists' Union. But he was not only an ornithologist, he had a considerable knowledge of botany and general zoology. To those who knew him, John Cordeaux will be remembered as a kind and courteous gentleman, a true and warm-hearted friend, always ready to impart information, always keen to seek the truth.

Science Notes.

Persons interested in the forthcoming total solar eclipse of May 28th, 1900, will be glad to learn that great care and forethought are being exercised by some of our leading astronomers in the necessary preliminaries for ensuring success, as far as is practicable, in the manifold problems which present themselves for solution in such expeditions. The path of the moon's shadow in the Eastern Hemisphere reaches from Oporto to Algiers, and the duration of totality ranges from 1m. 36s. in Portugal to 1m. 6s. in Northern Africa. The sphere of activity will be mainly in places between 8° longitude E. and W. of Greenwich, and latitudes 35° N. to 42° N., thus affording an exceptional opportunity of easy access at a moderate cost to those who wish to visit the scene of operations. It is urged that Algiers should be occupied on account of its low cloud ratio, its accessibility, and its excellent harbour; in the region south of Madrid several railway lines cut the shadow track, so that the difficulty of transporting instruments will thus be minimised; some inconvenience, however, may be caused by the slowness of the trains, which run about fifteen miles an hour, and the long intervals between them, there being in most parts only two a day, and only about one an hour out of even Lisbon. Mr. Maunder has been very active in bringing useful information together for the benefit of those taking part in the expedition, and in this connexion the following particulars may be helpful :—To Lisbon (or Oporto) and back, £10 ; to Cadiz, giving access to the centre of Spain, and back, £14 ; to Alicante, a port on the east of Spain, where the eclipse will be visible, £16. Algiers is the final place to which the steamer will proceed, and remain there to act as an hotel for the party. The cost for the entire trip for those going to Algiers and remaining on board during the stay at Algiers would be £22 10s. These figures represent the cost to members of the British Astronomical Association. To friends the charge will be guineas instead of pounds. The eclipse committee ought to know definitely before the end of the year the exact number of passengers going and the ports which they may have selected, in order to be able to complete arrangements. As yet one hundred and fourteen or one hundred and fifteen names have been given in ; but in order to justify the committee in completing the arrangements they ought to have at least two hundred taking part in the expedition. The entire trip will take eighteen days.

Mr. E. E. Austen, of the Zoological Department of the British Museum, has accompanied the expedition from the Liverpool School of Tropical Diseases to Sierra Leone in the capacity of naturalist. Though his special work is upon Diptera, and no doubt he will make a particular point of those insects which convey diseases, yet Mr. Austen will be able to do some more good general work on the lines of that he compassed during his trip up the River Amazon a little time back.

Anyone wishing to see the extent to which the Röntgen rays have influenced scientific instrument making will be repaid by a visit to the works of Messrs. Isenthal, Potzler & Co. All the latest additions to the radiographer's outfit and demonstrations of the wonderful effects achieved therewith are freely exhibited by these ingenious contrivers of apparatus for all kinds of work in this special line.

British Ornithological Notes.

Conducted by HARRY F. WITHERBY, F.Z.S., M.B.O.U.

Notes on the Razorbill. By Edward M'Canon (*Irish Naturalist*, June, 1899, pp. 132-136). Mr. M'Canon, one of the Irish lightkeepers, gives some interesting and original notes on the Razorbill, especially as regards the different plumages of the bird.

White Wagtails at Bartragh, Co. Mayo (Irish Naturalist, August, 1899, p. 187). Mr. Robert Warren records that Mr. Kirkwood again saw White Wagtails this spring on the island of Bartragh for the third year in succession. on their northern migration. From this it would seem that White Wagtails are in the habit of migrating along the west coast of Ireland in the spring, probably on their way to Iceland, and possibly Greenland, in both of which countries they breed.

The Construction of the Nest of the Little Tern (*Sterna minuta*). By Charles J. Patten, B.A., M.D. (*Irish Naturalist*, September, 1899, pp. 189-197). A very careful and detailed description is given here of the construction of Little Terns' nests found during several years at two colonies near Dublin city. Dr. Patten describes the "nests" as rather elaborately constructed hollows, lined with shells. These "nests" were made in shingle-covered sand, and Dr. Patten remarked that round the eggs was a narrow zone of bare sand. It must not be thought from this that all Lesser Terns' "nests" are constructed in the same way. We have found the eggs of these birds on the Kentish coast placed on the bare shingle, without even a depression, or apparently the disturbance of a stone, and we have found them in the Spanish *marismas* in the merest "scoop" on the bare, hard mud.

Blue-headed Wagtail in Cumberland (Zoologist, June, 1899, p. 267). The Rev. H. A. Macpherson says that after waiting for seventeen years he has at last detected *Motacilla flava* in Lakeland. He identified and watched a specimen of this bird for two hours on May 1st last, near Maryport, Cumberland. This Wagtail is very common in many parts of the Continent, but it can only be considered as an occasional migrant in Great Britain.

On some Remains of Birds from the Lake-dwellings of Glastonbury, Somersetshire. By C. W. Andrews, B.SC., F.Z.S. (*Ibis*, June, 1899, pp. 351-358). Mr. Andrews gives details of a number of bird bones found in the Lake-dwellings discovered in 1892 at Glastonbury. The author concludes that the birds were killed with the sling, and used as food by the inhabitants of the ancient pile-dwellings.

Report on the Movements and Occurrence of Birds in Scotland during 1898. By T. G. Laidlaw, M.B.O.U. (*Annals of Scottish Natural History*, July, 1899, pp. 140-158). This is a detailed and comprehensive record of bird movements in Scotland. Mr. Laidlaw's report, drawn from records furnished by some forty observers in different parts of the country, should prove of great value to Scottish ornithologists.

All contributions to the column, either in the way of notes or photographs, should be forwarded to HARRY F. WITHERBY, *at 1, Eliot Place, Blackheath, Kent.*

Notices of Books.

Man; Past and Present. By A. K. Keane, F.R.G.S. (Cambridge University Press.) In fulfilment of his promise, the author of the volume on "Ethnology," which has proved so successful, has supplemented that work by the present treatise, which deals in greater detail and more systematically with the primary divisions of mankind. Since the appearance, in 1874, of the English translation of Oscar Peschel's "Races of Man," there has been no such convenient text-book published as that now before us. The production of a volume like this involves the possession of a combination of qualities such as few can lay claim to. Happily, Mr. Keane's well-known linguistic powers, together with a general acquaintance with the details of physical anthropology and an intimate knowledge of the vast literature of the subject, have been the means of enabling him to impress upon this work, which must of necessity be largely a compilation of the observations of others, his own personality. The plan of the book is excellent. The first two chapters are devoted to the discussion of certain general considerations. In these we notice the author's adherence to such expressions as the "old stone age" and the "new stone age" as applied to chronological periods ; more properly they apply to stages of culture. We cannot but think that such abuse of the terms leads to much confusion. We speak of a neolithic period as if it were a past age. So it is, so far as we are concerned, but it may be pointed out that there are still many savage races living in a stage of neolithic culture. Furthermore, we lay far too great stress on the transition from the palæolithic to the neolithic stage of culture, forgetful of the fact that in the production of a neolithic implement it must first pass through the palæolithic stage of production ; hence it may be that many of the roughly-trimmed flints found with polished tools or weapons are but the specimens cast aside by the maker before he succeeded in obtaining one suitable to receive a better finish. The labour involved in chipping a rude flint is not great, hence the implement made may often have been thrown away after having been used ; on the other hand, the time and labour expended in the production of a polished implement rendered it an object of value to the owner, and doubtless, in many instances, it was handed down from generation to generation. Much, too, depends on the material employed, the more highly prized examples being always those most difficult to work. From the culture standpoint, a stone age in nowise differs from a bone age, though the remains of the latter are scarcer owing to their perishable nature. The succeeding chapters are devoted to a consideration of the various races of mankind ; each is preceded by a conspectus in which are briefly summarised the facts relating to the primeval home, present range of distribution, physical characters, temperament, speech, religion, culture, and main divisions of each group. In dealing with the four great divisions of mankind, the author discards the use of the term Aryan, and adopts instead that of Caucasic. As he points out, "Aryan" is a linguistic expression forced by the philologists into the domain of ethnology, and the Aryan prototype has vanished as completely as the Aryan mother tongue. The term Caucasic, as used by him, is a symbol to denote those peoples in whom we recognize "a common racial stamp on the facial expression, the structure of the hair, partly, also, in the bodily proportions, in all of which they agree more with each other than with the other main divisions," and in no way implies that they originated in the region of the Caucasus. In regard to the question of origin, whilst admitting that no final answer can yet be given, he supports the view that Africa north of the Sudan was probably the cradle-land of this vast race. Upholding in many respects the views of Sergi, in regard to the diffusion of the Mediterranean races, he succeeds in shedding additional light on the identity of the language of the Basques and Berbers. In his account of the characteristic appearances of the eye, the author, in several instances, falls into error. Thus, in describing the eyes of the Sudanese and Oceanic negroes, he states that they have a yellowish or dirty-yellowish cornea. Now the cornea is the transparent medium through which the colour of the iris is visible. The "white of the eye," to which he undoubtedly refers, is the sclerotic overlain by the conjunctiva. This is a minor detail no doubt, but in such a work accuracy is essential. Whilst our existing state of knowledge is such as to preclude the settlement of many of the vexed questions involved in racial affinities and migrations, and whilst we cannot in all respects agree with the author's conclusions, yet we are bound to say that he has stated his case clearly, and has laid the student of anthropology under a deep debt of gratitude. We venture to predict a great success for this the latest addition to the Cambridge Geographical Series.

A Russian Province of the North. By Alexander Platonovich Engelhardt. Translated from the Russian by Henry Cooke. (Constable.) Illustrated. 15s. The Province of Archangel, which is that dealt with in this book, is an exceedingly large one, embracing the whole of the northern seaboard of European Russia, a country about which little is known by the general public, and into which comparatively few Englishmen have penetrated. The author, the Governor of this Province, is a man of distinctly progressive ideas, which he has the energy and the resource not only to plan but to carry out; but our author is an official, and in this book betrays the presence of those rose-coloured spectacles through which an official in his own Province must see or seem to see many things. Bearing this in mind, and the fact that the country visited was always prepared for the advent of a high official, and he a Russian, the book will be found to be very instructive and in many parts entertaining reading. It contains many interesting statistics, especially regarding the fisheries of the Arctic Ocean, as well as a certain amount of light history and some airy tales, without which no book of travel is complete. The most important matter dealt with is without doubt the development of the northern coast of the Kola Peninsula, and the establishing of the new port of Ekaterina, which was officially opened only last July. This is in reality the only Russian port which is ice-free the whole year round. The harbour is a good one, but too small to make the place of any importance from a naval point of view. Whether there is enough trade to justify the very large amount of money that has been spent upon the new "town" and harbour itself is not for us to judge, but if in years to come a railway is run through the Kola Peninsula straight to St. Petersburg, Ekaterina will no doubt be a place of some importance commercially. For this reason it is a great pity that no better site for it could be found than a land of rocky hills and mossy bogs. Naturalists will find little of interest in the book unless they intend visiting part of the country of which it treats, in which case we can heartily recommend it for its statistics and accurate detail as regards distances to be traversed and means of travelling.

Insects: their Structure and Life. A Primer of Entomology. By George H. Carpenter, B.SC.(LOND.). (J. M. Dent & Co.) In the compilation of his very complete introduction to a fascinating study, Mr. Carpenter has made full use of the standard works of Prof. Packard and Dr. Sharp: and the list of upwards of two hundred authorities quoted in the valuable bibliography which forms an appendix to the volume, shows that his desire for accuracy has made him neglect the question of trouble altogether. Several of the well-chosen illustrations which the author has reproduced from Bulletins of the Division of Entomology of the United States Department of Agriculture, accentuate in a very decided manner the good work done by the very liberal distribution which that Department makes of the numerous monographs prepared by the officers in its various divisions. Mr. Carpenter's experience in the Dublin Museum of Science and Art, and his work for the Royal Dublin Society, have served him in good stead, and the consequence is that the beginner will here find an elementary account of the chief characteristics of insect life and habits which is altogether trustworthy.

Rambles with Nature Students. By Mrs. Brightwen, F.E.S. (Religious Tract Society.) Illustrated. 5s. Young people just beginning to take an intelligent interest in stones, mosses, insects, birds, and the thousand-and-one things which, taken in the aggregate, lend such inexhaustible charm to outdoor life, will find in Mrs. Brightwen's "Rambles with Nature Students" a most helpful companion and guide—a sort of mental microscope enabling them to discern beauties and varieties in the objects to be met with everywhere in the country. The book is divided into twelve parts, each part being assigned to one of the months of the year, and so the student who begins his studies with the aid of this charming little auxiliary need not wait for any particular season, but is provided with mental food ready to hand everywhere. Just such objects are selected for January and the rest of the months as are available and convenient for description at the time. The volume is handsomely bound, well printed, and tastefully illustrated, and, as such, is very suitable as a prize for young boys and girls in elementary schools.

The Hunterian Oration, 1899. By Sir William MacCormac. (Smith, Elder & Co.) 2s. 6d. Hunter was celebrated alike as a great surgeon, a profound biologist, and a man of genius. One way of keeping him in memory is by means of the Hunterian Oration, delivered in the Theatre of the Royal College of Surgeons, in alternate years, on the 14th February—Hunter's birthday. This year's oration contains only a slight biographical sketch, Sir William dwelling more in detail on the great surgeon's never-to-be-forgotten work on aneurism, venereal diseases, animal heat, gun-shot wounds, and inflammation, and it is remarkable how little has been done during the last hundred years, in certain directions, by way of improvement on the surgical operations initiated by Hunter. The oration is reproduced in large type, wide margins, and handsome cover, and thus forms a pleasing medium for acquiring readily a knowledge of the main facts concerning a master of organic science.

BOOKS RECEIVED.

Darwin on Trial at the Old Bailey. By Democritus. (Universal Press, Limited, Watford.) 2s.

Elementary Practical Physics. By F. Castle. (Nelson.) Illus- ated. 2s.

The Logic of Vegetarians. By H. S. Salt. (Ideal Publishing ion.) 1s.

The Teaching of Languages during the early period of a Deaf Child's School Life. By Lydia Roe. (Royal Institution for the Deaf, Derby.) 1s. 6d.

Rhymes of Road, Rail, and River. By E. Derby. (Arrowsmith.) 1 .

Handbook for Canterbury. British Association, Dover, 1899. (*Observer* Office, Dover.)

A Glance at Current History. By John Cussons. (Cussons, May & Co.)

The History of the European Fauna. By R. F. Scharff. (Scott) 6s.

Accentia: A System of Accented and Abbreviated Shorthand. By Armistead Cay. (Blackett, Bath.) 2s. 6d.

The Universal Illusion of Free Will and Criminal Responsibility. By A. Hamon. (Universal Press, Watford.) 3s. 6d.

Directory: Science and Art Department. Revised to July, 1899. (Eyre & Spottiswoode.) 6d.

Handbook: British Association, Dover, 1899. (*Standard* Office, Dover.)

The Pathology of Emotions. By Ch. Féré. Translated by Robt. Park, M.D. (Universal Press, Watford.) 15s.

Carvell's Nursery Handbook with Hints. (George Barber.) 1s.

Laboratory Manual. By H. W. Hillyer. (Macmillan) Illustrated. 4s. net.

The Wheat Problem. By Sir Wm. Crookes. (Murray.) 2s. 6d.

Musical Pitch: Letters, &c., on the Proposal to Adopt the Low Pitch. (Waterlow & Sons.) 2s. 6d. net.

Archives of the Röntgen Ray. Vol. III., No. 4, and Vol. IV., No. 1. 4s. net.

Precession Tables adapted to Newcomb's Value of the Precessional Constant—Epoch 1910·0. By Dr. A. M. W. Downing. (Neill & Co., Edinburgh.)

The Studio: an Illustrated Magazine of Fine and Applied Art. September. 1s.

BEN NEVIS AND ITS OBSERVATORY.—II.

By William S. Bruce, f.r.s.g.s., *formerly in charge of the Observatory.*

(Illustrated by photographs taken by the Author.)

The staff consists of three men, two observers and the cook who looks after the general comfort of the establishment and keeps the rooms in order. The observer in charge usually takes the night watch of eight or nine hours, from 8 p.m. till 4 or 5 a.m., then the second man is on duty for another eight or nine hours—*i.e.*, until noon or 1 p.m. During this latter time the night watchman sleeps, a fact not always realized, I am afraid, in summer by early visitors, who come up the mountain in the morning to see the sun rise, and often make a great noise, even getting on the flat roof of the Observatory and stamping vigorously to keep their feet warm, a proceeding which is promptly stopped by the day watchman. After dinner at 1 p.m., the afternoon is filled up by the shorter dog watches. By this means the observers not only record, but reduce, tabulate and average all the observations taken and put them into form for further investigation.

All the observations taken are eye observations, and this must necessarily be so for keeping a continuous record as will presently be explained. Every hour the observer goes the round. First of all the barometer, which is of the *Fortin* pattern, is read; for the next observation, it is

Fig. 3.—Observatory from South-East: Winter. All but Tower and Stevenson Screens buried under Snow.

necessary to go outside to some considerable distance from the building in order to read the dry and wet bulb thermometers, which are placed in an ordinary double louvred Stevenson screen. These two observations are always taken so as to exactly correspond with those being recorded by photography and clock-work at the Low Level Observatory in Fort William, and the remaining observations rapidly follow. The observer has carried out with him an empty rain gauge. This is changed for the one that has been out for the past hour, which is now covered up and taken back to the Observatory. Climbing up a ladder on to the roof of the Observatory, the observer faces as accurately as possible the wind, notes its exact direction and force (this is done with marvellous accuracy by an adept), immediately after he notes the velocity recorded by the anemometer, and thus his personal observation is checked. The clouds are next noted, whether they be *Upper* or *Lower*, and what species of upper or lower, and the percentage of the sky they cover above thirty degrees from the horizon. Is it raining at the time of observation? Is the sun shining clearly or gleaming through a cloud, or not at all? Are there clouds (or fog, as such clouds are called at Ben Nevis) below the summit, or are they passing over the summit? Are there glories, coronas, halos, fog-bows, rainbows, and such like, or is the summit enveloped in a cloud? Is that cloud in the form of mist (wet), or fog (dry)? Is it thick so that you cannot see more than five or ten yards ahead, or is it so thin that you can almost see the whole of the eleven acres of the summit of the Ben? Are there rifts in it, opening up a vista for a moment of some of the grandest of Scottish scenery, or is it tending to clear overhead, only hiding the blue sky with a thin veil? The direction in which the clouds are travelling, and whether they are travelling at a quick or a slow rate must be noted. Is there thunder or lightning; or do we hear the whole hill-top wildly hissing with Saint Elmo's fire at every point, if it be at night, gleaming with a living lurid flame? The tops of the chimney, anemometer, every post or pole, even the observer's fingers or pencil if he holds it up aloft, and perchance his hair, if he remove his cap, will hiss and blaze with dancing flames. It is a time when all but novices prefer to be below! Entering the tower door, and descending half-way down a ladder, he now steps into a little room, where, by means of an ingenious instrument invented by Mr. John Aitken, he counts with great exactness the number of dust particles per cubic centimetre of air—a very important branch of meteorological inquiry originated by Mr. Aitken. Then he descends, and enters the office, where he measures the amount of rain that has been collected in the rain gauge that he has just brought in with him. If there be snow in the gauge, then he has to melt it first. These are the regular hourly observations, but there are additional observations at certain hours. The maximum and minimum thermometers, which are read once a day; the black bulb thermometer in vacuo; the depth of the snow, if any, and so on.

After every set of observations the observer has some little time in the observatory before he gets ready to take the same series as those just described. During this time he is copying the observations he has made from the hourly slip on to larger "Daily Sheets," which hold all the observations taken for the whole day by the superintendent and assistant, and if it be on the night watch after midnight each set of the twenty-four hourly observations is added up and their mean taken. The maximum and minimum for the whole day of each of the twenty-four sets of observations is noted. During this time also he is keeping up in a similar way the "Monthly Record Sheets." These consist of separate sheets for rainfall, sunshine, temperature, wind, etc. Take barometric pressure, for instance, there are twenty-four columns in this sheet, and along the top line each hour's observation is set down for the whole day. On the second line each hour's observation is again set down for the second day of the month, and for the thirty-one days of the month. In addition to the twenty-four records, the sums and means, and maxima and minima are also recorded in each line, then at the end of the month each of these columns is added up vertically and meaned. Thus at the foot of the page is the series of means for the same hour for every day during the whole month, and in the last vertical column are all the means for the whole day every day of the month. The mean for the whole month is obtained by taking the mean of either of these columns—namely the vertical or horizontal one; and by working both, there is an effective check upon any arithmetical or clerical error, which not unfrequently occurs, and often involves a great deal of labour to find out. By this means not only are the observations made, but are tabulated and prepared for further discussion.

As long as the weather is fine all this work is straightforward enough, but fine weather, it may be said, is exceptional on Ben Nevis. It has been said that in summer the climate of Ben Nevis may be regarded as much the same as that of Spitzbergen. I have spent the summer in Spitzbergen as well as on the summit of Ben Nevis, and I should say that there is more fine weather during that period in Spitzbergen than on our Ben. As for the rest of the year the weather on Ben Nevis is far from pleasant, and during bad weather the work of observing is not to be envied. The usual rule is that every hour the man on duty has to put on his oilskins and sea boots and face pelting rain or driving snow, and find his way through thick mist or fog to the thermometer screens, rain gauge, and other instruments, stationed some way from the house in order that they may not be affected by it in any way; all the night long he has to take out a lamp every hour, and if the wind is high the lamp may blow out. This frequently happens, in spite of very carefully constructed lamps, in which case he has to grope his way back to the house in the dark, and woe betide him if he go in the wrong direction, for close to the Observatory is the Great Cliff, which is sheer up and down for nearly two thousand feet! Digging and clearing the snow from the lower windows and door is, as I have said, another duty of the observers, although "for days at a time digging is rendered useless by the continual drifting of the snow"; then paraffin lamps have to be burnt by day as well as by night. During such weather as this the observers have to go out oftener than usual. Thermometer screens have to be cleared of drifted snow which chokes up their louvres, and thus prevents a clear circulation of air round the instruments. What is even worse, the fog throws an accretion of ice crystals upon everything; then the instruments are blocked up even more than by driving snow. Worse than fog crystals or snow, however, is when the condition known as "silver thaw" prevails, that is, rain falling when the air is below the freezing point and freezing as it falls, covering every object with a clear hard layer of ice. Especially on the latter occasions, as well as when fog crystals are forming and snow drifting, have the thermometer screens to be cleared, and when they get hopelessly blocked up, they simply have to be brought—screen, instruments and all—into the house to be thawed, and a new set put out. This is more easily effected by a special movable box, which is always used during the winter months, and is lashed on to a ladder-like stand. Besides being a useful arrangement for allowing the screens to be brought into the house to get cleared, it is also useful for changing the height of the box. Shade temperature observations should always be taken at a height of about four feet from the ground, and by this arrangement, as the winter snow increases in depth, the Stevenson screen can be raised accordingly, so that it shall always be the normal height above the surface of the ground, for the surface of the snow must be regarded as the surface of the ground during winter. "The vital importance of thermometric observations is emphasised by the circumstance that without them the barometric observations are of comparatively small value, no approximation to a knowledge of the temperature of the air-stratum between high and low level observatories being possible. Ben Nevis is the only observatory that has hitherto coped successfully with this all-important department of the work of a high-level observatory, and one cannot sufficiently admire the heroic endurance with which the observers have made the hourly observations by night and by day, in all seasons, these years past."

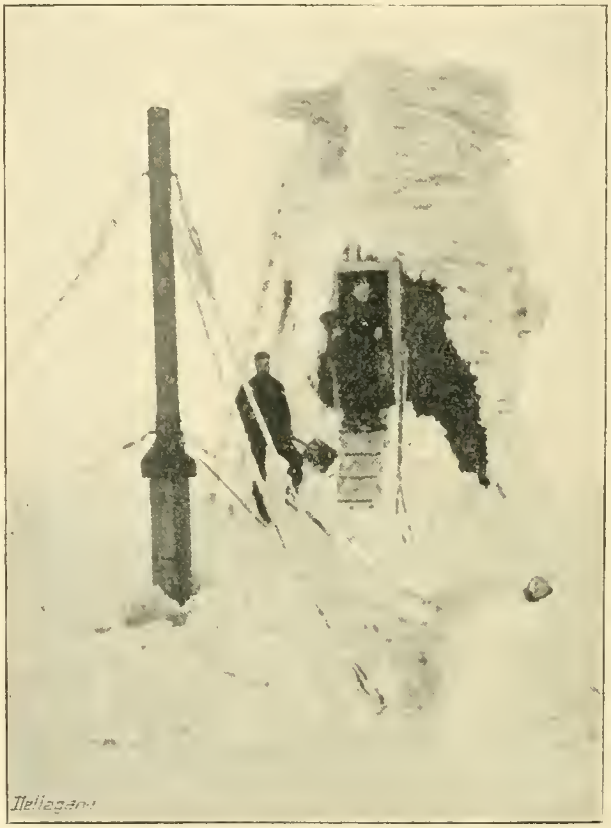


Fig. 4.—Fog Crystals covering Tower and Instruments: Winter.

In addition to the ordinary routine work of a "first-order meteorological observatory" a great deal of extra research work has been accomplished by volunteers and by members of the staff. Messrs. Omond and Rankin have made an exhaustive examination of the winds of Ben Nevis, which has been published in the *Transactions of the Royal Society of Edinburgh*. It is found that the Ben Nevis winds do not agree with the distribution of barometric pressure at sea level according to Buys Ballot's law of the winds in relation to pressure, but point to a widely different distribution of pressure at four thousand four hundred and seven feet as compared with the distribution at sea level. The effect of high winds on the height of the barometer is another of Dr. Buchan's investigations. In forecasting weather it is necessary to keep this effect constantly in mind, "with the view of arriving at a better approximation to the geographical distribution of pressure at a time the forecasts are being framed."

An examination of the relationship of the differences between the temperature at the summit and at the Low-Level Observatory, and the differences of the reduced pressures at the two stations, shows that a relatively greater pressure exists on the summit as the temperature on the summit becomes as high or higher than that at the base. Recently this problem has been further worked at by having a third intermediate station half-way up the mountain. Observations of the rainband carried on since 1885 have given very valuable forecasting results. A decreasing rainband from hour to hour "appears to be the earliest indication we at present have that an anticyclone is beginning to form and settle over North-Western Europe." Mr. H. N. Dickson, and Mr. A. J. Herbertson more recently, have both carried on important hygrometric examinations of the atmosphere. The observations taken with Mr. John Aitken's dust-counting apparatus have added to our knowledge of the diurnal movements of the atmosphere and of existing cyclones or anti-cyclones.

To fully appreciate the very valuable work that has been and is being carried on at Ben Nevis Observatory, it is necessary to refer to the many reports that have appeared in the Transactions of the Royal Society of Edinburgh and of the Scottish Meteorological Society. Under the Secretaryship of Dr. Alexander Buchan and the Superintendentship of Mr. R. T. Omond, and more recently Mr. Angus Rankin, the Ben Nevis Observatories, both High and Low Level Stations, have added much to our knowledge of the general laws of meteorology. The institution, under the auspices of the Scottish Meteorological Society so far has been supported almost entirely by private contributions, and by many volunteer workers, and it is hoped that further support both in coin and kind will be forthcoming in order to enable the Scottish Meteorological Society to carry on the good work it has been doing for the last seventeen years. To us as the greatest seafaring nation in the world it is of the utmost importance that we should know all we can about our atmosphere, so as to be able to predict more certainly than we can at present many of the disastrous storms that sweep our coasts before we have time to give our seamen sufficient warning. We cannot but admire the excellent work that has been done by private efforts at the Ben Nevis Observatories, but surely our Government ought to take interest in a piece of work which is of such national importance!

SOME SUSPECTED VARIABLE STARS.—III.

By J. E. Gore, F.R.A.S.

The stars included in the following paper look very suspicious, and seem deserving of further examination.

In his well-known *Bedford Catalogue*, Admiral Smyth says (p. 25), "Just 18′ south of μ Cassiopeiæ is a star which, though of the 6th magnitude, is not in Piazzi. It is followed nearly on the parallel, about 11s. off, by a 9th magnitude, and both are remarkable for being red, of a decided but not deep tint." There seems to be no star at present in Smyth's position, at least nothing approaching in brightness a star of the 6th magnitude. In *Nature*, October 21st, 1875, the following remarks occur with reference to Smyth's stars: "There is no star of the 6th magnitude near this position at the present time, nor, so far as we know, is there any record of such an object having been seen since the epoch of Smyth's observations, 1832–71. It may, however, prove to be a variable of a long period. . . . There is now a star of the 9th magnitude following μ Cassiopeiæ 17·2s. and 15′ 38″ south; this is clearly Argelander's star + 53°, No. 228 of the *Durchmusterung*, there estimated 9·5, a considerably fainter object than an average 9th magnitude in Bessel's scale; its place would appear to correspond better with that of Smyth's star, following his 6th magnitude nearly on the parallel, than with that of the missing star. Probably this small star may be variable also." The 6th magnitude star seen by Smyth may possibly have been a *Nova* or "temporary star." As several of these curious objects have been discovered in the past few years their occurrence may perhaps be more frequent than is generally supposed. A "new star" of the 6th or 7th magnitude might easily escape detection.

Birmingham II. 16 Leporis.—This red star was rated 7th magnitude by Piazzi, and $6\frac{1}{2}$ by Lalande (9785). It is not given by Argelander or Heis, but was rated 6·0 at Cordoba. It was estimated 5th magnitude by Morton in 1856; 6 by Sadler in February, 1875; 6·5 by Winnecke, December, 1875; 6·0 by the present writer in January, 1877; 7·5 and 7·2 by Espin, in December, 1877, and January, 1878; 6·0 by Espin, December 17th, 1878, 6·7 January 5th, 1879, and 6·5 in December, 1879. Cornish found it 5·6 magnitude in January, 1880, and "fairly bright to naked eye." Espin rated it 5·8 in October, 1880; and Pickering made it 5·86 in December of the same year. Ward gave it 5·5 in January, 1883, and it was rated 6·0 by the present writer in February, 1885, and February, 1886. In Stone's *Southern Catalogue* it is 5-6 magnitude (1878-76). Flammarion says, "Elle est certainment variable." It precedes ι Leporis 55·24 seconds, and is 53·25″ to the north of it, and may easily be found with a binocular field glass.

σ Orionis.—The 11th magnitude star preceding the principal star of this group may possibly be variable. It escaped the keen eye of Sir William Herschel, but it was seen by Ward with a telescope of $2\frac{7}{8}$ inches aperture; and the present writer found it plain enough with four inches in the Punjab in 1874. In March, 1883, the late Mr. Baxendell found it of unusual brightness.

Bayer shows a star of 6th magnitude 1° south of g Virginis. This was suspected to be variable by Pigott, who says: "This star is not in any of the nine catalogues. Maraldi looked for it in vain, and in May, 1785, I could not see the least appearance of it. It certainly was not of the 8th magnitude." The star may possibly be identical with either Lalande 24,283-4 ($7\frac{1}{2}$, $9\frac{1}{2}$ magnitude), or Lalande 24,393 ($7\frac{1}{2}$ magnitude). The latter answers better to Bayer's description, but the position of the former agrees more closely with the place given by Pigott (R.A. 12h. 53m., S. 10° 0′ for 1786).

A star about 40′ south following 53 Virginis was suspected by Olbers in 1797 to be a remarkable variable. He found it the brightest star in the immediate vicinity of 53 Virginis. In July and August, 1876, Tebbutt, at Windsor, N.S.W., estimated it $8\frac{1}{2}$ magnitude. On May 10th and 11th, 1876, it was rated 9 magnitude by the present writer, equal to Olber's star c, but brighter than Olber's star d (see *Nature*, April 13th, 1876).

In Heis' Catalogue of Stars visible to the naked eye in the Northern Hemisphere, his No. 67 of the constellation Draco is rated 6-7 magnitude, and identified with No. 1801 of Argelander's *Catalogue of Stars* between − 2° and + 90° declination. The present writer found this star only $8\frac{1}{2}$ magnitude on November 24th, 1878, and April 8th, 1883. It lies a few minutes *following* B.A.C. 5248. If it was ever visible to the naked eye it must certainly be variable. It is not in Argelander's *Uranometria*.

σ Coronæ.—A small star following this binary (51″, 1862) was rated only 15 or 20 magnitude by South in 1825, but "more like 10 magnitude" by Franks in 1876. I have seen this small star well with a 3-inch refractor in the Punjab sky.

In 1862, Tebbutt, while observing Comet III. of that year, noticed a star of 5th magnitude about "a degree north-east" of σ Aræ. Both stars were visible to the naked eye, the supposed variable being the brighter of the two. On examining the place of the star with a 4½-inch reflector on November 13th, 1877, Tebbutt only found stars of the 10th and 11th magnitudes near the spot. One faint star particularly attracted his attention, and its position agreed fairly well with that of the 5th magnitude star observed in 1862. There are some other faint stars near the place. As Tebbutt's 5th magnitude star lay in the Milky Way, it was probably a *Nova*, or "temporary star."

A star close to the *Durchmusterung* star, 17°, 3997, was rated 6, 6, and 6·5 magnitude by d'Agelet on July 26th, 27th, and 29th, 1783, but is not given by Lalande or Harding. In 1882 and 1883, Dr. Chandler failed to see any trace of a star in d'Agelet's position with a 6¼-inch reflector, and found it invisible with 15-inch refractor, November 14th, 1883. On September 18th, 1884, the present writer could see no trace of the star with a binocular in a clear sky. Have we here another *Nova?*

About 2½° *south preceding* σ Capricorni, Sir John Herschel observed a red star, which he rated 6½ magnitude, and says, "A fine ruby star. This is perhaps the finest of my ruby stars." I failed to see this star with an opera glass in July, 1875, and with 3-inch refractor found it only 8½ or 9 magnitude, and fiery red. In November, 1876, and August, 1879, I found it about the same magnitude. If Herschel's estimate of 6½ magnitude was at all correct, the star must certainly be variable. Closely following, a little north, is a fainter star about 10 or 10½ magnitude. Variation was also suspected by Secchi, and he estimated the star 7·5 magnitude on July 15th, 1868, and deep red; 7 magnitude, September, 1869. It was rated 6 magnitude by Webb on September 3rd, 1873, and 7·5 magnitude by Birmingham. Espin found it 7·3 magnitude on September 4th, 1882; 7·0 August 29th, 1883, and 7·1 on September 21st, 1883, and thinks it is "probably a variable of the 19 Piscium type."

7 Aquarii.—This star may possibly be variable. It was rated of the 3rd magnitude (!) by Ptolemy, 6 mag. by Al-Sufi (10th century), 5 by Argelander, and 6·5 by Heis. In Schjellerup's translation of Al-Sufi's Persian manuscript, its position is thus described :—"La 6ᵉ (7 Aquarii) est la suivante des trois étoiles situées dans la main gauche, et précède la 4ᵉ (β Aquarii) qui se trouve sur l'epaule gauche; elle est de la sixième grandeur, tandis que Ptolémée la dit de troisième, mais en vérité, elle est très obscure. La 7ᵉ (μ Aquarii) se trouve au milieu de ces trois étoiles et précède la 6ᵉ, s'inclinant vers le nord; elle est de petites de la cinquième grandeur; Ptolémée la dit de quatrième. Entre elle et la 6ᵉ il y a environ un empan. La 8ᵉ (ε Aquarii) est la précedénte des trois et des grandes de la quatrième grandeur; Ptolémée la dit de troisième." A glance at a star map will show that Al-Sufi's description is accurate, and proves that the star numbered 6 by Al-Sufi is identical with that numbered 7 by Flamsteed. Sir William Herschel found it less than μ but considerably brighter than 8 (Fl.) (Aquarii). It was rated 5·9 mag. by Gould, who suspects variation. It was measured 5·69 with the photometer at Harvard.

Sir William Herschel published in the *Philosophical Transactions* of the Royal Society for the years 1796, 1797, and 1799 a series of observations of the relative "lustre" of the stars in Flamsteed's Catalogue. In recently going through these interesting and valuable records of the comparative brightness of the stars at the close of the eighteenth century, and comparing Herschel's sequences with modern estimates and photometric measures, I have noticed a considerable number of suspicious cases. The following are perhaps the most remarkable and interesting.

With reference to the stars 30, 33, and 35 Arietis, Herschel gives the sequence 35, 30-33, which denotes that 35 was just perceptibly brighter than 30, and 30 a little brighter than 33. Herschel also gives 39, 35, 33. Now, according to the photometric measures made at Harvard, Oxford, and Potsdam, 33 is fainter than 35 but decidedly brighter than 30: 30 may therefore be variable. It is a double star—Struve I. 5—and the magnitudes of the components (which are 38·6″ apart) have been variously estimated by different observers. Struve gives them 6·1 and 7·1, or one magnitude difference, the fainter star *preceding* the other. Main found them equal in brightness in 1863; Dembowski rated them 5·4 and 6·6. Sadler thought there was not one magnitude difference in 1874, and Franks not more than half a magnitude in 1876. The photometric measures of the pair made at Oxford and Potsdam are discordant; those made at Oxford giving 6·33 and 6·78, or the *preceding* star the brighter, while the Potsdam measures gives 7·24 and 6·82, or the *preceding* star the fainter. This seems to show distinct variation, and the object should be further observed.

With reference to the stars in the Lynx, Herschel gives the sequence 22 — 21 — — 20, denoting that 22 Lyncis was a little brighter than 21, and 21 considerably brighter than 20. Now the photometric magnitudes of these stars measured at Harvard are 22 = 5·37 magnitude, 21 = 4·57, and 20 = 6·57, or 22 considerably *fainter* than 21. 21 was estimated 5th magnitude by Argelander and Heis, and 22, 6th magnitude. The *Durchmusterung* also makes 21 brighter than 22 — by 1½ magnitudes. Hence it appears that, if Herschel's sequence was correct (and most of his comparisons of relative brightness compare very favourably with modern measures), either 22 or 21 Lyncis is variable in light. These stars should be watched by variable star observers.

λ Geminorum.—In the notes to his catalogues Herschel says this star "seems to be increasing. There is an interval of nine months between the two observations of my catalogue. Mr. Bode supposes the star to be changeable." The Harvard measures make it very slightly brighter than δ Geminorum, while the Oxford and Potsdam measures make it slightly less. Both Argelander and Heis make λ perceptibly fainter than δ, and so does the *Durchmusterung*. The Potsdam measures vary between 3·5 and 4·1, and the star may possibly be variable to a small extent.

Herschel found ξ^2 (31) Geminorum only slightly brighter than ξ^1 (30), while Argelander, Heis, and the Harvard and Oxford measures agree in making ξ^2 about 1¼ magnitude brighter than ξ^1.

β and ζ Herculis.—Sir W. Herschel suspected both these stars to be variable. His observations make β sometimes distinctly brighter than ζ, and sometimes distinctly fainter. With reference to β he says, "By my observations the light of this star seems to be subject to change. Flamsteed's observations give it twice 3 m., and once 2 m." And with reference to ζ, he says, "From the expressions I have given of the brightness of this star, we have great reason to suppose it to be changeable." The Harvard and Potsdam measures make β slightly the brighter of the two, and so do Argelander and Heis.

SECRETS OF THE EARTH'S CRUST.

By Grenville A. J. Cole, m.r.i.a., f.g.s., *Professor of Geology in the Royal College of Science for Ireland.*

V.—THE GREAT EARTH-MILL.

The movements of the solid ground have always excited considerable interest. The terrifying sensations imparted by ordinary earthquakes, the visible rents that in some cases remain after the shock has passed, the slipping of huge rock-masses which were already in a state of strain, conspire to impress whole populations with the instability of the crust beneath them. The earlier geologists were only too willing to magnify these effects, and to explain by tremors and shatterings all the prominent features of the globe. When strata of identical character appeared on opposite sides of a great valley, it was asserted that they had become separated by the abrupt opening of a fissure. The vast taluses on the slopes of mountains were said to be due to similar cataclysmic action; and, indeed, the rock-falls of the Rossberg and the Dobratsch gave a good deal of colour to the statement. The ocean basins were thought to be formed by the swift destruction of old continents, while the earthquake-rollers that occasionally flood the Pacific coast were regarded as a picture in little of the agency that brought our marine fossils in past times high upon the land.

The fact that the crust behaves at present in a far milder manner did not trouble these heroic authors. In those days, each successive fauna in the stratified series seemed to represent a new creation; the life of the globe had been every now and then swept away, to be remoulded and reproduced upon a nobler scale. Man happened to be living in a period of rest, specially provided for his needs. The next catastrophic movement would be, in all probability, his day of judgment and of doom.

The extreme uniformitarianism introduced by Hutton still allowed of recurrent catastrophes, whereby the worn-down land surfaces were somewhat swiftly elevated, and were brought up again to cope with the agents of denudation. Lyell,* however, treated the matter from the observational point of view, and concluded that the greater movements of the crust might have resulted from the cumulative effect of small ones. These small movements, he urged, were spread over long periods of time.

Since the publication of his "Principles of Geology," observations in every quarter of the globe have negatived the suggestion of world-wide, or even continental, catastrophes in the past. The recognised succession of living things is in itself incompatible with the violent rending of the crust. At the same time, certain epochs may be indicated in which the formation of mountains, and therefore, in all probability, of oceanic hollows, went on more rapidly than at others. While it would be rash to assume that the surface is now in any degree stable, it may be true that we enjoy a period of calm, following on the amazing earth-storm of later Miocene times.

Marked changes of level have occurred since man appeared upon the earth†; we may infer, then, that the crust is not truly at rest at the present time. The earthquakes from which certain regions suffer are interruptions in the general movement; and the volcanoes which are often associated with such areas are parallel manifestations of the same movement. The earth-pressure may even be in many cases responsible for the outflow of the lava.

Miners and geologists are familiar with "faults," or planes of fracture in the crust. On one side of the plane the rocks have been lowered: on the other they have been moved upward. The vertical amount of movement, the "throw" of the fault, may vary from an inch up to several thousand feet; and it varies in different parts of the same fault-plane, until at last the fracture dies away. If we take a sheet of paper and cut a slit in it with a knife, leaving the edges of the sheet intact, we can bend down the paper on one side of the slit to a considerable extent, without seriously deforming the whole sheet. Such a slit may illustrate how faults, which arise in the rock-sheet known as the earth's crust, may have a marked throw at one point and a diminished throw towards either end.

Such fractures, when viewed in a quarry-section, seem at first to appeal to the catastrophist. Here we find the rocks actually dragged asunder. A crushed "breccia," containing fragments of the rocks on either side, has been formed along the fault-plane, and testifies to the amount of force employed. Those who have wittily called faults "fossil earthquakes," have, indeed, ample justification; for the jar caused by the slipping of rocks along a fault-plane is, no doubt, the source of many a serious shock.* In several cases, as in the Japanese earthquake of 1891, a fault is made visible at the surface; but it is of course possible that a larger and concealed movement may have caused the earthquake, and may have allowed the surface-rocks to slip at the same time.

Yet the whole movement along a fault-plane is probably one of slow degrees. Repeated slips have produced an accumulative effect; and in some cases the final displacement must be regarded as differential, movements in opposite directions having occurred in different parts of the same fault-plane, and therefore possibly in the same part. The faulting is in reality so slow that some of the larger fractures are known to belong to more than one geological period. In the French Alps, M. Lory† has remarked the continuous deposition of sediments on the sinking side of a fault-plane, the movement continuing from the Oxfordian to the Senonian epoch. Similar movement probably accounts for the great thickness of the Old Red Sandstone, deposited, layer by layer, in central Scotland, in the floor of a lake bounded by fault-planes; and the modern history of Lake Tanganyika points also to continuous faulting along its margins. These slow movements form part of the work of what we may call "the great earth-mill," whereby the surface-rocks are shifted on one another, while those lower down may actually be ground to powder.

The breccia found along a plane of faulting is known as the "fault-rock." The fragments in it are grooved by friction with one another: the more yielding ones are squeezed out of shape, or are dragged out into mere wisps and films. In some places, a rough flow of the fractured solid may be observed, the more finely powdered material having moved round the larger blocks, which have thus become embedded in a groundwork, in the form of knots or "eyes."

The same features may be observed in certain yielding rocks, such as serpentines or limestones, on a broad and considerable scale. Earth-movements may cause these masses to be torn to pieces, and the faulting or "shearing" at any point is obscured by the quantity of fault-rock produced. The magnificent brecciated marbles of Italy,

* "Principles of Geology," Vol. I. (1830), p. 79.

† *See* "The Edge of a Continent," Knowledge Vol. XX. (1897), p. 208.

* *See* the admirable discussion by Dr. Davison, in "The Hereford Earthquake of 1896" (Birmingham, 1899), p. 205.

† *See* De Lapparent "Traité de Géologie," 2me. éd., p. 1406.

which are often imitated in artificial forms, have thus originated in the great earth-mill. On a milder scale, but none the less convincing, we have the red Carboniferous marble of Cork in our own islands, which has assumed a sort of flow-structure during the overfolding of the district. Knots of the original fossiliferous rock are freely left in it, indicating the former structure of the mass.

Wherever, again, soft beds and brittle ones alternate in a stratified series, the less pliable beds tend to become broken up, while the yielding layers flow into their interstices. A false effect of fragmentation is thus produced, which is often intensified by the rounding of the included blocks. Such fragmental rocks of secondary origin have been styled "crush-conglomerates," and are of course nothing more than breccias in which flow has taken place.* The whole mass may be bounded at its margins by great fault-planes; but at the same time every block, and almost every layer, is faulted on a small scale against its neighbours.

Excellent examples of this form of brecciation may be seen where limestones and shales, in alternate beds, have become folded and compressed. Wherever a means of escape lay open, wherever the material could give way and flow, the shales have oozed out, and the limestones, which could not thus be elongated, have been at once broken into blocks. As the process goes on, these blocks become rounded until they resemble pebbles.† It is only here and there, by tracing the original bedding, that we are able mentally to reconstruct the series.

Such movements naturally have been noticed in rocks where true pebbles already exist. The Permian conglomerates of Worcestershire show many signs of the grinding of one hard pebble against the other, and the resulting striation, or "slickensiding," is so complete that it has been adduced as a proof of glacial action.‡ The quartzite pebbles, often two feet long, in the conglomerate of Cushendun, in Antrim, have been broken through again and again, the parts being faulted and then re-cemented at the contact. The limestone pebbles, again, of the "Nagelflüh" of northern Switzerland have actually been forced into one another, solution taking place at the same time, so that a large pebble may bear indentations from several of its neighbours, like the impress of a potter's thumb. Had the Alpine earth-movements continued, these massive Swiss conglomerates might have been reduced to crushed and unrecognisable calcareous shales.

If these things are done in the upper layers of the crust, and among rocks on the mere outskirts of a mountain range, we can form some conception of the changes that go on in the lower levels of the mill. The central axes of our mountains, moreover, where denudation has had full play, show us the crushed and crumpled rocks brought up by folding from below. In certain regions, again, such as Scandinavia and north-west Scotland, mountain ranges have been worn down to the roots, have been laid bare in horizontal section; and here we come into touch with some of the more intimate secrets of the crust.

Prof. Lapworth§ has recently dealt so clearly and succinctly with the whole question of metamorphic rocks, that one feels inclined to refer the reader at once to his historical and critical review. As a master in the work of unravelling metamorphic areas in the field, he perceives the difficulties of the student, and appreciates those cases which are susceptible of various explanations. Broad areas of gneiss occur, in which the foliation may be an original structure; the minerals in such cases, even while consolidating, may have been dragged out into lenticular forms by the flow of the viscid mass. But, in other cases, there are distinct signs of crushing; the flow is that of a brecciated material, and the knots and eyes represent those portions of the original mass that have escaped being ground to powder.

Prof. Lapworth has proposed the name "mylonite," from μυλών, a mill, for rocks in which the finer materials "have been sheared, dragged, and ground between the jaws of the gliding-planes."* The compact basis of such rocks is in truth composed of the flour of the great earth-mill. In microscopic sections cut from them, we see reproduced all the features that can be studied on a large scale in the neighbourhood of broken folds and faults. Matters are often complicated by the development of new crystalline materials along the planes of flow and foliation; but the conspicuous minerals in mylonites are commonly true residual eyes. In the example here chosen (Fig. 1), the gneissic structure is not readily apparent until polarised light is employed. Then the lumps of quartz and felspar are seen to be embedded in a fine rock-flour, which results from their abrasion. Whole flakes of quartz have been removed by shearing, and are accompanied, comet-like, by tails and streams of their own dust. The rock was originally a granite, almost free from mica; but it has begun to flow under earth-pressure, and its hardest minerals have been ground to powder along the shearing planes that traverse the whole mass.

By microscopic evidence, we are fairly able to discriminate between original and secondary flow. Quartzites, for instance, may be found, in which a flaky structure has been set up, and in which the larger grains are all lenticular. Such rocks, however, are not likely to have emerged as fluid lava from a caldron. The microscope shows how the lenticles are mere relics of larger granules, the opposite sides of which have been ground off, while a dust of quartz-fragments streams away along the planes of movement. Many grains are pulverised over all their surfaces, and we may conclude that others have disappeared altogether with the growth of the mylonitic ground.†

Rocks composed of more perishable or softer materials naturally suffer in still greater degree from the earth-mill. Gabbros go to pieces, the augites becoming dragged out as bands of brown-grey powder, and the basic felspars forming a compact and almost porcellanous ground.‡ In a great complex series of rocks, subjected throughout to pressure-metamorphism, it may often become impossible to recognise the character and relations of the original constituent masses.

We have passed from the inspection of fault-rock and breccias in the field to a consideration of rocks that may be regarded as regional breccias, and not as mere local accidents along planes of fracture. Down to their minutest structural details, these schists and gneisses bear witness to the great earth-mill. When we return from the laboratory to a review of their larger features, we see how one whole series of rocks may play the part of a

* *See* the full description by Mr. G. W. Lamplugh, "The Crush-Conglomerates of the Isle of Man," *Quart. Journ. Geol. Soc.*, Vol. LI. (1895), p. 563.

† Good illustrations of these processes are given in a paper by Messrs. Gardiner and Reynolds on "The Portraine Inlier," *Quart. Journ. Geol. Soc.*, Vol. LIII. (1897), pp. 528 and 532.

‡ *See* remarks by Mr. W. Wickham King, *Quart. Journ. Geol. Soc.*, Vol. LV. (1899), p. 128.

§ "An Intermediate Text-Book of Geology" (1899), pp. 113—145.

* *Op. cit.*, p. 144.

† *See* Sollas, "On the Structure and Origin of the Quartzite Rocks in the Neighbourhood of Dublin," *Sci. Proc. R. Dub. Soc.*, Vol. VII. (1892), p. 169.

‡ The rock of Penig, in Saxony, is a fine example.

groundmass to a more resisting series, the latter having been cut up into eyes some ten or twenty feet across. A granite may, for instance, be intersected by a number of basic dykes; when metamorphism sets in, that is, when one whole region of the crust begins to slide upon another, the granite flows again, tending to become finer in grain as its constituents yield beneath the pres-

Fig. 1.—Microscopic Section of Gneiss, with Mylonitic Structure in the more delicate bands. Loch Roag, Lewis, Outer Hebrides. × 12. Drawn under polarised light.

sure. The tough dark-coloured dykes become broken across, and huge lumps of them form eyes round which the new gneiss moves. At the same time, the margins of these eyes become foliated; augite breaks down into hornblende, streaked out by pressure into parallel layers. The extreme stage of such a complex mass gives us a regional gneiss of somewhat varying composition, here pale and granitoid, here dark with amphibole and biotite. These dark streaks, true foliation-layers in the gneiss, may be all that remains to us of the series of dykes that once broke through the granite.

The mental reconstruction of a series such as this forms one of the most fascinating problems for a geologist in the open field. But we soon perceive that we must abandon any idea of measuring the "eyes" of one rock entangled in another by our pocket-rule, or even by our surveying-tape. As Lapworth has shown us in the Scotch Highlands, or as Suess has impressed upon us in describing his "horsts" of ancient rock,* whole districts may be regarded as knots round which other districts have been forced to break and flow. It is odd to look from our microscopic section to the map of Europe, and to trace in both the action of the great earth-mill. The waves of contorted rock, pent up against some pre-existing crystalline core, and broken against it in all the complexity of overfolds and regional faults—what are these but the features that mark a gigantic foliation in the crust? The massive breccias that occur along the thrust-planes appear as films of flowing mylonite. At one point, an "eye" provides attractions for the Alpine climber; at another, the yielding ground-mass has been seized on by the peasant for his fields.†

* *See* Knowledge, Vol. XXI., p. 27.

† Since the above was written, Dr. Maria M. Ogilvie (*Nature*, September 7th, 1899, p. 444), in the course of a remarkable paper on "Torsion-structure in the Alps," has called renewed attention to the dragging and flow that accompany large movements in the crust.

NOTES ON COMETS AND METEORS.

By W. F. Denning, F.R.A.S.

Swift's Comet (1899 I.) is now on the northern region of Libra, but has probably passed out of reach of the most powerful telescope in existence. It was accurately observed for position during about five months.

Tempel's Comet (1873 II.) will be too far south for observation in this country. On October 25th the comet will be situated about 1° north of the brilliant star Fomalhault in Piscis Australis.

Holmes's Comet (1892 III.)—This object is extremely faint and only perceptible in large instruments. No observations, except the one announcing its discovery by Perrine, appear to have been published in any of the scientific journals. An ephemeris by Zwiers (*Ast. Nach.* 3582) gives its position on October 3rd as R.A. 3h. 6m., Dec. 46° 56′ north.

No new comets have been discovered during the past few months; in fact, there appears to be a temporary dearth of conspicuous objects of this class. The dark autumnal sky will, however, probably reveal one or two comets visible in small instruments, and we await the definite announcement of their presence from those vigilant observers engaged in comet seeking.

The August Meteors (Perseids.)—Additional observations of this shower have now been received, and it appears highly probable that the maximum occurred on the night of August 11th, between 13h. and 14h., but the number of meteors counted proves the phenomenon to have been one of very moderate intensity. Mr. Ivo F. H. C. Gregg, of Malvern, found the horary rate for two observers as 70 between 13h. 30m. and 14h. 30m. On about August 9th, 10th, and 11th, a number of determinations of the place of the radiant point were made by various observers, and it appeared to be in the usual position. On earlier and later nights the centre of divergence accorded well with the easterly motion which it exhibited in previous years. M. E. M. Antoniadi at Juvisy, Mr. W. E. Besley at Clapham, S.W., Mr. J. H. Bridger at Farnborough, and the writer at Bristol, noted this displacement of the radiant or very decided indications of it, and the observations as a whole corroborate it in a very distinct manner. It appears from a mean of the various positions that on August 1st the radiant was in $32° + 54°$, on August 10th in $44\frac{1}{4}° + 57\frac{3}{4}°$, and on August 14th in $50\frac{3}{4}° + 57\frac{1}{2}°$. One of the most brilliant of the Perseids seen during the recent display appeared on August 10th at 10h. 14m., and it was seen at Yeovil, Bridport, Bristol, Cardiff, and Shifnal, Salop. The meteor descended from a height of 76 to 40 miles from above Cheltenham to Bridgwater, and the length of its observed path was 54 miles.

Fireball of August 24th, 8h. 11m.—A splendid meteor was seen by a large number of persons in various parts of England. At places in Surrey the meteor passed through Perseus and disappeared just under Capella. At Meltham, Yorks., Mr. C. L. Brook estimated the meteor as one-sixth as bright as the moon, and gave the path as from $352° + 13\frac{1}{2}°$ to $2° + 12\frac{1}{2}°$. At Liverpool, Mr. C. Jefferies noted that it passed from the centre of Pegasus to between α Andromedæ and γ Pegasi, and thence into Pisces. He describes it as like a spear with shaft and head complete. A correspondent at Chester writes that he saw a brilliant meteor flying earthwards in N.E., and that shortly afterwards he perceived a strong odour of sulphur. Two observers near Leicester say they saw a ball of fire, which, crossing the road in front of them, fell into an adjoining field. It was quite low down, and did not appear more than one hundred yards away from them. Another writer, at Weaste, near Manchester, says that the meteor resembled a ball of fire of most dazzling brilliancy, and from which long fangs of fire were cast off during its transit. It disappeared suddenly when apparently about two hundred yards from the earth. For several days the newspapers contained a considerable number of letters on this phenomenon. The real path of the meteor was over the North Sea, and it appears to have fallen from a height of seventy-seven to twenty-seven miles. The length of its course was one hundred and eighteen miles, and its radiant point at $345° + 14°$, close to the bright star α Pegasi.

Fireball of August 27th, 10h. 13m.—This was an exceptionally fine object, though it does not appear to have been so generally observed as the one previously described. It appeared in the northern sky from the south of England, and took a long horizontal course from about north-west to north-east. Lieut-Col. Boileau, of Trowbridge, describes the path as directed from Ursa Major, afterwards passing above Capella and through Perseus towards Algol. Mr. J. L. Whittle, of Manchester, estimated that the meteor was half as bright as the moon, and describes its course as from Deneb Cygni to Aquarius. It was also seen at Oswestry, Birmingham, Bristol, &c., but the observations are not sufficiently exact to indicate the radiant accurately. This point was situated in Ursa Major, and further descriptions of the visible path of this fine meteor would be very valuable in aiding to fix the position definitely.

Other large meteors.—The following have recently been recorded :—

Date.	Time. h. m.	Mag.	α °	δ °		α °	δ °	
August 27 ...	9 15	♀	216	+38½	to	201½	+32½	Slow. W. E. Besley, London, S.W.
,, 28 ..	9 30	♃	302½	+13½	to	315½	− 5	Slow. Train. W. E. Besley, London, S.W.
,, 28 ..	12 35	Full ☽	292½	+17	to	301	+ 3	Slow. Train. W. E. Besley, London, S.W.
Sept. 2	12 4	3× ♀	40	+67	to	37	+74	Swift. Streak. W. F. D., Bristol.
,, 4	8 13	♀	220	+35	to	217	+25	Slow. A. S. Williams, Hove.
,, 4	8 14	♃	297	+28	to	296	+13	Swift. Streak. T. H. Astbury, Wallingford.
,, 8	8 21	> ♀	313	+ 4	to	287	+ 4	Slow. Train. T. H. Astbury, Wallingford.

The last of these meteors was also seen by Mr. A. King, of Leicester. It belonged to a radiant at 347° +3°, and appeared over the English Channel and south of England, descending from seventy-one to twenty-six miles during a visible flight of one hundred and fourteen miles.

Additional observations of these objects would be very useful.

In October the Orionid meteoric shower will form the principal display. The moon will be full, however, at the time of the maximum (about October 18th to 20th), but the early part of the shower, on October 12th to 15th, may be well observed if clear weather prevails.

Microscopy.

By JOHN H. COOKE, F.L.S., F.G.S.

The addition of a little ammonia to the water in which diatomaceous materials are being washed facilitates the removal of slimy, gelatinous products, cleanses the diatoms, and hastens their settlement to the bottom of the vessel.

To extract siliceous organisms from rock fragments, heat the rock to about one hundred degrees Fahrenheit, and then plunge it into a boiling solution of soda sulphate. This salt takes up water as it crystallizes, and the rock, therefore, readily pulverizes under its influence.

Balsam of tolu, from which the cinnamic and benzoic acids have been removed by prolonged boiling in a large quantity of water, is an admirable mountant for diatoms. It should be dissolved in rectified benzine, filtered, dried, and finally dissolved in alcohol or chloroform. The refractive index of the balsam thus prepared is 1·72 when dry.

Methyl-green is an effective double stain for all vegetable sections. When applied to fibres, whether of pure cellulose or of lignin, it produces a deep green if the fibre has been mordanted before staining ; while a light green is produced when the order of stain and mordant is reversed. Apply in a strong aqueous solution.

For the preparation of permanent mounts of living amœboid organisms, the following method, first suggested by Certes, will be found to give satisfactory results. To thirty cubic centimètres of the water containing the living amœbæ, add about one cubic centimètre of osmic acid solution (one per cent.). After settling for a few hours wash the deposit, concentrate, stain, and mount in distilled water containing a trace of osmic acid.

To demonstrate in yeast cultures the formation of alcohol as a result of the growth of the plant in a sugar solution, Mr. A. L. Treadwell suggests the following method as being less troublesome than the ordinary qualitative tests, and much more satisfactory. To the yeast culture add a few drops of iodine solution, and then enough KHO solution to destroy the colour of the iodine. Iodoform will be produced and can be recognized by its characteristic odour.

The proper preservation of soft-bodied organisms is one of the chief difficulties that the working microscopist has to contend against. The number of preserving media is great, but there are few of them that are at once as simple and effective as that suggested by A. E. Verrill for preserving insects in their natural forms and colours. The solution consists of two-and-a-half pounds of common salt and four ounces of nitre dissolved in a gallon of water and filtered. The specimens should be prepared for permanent preservation in this solution by being previously immersed in a solution consisting of a quart of the first solution and two ounces of arsenite of potash in a gallon of water.

To kill sponges extended, Mr. W. R. Melby proceeds thus : The specimen is placed in a glass jar filled with water, and the following solution is added drop by drop at intervals of one minute :—Methyl alcohol, ten parts ; salt water, ninety parts ; natrium chloride, six-tenths of a part. If the specimen does not retract after forty-five minutes, pour some hot sublimate on quickly. To preserve specimens for sections, put them in one per cent. osmic acid for two minutes and then successively in five, ten, twenty, thirty per cent. alcohol up to ninety per cent., harden in absolute alcohol and imbed in paraffin, stain with borax carmine and hæmatoxylin.

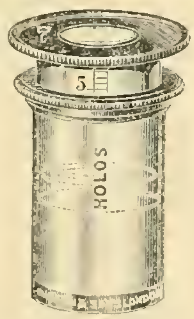
The distribution of aquatic life from season to season throughout the various zones of the plankton in the larger masses of water of the globe is an object of study which has received considerable attention at the hands of investigators during the last decade. The greatest difficulty that has been experienced has been the need of an apparatus upon which the operator can rely to work satisfactorily under all conditions and at all times of the year. The nets that are usually used cannot claim these advantages, inasmuch as they are always liable to damage and loss when working on a rocky bottom, and during the winter months, when the plankton yields its most interesting results they are inadmissible in northern latitudes owing to floating ice. The accuracy of the results, too, leave much to be desired, as with the net it is not possible to determine exactly the volume of organisms actually present in a given quantity of water, nor is it practicable to determine the various groups that are characteristic of the many vertical zones or strata of water of which the plankton is constituted.

For critical work, nets have had to be discarded, and in place of them Dr. H. B. Ward has used, during his recent investigations on the Great Lakes, a light weight force pump which he calls the "plankton" pump, and which can be carried about and operated by one person. The cylinder of the machine is eleven inches long by three and a half inches diameter, and it has a capacity of three hundred and forty-seven and a half cubic inches per stroke. It is essentially an ordinary force pump, save that it has very finely ground check valves, to which, it is believed, the accuracy of the working of the apparatus is largely due. The pump is connected with the water by a hose one and a half inches in diameter, the lower end of which is adjusted to the various vertical zones of water by means of an attachment to a floating block. Most gratifying results have attended the use of this apparatus. It is possible to measure with great accuracy the amount of water filtered. Collecting can be carried on without any disturbance of the water, and water can be drawn from any stratum, thus enabling the investigator to examine in detail the vertical distribution of the plankton.

Dr. H. A. Hagen has made careful records for the purpose of determining the durability of the rubber stoppers which are used in vials containing microscopic objects in alcohol. From an examination of some seven thousand vials with rubber stoppers, two-thirds of which had been in use for from ten to twelve years, he comes to the conclusion that less than one in a thousand gives out every year after twelve years' use, and in the first six years probably only one out of two thousand. Stoppers of large size keep much longer than those of small size. American rubber stoppers are all made of vulcanized indiarubber, and have the disadvantage of forming small crystals of sulphur about the stopper, which become loosened and attach themselves to the specimens. It is supposed that pure rubber stoppers used for chemical purposes would not present this disadvantage, which may be obviated, however, or very much reduced, if the stoppers are washed or soaked in hot water for an hour or two before being used.

The usual processes that are adopted for the hardening of brain and similarly soft tissues, frequently result in failure by reason of the pressure of the tissues on the hard surface of the containing vessel, and the consequent mis-shapening of the lobes and convolutions, or the rupturing of the delicate superficial membranes. To prevent this, Prof. W. C. Krauss, of Nebraska University, has devised a hardening receptacle which obviates most of the disadvantages of the old method besides being exceedingly simple and inexpensive. An oval tin pail, of from four to six quarts capacity, with an ordinary handle and a tight fitting cover, has a series of about ten hooks soldered on the inside about one inch from the top of the rim. The convex surface of the fresh brain is covered with a sheet of cotton, and over this is placed a piece of netting. The whole is then lowered gently into the pail containing the hardening fluid, and suspended in it by means of the hooks. The brain thus undergoes hardening in all directions at once, and does not lose its normal symmetry. The cotton protects the convolutions from being ruptured.

Many workers have in their battery of objectives samples of both the achromatic and apochromatic types, having their favourites of both series. But this has necessitated two sets of eye-pieces, the Huyghenian for the former, and the Compensating for the latter; but this will no longer be necessary, because in the "Holoscopic" eye-piece of W. Watson & Sons we have an eye-piece which has been specially devised for both purposes. It consists of two tubes, the outer one carrying the field lens, and the inner, or telescopic one, having fixed to it the eye lens and diaphragm. Carefully selected appropriate glasses are used for the lenses, and when the telescopic tube is pushed in as far as it will go, the eye-piece is an under-corrected one, suitable for work with achromatic objectives. As the tube is drawn out, the eye-piece becomes increasingly a compensating one, possessing the so-called over-correction associated with the compensating eye-pieces which are used with the apochromatic objectives. This eye-piece yields really beautiful images, and not only does it obviate the necessity for two sets of eye-pieces, but it gives to the worker a power of adaptation which he has not hitherto possessed. Very few of the apochromatic objectives have the same amount of under-correction, consequently with the fixed eye-pieces the over-correction is frequently too great. With the "Holoscopic" eye-piece, the over-correction can be exactly adjusted to the objective, and a divided scale is engraved upon the draw-tube, so that the position may be recorded. It is made in the following magnifying powers :—



For the six-inch tube length, 5, 7, 10, and 14 diameters.
For the ten-inch tube length, 7, 10, 14, and 20 ,,

The cost is very little greater than that of the Huyghenian eye-pieces.

THE FACE OF THE SKY FOR OCTOBER.

By A. Fowler, F.R.A.S.

The Sun.—On the **1st** the Sun rises at 6.2, and sets at 5.38; on the **31st** he rises at 6.54, and sets at 4.34. Sunspots are not likely to be either numerous or conspicuous.

The Moon.—The Moon will be new on the **4th**, at 7.14 p.m.; enter first quarter on the **12th**, at 6.10 a.m.; will be full on the **18th**, at 10.5 p.m.; and enter last quarter on the **26th**, at 9.40 a.m. The following occultations are the most interesting during the month :—

Date.	Name.	Magnitude.	Dis-appearance.	Angle from N.	Angle from V.	Re-appearance.	Angle from N.	Angle from V.
Oct. 10	4 Sagittarii	4·6	7.3 p.m.	93°	74°	8 10 p.m.	242°	211°
,, 16	19 Piscium	5·2	11.53 p.m.	52	30	13.0	251	221
,, 21	κ^1 Tauri	5·5	8.37 p.m.	76	118	9.35 p.m.	261	303

The Planets.—Mercury is in superior conjunction with the Sun at 4 a.m. on the **1st**, and will, therefore, be an evening star throughout the month. He is, however, unfavourably placed for observation on account of nearness to the Sun and southerly declination.

Venus has now become an evening star, but is still too near the Sun for observation. On the **26th**, at 6 p.m., she will be in conjunction with α Libræ, the star being 0° 6′ S., but both star and planet will have set nearly an hour before this event.

Mars and Jupiter are both evening stars, but are too near the Sun for useful observation. They will be in conjunction with each other on the **11th** at 5 p.m., Mars being 1° 11′ S., and both being very near to α Libræ: the planets, however, will set about three-quarters of an hour after the Sun, so the conjunction can hardly be considered observable.

Saturn remains in the southern part of Ophiuchus, and may be observed in the early evening, low down in the south-west, under favourable conditions. Near the middle of the month he sets about 7.40 p.m. The rings are widely open.

Uranus is not observable.

Neptune, in Taurus, may be observed by those prepared to take the trouble to identify it. He rises about 8 p.m., and is situated in the Milky Way, nearly midway between ζ Tauri and η Geminorum.

The Stars.—About 9 p.m. at the middle of the month, Auriga and Perseus will be in the north-east; Taurus low down in the east; Aries, Pisces, and Cetus in the south-east; Andromeda and Cassiopeia high up and a little south of east; Pegasus and Aquarius in the south; Cygnus high up to the south-west; Aquila, lower; Lyra and Hercules towards the west; Corona towards the north-west; and Ursa Major in the north.

Convenient minimum of Algol occur on the **7th** at 10.18 p.m., on the **10th** at 7.7 p.m., and on the **30th** at 8.50 p.m. It will be interesting, too, to watch Mira Ceti, which should be at or near a maximum about this time.

Chess Column.

By C. D. Locock, B.A.

Communications for this column should be addressed to C. D. Locock, Netherfield, Camberley, and be posted by the 10th of each month.

Solutions of September Problems.

No. 1.

(By H. Bristow.)

1. R to Q2, and mates next move.

No. 2.

(By P. G. L. F.)

Key Move—1. K to B5.

If 1. . . . Kt moves. 2. Kt to Kt6ch, etc.
1. . . . P to Q6. 2. Q to R4ch, etc.
1. . . . B moves. 2. Q to R6ch, etc.

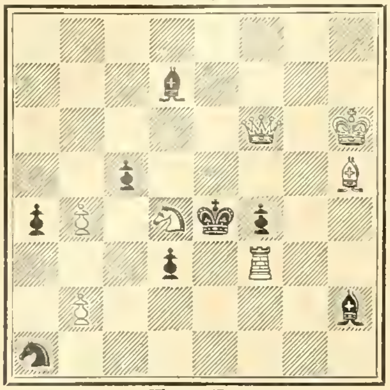
Correct Solutions of both problems received from A. H. Doubleday, Alpha, J. Baddeley, N. M. Munro, G. C. (Teddington), W. W. S., J. E. Lelliott, W. de P. Crousaz, G. D. Crowther, Capt. Forde, H. Le Jeune.

Of No. 1 only, from A. J. Head.

Mexfield.—The work referred to is not published.

PROBLEM.

Black (8).



White (7).

White mates in four moves.

[The above is a competing problem in the current tourney of the *British Chess Magazine*. In spite of its difficulty it will well repay the trouble of solving, a trouble which we hope some of our solvers will not grudge.]

CHESS INTELLIGENCE.

Mr. H. E. Atkins won the first prize in the Amsterdam Amateur Tournament without losing or drawing a single game. This is undoubtedly a very fine performance, even though the majority of the sixteen competitors were not quite of the front rank. Mr. Atkins also won the Brilliancy Prize; the game which obtained it will be found below.

Another celebrated chess player and theorist has passed away. Baron von Heydebrandt und der Lasa died on July 27th, at the age of eighty years. He was one of the very finest players of his time, and the original author of the "German Handbuch."

The appended game obtained the Brilliancy Prize in the recent amateur tournament held at Amsterdam:—

"Ruy Lopez."

White. (J. D. Tresling.)	Black. (H. E. Atkins.)
1. P to K4	1. P to K4
2. Kt to KB3	2. Kt to QB3
3. B to Kt5	3. Kt to B3
4. Castles.	4. P to Q3
5. Kt to B3 (*a*)	5. B to K2 (*b*)
6. P to Q4	6. Kt to Q2
7. Kt to Q5	7. Castles
8. Kt×Bch	8. Q×Kt
9. P to Q5	9. Kt to Q1
10. B to Q3	10. K to R1
11. Kt to K1	11. P to KB3
12. P to QB4 (*c*)	12. Kt to B2
13. B to K3	13. KR to Kt1
14. R to B1	14. P to KKt3
15. R to B3 (*d*)	15. Kt to B4
16. B to B2	16. P to B4
17. P to B3 (*e*)	17. P to B5
18. B to B2	18. P to KKt4
19. P to KKt4	19. Kt to Q2
20. R to R3 (*f*)	20. Kt to B3
21. K to Kt2	21. P to KR4
22. P to R3	22. K to Kt2
23. R to R1	23. R to R1
24. P to Kt4	24. Kt to R3
25. P to B5	25. B to Q2
26. Q to B1 (*g*)	26. K to Kt3
27. BP×P	27. BP×P
28. B×RP (*h*)	28. P×P
29. RP×P	29. Kt (R3)×P (*i*)
30. B to KKt1 (*j*)	30. R×R
31. K×R	31. Q to R2ch
32. K to Kt2	32. Q to R6ch
33. K×Q	33. Kt to K6 dis ch
34. K to R2	34. R to KR1 mates

(*a*) I prefer 5. B×Ktch, and 6. P to Q4.

(*b*) Not usually a good square for the Bishop in the close forms of the Ruy Lopez. 5. . . P to KKt3 might be played.

(*c*) As the result of Black's dilatory manœuvring, White should here get some attack by 12. P to KB4, and P to B5 if the Pawn be not taken.

(*d*) Perhaps 15. B to Ktsq is better. Then if 15. . . . Kt to B4, 16. P to QKt4; as it is, Black gets time to advance his KBP and free his game considerably.

(*e*) 17. P×P would give him a freer game, with prospects of playing the Q to R5 in the near future. Black's open Knights' file would not be particularly formidable.

(*f*) This is useless, as he cannot conveniently take the RP. 20. P to QKt4 is probably his best move.

(*g*) To defend the Rook, with a view to B×RP; but the manœuvre is too slow. P×P at once would be better.

(*h*) Overlooking Mr. Atkins' not very hidden sacrifice.

(*i*) Correct on principle. Two such Pawns alone are worth the Knight, apart from the attack which would inevitably follow its capture.

(*j*) If 30. Kt to Q3, R×R, 31. Q×R, R×B, etc. His best chance lies in 30. R×R, R×R; 31. P×Kt. The actual finish is pretty and problematic, though not unobvious. Mr. Atkins played the final attack with skill, after a somewhat cramped opening development.

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CONTENTS.

THE MYCETOZOA, AND SOME QUESTIONS WHICH THEY SUGGEST.—VI.

By the Right Hon. Sir Edward Fry, d.c.l., ll.d., f.r.s., and Agnes Fry.

The Individual and the Generation.—But it is time to return from the long digression into which we have been led by the unicellular plants. If we consider ourselves or any other higher organism, whether animal or vegetable, and ask what is the individual and what is the generation, we feel at first quite able to reply. We know that the answers to these questions, when we seek to pursue the enquiry to the bottom, involve other profound questions, perhaps, insoluble difficulties, but on the surface the answers are easy.

If now we turn to the myxies and ask what is the individual, the answer seems attended with no small difficulty. In the swarm spore stage each separate protoplast is the individual; each is capable of separate motion, of digestion, and of multiplication. If we turn to the plasmodium stage, the individual appears to be the entire plasmodium, built up as it has been by the union of a great number of protoplasts, and not always the descendants of the same parents; if we take the sporangium stage, and consider especially those cases in which each sporangium stands on its own hypothallus, separated from the hypothallus of its neighbours, the sporangium seems to represent the individual. The life-circle of the myxie thus exhibits a curious alternation of individualism and collectivism—an harmonious solution of the problem raised by the claims of the two principles which are found in conflict in other organisms and states of society.

Death and Reproduction.—We know that of late years many interesting theories and questions have been propounded in relation to the great fact of Death, and that the entrance of Death into the great chain of organic life has been watched and studied.

One view, to which Professor Weismann has given great prominence, is that unicellular organisms possess an unending duration, or, in other words, that though susceptible of death by external force—as, *e.g.*, by fire—there is no natural death, but on the contrary a potential immortality. He considers death, therefore, to have come in with the multicellular organisms, and to take place, as he says, "because a worn-out tissue cannot for ever renew itself, and because a capacity for increase by means of cell division is not everlasting but finite."

Another view put forward (not by Weismann but by Götte) holds that death is always connected with reproduction, and is a consequence of the latter in the lower animals.

Lastly may be noticed another view, also propounded by Götte, that the first form of death is to be found in the phenomenon known as encystment, which occurs when an organism which has been alive and exhibiting the phenomena of motion becomes stationary, develops a cyst or coat around it, and after a period of rest and suspended animation again revives when the favouring circumstances occur.

We thus state some of the views with regard to death because we think that it will be found that the life-history of the myxies throws some light upon them.

Let us, however, first make these remarks: that in the higher organisms we know of death in two forms, the death of a part cast-off, as when we shed a hair or lose a tooth, or as when a tree casts off its dead leaves; and, secondly, the death which affects the whole organism; and further that reproduction is in a great majority of the higher organisms accompanied by the casting off of some parts of the organism which have been devoted to the nutrition and protection of the young offspring. In plants we know how the floral envelopes drop off, and how the seed vessels are allowed to fall and decay when their duty is done; and corresponding phenomena exist in the animal world.

When the plasmodium of the myxie has differentiated itself into the hypothallus and the sporangia, and these have sent forth the spores, how are we to regard the events which have happened? Is the true view that a parent organism has died; that the empty sporangium and the stalk, and the capillitium and the hypothallus which are left behind to decay are the dead body of the parent, and that the spores represent the new generation?

If this be the true view, and there seems much probability in it, then we have clearly before us an unicellular organism of the simplest kind, which exhibits the phenomenon of death, and we cannot say with Weismann that it is with the multicellular organisms that death for the first time occurs.

On this assumption it further follows that we have in the myxies an instance of the close association of death with reproduction; and we are reminded of the analogous cases of the mayfly and the butterfly, which die after laying their eggs, and of the death of the male bee after pairing.

The other view of the facts to which we have referred is that the throwing off of the sporangium and the capillitium, and the shells of the spores, is not the death of the whole parent organism, but the partial death only which occurs when the parts which have become useless are cast off and allowed to die, and in this view there is in the cycle of the myxie's life neither death nor generation, but an everlasting life; the same protoplasm would be thought of as going on in an eternal round of life, subject only to accretions and to losses. True it would be that the shell of the spore, the coats and foot of the sporangium, and the capillitium which it contains, have been thrown aside and perish; but the residue of the protoplasm seems to pass from swarm spores into plasmodium, from plasmodium to swarm spores, and so on in a perpetual round. The swarm spores thus appear not as emanations from the parent but as the parent itself, and the new generation and the old are but one person (if personality may here be spoken of). If we think of death we search without success for the moment of its occurrence, and we look in vain for the dead body.

Whether of these two views be the more reasonable it may be hard to decide. However that may be, it is certain that there are unicellular bodies, such as the Diatoms, in respect of which Weismann has so forcibly shown that death cannot be thought of as a normal event. Thus out of the depths and first rudiments of organic life there crops up a suggestion of that immortality which is the hope and aspiration of its very highest members.

Then with regard to encystment. We have seen that this occurs in two forms in the life-history of the myxies. We have found that the single swarm spore may be encysted and is then known as a microcyst, and that from this condition it may be awakened and recalled to its activity as a swarm spore, and we have found also that, in the form of sclerotium, the whole plasmodium may become quite dry and hard as an aggregation of cysts, and thus be reduced to a condition of suspended vitality, but from this also it may be aroused to its former powers of movement and life as a plasmodium. In neither of these cases do we find encystment to be associated with death, nor with reproduction. "The essential characteristic of encystment," says Weismann, "is a simple process of rejuvenescence without multiplication."

The length of time during which animation can be suspended in the case of plasmodia is very remarkable. De Bary found a plasmodium of *Didymium serpula* to move after seven months' desiccation; and a case is cited by him of a plasmodium which after twenty-five years' residence in an herbarium began, after four or five days' immersion in water, to develop as a beautiful network.

Relations of the Group.—The proper position of the myxies in the world of organized beings is a subject on which there has been and still is a great difference of opinion. So profound is the difficulty of the question whether they are animals or vegetables that one of the most careful students of their nature has declared that its solution "depends rather on the general philosophic position of the observer than on facts."

Those authors who place the myxies in the animal kingdom have generally attached most importance to the swarm spore and plasmodium stages of their existence, and have insisted on their likeness to the protozoa; the advocates of their vegetable character have mainly dwelt on their method of reproduction—on their sporangia and their spores.

But even assuming them to be vegetables, there remains the question where they are to take their place in that realm of Nature. They were placed among the fungi by Fries, but with a lively consciousness of how entirely they differed from all the other members of the class. "Vegetatio maxime singularis et a reliquorum fungorum prorsus diversa," he says of this group. The fungi seem as a natural group to be well characterized by a prothallus constituted of hyphæ—generally multicellular—whereas the myxies are represented in that stage by the strange plasmodium of which we have said so much.

Attempts have been made to show that different sections of the myxies correspond with different sections of fungi: the common myxies being treated as of the Gasteromycetic type; the *Dictyostelium* as of the Mucorine type; and, according to some writers, the *Ceratomyxa mucida* as of the Hydnum type and the *Ceratomyxa porioides* of the Polyporus type; and from this supposed correspondence of type it has been suggested as probable that other types of fungi will be found to be represented amongst myxies, and that so we shall have two parallel series of fungi; the difference in each case being that the one is characterized by a mycelium of hyphæ, and the other by a plasmodium. This view appears to us to be fanciful, and to slur the really broad line of distinction between fungi and myxies. More rational would seem to be the view put forward by one of the latest writers on classification, who has formed of these little organisms one of the four primary divisions of the vegetable kingdom, and made for them a place of equal rank with the whole of the phanerogamous plants; so distinct a position scarcely seems excessive to mark the singularity of their structure and life-history. In fact, one of the many interesting points about this group of organisms is the extent to which they stand alone; the difficulty of finding any other creatures to which they stand in the relation either of descendants or ancestors. "The mycetozoa," says De Bary, "show only a slight agreement, either in the general course of their development, or in the characteristic features of its separate stages, with organisms which are of undoubted vegetable origin, whether they be fungi or plants other than fungi; the agreement, with the exception of the few cases in which cellulose makes its appearance, is common to phenomena which are common to all organised bodies."

We are much impressed with the notion that the position of the myxie will be found to vary according as the one or the other stage of their existence is held to have the highest classificatory value. We therefore propose to consider what relations they exhibit in these various stages of their life-history.

SHELLS AS ORNAMENTS, IMPLEMENTS, AND ARTICLES OF TRADE.

By R. Lydekker.

FROM the intrinsic beauty of their form and coloration, coupled with their almost imperishable nature, the shells of numerous kinds of molluscs have been employed from the earliest times by aboriginal tribes in all parts of the world as articles of personal adornment. Others, again, are suitable as implements for culinary and kindred purposes; while a few have been selected as convenient media for exchange. Not only are entire shells, either singly or strung together, employed as personal decorations, but in many instances the shells are cut or ground, either into bangles, or into pieces capable of being more conveniently strung together than are entire specimens. In later times, shell-cameos have commanded well-deserved admiration; while the beauty and utility of mother-of-pearl has been recognised from time immemorial. Since a separate article has been devoted to the latter substance, attention may be restricted in the present communication to the uses of shells of other descriptions. So numerous, however, are their applications, and so great is the number of species concerned, that only a very few of the more striking examples of each type of use can be even mentioned. With regard to the volume of the trade in shells, which is mainly carried on in Britain, it is to be regretted that precise statistics are not forthcoming. In the Board of Trade returns, the item "shells" is taken to include both mother-of-pearl and tortoiseshell, so that the figures convey little real information, especially as they relate to value alone. In this wide sense, the declared value of the "shells" imported into the United Kingdom during 1897 was five hundred and eighty-five thousand, five hundred and fifty-three pounds. Whatever be its precise amount, it may be taken for granted that the British trade in shells, other than mother-of-pearl and tortoiseshell, is of very considerable volume.

Evidence of the early development of the taste for shells as articles of personal adornment is afforded by discoveries made among the remains of the prehistoric inhabitants of central France. Living at a distance from the sea, these primitive people were unable to procure recent shells, and accordingly had recourse to some of the fossil species so abundant in the neighbouring tertiary deposits. Although deprived of their colours, these fossil shells, which have been perforated for stringing into necklaces by the cave-dwellers, still retain their original polish, and are thus objects of considerable beauty. Among modern aborigines the taste for shell ornament seems to have attained its highest development among the Melanesians and Papuans of the South Seas. In Fiji and Tonga the chiefs wore the lovely orange cowry as a special badge of rank; while the large egg-cowry (*Ovula ovum*) is much favoured by many Melanesian tribes, and especially the Papuans. Not content with their own shells, these latter savages imported those of a species of *Struthiolaria* (a distant relative of our whelk) from New Zealand; these they ground down till little except the mouth remained, in which condition they were strung together into necklaces. Sections of the melon-volute (*Melo*) were also worn as part of a breast decoration, while shells of a large *Turbo* and *Conus* were ground down into bangles or sheaths for the upper arm. A coronet made of a species of periwinkle (*Littorina*) was in use among the Fijians; and necklaces and coronets composed of *Naticas*, top-shells, etc., were worn by many of the islanders of the South Pacific, especially those of the Ellice group and of Flinders' Island. Very curious is a necklace in the writer's possession, which probably came from the Marquesas; it is shown in the accompanying figure, with an entire shell of *Conus virgo* in the centre.* The necklace is formed of the tops of thirty-one specimens of that shell, and as these were doubtless reduced to their present condition by grinding, the labour expended on this ornament must have been very great. Large specimens of the same white cone were cut in two and worn as neck-ornaments in Samoa. Very elaborate are the tall coronets of black and white shell formerly worn by the chiefs in the Marquesas. These consisted of upright pieces of thin curved shell, about two inches in height and somewhat less in width, apparently belonging to some kind of bivalve; every other one was stained black, and all were fastened together by a circle of cord. Long necklaces of money cowries were often worn by some South Sea Islanders; the back of each shell being ground down to display the inner whorls. We have likewise seen a belt from India ornamented with a number of these cowries sewn on it with their mouths exposed. Beads made from

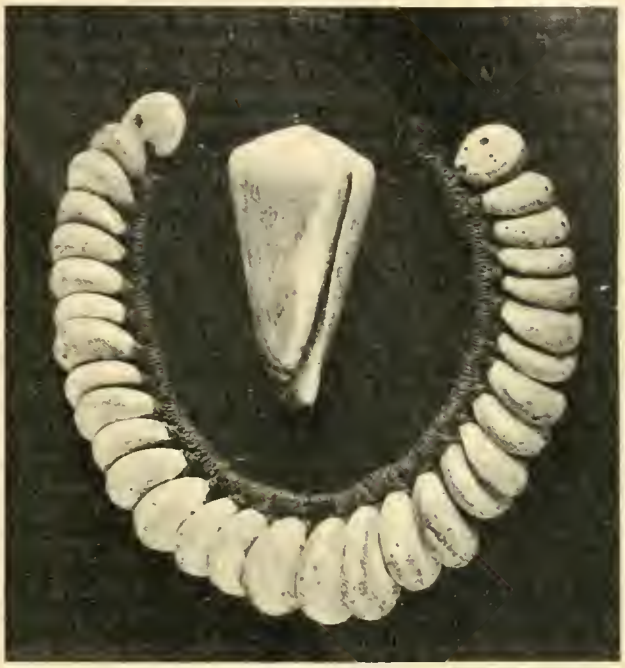


Fig. 1.—Necklace made from the Virgin Cone, with an entire specimen of the Shell.

the crimson lip of a large *Strombus* are also worn as necklaces by the Papuans; while nose-ornaments are formed by grinding down segments from the horned helmet-shell (*Cassis cornuta*). A fillet on the forehead bearing a single specimen of the warty egg-cowry (*Ovula verrucosa*) distinguishes the chief of a Papuan village; while the ears of many of the same race are often decorated with a piece of bivalve shell, through a hole in which locks of hair are passed. In Samoa an elaborate fillet was made from the pearly inner whorls of a *Nautilus* imported from New Zealand and Australia. The brilliantly polished green *Trochus iris*, the so-called *Elenchus*, was used as an ear-drop by the Maories.

Equally partial to shell-ornaments were the aboriginal inhabitants of America. In South America the cloaks of the women were adorned with various land and fresh-water shells, such as *Ampularia* and *Bulimulus*; while large species of *Bulimus* were worn on the breast connected with chains of other substances. Some North American tribes used tooth-shells (*Dentalium*) to decorate the nose and ears; while others, as those of the Salt Lake district, made necklaces of various small univalves belonging to the genera *Oliva* and *Marginella*. In these instances the shells were used entire; but many other kinds were ground down either into disks or cylindrical beads, which after being strung together, were employed as money under the name of wampum. Ordinary cylindrical wampum was made from the bivalve shell of the common clam (*Venus mercenaria*); some of the beads being of the white colour of the shell, while others, which bore a higher value, were cut from the purple margin. Another kind of wampum

* No specimen of this type of necklace exists in the British Museum.

was made from a reversed univalve shell (*Fulgur perversus*), allied to the Indian chank-shell; and a third description from a species of *Olivella*. Large and much valued cylindrical beads (some of between two and three inches in length, and of the shape of a cigar) were likewise cut with great labour from the pink core, or columella, of the queen conch (*Strombus gigas*). Not only was wampum employed as a means of exchange, but it was also worn as a personal adornment; while by a careful arrangement of the beads according to size, shape, and colour, it also served the purpose of an historical record, and to convey messages. On the invasion of the east coast of America (to which the use of wampum was restricted) by Europeans, shell beads of various descriptions were soon introduced, and the value of wampum discredited.

In its monetary aspect, wampum naturally leads on to the consideration of those shells employed as media of exchange in their natural condition. In north-western America such money took the form of a species of *Dentalium*, the hollow, tusk-like shells of which were threaded on strings, whose value depended on the number and condition of the specimens they bore. In certain islands of the South Pacific a species of nerite served as currency; and in the New Hebrides, sandal-wood for the China market was purchased with a species of egg-cowry (*Ovula angulosa*). The shell which has long served in the capacity of money throughout many countries is, however, the well-known white money-cowry (*Cypræa moneta*); the nearly allied ring-cowry (*C. annulus*) being also employed to a considerable extent. A native of the Pacific and Eastern Seas, the money-cowry has from time immemorial been employed as the lowest medium of exchange in India, where even at the present day a few grains of parched corn can be obtained in return for one of these shells. But it is also very largely employed among the natives of the west coast of Africa. To supply these districts, cowries are imported from the East into Liverpool, whence they are again shipped to their destination. Thirty years ago the annual import of money-cowries into Lagos ranged between fifty thousand and sixty-five thousand hundredweights, but of late years the trade has fallen very greatly. From the west coast, cowries penetrate far into the interior of Africa, reaching even to the Sudan, where they are employed to decorate the conical caps of the inhabitants of the Bahr-el-Ghazal valley. On the west coast their value ranges between ten and fifteen pence per thousand.

Allusion to necklaces of money-cowries has been already made; and it should be added that throughout India these shells are largely employed to decorate the trappings of horses, camels, elephants, etc., while they are worn on the dress by Binjari women. In the British Army the bridles of the Tenth Hussars are ornamented with money-cowries. By the Dyaks a somewhat ghastly use is made of these shells, who stick one in each eye-socket of the skulls of their slain enemies.

Returning for a moment to the use of shells as personal ornaments, it may be mentioned that bracelets are occasionally made from the prettily marked zigzag cowry (*Cypræa undata*), a number of which are mounted side by side, with their long diameters parallel. The flattened and circular spiral shells of the genus *Rotella* are mounted both as bracelets and as studs. Elegant bracelets are likewise made from the polished green opercula of certain kinds of *Turbo*, small specimens of the same being employed for studs. Bracelets and brooches made of shell-cameos are noticed later.

The most important industry connected with shells as articles of personal adornment would seem to be the cutting of bangles from the chank-shell (*Turbinella rapa*), which is carried on at Tuticorin. This shell, which is sacred to Vishnu, and figures on the coins and postage-stamps of Travancore, is a large and heavy spiral univalve, with a long siphon and three bold ridges on the core. When the epidermis is removed, the shell is white and porcellanous. Occasionally reversed, or sinistral, specimens are met, which are highly prized. One such obtained in 1887 fetched 700 rupees; and a second specimen has been subsequently dredged. The chief trade is done in green, or living chanks, which are dredged in from one to three fathoms of water off the coasts of Ceylon and Southern India, the white, or dead chanks, cast on the shore by the waves being of comparatively little value. Formerly the export of chanks from Tuticorin to Madras and Calcutta averaged something like half a million annually, with an estimated value of from ten thousand pounds to fifteen thousand pounds; while a rent of four thousand pounds a year was paid for the right of fishing in Ceylon. Of late years, however, the trade has decreased, the number of shells obtained during the winter of 1885-86 being three hundred and thirty-two thousand, with a value of nearly twenty-four thousand rupees. The great bulk of these shells go to Dacca, where they are sliced into bangles and anklets for Hindu women by means of a primitive saw shaped somewhat like a cheese-cutter. Many of these sankha, as they are called, are of a complex structure, having a movable segment which can be fixed by means of pins; and they are frequently decorated with tinsel and coloured glass. The practice of leaving the sankha on the body during cremation renders the demand for these articles constant.

But it is not only as bracelets and anklets that chanks are employed; in the uncut condition they are mounted in metal and bored to form trumpets, while they are also sometimes used as oil-vessels in Hindu temples. In Dacca they are also stated to be employed for glazing calico, and in Nepal for polishing paper. Neither are bangles cut from these shells alone, as they are made in Queensland from the pearl-oyster, and in the Marquesas from the large top shell (*Trochus niloticus*), while mention has already been made of those cut from a *Turbo* in Papua.

The employment of the valves of a large scallop (*Pecten*) as a badge by pilgrims is familiar to all. In addition to their use as personal ornaments and decoration to trappings, shells are employed by aboriginal tribes for other decorative purposes. In the Solomon Islands, for instance, canoes are ornamented with rows of univalves of the genus *Natica*, while cowries decorate the shields of the same people. The large egg-cowry (*Ovula ovum*), in addition to its use as a personal ornament, is attached to the drums of the Papuans, and the eroded cowry (*C. erosa*) to their drinking vessels.

With the chief exceptions of wampum and the money-cowry, the chief uses of shells noticed above have been as articles of luxury rather than of real use. In Fiji, however, the Surinam-toad cowry (*Cypræa mauritiana*), together with a large species of *Turbo*, is employed by the natives for sinking their nets. A bisected tiger-cowry (*C. tigris*), enclosing a stone, and decorated with a pair of bright-coloured olives (*Oliva*), is found to form an attractive bait for cuttles in the same islands; while in the Tonga group a nearly similar bait is made by fastening several pieces from the back of the same species of cowry around a core of hard wood. In all the Pacific Islands, fish-hooks, which in some cases appear to act also as artificial baits, are cut from ear-shells (*Haliotis*), as well as from wing-mussels (*Avicula*), additional strength being sometimes given by a splint made from the core of the nutmeg-cowry (*C. arabica*). In the Andaman Islands, according to the late Dr. V. Ball, the natives employ a bivalve (*Cyrene*) as a knife; and the Fijians make knives and scrapers from the pearl-oyster. In Woodlark Island, small axe-heads are ground out of a species of auger-shell (*Terebra*), larger implements of the same nature being made in Fiji from giant clam (*Tridacna gigas*). Cubical blocks cut out from the same shell were used in the Tonga group as missiles in war. As receptacles for holy water in churches, large valves of the aforesaid species, which may measure as much as a yard in diameter, have long been in use. As a substitute for glass in windows, the thin flat valves of the glass-oyster (*Placuna placenta*) have been employed for ages among the Chinese. As spoons and balers, the shells of many species, both bivalved and univalved, are employed in different parts of the world. Among them, it may be mentioned that a melon-volute (*Melo diadema*) is used in Papua to bale the water from canoes; while in the Moluccas neat spoons of various sizes are cut from the outer side of another species of the same genus and mounted with horn or bone handles. In West Africa the great snail shells of the genus *Achatina* are used as spoons; and in some countries melon-volutes are made into lamps. Valves of marine and freshwater mussels are used by the Papuans to peel yams; and the employment of mussel-shells to hold gold and silver paint is well-known. As trumpets, in addition to the Indian chank, reference may be made to the large triton (*Triton tritonis*) and the horned helmet-shell (*Cassis cornuta*) of the South Pacific, as well as to a species of the allied genus *Ranella*. In the West Indies the queen-conch is used for this purpose. A hole is drilled in one of the smaller whorls of the spire of these shells to serve as a mouthpiece. In some of the Malay countries table ornaments are made from nautilus shells by cutting open the central chambers; while the entire shells may be used for drinking cups, and are sometimes mounted in Europe as flower vases or dessert dishes. Finally, mention may be made of the Fijian practice of carving imitations of the orange-cowry and the mole-cowry out of sperm-whale teeth.

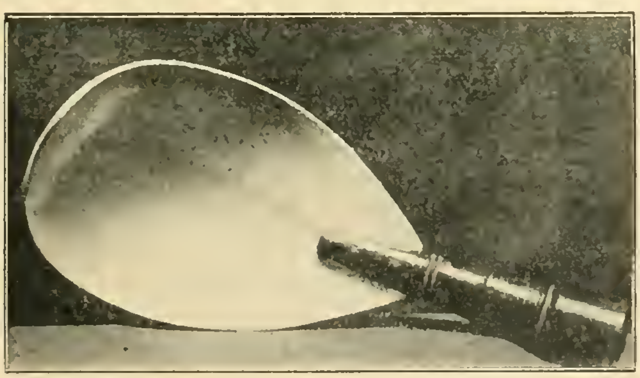


Fig. 2.—Spoon made from the Shell of a Melon-volute.

Turning to the uses of shells, other than mother-of-pearl, among civilised nations, we find the cutting of shell-cameos forming an important industry; although, owing to large brooches being out of fashion, this trade is probably much smaller than in past years. In 1870 the value of the shell cameos imported into Great Britain was three thousand four hundred and forty-five pounds. The favourite shells for large cameos are the black helmet (*Cassis madagascariensis*) from the West Indies, in which the white cameo shows up on a claret ground; the horned helmet (*C. cornuta*) of the South Pacific, which has an orange ground; the scarlet bull's-mouth helmet (*C. rufa*), imported from India and Ceylon, which shows a red or sardonyx ground; and the West Indian queen conch (*Strombus gigas*), with a beautiful pink ground. Of these, the horned helmet is the least satisfactory, as the layers are apt to split; the best being the black helmet, from which a number of cameos can be cut. Those cut from the queen conch lose their colour. The cameos may either be left in the shell, or cut out separately, when they are mounted as brooches, bracelets, studs, etc. Occasionally they are cut in the tiger cowry, when a purple ground is obtained.

In addition to its employment for cameo-cutting, the queen conch is largely imported for other purposes. It is frequently exhibited as an ornamental shell, especially in the London milk-shops; but its chief use is for grinding into powder and mixing with the other constituents of the finer kinds of porcelain. In the year 1850 no less than three hundred thousand of these shells were imported from the Bahamas into Liverpool. Shells also form the finest quality of lime for building and cement; and such lime may be made either from the accumulations of shells on beaches, or by collecting shells for the purpose. In the neighbourhood of the Salt Lake, some distance from Calcutta, two large conical blackish univalves, belonging to the genera *Potamides* and *Telescopium*, are collected from the brackish water in enormous quantities for this purpose. The huge heaps of these molluscs are left to fester in the sun till the soft parts are decayed; and the smell emitted during this process can be better imagined than described. Money-cowries have been employed to form the enamel used in watch and clock faces.

Although the finished products can scarcely be regarded as occupying a very high position when judged by the artistic standard, the manufacture of shell-covered boxes and fancy articles occupies a very important position in the British shell-trade. A large percentage of the shells thus used are collected on the British coasts, and are known in the trade as grotto-shells. Both in this country and in Japan, shells are also employed to make artificial flowers. In the British manufacture large flowers, such as tulips and roses, are those generally selected for imitation; but the Japanese attempt smaller and more delicate blooms. Elegant specimens of their work may be seen in the shell-gallery at the Natural History Museum. Then, again, there is a large trade in various descriptions of common shells, such as small scallops, cockles, polished mussels, whelks, etc., which are mounted with velvet and silk to form pin-cushions, needle-books, purses, and other fancy articles. A number of species of shells are polished and sold as ornaments, as are many of the larger and handsomer kinds in their natural condition. These are known in the trade as fancy shells; and when to these are added the hosts of less common species which pass through the dealer's hands previous to finding a place in the cabinet of the shell collector, it is evident that the total traffic in these beautiful objects must be very large indeed. It seems, however, that the trade is by no means in such a flourishing condition as it was some twenty or thirty years ago; the popular taste for shells, either as natural history specimens, as ornaments, or in the form of shell-boxes, having very appreciably declined.

It may be added that while the majority of shells claim our admiration, both from their form and their colouring, mother-of-pearl owes its position solely to its unrivalled lustre. Another lustrous substance obtained from molluscs is the so-called shell-opal, formed by the fossilized remains of ammonites.

ELECTRICITY AS AN EXACT SCIENCE.

By Howard B. Little.

VI.—The Relation of Modern Electrical Practice to its History, its Units, and its Reasoning.

History, units, and reason are the three essentials to the existence of every exact science. Accidental discovery or observation lays the foundation of history by the recognition of certain facts. The application of reason to these facts tends to the increase of their number, till ultimately the history is sufficiently far advanced, and the reason is sufficiently well directed to produce a series of units, which must, in time, be brought together and arranged in some definite system, and the said system, while rendering as many as possible of its constituents absolute, should also bring about their mutual dependence.

The more exact the science, the greater is its dependence on its history, the more complete its system of absolute units, and the more logically, or mathematically, sound its reasoning.

If it be correct to consider the fulfilment of all the above conditions as essential to the existence of any exact science, and if the above conditions require no amplification, we are furnished with the complete series of tests required for the substantiation of the claim suggested by the main heading of these papers.

Before dealing categorically with these tests it may be well to glance at another proposition:—The ultimate object of the pursuit of scientific truth should be the leading up to some useful practice. Yet, the pursuit is under no circumstances to be abandoned, if only because practice never does make perfect.

But will electrical science pass successfully through the entire series of tests as suggested above?

In answer to this, permit, for the moment, the asking of another question: In which does it fail? The answer is inevitable—In none. But bear with me one moment yet. I wish to press this point, and yet make no assumption which cannot be justified. Assuming the accuracy and completeness of these tests, in the light of the last answer, electrical science would appear to be the very perfection of science. Yet, alas, we are compelled to make this assertion with one important reservation, indicated by the words, "according to our present knowledge."

The idiot's reasoning is undoubtedly, according to his present knowledge, the perfection of logical reasoning. Yet, while freely admitting the truth of this, our appeal is made to the majority, and so far as our discussion has now taken us, we are in this position, we rely upon the verdict of the majority to prevent our falling into mistakes such as could only be termed idiotic. In other words then, our reservation may be expressed by the simple statement that a majority is not always infallible.

Obviously all this implies that our knowledge must be increased, so that future generations may have more history to refer to. It may be urged that the favourable verdict of the majority is taken for granted here. So it is, but with the best justification that can be found, which is that, daily, electrical undertakings are being entered upon, and information from the past (history), units, and reason, as already alluded to, render the carrying out of such undertakings possible.

But now to consider the application of the tests individually. Is modern electrical practice really dependent on its history? Yes, because, apart from the details of observed fact handed down to us, we find that a mere fable, coming to us from the "dark ages," was sufficient to turn the thoughts of many into a channel which ultimately led to the evolution of modern telegraphy.

It will be noted that very frequent reference has been made to telegraphy throughout these papers; this is partly because that branch of the science does furnish a number of very striking object lessons, and partly because, in a limited space, a more striking claim can be worked out if it be based, as far as convenient, upon a single branch.

Is modern electrical practice dependent on its units? No. The value of every unit might be doubled, halved, or multiplied by any arbitrarily chosen number or fraction. Yet, whatever system of units be adopted, modern practice requires such units; and, history leads us to assert that the existing system is the most simple and easily dealt with, therefore the one most in conformity with logical reason. Added to this, what other scientific or commercial measurement is established upon such a basis that the consumer is only expected to pay for that effect which is useful to him?

It seems absurd to put the third test: Is modern electrical practice dependent upon electrical reasoning? Let it suffice to assert that the electrician whose brain is not furnished with a just appreciation of logical argument and an equally just appreciation of mathematical accuracy of thought and practice, besides having these mental weapons so disposed that they are ever ready to hand, had better pause, and consider his equipment before entering upon the struggle perpetually raging in the "excited field."

And, finally, if I have in any way succeeded in the task which I originally set myself, I have made it clear that of all sciences as we know them to-day, "Electricity *is the most* exact." I lay myself open here to very many accusations, and I would attempt to deal with the charge which is likely to be preferred against me by the greatest number of scientific workers. I mean that I shall probably be told on all hands: "Ah, yes, but you have not studied our science, so your claim is absurdly unscientific; how dare you make it?" In such a case, my answer would be, Is there any living man who has completely studied any single science? I am free to admit that I have by no means done this as regards electricity, and with reference to any other science concerning which I may have gleaned a few facts, it is highly probable that my knowledge there is only sufficient to be dangerous.

Yet, from what I know of electricity I am compelled to the assertion that not all the other sciences put together, excepting perhaps mathematics, have contributed to the advancement of matters electrical so much as the expansion of electrical undertaking has added to almost any single one of its sisters which have been longer in practice.

Even at the risk of seeming impertinent (need I explain that my object is simply to bring out the truth?), I would venture to assert that electrical practice *per se* to-day is saving human life at a greater rate than that accomplished by medical practice. Also it should not be forgotten that while doing this *the* science finds time to vastly strengthen the hands of the medical practitioner to a far greater extent than has occurred in the other direction.

Again, the bacteriologist, or let us say the chemist, owes more individually to the electrician than the latter owes to them collectively. But it seems at best ungracious to continue expatiating upon such a theme. Let us look upon the other side of the medal.

Electrical science owes almost every good thing it has to show to mathematical reasoning. Indeed it is just because so very many electrical problems can be worked out upon a basis of pure mathematics that electricians are so frequently able to prophesy. Mechanical engineers do this, too, to a great extent, yet not, I think, quite so often as electricians, added to which, the calculations of mechanical stresses and strains, steam pressures, and the heat to be got from any particular fuel, are not yet quite so nicely calculable as we may expect to see them in the future.

In this connection I would turn aside for a moment, and endeavour to make clear a point which I attempted to bring out in the first chapter of this series. I stated there (p. 20, bottom right) that "Electrical science owes its present position to the facts, and distortions of fact, propounded by the ancients." This statement has since been called into question more than once, and I have been blamed for asserting that any science could be indebted (in any circumstances) to a distortion of fact. Doubtless I did not express myself well there. What I meant to imply was that a deliberate untruth which savours of the marvellous will often draw attention to the subject concerning which it has been told, and so, investigation in a thoroughly honest spirit will frequently ensue.

And, since "There must be no finality"—I forget from whom I am quoting, but remember that the remark was made some time since with reference to electrical research —shall I be transgressing if I venture to point out that scientific workers everywhere are constantly having a "full stop" put to their undertakings by a most vexatious system which unfortunately prevails among us?

As we approach the dawn of the twentieth century it is depressing to find that, while the Institution of Electrical Engineers has taken great pains to formulate a series of rules for the wiring of houses, yet that body has absolutely no power to enforce the adoption of such rules.

In this connection many other instances of something like grave (if not culpable) stupidity on the part of some person, or persons, could be cited. Anyone who has carefully studied several reports of the proceedings of Royal Commissions, or of Board of Trade enquiries, will in all probability see quite clearly what I mean.

But, the disease having been alluded to, what is the remedy?

Expert evidence is almost invariably discounted, and as a rule to no small extent, simply because the legal mind (having devoted very much the greater part of its energy to the study of "the Law") has neither the time nor the capacity to understand nice points of technical difficulty. This being the case, why should not recognised scientific bodies become, to a much greater extent, a law unto their several members? Must the settlement of some intricate point connected with polyphase distribution be discussed, argued, and finally decided upon, by men who are uncertain yet as to whether it is or is not possible to find a spot on earth which cannot be regarded as a place?

What is to be done? As time goes on the "infant" will some day attain its majority, and demand its inheritance. What then will be the position of its guardians for the time being if they have to answer that the heritage referred to is in Chancery, or has been "fisked" by some constituted authority?

But it is by no means only electrical science which is like to be kept out of its own—at least for a longer period than is right. Every other useful science is "put upon" in the same manner.

And the one hope seems to rest upon the chance that some day all scientific bodies will develop a far better feeling of public spiritedness and, in consequence, will unite, so strengthening the position for themselves in the first place, then, following up this action, will make a dispassionate appeal to a right-minded government, asking only that something may be done to remove this stumbling block.

I am suggesting no Utopia, but venture to urge that at least one step be taken in the direction I have ventured to indicate.

UPS AND DOWNS IN OUR DAILY WEIGHT.

By W. W. Wagstaffe, B.A., F.R.C.S.

These are days of "penny in the slot," and possibly everyone weighs very frequently for his own amusement. Even if the machines are not very accurate, the probability is, that if you weigh regularly on the same machine, you can see correctly whether you increase or diminish in weight.

We are not concerned here with the steady increase or diminution in weight at various times of the year, or before and after an illness; but I want to draw attention to the fact that in health we vary in weight from hour to hour, and that this does not seem to be recognized.

It is strange to see what absurd fallacies occupy the popular mind. *A propos* of the subject of this paper, it has been seriously asserted by many people that you are naturally lighter after a meal, and they have even gone the length of explaining this by the amount of gas that is developed from the food. These people must be very uncomfortable after meals! It reminds one rather of the famous fallacy said to have been submitted to the Royal Society, asking why a fish could be put into a basin brimful of water without making it run over. When it was tried at someone's suggestion the water, of course, did run over.

Supposing we want to find whether we do really vary in weight or not, there are two ways to set about the enquiry. We can either sit in a weighing machine and live there—which does not commend itself to most of us—or we can weigh ourselves at regular times during the day, which is more feasible. Now common sense points out that we must vary in weight according to the amount of food we take in, and the amount of material that we lose.

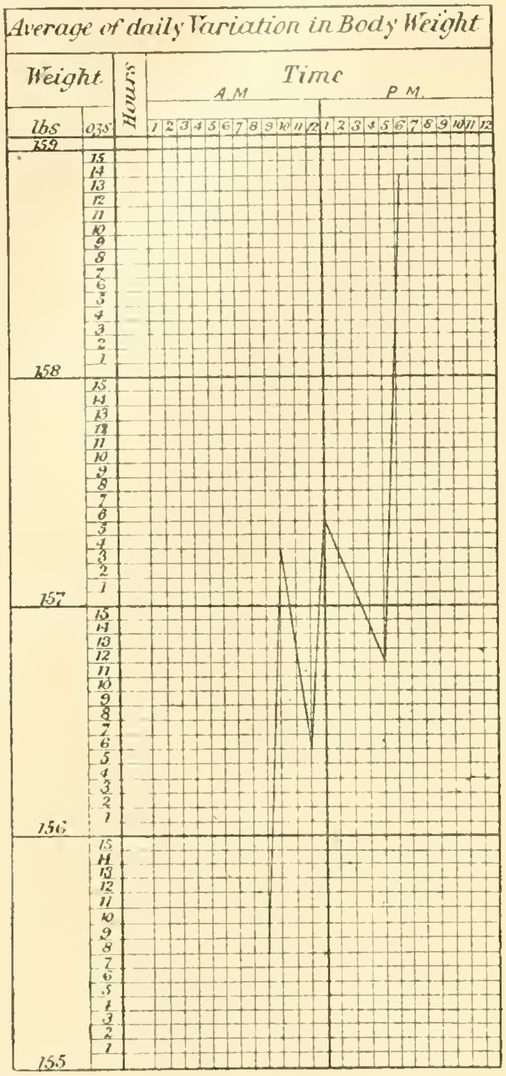
In the following chart the observations are arranged in such a way as, I think, will make them clear. Statistics are always painful, unless the writer has the wonderful power of Mr. Schooling, who certainly can make statistics attractive. But, perhaps, the most convenient method is to look at the summary diagram first, and this shows what can be represented in figures without much difficulty.

Average.	lbs.	ozs.		lbs.	ozs.	
9 a.m.—Before breakfast	155	8	(losing	3	6)	during night.
10 a.m.—After ,,	157	4	(gaining	1	12)	
12 noon.—Before lunch	156	6	(losing	0	14)	
1 p.m.—After ,,	157	6	(gaining	1	0)	
5 p.m.—Before dinner	156	12	(losing	0	10)	
6¼ p.m.—After ,,	158	14	(gaining	2	2)	

By these it will be seen that we lose three pounds six ounces between night and morning; that we gain one pound twelve ounces by breakfast. That we again lose about fourteen ounces before lunch; that lunch puts on an average of one pound; that we again lose during the afternoon an average of ten ounces; but that an ordinary dinner to healthy persons adds two pounds two ounces to their weight. What would be the result of a big dinner? It is easier to imagine than to describe. And yet on more than one day there was a difference of two pounds eight ounces; but this is not very excessive considering that a pint of fluid weighs about a pound.

Now what are the greatest differences here recorded?

The greatest difference was between the night and morning of three pounds twelve ounces, and this may be accounted for by the natural loss of weight, partly by the perspiration at night, which is variously estimated by different authorities at from two to four pounds, and partly by the natural loss of weight from obvious causes. It



would be a simple course to weigh the *excreta*; but has this been done?

The foregoing are the average weights of a healthy man, engaged in ordinary work; however, fuller observations are certainly wanted.

Some very curious records of variations in body-weight at different times in the year have been given by a Danish observer, Mr. Hansen, but these are what may be called periodic phenomena. If children be studied—and these are more closely related to the lower forms of animal and vegetable life than are adults—periods of growth, of fattening, and of equipoise are distinguishable. Mr. Hansen, of Copenhagen, from a very large series of observations of children, shows that there is an increase of weight from August to December, and a season of growth from April to August, and a period of rest both in weight and growth from December to April. These observations, however, do not touch the question which this paper tries to make rather clearer—that of daily variations in body-weight in a healthy person.

If any one were careful to take similar observations in asylums, infirmaries, and hospitals, it is quite possible some difference might be found according to age, sex, and conditions of disease, and it is possible there might be a difference according to nationality.

What has been learnt from the weighing of a fasting man at different times? And would not periodical weighing help to detect some of the shammers?

I think it will be seen from the above that it is important to choose the time for weighing a recruit, or even a person submitting himself to life insurance, and is it not a matter of interest to all of us to learn a little more about ourselves in any way?

IS THE STELLAR UNIVERSE FINITE?

By Gavin J. Burns, B.Sc.

In my paper on the "Distribution of Stars in Space,"* I advanced some facts and observations which tend to show that the number of faint stars is much smaller than it would be on the hypothesis that stars of all degress of intrinsic brightness are uniformly distributed throughout space, and so the stars present the appearance of thinning out as we recede from the solar system.

There appear to be four possible hypotheses as to the probable cause of the reduction in the number of faint and telescopic stars:—

1. Absorption of light by the luminiferous ether.
2. Absorption of light by a gas filling interstellar space.
3. Absorption of light by cosmical dust.
4. A progressive decrease in the density of stellar aggregation as the distance from the sun increases.

The loss of light in passing through a semi-transparent medium will augment as the distance increases and the light of the most distant stars practically obliterated.

1. We may dismiss the hypothesis that a plane wave of light diminishes in amplitude in traversing the luminiferous ether as being void of experimental foundation; moreover, it is difficult to reconcile with the law of the conservation of energy. When light is absorbed in its passage through a material medium, it is transformed into heat, and the medium is warmed; but in traversing the ether, what would become of the heat?

2. Regarding the hypothesis that the interstellar spaces are filled with matter in the gaseous form, matter can only exist in the attenuated state when above a certain temperature, and in extra-terrestrial space a cold obtains akin to absolute zero in which known gases would be congealed; besides, if a gas were diffused throughout space, we should expect to see its absorption lines present in the spectra of all stars, but no such lines have been observed.

3. Absorption of light by cosmical dust must be regarded as not only possible but probable; the only pertinent question which presents itself is—what is the quantity distributed and the amount of light it can intercept? Suppose that at some remote period of time cosmical dust was densely scattered throughout all space, producing an effect on the light of the stars like that of a terrestrial fog, causing the nearer lights to be dimmed, and the farther ones entirely obscured; then, if these particles of dust were originally at rest, they would not remain so; for, since gravitation is universal, each particle would begin to move towards some centre of attraction and its motion continue with ever-increasing velocity till it reached the attracting centre; thus, in a comparatively short space of time, the whole of the cosmical dust would aggregate around the larger masses which might, or might not, be lucid stars. If the particles of cosmical dust were originally in motion, a like result would follow, the time required being greater, for each particle, moving till it came within the influence

* See Knowledge, July, 1899, p. 152.

of some attracting mass, would ultimately fall therein, the particles of highest initial velocity deferring this common fate the longest. The extraneous comets and meteors that visit the solar system must be considered as a few scattered fragments that have avoided capture. The light intercepted by the small bodies that still wander in space unattached to an attracting centre we may look upon as a negligible quantity.

4. There remains the hypothesis—the only natural and obvious one—that the stars do really thin out and ultimately cease as their distance from us increases. On the supposition that the stars are infinite in number, it follows that a straight line drawn in any direction from the eye of an observer on the earth will ultimately meet a star. Now, it is a well-known law in optics that the brightness of a body is independent of the distance, and that the quantity of light received from a sphere of constant brightness only depends on the area of its apparent disc; consequently the total light received from a number of stars is proportional to the total area of their apparent discs; but, if the number of stars were infinite, this area would be simply that of the whole sky; hence we should have the whole sky one blaze of light! Therefore the number of stars must be finite.

It does not, however, absolutely follow that the stellar universe is finite. We may escape from this conclusion by imagining that outside the luminous stars there is an infinite number of dark bodies that are never seen, and that the visible universe is bounded by clouds of cosmical dust which conceal everything beyond; but this is unsupported by evidence.

A reference to popular works on astronomy will show that there is a great reluctance to adopt the view here presented. "We cannot imagine such a thing to be possible" is the argument put forward. What any person thinks possible or impossible depends on his mental constitution.

Granting that the universe is finite in space it follows that it is finite in time, for the quantity of matter and of energy it contains are both finite; the energy is being steadily dissipated in the form of radiant heat; this constant loss of heat cannot have persisted for an infinity of time past, and it must end in the future.

But if we adopt the hypothesis of a finite universe, we at once meet with a number of questions which it is impossible to answer. What, for instance, is the destination of 1618 Groombridge, with its velocity of two hundred and thirty miles per second? It has been calculated that this star must pass out of the stellar universe altogether, there being no known force sufficient to restrain it. Are there other universes constructed on different principles from ours? Is the ether finite? and what becomes of the heat constantly radiated into space? Perhaps the real solution of the difficulties thus presented by a finite universe is metaphysical. The human intellect is so framed that it can only conceive space as infinite, and yet can form no conception of infinite space. Possibly space without limit is a mental illusion.

The only satisfactory method of dealing with such a question as the limits of the stellar universe is by inference from observed facts.

[We fear Mr. Burns' handling of this subject is scarcely conclusive. We have no means for experimenting on the first of his four hypotheses. Mr. Burns' second argument proves too much. It would follow that the existence of matter in the gaseous state is impossible in interstellar space, a conclusion which the existence of gaseous nebulæ of enormous tenuity and extent appears to controvert. Under the third head he supposes that the particles of cosmical dust would all soon fall in to some attracting body; whereas they would revolve round it in nearly all cases. Whilst the assumption that if the stars were infinite in number, "the whole sky would be one blaze of light," supposes something as to their distribution. We see that the earth is small as compared with its distance from the nearest other planet, and that the solar system is small as compared with the distance separating it from the nearest star. If the same rule prevails on the larger scale; if the dimensions of star systems are small as compared with the distances between them, then "a straight line drawn in any direction from the eye of an observer on the earth, will," in most cases never "meet a star."—E. Walter Maunder.]

PHOTOGRAPH OF NEBULÆ SURROUNDING THE STAR D.M. NO. 1848 MONOCEROTIS.

By Isaac Roberts, D.Sc., F.R.S.

The photograph annexed is of the region in the sky comprised between R.A. 6h. 57m. 53·5s. and R.A. 7h. 2m. 52·7s., and in declination between south 11° 9′·9 and 9° 34′·1. The area, therefore, is 4m. 59·2s. in extent from *following* to *preceding*, and 1° 35′·8 in south declination. Scale, one millimètre to twenty-four seconds of arc.

Co-ordinates of the fiducial stars marked with dots for the epoch 1900.

Star (.) D.M. Schönfeld No. 1818 Zone −9° R.A. 6h. 59m. 12·9s. Dec. S. 9° 58′·6. Mag. 6·3.

Star (..) D.M. No. 1862 Zone −10° R.A. 7h. 1m. 6·3s. Dec. S. 10° 30′·5. Mag. 7·0.

Star (∴) D.M. No. 1854 Zone −9° R.A. 7h. 2m. 36·7s. Dec. S. 9° 49′·7. Mag. 7·3.

The nebulæ I assume to be new to science, for they are not referred to in the catalogues, and by referring to the nebula N.G.C. 2237–9 Monocerotis, a photograph of which was published in the number of Knowledge for June last, it will be seen that the three nebulæ are in near proximity to each other.

The photograph was taken with the twenty-inch reflector, and exposure of the plate during 2h. 47m., on the 9th of March, 1899, and it shows the brighter nebula to be of a flocculent character with some faint star-like condensations involved, and the star D.M. 1848, which is *north preceding* the centre, seems to be on the margin of a dark sinuous vacancy, or rift, in the nebula, through which we can see into the starless vacancy of space beyond it. Sharply-defined zig-zag dark rifts have been shown on other photographs of cloud-like extensive nebulæ which have been published in Knowledge, notably that designated N.G.C. 2237–9 Monocerotis, and in a less striking manner, N.G.C. 1499 Persei, H V. 37 Cygni, H V. 14 Cygni, the Great Nebula in Orion, and others. The "keyhole" in the nebula round η Argûs greatly resembles that shown in this nebula.

These vacancies are most conspicuously seen where the surrounding nebulosity is dense, though they are also visible in some parts where it is relatively faint. The margins of the vacancies are often sharply defined and suggestive of the idea that in consequence of some internal strain, operating from opposite directions, the nebula was rent asunder and the parts separated from each other. We could also imagine that another nebula, of smaller area than this, moving in space at nearly right angles, and being edgewise to it, rushed through carrying along in its course so much of the material of this nebula as would be represented by the sectional area of the other, and thus producing a vacancy resembling the sectional contour. At first sight this idea would appear to be too improbable, but if we examine some of the nebulæ that have been photographed and presented to our view nearly as straight lines because they are seen edgewise, and others seen nearly edgewise and with rugged irregular surfaces which are not unlike some of the outlines of these vacancies, we should admit that there is some force in this suggestion. This nebula presents, roughly, a circular surface with a large gap cut out of it on the *north following* side. It measures about twenty-two minutes of arc from *south following* to *north preceding*, and eighteen minutes from *north following* to *south preceding*. On the south, *south following* and onwards to *north following*, is an extensive faint cloud of nebulosity more than one and a half degrees in extent, and apparently connected by faint streams of nebulous matter with the nebula just described. It curves round the fiducial star (..), and almost touches fiducial star (·.·).

The surfaces of these nebulæ are strewn with numerous stars besides the nebulous condensations which are, doubtless, involved in the nebulosity, but it is probable that the stars are not involved, and are placed either behind or else in front between the earth and the nebulæ.

The stars that are shown to be distorted on the photograph are double or multiple stars, although it does not follow that they are physically connected, and it will be many years hence before this can be either proved or disproved because of their vast distances from the earth.

THE NOVEMBER METEORS OF 1899.

THE predicted time of maximum of the November meteors is November 15th, 1899, at 18h. Greenwich mean time. As a similar shower may not occur again for thirty years, no pains should be spared to secure the best possible observations. The most useful observations that can be made by amateurs are those which will serve to determine the number of meteors visible per hour throughout the entire duration of the shower. Circular No. 31 was accordingly distributed last year, and numerous valuable observations were thus secured from observers in all parts of the world. The results are now being discussed by Professor W. H. Pickering, and will be published later in the Annals of the Harvard Observatory. Similar observations are desired this year, and it is hoped that they may be made on November 15th, and also on the two preceding and following evenings. The most important time for observation is from midnight until dawn, as comparatively few meteors are expected earlier. Observations are particularly needed at hours when they cannot be made at the observatories of Europe and America. In general, the time required for ten or more meteors to appear in the region covered by the accompanying map should be recorded. This observation should be repeated every hour or half-hour. If the meteors are too numerous to count all those appearing upon the map, the observer should confine his attention exclusively to some small region such as that included between the stars μ Ursae Majoris, 40 Lyncis, δ and α Leonis. If the meteors occur but seldom, one every five minutes, for instance, the time and class of each meteor should be recorded. Also, note the time during which the sky was watched and no meteors seen, and the time during which that portion of the sky was obscured by clouds. Passing clouds or haze, during the time of observation should also be recorded. The date should be the astronomical day, beginning at noon, that is, the date of early morning observations should be that of the preceding evening. Specify what time is used, as Greenwich, Standard, or Local Time. When a meteor bursts, make a second observation of its light and colour, and when it leaves a trail, record the motion of the latter by charting the neighbouring stars, and sketching its position among them at short intervals until it disappears, noting the time of each observation. If the path of a meteor is surely curved, record it carefully upon the map.

On November 14th, 1898, thirty-four photographs were obtained of eleven different meteors. Their discussion has led to results of unexpected value. The greatest number of meteors photographed by one instrument was five. Only two meteors were photographed which passed outside of the region covered by the map, although the total region covered was three or four times as great. No meteors fainter than the second magnitude were photographed.

Photographs may be taken, first, by leaving the camera

at rest, when the images of the stars will trail over the plate and appear as lines, or, secondly, attaching the camera to an equatorial telescope moved by clockwork, when a chart of the sky will be formed, in which the stars will appear as points. A rapid-rectilinear lens is to be preferred in the first case, a wide-angle lens in the second. The full aperture should be used, and as large a plate as can be covered. The most rapid plates are best for this work; they should be changed once an hour, and the exact times of starting and stopping recorded. Care should be taken to stiffen the camera by braces, so that the focus will not be changed when the instrument is pointed to different portions of the sky, especially if the lens is heavy. If the first method is employed, the position of the camera should be changed after each plate, so as to include as much as possible of the region of the map on each photograph. If pointed a little south-east of ε Leonis, the radiant will reach the centre of the field about the middle of the exposure. A watch of the region should also be kept, and the exact time of appearance and path of each meteor as bright as the Pole Star should be recorded. The plates should be numbered on the film side with a pencil, and should be sent to this Observatory with accompanying

NEW NEBULÆ IN MONOCEROS.

By ISAAC ROBERTS, D.Sc., F.R.S.

S.

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N.

notes and other observations. After measurement here, they will be returned if desired. The value of the results will be much increased if similar photographs can be obtained by a second camera from ten to forty miles distant, and preferably north or south of the other.

Edward C. Pickering.

Harvard College Observatory, September 18th, 1899.

THE "SEAS" OF THE MOON, WHAT ARE THEY, AND WHAT IS THE CAUSE OF THEIR OBSCURE APPEARANCE?

By J. G. O. Tepper.

The dark areas in the moon known as "Seas" were originally considered to be real seas, but now that it is known positively than no water can exist there, either as such, or as ice, or vapour, the dark areas still remain unexplained. For, while perfectly visible at the full in distinct outlines of one form, they either disappear entirely in very oblique light, or their form is wholly changed. This shows that the dark appearance is merely the effect of excessive absorption of light, and of diminished reflection according to the incident angle, but not of irregularity of surface, *i.e.*, effect of shadows.

In venturing to suggest a *possible* explanation, I do so with the distinct aim of initiating a discussion on the phenomenon, and not of proving the suggested hypothesis as anything more than probable.

The moon is known, or rather accepted, to be a dead world, *i.e.*, one once exhibiting similar phenomena of physical life to our own, viz., supporting vegetable and animal organisms.

Now what would happen if our Earth suffered the same fate?

The great bulk of both plants and animals consists of water and carbon. The burning of the latter, its combination with oxygen, produces the bodily warmth requisite for animal life, the combination escaping in gaseous form into the atmosphere as carbon dioxide (CO^2) popularly known as carbonic acid, which in Nature plants alone can dissociate, and so as to reproduce the carbon in suitable form for food. Besides this, carbon forms the fuel for the production of artificial heat, as wood, coal, kerosene, etc.

If the water supply is at all small in comparison with anhydrous minerals eager to combine with it into permanent heat-resistant compounds (rocks), it will gradually diminish and finally disappear. The same will be the case with the nitrogen of the air as well as the oxygen, the greater part of oxygen being locked up for the time in vegetable substances, such as wood, coal, mould, and animal bodies, while nitrogen would principally be absorbed by animals and caustic alkalies together with the remaining oxygen.

With the diminution of the water, and the atmospheric gases the decay (disintegration) of dying organisms would be at first more and more delayed until all were dead besides the *mould* of the soil, the last memorials of organic life.

There being no longer any amelioration of heat or cold through the biophysiological action of plants, air, etc., they would now succeed each other without gradation. While the cold would tend to preserve the carbon compounds, the heat, with the sun pouring its rays on the highly absorbent rocks for half a month would probably raise their temperature to, or above, 200° or 300° Cent.; then the organic bodies would be gradually dissociated (not *burned* but charred, for there would not be sufficient oxygen), the excluded gases and moisture would be eagerly appropriated by the nearly red hot minerals, and locked up permanently among the rocks.

The only substance that would remain unprovided for on account of its weak affinities to any of the common gases at high temperatures would be carbon, and most likely in the form of dust, or minute flakes, wafted by the more and more decreasing currents of the last remnants of an atmosphere to the lee of gentle declivities, and upon the great low-lying plains, wherever the opposing currents counterbalanced each other.

Since the total disappearance of the atmosphere no currents can possibly exist, and the finest, lightest dust must remain eternally undisturbed, except by the rude shock of a colliding meteor, or when ploughed aside by such, if gliding along after a very oblique impact.

It is well known that there is no body more absorptive of light than finely divided carbon particles, hence their intensely black aspect. At the same time, dust, or loosely cohering matter, reflects little light, except at very oblique angles of incidence.

In the "seas" of the moon we may, therefore, have large areas covered by carbonaceous dust, the last remains and the last evidence of the former vegetable and animal organisms of our satellite. For the one class cannot possibly exist without the other, unless in the lowest forms known as Protozoa and Protophyta (*i.e.*, the same organism discharges the function of both, in absorbing carbon and nitrogen exclusively).

As an hypothesis the above appears to me to fulfil most, if (perhaps) not all, the conditions demanded in the works perused by me, and I shall be glad to learn wherein it fails.

Letters.

[The Editors do not hold themselves responsible for the opinions or statements of correspondents.]

"MAN; PAST AND PRESENT."

To the Editors of Knowledge.

Sirs,—In his appreciative notice of this book, for which he has my best thanks, your reviewer objects to my use of the expressions "old stone age" and the "new stone age" as applied to "chronological periods; more properly they apply to stages of culture. We cannot but think that such abuse of the terms leads to much confusion. We speak of a neolithic period as if it were a past age. So it is, so far as we are concerned, but it may be pointed out that there are still many savage races living in a stage of neolithic culture." This is also my teaching, and I take some pains to make the matter plain in the "Ethnology," which the writer has evidently not seen, but is necessary to the right understanding of "Man; Past and Present." Thus, p. 72: "The question is beset with snares and pitfalls, due especially to the fact that the very terminology itself does not everywhere connote the same order of sequence, much less the same periods of absolute time. Thus palæolithic implements in the New may in some cases correspond with neolithic implements in the Old World, and in all the continents except Australia, where one order alone exists, various phases of progress go on simultaneously rather than consecutively." After giving several instances, I go on (p. 73): "Such overlapping of old and new, such persistence of low primitive cultures in the midst of highly advanced populations, tend to obscure the time relations, which are here under consideration. It is obvious, for instance, that implements of the most primitive types . . . . cannot of themselves be any test of age. They represent no sequences, but only an incipient growth permanently arrested and by adverse conditions prevented from attaining its normal development. Where there is no change there is no standard by which to measure time. Hence the mistake made, especially by some American ethnologists, who have assigned a considerable antiquity to certain native cultures, solely on the ground of the rude implements with which they appeared to be associated. Certain objects, such as flint flakes or chippings, if found on or near the surface, or under other circumstances not necessarily involving great age, might have been made at any time, and are now still made by many peoples not yet brought under higher influences." Hence readers of the "Ethnology" understand quite well that the expressions in question are used in "Man; Past and Present" not in an absolute, but only in a relative sense, implying time sequence not universally, but only in the culture areas.

Farther on the reviewer criticises the use of the term "cornea" as applied to the yellowish sclerotic of the negro peoples. Here, also, a reference to the "Ethnology" ("sclerotic" in the European whitish, in the negro yellowish, pp. 186-7) shows that I am speaking, not of the *Cornea pellucida over* the iris, which, of course, is transparent and colourless, but of the *C. opaca round* the iris, the colour of which varies racially. The two books are intended to be read together, and I may here add that they form parts only of an ethnological treatise which I hope to complete in a third volume. Then many things which now seem strange, and have laid me open to criticism, especially by specialists, will be made clear. A. K. Keane.

TREE STRUCK BY LIGHTNING.

To the Editors of Knowledge.

Sirs,—I have read with much interest Baron Kaulbars' letter in your issue of this month, as a parallel case to those he mentions occurred in 1852 to a large old oak tree in Westwood Park, near Droitwich. The tree was completely uprooted, and the trunk shivered into three parts, the remains of which are still lying where they fell. The boughs were rent and scattered in all directions, some to a distance of many feet. Such a result of lightning was, I think, then considered to be unique, and Faraday was asked his opinion as to the cause. He held that the lightning must have got down the hollow stem, and, meeting with damp at the bottom, generated steam, and so caused an explosion. After reading Baron Kaulbars' letter, I have no doubt it was the true explanation. It is possible this case may still be unique as an effect of lightning on a *tree*, as the only precisely parallel case Baron Kaulbars gives is the very curious one of the monumental column in Gatchina. Hampton.

Waresley Court.

SUSPECTED VARIABLE STARS.

To the Editors of Knowledge.

Sirs,—I object to convicting anything on suspicion, be it man, woman, or star, and although my friend Mr. Gore's suspicions would be quite sufficient to convince the Home Office in the case of a convict, they do not convince me.

With regard to photometric measures, the Pole Star has been always (I think) adopted as the standard. But what if the Pole Star varies in its light? I have not as yet seen the details of the alleged discovery made in relation to it at the Lick Observatory; but with a binary or ternary system of very short period there must always be a considerable risk of one of the members of the system overlapping another and thus diminishing the light. If this occurs with the Pole Star, its variations may cause other stars to be erroneously suspected.

Then, as to stars whose light is of different colours, it is probable, as Mr. Backhouse remarks, that different observers will rate them differently, owing to the peculiarities of their sight. One eye may be more sensitive to white light and another to light with a reddish tint. And very possibly there may be a systematic difference on this point between the Oxford and Harvard photometries in which the methods of estimating star-magnitudes are different. I would lay very little stress on one observer describing Vega as brighter than Arcturus, while another described Arcturus as brighter than Vega. Nor is this difficulty surmounted by photometry. The ultimate comparison is made by the eye, and the colour of the stars may affect this. We must have the same observer in order to prove the variation, unless the amount is large. And even with the same observer the result is open to question. The stars are probably not at the same altitude, and a larger proportion of the light of the star is absorbed when the star is at a low altitude than when it is at a high one. But we have further a proof every moonlight night of how much the visibility and brightness of a star depends on the condition of the surrounding portion of the sky. Indeed, but for this, all the stars would be seen in the day time. Hence a star which lies pretty low in the west will look faint after sunset, as one which lies pretty low in the east will look faint before sun-rise. And on a moonlight night a star near the moon will look fainter than one remote from it. We may, perhaps, even underrate the magnitude of a star in or near the Milky Way owing to the comparative brightness of the surrounding portion of the sky.

As to star-magnitudes, it is only very recently that any scientific scale was adopted for measuring them. Even Sir J. Herschel seemed to conclude that we could not go beyond 0, and thus crowded an undue number of stars into the interval between 0 and 1. The chief value of magnitudes determined without the guidance of any fixed scale seems to consist in showing which of two stars was regarded as the brighter by a person who observed both. Double stars often afford examples of the defects of eye-estimates not guided by principle. Take for example Castor and γ Leonis. Referring to the *Handbook of the Double Stars* (ed. 1879), I find the components of Castor given as 3·0 and 3·5 (in the catalogue 3 and 4) and those of γ Leonis at 2·0 and 3·5 (in the catalogue 2 and 3). Webb (ed. 1881) gives for Castor 2·7 and 3·7, and for γ Leonis 2·0 and 3·5. According to these estimates γ Leonis would of course be the brighter star. I find similar estimates given as late as the last edition of Mr. Chambers' *Descriptive Astronomy*—and Prof. Pickering published an elaborate computation based on them as well as the supposed orbits. But it is beyond question that Castor is brighter than γ Leonis by at least half a magnitude, and consequently the estimated magnitudes of the components must be seriously in error. Even as regards Algol the old estimate of the reduction of the light by two magnitudes seems to be generally current, notwithstanding the photometric measures of Prof. Pickering, which make it almost exactly one magnitude.

That some of Mr. Gore's "suspects" are really guilty I can quite believe, but I think we require a further investigation into the causes of variation in observers' estimates. I have an idea, too, that an examination of the spectrum of a star would often tend to confirm or remove the suspicion. A good determination of the spectra of all known variable stars would, I believe, form a very useful guide to the examination of suspicious objects.

W. H. S. Monck.

R. LEONIS, MIRA, AND S. S. CYGNI.

To the Editors of KNOWLEDGE.

SIRS,—A maximum of R. Leonis was predicted for June 26th, 1899, but eliminating all corrections and seeming errors, and computing from previous data, especially from Gore's observation of February 17th, 1890 (*B. A. A. Reports*), which was, according to Yendell (*Pop. Ast.*, June 1897), four days late, the maximum should have occurred July 23rd of the present year. I have followed the star assiduously this season, and hope the figures presented will show a curve characteristic of this highly interesting variable.

		Mag.			Mag.
Feb. 19, 27	...	10·00	May 5	...	8·05
Mar. 2	..	10·00	,, 6		7·90
,, 8	...	9·70	,, 7	...	7·85
,, 9	.	9·75	,, 8		7·65
,, 12	...	9·60	,, 9		7·10
,, 15	..	9·50	,, 12	...	6·90
,, 19	.	9·32	,, 13	...	6·95
,, 28	..	8·80	,, 14, 15	...	7·00
,, 29, 30	..	8·70	,, 16	...	6·87
Apr. 1	. .	8·65	,, 19	(red)	6·35
,, 4	..	8·45	,, 20, 21	...	6·25
,, 8	...	8·47	,, 24, 25, 26, 27, 29, 31		6·25
,, 9	...	8·37	June 1, 2, 3, 4	...	6·25
,, 12	..	8·00	,, 5, 6, 7	.	6·30
,, 15	..	8·15	,, 13	...	6·35
,, 16, 17	..	7·90	,, 14	...	6·30
,, 23	.	8·10	,, 17	...	6·45
,, 25	...	8·05	,, 18, 19	...	6·40
,, 26	..	7·90	,, 21	...	6·50
,, 27, 28	.	7·95	,, 22, 23	...	6·55
,, 29	...	8·05	,, 27, 30	..	6·65
,, 30	. .	8·00	July 2	...	6·95
May 1	.	7·95	,, 3	...	7·10
,, 3		7·90	,, 5	...	7·15
,, 4	...	7·41	,, 9	...	7·40
			,, 10	(lost behind trees).	

Putting the maximum on May 21st, the star is still, allowing all corrections and errors, thirty-five days ahead, and by my own figuring sixty-three days. The following is a record of S. S. Cygni, maximum just passing :—

		Mag.			Mag.
Aug. 22	(invisible)		Sep. 2	...	8·15
,, 23	...	8·25	,, 3	...	8·30
,, 24	...	8·20	,, 4	...	8·35
,, 25, 26	...	8·05	,, 5	...	8·90
,, 27, 28, 29, 30		8·25	,, 6	...	9·60
Sep. 1	...	8·30	,, 7	(last seen)	10·00

There is no error or mistake in the light of the star on August 25th and 26th, as it stood out bright and distinct from its surroundings.

My first view of Mira o Ceti this season was on July 19th at 3 a.m., when it was about 7th magnitude, and I have eighteen observations since then, more than one-half being in the small hours of the morning. From July 19th to August 20th, the star advanced slowly and came to a halt, at which it remained for several days and then fell slowly, reaching 5th magnitude when last seen September 7th. Whether the maximum is past or one is to come remains to be seen.

Memphis, Tenn., U.S.A., DAVID FLANERY.
11th September, 1899.

British Ornithological Notes.

Conducted by HARRY F. WITHERBY, F.Z.S., M.B.O.U.

Rose-coloured Pastor in Ireland (*Irish Naturalist*, October, 1899, p. 230).—Mr. E. Williams records that an adult male of this species, which is of very irregular occurrence in Ireland, was shot by Mr. A. Brooke, at Killybegs, Co. Donegal, on July 20th last.

Night Heron in Co. Wexford, Ireland (*Irish Naturalist*, October, 1899, p. 230).—Mr. G. E. H. Barrett-Hamilton records that a male of this species was shot near Killinick, and is now in the Dublin Museum. The Night Heron is a rare visitor to Ireland. Mr. Hamilton thinks that only fifteen instances of its occurrence have been recorded, while Mr. Saunders puts the number at about twenty.

Wood Sandpiper in Co. Waterford, Ireland (*Irish Naturalist*, October, 1899, p. 231).—Mr. E. Williams writes that a Wood Sandpiper was shot by Mr. J. F. Knox on the Black Strand, Tramore, Co. Waterford, on August 26th last. This is only the fifth specimen of the species which has been recorded for Ireland.

Increase and Decrease of Certain Species of Birds in the Tay Area. By Col. John Campbell, M.B.O.U. (*Annals of Scottish Natural History*, October, 1899, pp. 198-206).—Col. Campbell gives an interesting and satisfactory history of the increase of the Tufted Duck, the Pochard, the Widgeon, the Shoveller, and the Stock Dove in the Tay area. He also gives reasons for the deplorable decrease of the Goldfinch, Dotterel, Spotted Woodpecker, and other birds, and suggests remedies. The paper is a valuable addition to others of the same kind which have appeared from time to time in the pages of our contemporary.

Observations on the Birds of the Islands of Tiree and Coll. By Lt.-Col. L. H. Irby, F.L.S., F.Z.S. (*Annals of Scottish Natural History*, October, 1899, pp. 206-210).—Col. Irby here supplements a list of the birds in Tiree by Peter Anderson, published in the same magazine in July, 1898.

Scaup-duck Nesting in Scotland. By J. A. Harvie-Brown (*Annals of Scottish Natural History*, October, 1899, pp. 215 and 216).—Mr. Harvie-Brown publishes a communication which he has received from Mr. H. Noble, to the effect that he found in June the undoubted nest of *Fuligula marila*, in Sutherlandshire. Mr. Noble identified the male at close quarters, and saw the female leave the nest. The nest was deep, cup-shaped, and better made than most ducks' nests. There were nine eggs. The Scaup is a very common bird on our shores in the winter months, and although it has several times been asserted that the bird has bred in Scotland, this is the first record which has been confirmed.

Buff-breasted Sandpiper in Norfolk (*Zoologist*, October, 1899, p. 475).—An immature male specimen of the American wader (*Tringites rufescens*) was shot by Mr. E. C. Arnold on September 7th, between Wells and Cromer. This bird is an exceedingly rare straggler to our islands.

Icterine Warbler in Norfolk (*Zoologist*, October, 1899, p. 475).—Mr. E. C. Arnold records that he secured a specimen (sex not mentioned) of this bird on September 5th, between Wells and Cromer. The bird has been identified by Mr. J. H. Gurney. Although a common enough species on the Continent, we believe that the above is only the ninth example which has been identified in the British Islands.

Breeding of the Tufted Duck in South-west Derbyshire (*Zoologist*, October, 1899, p. 476).—From a note by the Rev. Francis C. R. Jourdain it seems that this bird now breeds regularly in several places in Derbyshire.

Grey Phalarope in Co. Armagh, Ireland (*Zoologist*, October, 1899, p. 477).—Mr. Marsden received, on September 30th, a young male of this uncommon visitor to Ireland from Mr. W. Keatley, who shot the bird on the Logan on September 28th.

All contributions to the column, either in the way of notes or photographs, should be forwarded to HARRY F. WITHERBY, *at 1, Eliot Place, Blackheath, Kent.*

Science Notes.

The Buckinghamshire Archæological Society has finished for the season the excavating work which it resumed at Hedsor after a lapse of some years. Originally brought to light in 1894, this site of pile dwellings in the Thames Valley ranks with the few, such as those at Glastonbury and Braintree, which have been discovered in the southern part of this island. One must not judge of the interest which surrounds the place in question by the special remains of early man and his work, which have been dug up in addition to the piles and brushwood floor, for there are not many. The explorers have not met with anything of great interest in this connection during their recent work, to make the laborious task of examining every individual spadeful more pleasant. Perhaps the most valuable find was a beaver's jaw, though the remains of domestic animals, and shells of oysters used for food, continually cropped up. A deposit of land and fresh-water shells, also chanced upon, may possibly yield interesting records. The dwelling ante-dates the Roman occupation of Britain, but does not seem to go back further than Celtic times. The piles are accurately sharpened by bevels on four sides, and the tops are occasionally squared. Excepting that the workmanship is less primitive, the Hedsor settlement seems to be constructed on the same plan as that at Braintree (the first inhabitants traced here were certainly Neolithic men), for the piles cannot be made to correspond with any supposed individual dwellings, and were driven into the mud to hold in position, apparently, an artificial island, with a floor of branches and earth raised above the water on which the huts were built. Only a small watercourse (Blessing's Ditch), which runs through the site, marks the direction once taken by a larger tributary of the Thames that now flows into the river higher up. Its waters must in olden times have surrounded the settlement, and the causeway leading from the latter to the dry land has been followed for some distance.

The arrangement of a collection illustrating the modifications of animals that have followed upon domestication has been begun at the British Museum (Natural History), and already a number of interesting stuffed specimens and skeletons have been placed on exhibition in the gallery of British zoology. These include several celebrated dogs, such as the greyhound "Fullerton," as well as a series of South American sheep with four or more horns.

We notice that Mr. J. H. Steward, the well-known optician, has just put upon the market a very elegant and effective equatorial telescope suitable for amateurs, at a price within the reach of all earnest students of celestial objects. Lightness and ease of manipulation are secured without sacrifice of rigidity—a quality which all practical workers can fully appreciate without further amplification. The motion in right ascension is controlled from the eye-end by means of a long handle provided with a Hook's joint, and the clamp for the declination axis is also worked from the eye-end of the telescope. By means of a vernier the declination of an object can be read to five minutes of arc, and the hour circle to twenty seconds.

Dr. Ross, who was sent out to Sierra Leone by the Liverpool School of Tropical Diseases, to trace the cause of malaria, says in a letter:—"For many scientific reasons we have come to the conclusion that the truly malarial fever is caused here solely by the mosquito—probably entirely by the *Anopheles* species. We estimate, then, that most of the malarial fever here can be got rid of at almost no cost, except of a little energy on the part of the local authorities." Perhaps the most encouraging part of Dr. Ross' letter is that in which he says the destruction of the peccant insects, in the puddles in which they spend their larval stage, can be effected by an agent so comparatively harmless as kerosine. For a history of the relations between mosquitoes and malaria, we may refer the reader to an article by Mr. Percy H. Grimshaw, printed in the March, 1899, number of KNOWLEDGE.

RECENT WORK OF THE UNITED STATES BIOLOGICAL SURVEY.

By WILFRED MARK WEBB, F.L.S.

NATURALISTS are beginning to look forward to the interesting as well as useful researches made from time to time by the Biological Survey of the United States. The survey forms a division of the Department of Agriculture, whose year-book has been recently issued. In this volume, among many valuable papers, we find several contributions from biologists.

The first one that we will mention has the title of "Birds as Weed Destroyers," and is written by Dr. Judd, who, it will be remembered, so well weighed the evidence for and against the usefulness of shrikes. Of particular interest is it to us in view of the many attacks upon the character of the English sparrow to hear what this impartial judge has to say about the members of this species, now so thoroughly established in the United States. Dr. Judd says with regard to the native American sparrows that they have been collected in practically all the States, in the district of Columbia, and in Canada. Their stomachs, to the number of four thousand, were examined previous to the writing of his paper, and it was shown that during the colder half of the year the food of these birds is practically made up of the seeds of weeds.

This would lend considerable support to the general idea that the native sparrows are useful, while the English one, seeing that it drives the others away, might for that alone be reasonably regarded as a pest. Now as to the other charges against *Passer domesticus*. A number of birds, including five specimens of our and nineteen of the American sparrows, were collected in a cornfield. All the former were gorged with wheat, while only two of the latter had touched the corn, and then had only partaken of a single grain in each case.

Still, Dr. Judd has a good word to say even for the English sparrows, for they destroy large quantities of weed seeds. He says that they come in thousands to the lawns of the Department of Agriculture, and feed on the grains of two useless grasses which crowd out the ones better adapted for making turf. We are also glad to hear that they make many a meal of dandelion fruits.

Several native birds, such as the song sparrow (*Melospiza fasciata*), the chipping sparrow (*Spizella socialis*), and the white-throated sparrow (*Zonotrichia albicollis*), help the English species in his work of destruction. They usually, however, leave the hardest part of the task to him, and do not open the heads themselves, but seize the exposed fruits or pick up those which have been dropped by their cousins. The latter adopt the following method of securing their food:—Several of the green outer bracts are removed by being cut through close to the swollen part of the stalk or receptacle to which they are attached. The heads selected are those from which the yellow strap-shaped corollas of the florets have disappeared, while from the closed protective bracts, the down-like calices project that ultimately would spread out and form the miniature parachutes that carry away the one-seeded fruits on the wings of the wind. The removal of the casing exposes the down, and below this the fruits; a mouthful of the last is seized by the bird, who separates the down from them by a movement of his beak and swallows them. When a bird is hungry, however, it may not pause to remove the downy tufts, and these are eaten too.

To return to the native birds, although a song sparrow in captivity was able to secure the fruits in the same way as its English relative, yet, as mentioned previously, in a wild state it does not take this trouble. The goldfinch (*Astragalinus tristis*) has a different plan; it waits until a head is ripened sufficiently to open once more, and alighting upon the stem of the latter the bird moves towards it so that it is bent down to the ground, as shown in a pretty vignette. In this position a meal is easily obtained. Prof. Beal, after careful observation in the Upper Mississippi Valley, says that the tree sparrow (*Spizella monticola*) must eat at least a quarter of an ounce of weed seed per day during the winter. Following this up with a calculation of the number of birds to the square mile, it works out that one million seven hundred and fifty thousand pounds, or eight hundred and seventy-five tons, of weed seeds are destroyed in a single winter in the State of Iowa alone.

Another direct piece of evidence in favour of the usefulness of birds was obtained on a farm in Maryland. Here, in December, a number of sparrows of species whose common names we have already mentioned, together with juncos (*Junco hyemalis*). fox sparrows (*Passerella iliaca*), and whitethroats occurred in positive swarms. They paid particular attention, when feeding, to the tangles of smartweed, and towards the Spring the ground under a particular thicket, some three feet high, was examined. The surface of the soil was quite black with seeds, but these were found to have been split open and emptied of their contents. In a patch eighteen inches square, one thousand one hundred and thirty half-seeds were obtained, but only two whole ones had escaped the birds.

Summing up the matter, it may be said that some fifty species of birds help in destroying the seeds of more than sixty kinds of weeds. Among these are reckoned the blackbirds and their allies as a set-off to their grain-stealing habits. The palm is given to the numerous species included under the heading of sparrows, who, Dr. Judd says, "are little weeders whose work is seldom noted but always felt."

Another paper of interest, dealing with the dangers of introducing noxious animals (mammals) and birds, is by Mr. T. S. Palmer, also of the Biological Survey. Here it is laid down that sometimes the acclimatization of animals has not been followed by such useful results, ultimately, as that of plants, for as a rule the latter are for cultivation, and, consequently, kept within bounds, whereas the animals are set free under conditions that are the nearest possible to their natural environment. Occasionally a garden plant may "escape" and multiply until it is reckoned an objectionable weed, or a wild one may accidentally become introduced with the same result, but the rule holds good. How even a valuable domestic animal may run wild, and cause serious damage, is illustrated by the case of the horse in Australia and the Western States of America. Indeed, in 1897, a law was passed in Nevada to authorize the shooting of wild horses.

The way in which the goats, introduced into the beautifully wooded island of St. Helena in 1513, had converted it into a howling wilderness by 1810, carries with it the mournful remembrance of plants and the animals dependent upon them reduced to extinction that no naturalist likes to dwell upon. We will only mention that it costs the Government some £3000 a year to import fuel for their own use. The introduction of carnivorous animals like cats directly kills off many forms that are not prepared for such an attack in places like oceanic islands where there is no escape.

Next we are given an interesting history of the invasion of the common brown rat, with the dates of its introduction into various countries. Its original habitat is said, upon the authority of Dr. Blandford, to be Chinese Mongolia. The case of the rabbits at the Antipodes is too well known for us to dwell upon, but it might be worth while considering the remedy, which seems to be worse than the evil. Ferrets have been liberated in thousands, together with weasels and stoats, to keep the numbers of the rabbits down, but the two wild species in particular have not confined their attentions to the rodents, but have diminished the number of game birds, and brought many of the interesting local birds to the verge of extinction.

A similar state of affairs has resulted from the turning out of the mongoose in Jamaica to exterminate the rats infesting and damaging the sugar-cane crops. In 1872, four males and five females were imported. In 1882 the saving to the sugar planters was estimated at forty-five thousand pounds. As the rats became scarcer a sad state of affairs began to come to pass. Domesticated animals, particularly young ones, were destroyed continually, the native mammals and birds, as well as snakes, lizards, and other insect-eating creatures, fell a prey to the mongooses, and by-and-by a plague of ticks and swarms of noxious insects filled the island. Even fruits did not escape being eaten by the mongooses when animal food failed. At the present time, however, the carnivorous foreigners are less numerous, but greater loss by far resulted from their acclimatization than if they had never been brought to stay the ravages of the rats.

In the Hawaiian Islands the same beast did much the same things, and when an unfounded rumour of its proposed introduction into the United States by the Department of Agriculture got about, many who knew its history elsewhere raised a great outcry, while others in ignorance made arrangements for the introduction of specimens which through strenuous efforts was prevented from being carried out. Stringent measures of recent years have alone prevented the importation into California of the fruit-eating bat, or flying fox, which is one of the greatest pests of the fruit growers, and threatens their industry with destruction in a great part of Australia. There seems to be considerable danger of the creature getting a hold in the Sandwich Islands, if the matter be not carefully looked after.

Coming to birds, Mr. Palmer gives a map showing the distribution of the English sparrow in the United States, and the colonies it had formed in 1860, 1870, and 1886, from which it has still further spread. The old crimes of damaging fruit and grain, of becoming a nuisance in cities, and replacing native birds, are laid once more at its door, without any redeeming features such as were given in the paper previously considered. Its marvellous adaptability is shown by the number of places throughout the world where the sparrow is now established.

The starling has to be given the credit of destroying insects in this country, but with change of scene comes change of habits, and in New Zealand we find our friend with omnivorous rather than insectivorous propensities. The Government of New South Wales, after careful consideration, came to the conclusion to prohibit the importation of starlings into their territory, as they have done that of other creatures harmful to the agriculturalist, by means of a special law.

A contrast is drawn between this arrangement and the unrestricted introduction of all forms of life into the United States. We see, too, from the paper under discussion, as well as from others in the year-book, how quickly attention is turned by the various divisions to the possibilities of the new possessions of America, and again it is emphasized that the mongoose must not be allowed to reach the mainland from Hawaii or Puerto Rico, nor must the fruit-eating bat be permitted to obtain an entry into the first of these places from Australia.

Notices of Books.

A List of British Birds belonging to the Humber District. By John Cordeaux, J.P., F.R.G.S., M.B.O.U. (Porter.) 2s. 6d. net. Just before his much lamented death Mr. Cordeaux published the above list of the birds of his district. This district, which may be roughly described as the land and sea surrounding the mouth of the Humber, is a very remarkable one ornithologically. Mr. Cordeaux's list includes the extraordinary number of three hundred and twenty-two different species of birds identified as having occurred there. A number of these are "accidental visitors" which have been recognised but once or twice, while a large number of them are "periodical visitors" which pass through this favoured district twice a year. The pamphlet will be invaluable to all ornithologists, not merely as a list, but also for its information regarding times, seasons, and extent of migrations, calculated from the notes for which the author was so famous, and which extended over thirty-five years, and for its accurate details and references concerning the rare visitors which have been recorded for the district.

Telephones, their Construction and Fitting. By F. C. Allsop. (London: Spon.) Illustrated. 3s. 6d. In handling this, the fifth edition of Mr. Allsop's book, we have that pleasant feeling as of meeting an old friend. There is certainly no book concerning telephones—in the English language—which is so thoroughly popular or so eminently practical. Note in this connection the opening sentence: "A telephone instrument consists essentially of three parts—." It should of course be remembered that the work is intended for readers who consider it more important to know "how" than to know "why," so that we have no right to criticise the author's English. We note, p. 25, that the word "caking" is substituted for the more usual expression "packing." And on p. 32 there is a somewhat narrow statement which reads: "An induced current is always of higher E.M.F. than the inducing current." The action of the "armature shunt" (usually so great a stumbling block to the tyro) is explained with wonderful clearness. A little later on we are sorry to see (p. 55) diagrams which show the contacts with their conventional lettering. This seems to imply that there is no need for brain power on the part of persons making the connections. The notes on intercommunication systems are good, and published for the first time in this edition. Going further, under the heading "batteries," we find a vicious suggestion made, to the effect that it may sometimes be advisable to knock a hole in the bottom of the porous pot. And there is in this section, too, that oft-repeated error which makes the E.M.F. of the Leclanche out to be higher than it actually is. Also we note that the B.W.G. is adhered to throughout, instead of, as one would expect, the more modern "standard" gauge being used. On p. 165 there is a statement which, in the light of recent events, should form unpleasant reading for the directors of the National Telephone Co. On p. 169, "section No. 2, the wires 3, 4, and 5," should read "section No. 2, the wires 4, 5, 6." But all the faults we have succeeded in finding are scarcely more than trivialities, and Mr. Allsop deserves hearty congratulation.

Haunts and Hobbies of an Indian Official. By Mark Thornhill. Murray.) 6s. A volume of entertaining reading has been compiled under the above title by a retired officer from a diary kept in India many years ago. The diary contained observations on birds, insects, and animals, as well as memoranda on the weather, notes of interviews with native visitors, and all sorts of information peculiar to India and its people. The author draws a vivid picture of his own quiet life; describes his house, and the arrangement of the rooms; gives an account of his office; and introduces notices of native habits, institutions, superstitions, and weird stories coming within his own experience. Although the author declares his "observations are quite unscientific," he, nevertheless, writes with a lucidity and a power of marshalling a heterogeneous multitude of facts quite beyond the attainments, in this direction, of many who occupy lofty positions in the world of science. As a book of popular information, gleaned by an European official in the plains of India, we can, with assurance, recommend it, both for the diversion of fireside travellers, and those who, for practical purposes, desire to acquire sound knowledge of the country and its inhabitants through a pleasant medium.

A Select Bibliography of Chemistry, 1492–1897. First supplement. By Henry Carrington Bolton. (Smithsonian Institution.) This octavo volume of about five hundred pages is a continuation of the chief work, published in 1893. It brings the literature of chemistry down to the close of the year 1897. Works on chemistry—using the term in its broadest significance—are grouped:—(1) Bibliography; (2) Dictionaries; (3) History; (4) Biography; (5) Chemistry, pure and applied; (6) Periodicals; and (7) Alchemy. The last-named section is confined to the original volume, as might have been expected, seeing that it is a sort of dead language in our time. To give some idea of the extent of chemical literature, we may here mention that the number of titles in the present volume is five thousand five hundred and fifty-four, and in the first volume twelve thousand and thirty-one, making a grand total in the two volumes of seventeen thousand five hundred and eighty-five! Here is a marvellous resurrection: a gathering together of the dry bones, so to speak, of old books for five hundred years past, and interesting chiefly to one class of students—the chemists. Although they may never be found accessible under one roof, it is gratifying to know that most of them may be consulted in our national collection at the British Museum.

A Short History of the Progress of Scientific Chemistry in Our Own Times. By Prof. W. A. Tilden, F.R.S. (Longmans.) 5s. net. To the student of chemistry, and to the general reader, this volume will be of deep interest. It contains a concise statement of the present position of chemical knowledge, and a clear account of advances made during the past sixty years. Among the subjects, of which the modern developments are traced, are—thermo-chemistry, atomic theory, the periodic law and dissociation, valency, synthetical chemistry, stereo-chemistry, chemical affinity, and the liquefaction of gases. So far as we are aware, no other volume exists in which the growth of knowledge around each of these cardinal principles and divisions is dealt with distinct from the general history of chemistry. Honours students of the Department of Science and Art should find the volume particularly helpful.

Physics: Experimental and Theoretical. Vol. I. Mechanics, Hydrostatics, Pneumatics, Heat, and Acoustics. By R. H. Jude, D.SC., M.A. (Chapman & Hall.) Dr. Jude originally intended simply to translate Prof. Gossin's well-known "Cours de Physique," but a consideration of the differences in the requirements of British students preparing for examinations in physical science led him to decide upon certain additions to, and modifications of, the French treatise. The sections dealing with heat and sound have been largely re-written and very much amplified in the present volume, while the earlier chapters remain in much the same form as the original. The final result is not altogether satisfactory, and the inequality of treatment will, we fear, prove very misleading to students. The first two hundred pages or so of the volume supply a popular and more or less introductory account of the leading principles of mechanics, hydrostatics, and pneumatics, of much the same kind as is to be found in the older books based upon Ganot and Deschanel. The laws of heat, on the contrary, are treated much more exhaustively, including as they do a mathematical exposition of thermo-dynamics, which, for its intelligent appreciation, requires a knowledge of fairly high mathematics, and leads the student as far as the study of entropy and Van der Waal's theorem. The volume is, on the whole, well illustrated, though why Dr. Jude permitted the introduction of the roughest of rough sketches on pages 173 and 175 we are at a loss to imagine. And why is there no index? One of the chief uses to which the work was likely to be put is that of a reference book in the numerous schools of science which have lately grown up, but in its present incomplete form it cannot be used for this purpose. But in spite of these deficiencies, Dr. Jude is too good a teacher to produce an altogether second-rate book. His style is clear and lucid, and we have no doubt that many students will read the volume with interest and advantage. Our only regret is that the inattention to the accessory matters which we have mentioned detracts so much from the value of a careful and extensive piece of labour.

Stars and Telescopes. A Handbook of Popular Astronomy. Founded on the Ninth Edition of Lynn's Celestial Motions. By David P. Todd. (Boston: Little, Brown and Company. 1899.) Mr. Lynn is known throughout the astronomical world for his miniature volumes dealing with "Remarkable Comets," and "Eclipses," and the "Celestial Motions." Taking the last-named volume as a basis, Prof. David Todd has expanded it into a most valuable compendium of what are the principal facts of astronomy known at the present day. Although professedly based on Mr. Lynn's earlier work, "Stars and Telescopes" is a new creation, and bears the stamp of original treatment that Prof. Todd seems able to impress on all the books he issues.

It is impossible to give a detailed review of such a book, but we desire to draw attention to one feature, that of itself alone would render the volume an invaluable contribution to astronomical literature. This is the bibliographical appendix to each chapter and section, giving full references to all the principal books, magazines and papers which contain information bearing upon the subject treated. The illustrations are numerous, have reference both to celestial bodies and to bodies terrestrial, and are nearly all new.

Funafuti: or Three Months on a Remote Coral Island. By Mrs. Edgeworth David. (Murray.) Illustrated. 12s. As far back as 1842, when Darwin ennunciated his hypothesis on the origin of *coral reefs and atolls*, a lively interest in the structure and distribution of these curious formations began to be displayed by students of Nature. Funafuti is an atoll about twelve miles from north to south, and eight miles in greatest breadth. Mrs. Edgeworth David, who accompanied her husband to the island, here gives an account of the 1897 Funafuti coral-boring expedition, and a charming account it is, not particularly of the scientific operations conducted by her husband and others, but of the inhabitants of this far-away little isle in the Pacific Ocean—manners and customs of the people, amusements, morals, superstitions, and so on. She expresses "a faint hope that this book will enlist sympathy for the Funafutians, and, perhaps, be indirectly the cause of securing a medical missionary for the island." Excepting some oblique efforts at punning—hollow jokes like nuts without kernels—the book forms a fair chapter in ethnography.

Practical Zoology. By the late A. Milnes Marshall, F.R.S., and the late C. Herbert Hurst, PH.D. Fifth edition. Revised F. W. Gamble, M.SC. (Smith, Elder & Co) Illustrated. In the new edition of this well-known work, Mr. Gamble has "thought it well to recast the chapters on technique, and to adopt many of the alterations and additions which have been suggested by a constant use of the last (1895) edition." In other respects no new matter involving a change in the plan of the work has been added. A book of this kind, which has survived four previous editions, scarcely needs the impetus of a Press notice to impart to it a new lease of life. The animals selected for detailed study include characteristic representatives of the more important great groups, and a conscientious worker who follows the lucid instructions here given will acquire a good insight into the leading features of animal structure, and a sound basis of the principal methods of research. Beginning with the amoeba and hydra, and ending with the rabbit and pigeon, it will be seen that the authors take the opposite course to that advocated by the late Prof. Huxley—a course which, ascending from the simple to the more and more complex, is now regarded by most zoologists as being more easy and rational. Some very useful and necessary information is given in an appendix on reagents for killing, hardening, and preserving specimens; staining, clearing, and mounting media; injection fluids, and cements for fixing down sections cut in paraffin. The illustrations, rather sparse, are clear—too clear, in a sense, for sections in flesh and blood, and look so hard, cold, and symmetrical as to give one the idea that they had been reproduced from wooden models.

Bacon or Shakespeare? An Historical Enquiry. By E. Marriott. (Elliot Stock.) 1s. Miss Marriott is a loyal Shakespearian, who has here compiled a lucid and interesting statement of the case against Bacon. We fear the confirmed Baconian, impervious to the facts, is quite beyond the reach of argument, but Miss Marriott's closely-reasoned work may be heartily commended to anyone who feels in need of a fair and comprehensive survey of an exhausted controversy.

Wonders of the Bird World. By R. Bowdler Sharpe, LL.D., F.L.S. (Wells, Gardner, Darton & Co.) Illustrated. 6s. Dr. Sharpe has here put together the lectures on birds which he has been in the habit of giving for the last ten years. The book is written in quite a popular style, and is very pleasant and instructive reading. Dr. Sharpe has chosen a good and inexhaustible subject. Among the chapter headings we may note: Decoration in Birds, Playing Grounds of Birds, Wonderful Nests, Courtship and Dancing of Birds, Parasitic Birds, and Migration of Birds. Dr. Sharpe quotes innumerable authors and field naturalists for his facts, which are detailed and commented upon in a very interesting manner. A few of the stories told, however, can hardly be considered as anything more than "yarns," and we think the author would have done well to have omitted them in his book, though they, no doubt, were well received in his lectures. Altogether the book is very entertaining.

Truth and Error, or the Science of Intellection. By J. W. Powell. (Kegan Paul.) 9s. An attempt is here made to set forth the origin and history of fundamental fallacies. The failure to distinguish between properties and qualities, it is alleged, is the rock on which modern metaphysicians are wrecked. Our author says—"The war of philosophy is between idealists and materialists. The philosophy here presented is neither idealism nor materialism; I would fain call it the philosophy of science." Whatever name it is labelled with, however, the work will remain unattractive. It lacks the requisite continuity and sequence to enable the reader to follow the reasoning clearly. Molecules, stars, stones, and plants, we are told, do not think; only animals have minds; plants do not have minds, but their particles have judgments as consciousness and choice which are developed into psychic faculties only by the organization of animate bodies. The total result of the work does not, we think, strengthen the foundations of philosophy, but it is rather a shifting from one slough into another.

Early Chapters in Science. By Mrs. W. Awdry, edited by Prof. W. F. Barrett. (Murray.) Illustrated. 6s. If accurate information, vouched for by learned professors, constitutes acceptable credentials for the reception of a new book, then Mrs. Awdry's volume should be welcomed by those who desire to know a little of the procession of life and unfolding of phenomena which it is the business of science to arrange in an orderly sequence. Many of the staff of the Royal College of Science, Dublin, have seconded what the authoress has to say on the World of Life and the World of Experiment—a dissertation of very wide scope, indeed, and Prof. Barrett says of the book, "whilst more elementary and not covering so wide a field as M. Paul Bert's volume, it is written in a more attractive style, and avoids the kind of scientific 'pemmican' which characterises M. Bert's volume, and which must be to young people so indigestible, and favourable to mere cram." If, however, one receives too much mental food in M. Bert's book, the reader in the volume before us gets only the smell, as it were, of his intellectual fare, and, in our humble opinion, not a very pungent or appetising smell. The several sections are too laconic to form a useful introduction to general science. We will not challenge the accuracy, but we venture to observe that in these days when School Boards and County Councils are disseminating science broadcast, the need for such books as this is at a minimum, more particularly as it can only be regarded as a primer which, to reach its proper constituency, should have been published at sixpence or a shilling.

True Tales of the Insects. By L. N. Badenoch. (Chapman & Hall.) Illustrated. The title of this work is somewhat misleading. One would expect, from the all embracing "The Insects," a very comprehensive discourse, whereas the contrary is the truth. The book in reality consists of a few essays, some of which have appeared in serials, and as short articles for illustrated magazines. The matter and style are very appropriate, but we are not by any means of opinion that the re-publication in such a luxurious form as here presented is a prudent step on the part of the author, or a shrewd venture by the publishers. Setting aside a little individuality in the manner of treatment, which is very attractive in places, there is little or nothing new about the insects dealt with, and a considerable portion of the matter is too sketchy to add to the value of the volume—a mere skeleton at the best. Great pains have been taken to impart a good effect to the illustrations from an artist's point of view, but this result has been obtained at the sacrifice of much loss of detail according to the practical entomologist's way of representing insect structure.

Siddhánta-Darpana. A Treatise on Astronomy. By Mahámahopádhyáya Sámanta Sri Chandrasekhara Simha. Edited with an introduction by Jogés Chandra Ráy, M.A., Professor of Physical Science, Cuttack College. (Calcutta, 1897). Of all the numerous works on astronomy that have been published within the last few years, this is by far the most extraordinary, and in some respects the most instructive. It is written in Sanskrit by a Hindu of good family of Khandapárá in Orissa, and is a complete system of astronomy founded upon naked eye observations only, and these made for the most part with instruments devised and constructed by the writer himself. Those who read the sixty pages of the introduction in English, which the fellow-countryman of the author, Prof. Chandra Ráy, of Cuttack College, has written, will certainly regret that the barrier of an unknown tongue debars them from a more intimate acquaintance with the very striking personality that Prof. Ráy describes. The work to which Chandrasekhara has devoted himself, and which he has carried out with very conspicuous success is this: The native Hindu almanacs computed from the Siddhántas were falling into serious error, and no two current almanacs agreed in their computations. Chandrasekhara, therefore, has re-determined the elements of the old Siddhánta, but has rigorously confined himself to the ancient methods, his principal instrument of observation being a tangent-staff, devised by himself, of a thin rod of wood twenty-four digits long, with a cross-piece at right angles to it. With these rude means he has obtained an astonishing degree of accuracy; his values for the inclinations of the orbits of the nearest planets are correct to the nearest minute in almost every instance. The ephemerides computed from his elements are seldom more than a few minutes of arc in error, whilst the Bengali almanac may be in error as much as four degrees. To Hindus, for whom their religious observances are regulated by astronomical configurations, this work by one of themselves, a strict follower of the severest laws of their religion, and conducted throughout solely by traditional Hindu methods, is of the highest importance, as it removes the confusions which had crept into their system, without in the least drawing upon the sources of Western science. But the work is of impoıtance and interest to us Westerns also. It demonstrates the degree of accuracy which was possible in astronomical observation before the invention of the telescope, and it enables us to watch, as it were, one of the astronomers of hoary, forgotten antiquity actually at his work before us to-day.

Observations taken at Dumraon, Behar, India, during the Eclipse of the 22nd January, 1898. By Rev. V. de Campigneulles, S.J. With fourteen plates. (Longmans, Green & Co.: London, New York, and Bombay. 1899.) Amongst the numerous parties organized to observe the late eclipse was one arranged by the Jesuit Fathers of the Western Bengal Mission, who took their station at Dumraon, Behar; and the present volume is the account of their observations by the chief of the expedition, Father De Campigneulles. Both the work itself and the report here given of it reflect the highest credit upon the members of the party and on their director. The instruments at their disposal were but of moderate calibre, but were all, with the exception of one of the photographic cameras, quite successful. The other two cameras each secured fourteen good pictures of the corona, whilst the prismatic camera was also very successful. The grating camera failed to give much result owing to the shortness of the exposures, as it was not driven by clockwork. The volume, which is very attractively got up, is far from being a dull dry report. The account of the eclipse itself is brightly written, and two chapters, on solar physics and the spectroscope in connection with eclipses, set forward the principles of eclipse observation in a clear and sufficiently popular manner without for one moment ceasing to be scientific. The results which the Fathers obtained are then sufficiently discussed, and the concluding chapter reviews the results obtained at other stations. One or two printer's errors have escaped the eye of the proof reader. In particular, we note on page 97, "this green ray could be followed up to some six feet from the lunar disc"—minutes of arc of course being meant.

Results of Rain, River, and Evaporation Observations made in New South Wales, 1897. By H. C. Russell, F.R.S. (Gullick: Sydney.) Illustrated. 3s. 6d. When one inspects a comparatively large volume like this, crowded from beginning to end with dry figures, to obtain which a tremendous amount of work must have been accomplished, the question naturally arises—What is the use of it? In 1897, for example, there were one thousand five hundred and fourteen observers engaged in bringing together the data here given from as many stations; these observations show that the average rainfall over the whole Colony for 1897 was 18·89 inches, whereas in 1887 it was 34·99 inches. As regards the utility of the work, Prof. Russell says—"It is becoming generally recognized . . . that the quality of the soil is by no means the only index of value; it is essential that we know also the character of the rainfall at the place . . . before it can be decided if it will grow wheat, and justify the construction of a railway to it and the settlement of a large population." Maps are given showing the localities where rain gauges are in use, but the average set down is the arithmetical mean of all the stations, so the rain gauge of any spot may not show the average for the district it represents. At any rate, in spite of some drawbacks, Prof. Russell is doing an immense service to meteorological science, and, more particularly, to those engaged in agriculture, as well as intending emigrants to the colony of New South Wales.

The Cambridge Natural History. Insects. Part II. By David Sharp, M.A. (CANTAB.), M.B. (EDIN.), F.R.S. (Macmillan.) 17s. net. Comprehensive in scope, satisfying in treatment, with authoritative text and numerous brilliant illustrations, the volumes on insects in the *Cambridge Natural History* are of the highest merit. The present part concludes the discussion of the *Hymenoptera* (bees, wasps, and ants), and deals with the Orders and Sub-orders not treated in Part I., namely, *Coleoptera* (beetles), *Lepidoptera* (butterflies and moths), *Diptera* (flies), *Aphaniptera* (fleas), *Thysanoptera* (thrips), *Hemiptera* (bugs), and *Anoplura* (lice). To describe the characteristic insects in these Orders in satisfactory detail, without giving undue prominence to any particular Order, is a difficult task, but Dr. Sharp has performed it in a manner which will be approved by most entomologists. It is interesting to notice the numbers of insects of various kinds. Dr. Sharp estimates that there are one thousand five hundred species of bees at present known; eight hundred species of solitary wasps, and five hundred or six hundred of social wasps. The number of species of beetles at present known is about one hundred and fifty thousand, of which three thousand three hundred have been found in Britain, and there are about fifty thousand species of butterflies and moths, and forty thousand species of *Diptera*, or two-winged flies. It is therefore not surprising that much has yet to be learnt concerning the structure and habits of many insects. It would be easy to quote many interesting facts with regard to insect life and intelligence from Dr. Sharp's pages, but we prefer to advise students of natural history to see the volume for themselves. The work is not popular in the sense usually understood, but it contains an account of insects written in the clearest possible language consistent with accuracy and the scientific spirit.

BOOKS RECEIVED.

The Social Life of Scotland in the Eighteenth Century. Two Vols. By Henry Grey Graham. (A. & C. Black) 24s.

Birkbeck Literary and Scientific Institute Calendar, Session 1899-1900. (Witherby & Co.) 6d.

Natural and Artificial Methods of Ventilation. (Boyle & Son, Limited.)

Elementary Algebra (to Quadratics). By C. H. French and G. Osborn. (Churchill.) 4s. 6d.

Animal Biology. By C. Lloyd Morgan, F.R.S. Third Edition. (Longmans.) Illustrated. 8s. 6d.

The Children's Study—Canada. By J. N. McIlwraith. (Unwin.) 2s. 6d.

The International Geography. By H. R. Mill, D.SC. (Newnes.) Illustrated. 15s.

The Pillar of Fire. By Rev. J. H. Ingraham. (Ward, Lock & Co.) 3s. 6d.

The Photo-Miniature. September. (Dawbarn & Ward.) 6d.

Billiards, Mathematically treated. By G. W. Hemming, Q.C. (Macmillan.) 3s. 6d. net.

Heat. For Advanced Students. By Edwin Edser. (Macmillan.) Illustrated. 4s. 6d.

The North American Slime-Moulds. By Thomas H. Macbride. (Macmillan). 10s. net.

Optics. A Manual for Students. By A. S. Percival. (Macmillan.) 10s. net.

Pitman's Shorthand and Typewriting Year-book for 1900. 1s.

Handbook of Optics. By William Norwood Suter, M.D. (Macmillan.)

Practical, Plane, and Solid Geometry. For Advanced Students. By Joseph Harrison and G. A. Banandall. (Macmillan.) 4s. 6d.

Inorganic Chemistry. For Advanced Students. By Sir H. Roscoe and Arthur Harden. (Macmillan.) 4s. 6d.

Matter, Ether, and Motion. By Dr. A. E. Dolbear. (S.P.C.K.) 5s.

London University Guide and University Correspondence Calendar, 1899-1900. Gratis.

Magnetism and Electricity. For Beginners. By H. E. Hadley. (Macmillan.) 2s. 6d.

Elementary Practical Mathematics. By Frank Castle. (Macmillan.) 3s. 6d.

The Story of Ice. By W. A. Brend. (Newnes.) 1s.

Our Secret Friends and Foes. Prof. Percy Faraday Frankland. Fourth Edition. (S.P.C.K.) Illustrated. 3s.

The Latimer Collection of Antiquities from Porto Rico. By Otis T. Mason. (Smithsonian Publications.)

Report of the Chief of the Weather Bureau, 1897—8. (U. S. Department of Agriculture.)

The Studio. October. 1s. (15, Henrietta Street, Covent Garden.)

THE STORY OF THE ORCHIDS.—III.

By the Rev. Alex. S. Wilson, M.A., B.Sc.

The most remarkable example of sensitivity among orchids is, however, *Catasetum tridentatum.* The flower is polymorphic, and the three forms were for long referred to distinct genera. All three sorts of flowers are occasionally produced on a single plant. *Monacanthus viridis* is the female, *Myanthes barbata* the hermaphrodite, and *Catasetum tridentatum* the male variety; all three being merely sexual forms of the same flower. The rostellum develops two long slender prongs which protrude from the flower. These antennæ are exceedingly sensitive, and if either of them be touched the impulse is transmitted to the membrane of the rostellum, which covers the glandular disk of the pollinium. This membrane suddenly splits, and the pollinium, which the membrane kept curved in a state of extreme tension, springs up, and tearing itself out of the anther-lobe is projected to a distance of several feet like a stone from a catapult. The pollinium is thrown out in the direction from which the stimulus comes, the sticky disk being foremost; if the cause of the irritation be a bird or large insect the projectile can hardly miss its mark. The ejected pollinia of *Catasetum* have been found sticking on panes of glass in a greenhouse at a distance of several feet from the flowers.

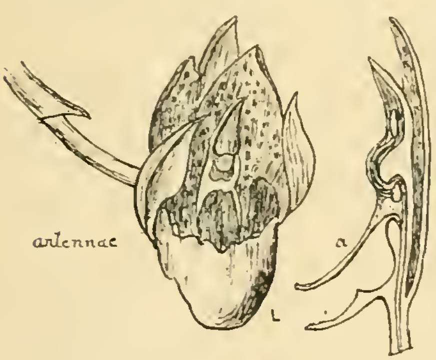


Fig. 8.—*Catasetum*: in Front and Section.

Another extraordinary flower is that of *Coryanthes speciosa*, of Trinidad. The labellum is in the form of a rounded pitcher or bucket, into which drops of sweetened water continually fall from two horn-like projections on the column: over an ounce is collected in this way. When the bucket is full the liquid overflows by a spout at the back. Over the bucket there is an expansion of the labellum (hypochilium), on which certain humble bees congregate; and as they struggle for room, one after another is pushed over into the bucket beneath. With their wings drenched they are unable to fly, and so crawl out by way of the spout in a regular procession. The floral arrangements being similar to those in Cypripedium the stigma is pollinated, and the pollen removed as the visitors emerge from their involuntary bath.

The *ne plus ultra* of adaptation to insects is, however, attained by *Angraecum sesquipedale*, an orchid which grows in the island of Madagascar. Its pale white blossoms have a whip-like nectary over a foot in length. Naturalists confidently predicted that an insect with a proboscis of corresponding length would be discovered, and this was ultimately done by Mr. W. A. Forbes, who visited Madagascar and secured a huge sphinx moth having a tongue which measured eleven inches. More recently, Mr. G. F. Scott-Elliot found sphinx moths with proboscides eighteen inches long. This observer also saw sun-birds visiting the flowers of Angraecum. In Brazil, Fritz Müller caught a hawk moth with a proboscis of eleven inches; analogy would lead one to infer the existence of flowers to correspond. The length of the nectary varies a good deal in different specimens of Angraecum, but those flowers in which it is shorter than the visitor's proboscis are placed at a disadvantage, for the insect can remove their nectar without bringing its head in contact with the rostellum. Natural selection must therefore tend to perpetuate those flowers with the longest nectaries. The forcible ejection of the pollinia in *Catasetum* and *Dendrobium*, already considered, is but another method of securing the same end that is served by the elongated spur of Angraecum.

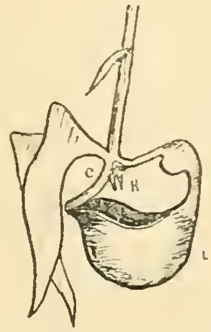


Fig. 9.—*Coryanthes speciosa.* L. Labellum; H. Secreting Horns; C. Column.

Even among British orchids there is a distinct tendency towards adaptation to special insects. This appears even from a general survey, but is much more obvious when the details of their structure are studied. H. Müller has remarked that many species which in the lowlands are specialized in relation to bees, have in the Alps acquired deeper nectaries and become adapted to butterflies, which are more numerous than bees at lofty elevations.

To account for these mutual relationships between orchids and insects would be a comparatively simple matter were we at liberty to make two assumptions—viz., the existence of highly specialized fertilizing agents to begin with; and the superiority of cross-fertilization over self-fertilization. The botanist, in seeking to explain the development of flowers, naturally postulates the requisite variety of insect forms; the zoologist, to account for the differentiated organs of the insects, as naturally postulates a corresponding variety of floral structures. We see, therefore, that these special relationships could only have arisen out of conditions much more simple. Flowers and insects must have become differentiated together. The primitive shallow blossoms and short-lipped visitors would necessarily be in a state of stable equilibrium; in the absence of any means of isolating those flowers and insects in which corresponding variations happened to take place, whatever variations did occur, would tend to neutralize each other and no evolution would be possible. But in this case, as in artificial selection, the element of volition comes in. The instinct and intelligence of the insects themselves leading them to select those flowers which suited them best would, to some extent at

Fig. 10.—*Angraecum sesquipedale.*

least, secure the isolation required, and must, therefore, have played an important part in bringing about these extraordinary co-adaptations. It is held by some that the very complete adaptations in orchids to cross-fertilization could not have been possible but for the long interval that elapses between the pollination of the stigma and the impregnation of the ovule by the pollen-tube. Be this as it may, orchids are exceedingly liable to vary, and therefore furnish abundant materials upon which natural selection can work. But natural selection only comes into operation with favourable variations, and, so far as orchids are concerned, it is by no means certain that variations which favour intercrossing are advantageous. Notwithstanding the wonderful contrivances for facilitating intercrossing, self-fertilization occurs extensively throughout the order. Many of the most abundant orchids habitually fertilize themselves. The fly orchis is even more fertile with its own pollen than when crossed. The structure of some orchids is such as entirely to prevent spontaneous self-fertilization; nevertheless, they are perfectly fertile with their own pollen when artificially fertilized. Henslow will even have it that crossing, so far from being advantageous, is a decided disadvantage to the plants. On this view the first modification of flowers arose from degeneration brought about by the interference of insects. Only when this process had gone so far, and consequent malformations had been produced which rendered self-fertilization difficult or impossible, did the necessity for crossing arise. Not till then could natural selection begin to tell in the production of contrivances for intercrossing. The orchid pollinia result, no doubt, partly from the arrested development of the pollen grains and their mother-cells, but it is hard to believe that such an elaborate structure as the rostellum is merely due to degeneration or arrested development. Even if it could be shown that self-fertilization was more prevalent and effectual than it is, we should have difficulty in accepting the view that the elaborate arrangements in flowers for cross-fertilization have been called into being with no direct or primary reference to the interests of the flowers themselves. While Henslow's explanation is just the inverse of Darwin's, both are probably somewhat one-sided. As the stability of the solar system depends alike on the centrifugal and centripetal forces, so it may be in the organic world. It is conceivable that self-fertilization may be advantageous perhaps in the way of fixing or transmitting acquired characters while cross-fertilization may be beneficial in other directions. Nature at least does not incautiously discard either alternative, but prefers to retain both, fulfilling herself in many ways,

> " Lest one good custom should corrupt the world."

The orchids are an exceedingly numerous order, the Compositæ among flowering plants alone excel them in respect of variety. Upwards of eight thousand species are known, of which about forty are British. The bright-coloured kinds are, however, only a small minority; a vast number have comparatively unattractive, valueless flowers. The task of the orchid hunter is by no means easy, he may travel far and incur many risks before he discovers a flower sufficiently attractive to repay cultivation. A collection of tropical orchids awakens in us feelings not unlike those of which we are conscious in visiting a menagerie. These feelings would doubtless vanish could we see the flowers amid their native haunts and natural surroundings. Their strange and grotesque forms appeal to our curiosity; their endless variety of colouring excites our admiration. There is the azure Vanda of the Himalayas, with its great profusion of blossom, a single plant according to Sir Joseph Hooker sometimes bears three hundred or four hundred flowers in one season. Again we have the Dendrobriums with their exquisite contrasts, the Oncidiums with their soft delicate tints, the rich white and crimson hues of the stately Cattleyas, the Lælias, the Cælogynes, the Odontoglossums, and a host of others equal in splendour. Yet, withal, these eccentricities of Nature, beautiful, elegant, and interesting as they are, lack for us that homely grace and charm which the associations of childhood have thrown around the more familiar flowers of our native land.

ON THE DUTY OF A FIELD NATURALIST.

By E. A. S. E.

WANDERINGS amongst the banks and braes, and o'er the billowy ocean and mountain crag have evolved some of the grandest thinkers of the age—Darwin, Owen, Huxley, were all field naturalists of the highest type, and surely all of us are better for their writings.

After all, field naturalist is but a trivial name given to one who, if he be a naturalist at all, is at heart a natural philosopher, seeking amongst the secrets of Nature the evidence of truth. It is for him to "labour and to wait"; full well he feels that—

> " Art is long and time is fleeting,
> And our hearts, tho' strong and brave,
> Still like muffled drums are beating
> Funeral marches to the grave."

Who has not felt a thrill of emotion on hearing that harbinger of spring—the cuckoo—for the first time on an April morn, a feeling of thankfulness for having lived to see another year burst forth into promise, or yet when the skylark, springing upwards to the very vault of heaven itself, pours forth its love-inspired song in tuneful ecstasy; or, again, in the solitude of the moorland hills, has not been struck by the impressiveness of the scene—

> " Where the fox loves to kennel and buzzard to soar,
> All boundless and free o'er the rugged Dartmoor."

It seems incomprehensible that anyone can live in a state of utter indifference to the bountiful gifts of Nature met with on every hand, yet there are those who have a positive dislike for things of the field, whilst as for wishing to know anything about their economy, that passes their wit altogether.

I have been brought more in contact with birds than any other subject of natural history, so I naturally turn to them for an expression of my thoughts, and, singularly enough, it is to be found in their nomenclature. Many of these names were given by one of the greatest field naturalists who ever lived—Linnæus, and so we often get summed up in one little Latin or Greek word the chief characteristic of the species, simply because of his observations in the field. For instance, *Cælebs*, a bachelor, is the specific name given to the Chaffinch because the males flock together in the autumn and keep separately from the females until pairing time comes again.

The genus *Phylloscopus* (from φύλλον, a leaf, and σκοπέω, I look at) derives its name from the habit these little warblers have of searching amongst the foliage for the tiny insects they feed on. The Great Grey Shrike (*Lanius excubitor*) indicates the bird's habits to a nicety. *Lanius*, a butcher, and *excubitor*, a sentinel or watchman, from this bird's habit of perching on the topmost twig of a bush on the look-out either for prey to butcher and impale, or an enemy to avoid. The genus *Lagopus* derives its name from the fact that the legs of the grouse by their complete covering (in winter) of short hair-like feathers resemble those of a hare (*Lagopus*, λαγωποῦς, from λαγώς, a hare, and ποῦς, a foot). The Rose-coloured Starling owes its name, *Pastor roseus*, to the fact of its following in the tracks and even perching on the backs of cattle or sheep in search of grubs: (*Pastor*, a shepherd). This trait is again exemplified in the Buff-backed Heron (*Ardea bubulcus*), (*bubulcus*, a herdsman).

The Wrens, again, owe their name *Troglodytes* from the fact of their building a domed nest. *Troglodytes*, τρωγλοδύτης, one who lives in holes.

The Golden Plover was given its specific name *Pluvialis* (rainy) because it was supposed to become more restless and noisy on the advent of wet weather, not because it frequented marshy places. The Dotterel obtains its specific name, *Morinellus*, dim. of *Morus* (μωρός, a simpleton), because the bird on the approach of the fowler was said to imitate his gestures, stretching out a wing when he did an arm, etc., but this habit is not an imitative one, and is common to all the *Charadriidæ*, to which this species is allied. At the same time the Dotterel is a very simple bird, and easy of approach, so that the name still holds good. The Common Snipe owes its specific name *Cælestis* (belonging to heaven) from the habit of the male, which during the breeding season is continually rising with rapid beat of wing far into the skies.

The Barn Owl (*Strix flammea*) owes its generic name to στρίξ, from the root of τρίζω (I cry sharply or shrilly), and we find a word derived from *Strix* used in mediæval times of peculiar significance, when so many poor wretches were tortured and put to death under the impression they were persons of ill-omen—namely, *Strigia*, a witch or hag.

Turnstone, as well as the scientific name of the bird (*Strepsilas interpres*), denotes its habits, *Strepsilas* being derived from στρέφω (I turn), and λᾶσ (a stone). *Interpres* is stated to have been given by Linnæus because this bird is a warner or explainer to other waders, but the Turnstone is a peculiarly silent bird, and I think the great naturalist used the word in its broadest sense—that is, meaning a go-between, or broker; one who gets his living between two persons or things. This puts me in mind of another specific name of interest, namely, that of the Fieldfare. The specific name, as we have it, of the Fieldfare is *pilaris* (a ball). Now there is nothing characteristic in the spots on the breast of the Fieldfare; they are common to all the Thrush tribe. We find *pilaris*, the translation given by Gaza (1476) of τριχάς (a kind of Thrush), in Aristotle, Hist. An. IX., 20, as if that name were derived from θριξ (*Pilus*, a hair), and *os* (*oris*, a mouth, which might refer to the rictal bristles); but here, again, we have the difficulty that this is a characteristic of all the *Turdidæ*, and the Fieldfare is not the type of the Thrushes. Can it be that the word meant is *pileus* (πῖλος, a felt cap or hat made to fit close, and shaped like the half of an egg—a cap worn by the Romans at entertainments and festivals)? The grey crown of the Fieldfare in breeding plumage so exactly suits this description.

Nothing can be turned to better account than the interpretation of the specific name of the Cirl Bunting (*Emberiza cirlus*). *Cirlus*, like the German *Zirl-ammer*, is from the Italian *Zirlare* (to chirp, to cry " zi, zi "). The bird is called *Zizi* by the Piedmontese, the note of the male-bird being exactly interpreted by this sound, and one's attention in spring is instantly arrested by its constant repetition from some conspicuous twig which is favoured by the bird.

The Flycatchers (*Muscicapa*) again obviously take their name from their habit of obtaining food: *Muscicapa*, from *musca*, a fly, and *capio*, I catch.

The generic of the Ringed Plovers, *Aegialitis* (αἰγιαλίτης, a dweller by the sea-shore), has a deeper meaning than its literal one, for the derivation αἰγιαλεύς referred in heathen mythology to the brother who was cut to pieces, and whose remains were scattered along the sea-shore by his sister Medea. Everyone who knows the habits of these birds, how the flock, on dropping down, after a wheeling flight, radiate and spread out all over the sands, can appreciate the appropriateness of the synonym, the habit being in marked contrast to those of the Sanderling (*Calidris arenaria*), which in little compact flocks advance and retreat with each ebb and flow of wave with surprising regularity and nimbleness.

Other birds, again, are named with reference to distinctive marks of colour in the feathers or soft parts, such as the bill or legs, as the Black-throated Thrush (*Turdus atrigularis*), *atrigularis* from *atri*, black, and *gula*, a throat. The Twite (*Linota flavirostra*), *flavirostra* from *flavus*, yellow, and *rostrum*, a beak; in fact this bird is known as the yellow-nebbed lintie in North Britain. The Golden Oriole (*Oriolus galbula*), *Oriolus* from *Aureolus*, golden, *galbula*, a yellow bird, the sight of which was supposed to cure jaundice, though the bird died. The Harlequin Duck (*Cosmonetta histrionica*), *Cosmonetta* from κόσμος, ornament, and νῆττα, a duck; from its brilliantly contrasted plumage: *histrionica*, belonging to or like an actor.

It is interesting to note how this peculiarly beautiful style of plumage takes the popular fancy. A handsome little Quail (*Cyrtonyx montezumæ*) of America is known to the miners of Lower California and Arizona as the Fool Quail, for the reason that its plumage is spotted and striped in strong contrast. The Green Sandpiper (*Totanus ochropus*), *ochropus* from ὤχρος, pale yellow, and ποῦς, a foot.

Again, some abnormality of structure has called forth attention, and a name given to emphasize the fact, such as Pallas's Sand Grouse (*Syrrhaptes paradoxus*), *Syrrhaptes* from συρράπτειν, to sew or stitch together, because the last phalanges of the toes alone are free, all the toes being as it were sewn together like a fingerless glove: *paradoxus*, strange, contrary to expectation, referring of course to the curious structure of foot.

In fact, the nomenclature of birds opens up enough romantic material to fill a four volume novel, and breathes in every line the work of a field naturalist, and yet it merely touches the fringe of one subject in natural history. Let us not, however, be dismayed at the wide field which opens out for investigation; rather let us increase our ranks, and endeavour to instil into others the enthusiasm which is the very essence of our life, and whilst we make truth, keen observation, and sympathy our cardinal principles, let us emulate Longfellow's village blacksmith:—

"Toiling—rejoicing—sorrowing
Onward through life he goes:
Each morning sees some task begun,
Each evening sees its close:
Something attempted, something done,
Has earned a night's repose."

Microscopy.

By John H. Cooke, F.L.S., F.G.S.

The embedding of lichens is, at best, a delicate operation. Prof. G. F. Pierce, of Stanford University, California, has devoted some attention to this phase of microscopical technique, and recommends a mixture of hard and soft paraffin, which melts at about 60° C., as a satisfactory medium. After fixing the material, small pieces of the paraffin are added to the pure xytol, in which the material has already been cleared, and the dish is kept warm, both to increase the solvent power of the xytol, and also finally to evaporate it all. The material is thus slowly warmed and penetrated with paraffin, and is left for about three hours after the xytol has all evaporated. The sections should be very thin, and, before cutting, the block should be chilled to somewhat below 20° C. Staining on the slides by any of the usual methods is easy, and the results satisfactory.

The fugitive character of staining effected by aniline colours has led E. Van Ermengem to devise the following process for staining the cilia of bacteria. It is founded on the reduction of silver from a solution of its nitrate. The bacteria films are well dried, and immersed in a fixing bath consisting of osmic aoid (two per cent.) one part, and tannin (ten per cent.) two parts. They are then washed carefully in water and in alcohol, and passed to a weak solution (·5 per cent.) of silver nitrate. Without further washing, transfer to a bath of gallic acid, five parts; tannin, three parts; sodium acetate, ten parts; and distilled water, three hundred and thirty parts. After a few moments they should be returned to the silver bath, washed thoroughly, dried, and mounted in balsam.

Algæ introduced in small quantities into aquaria containing good aerating plants like myriophyllum, calumba, ranunculus, water mosses, etc., will thrive for long periods, and so furnish the microscopist with a supply of material for use at any time. Freshwater crustaceans, as cypris and cypridospis, may be added with advantage, their functions as scavengers adding considerably to the purity of the water. They are particularly fond of the mesophyll of leaves which they remove, leaving beautiful leaf skeletons.

A bristle from an old shaving brush, when fastened in a wooden handle, makes a useful accessory for selecting foramens, mineral fragments, diatoms, etc. These bristles are nearly always split, and, when pressed on the glass slips, the ends readily separate. The material and slip should be so arranged that the selected object shall occupy a position between the split portions. On removal of the pressure the bristle closes, and the object, being secured, is transferred from one slide to another.

The sectioning of entomostraca and other minute crustaceans offers many difficulties, both on account of the hardness of their chitinous coats as well as of their small size. To overcome these, Dr. Giles suggests the following method, which he has practised with marked success. The animal is taken from absolute alcohol, and clarified in oil of cloves, after which it is placed in a watch-glass containing a few drops of Canada balsam, and gently heated over a spirit lamp. The balsam quickly drives out the clarifying agent, and permeates the tissue of the object, forming round it a hard bead. A single drop of balsam is then placed on a glass slip and heated, until on cooling it becomes quite hard. The bead of balsam containing the object is next propped up on the balsam on the slide, which has been previously warmed, in the position in which it is desired to cut the section. It is necessary that the balsam should be neither too soft nor too brittle. If too soft, it will stick to the razor blade when sectioning; and if too brittle, it will chip away. A few trials before embedding the object will enable the microscopist to estimate the amount of heat that is necessary to reduce the balsam to the requisite consistency. The beauty of the sections obtained by this method will well repay the trouble and care expended.

In the biological laboratories of Denison University, wax-modelling is largely used for demonstrations in the morphological and comparative study of organic structures. The methods employed consist, essentially, in constructing enlarged patterns of a series of microscopic sections, and from these patterns constructing a model which will represent the original unsectioned tissue, but on a greatly enlarged scale. The sectional drawings are traced on wax sheets of uniform thickness by the aid of the camera lucida, or the projection microscope. A porcelain stylus, or an ordinary lead pencil, are equally suitable for the purpose. After outlining the sections on the wax sheets, they are cut out in serial order, either with an ordinary penknife or with a fine, stretched wire. To guard against misplacement in the final reconstruction, each section is given a number which corresponds to that on the drawing, and the whole is cemented together by means of heat. The model is finally glazed over by being held for an instant over a hot flame.

Most petrologists are conversant with the methods employed in the uses of dense liquids for the isolation of the mineral constituents of a rock-mass. Many of the liquids used for this purpose are, however, of a dangerously corrosive and poisonous character, while others are so expensive as to be beyond the reach of the average private student. In the latter category may be placed Klein's solution of boro-tungstate of cadium, a reagent which is essential to the complete equipment of the micro-petrologist. If purchased in the ordinary way, this solution is one of the most expensive. By means of the following method, first suggested by Mr. W. B. Dallas Edwards, its cost of production is very trifling. Dissolve 450 grains of sodium tungstate in as little boiling water as possible, and add slowly 675 grains of boric acid in small crystals. Allow sodium borates to crystallize out by repeated stages and partial evaporations till the sodium boro-tungstate is obtained as a heavy liquid, in which felspar floats. Boil this, and add 150 grains of $BaCl_2$ dissolved in 200 c.c. of water, a little at a time. Wash and collect the precipitate, and add 300 c.c. of ten per cent. HCl. Evaporate to dryness, and add 40 c.c. of HCl. towards the end. Dissolve in 300 c.c. of hot water, and filter off the green tungstic hydrate. Evaporate down till most of the barium boro-tungstate is obtained as light-yellow, lustrous crystals. Re-crystallize, and dissolve in 200 c.c. of water, and add $CdSO_4$ drop by drop. Filter and evaporate to sp. gr. 3·46. On standing some crystals separate, and the sp. gr. falls to 3·28.

Microscopical investigations may be carried on without the operator incurring any risk of injuring his eyesight, provided that the following conditions be strictly observed. Never commence work directly after a meal. Do not use too strong a light. Unmodified sunlight should not be employed, except in special cases. North light is best, and most uniform. To avoid the shadows produced by the hands in manipulating the mirror, it is better to face the light; but when so doing, care should be taken to shade the eyes and the microscope stage. Otherwise endeavour to so arrange the light, whether it be sunlight or artificial, so that the illuminations shall come over the left shoulder, as in reading. And lastly, work at a table of a height such that, when seated, the ocular will be on a level with the eye of the operator. The top of the table should be painted a dead-black.

The "soap mass" is one of the best embedding materials that the student of botany can use for cutting sections of fresh vegetable tissues. A simple and expeditious method of preparing it is as follows. Take good, white, hard soap, cut in very thin slices, and having gently compressed them in a suitable dish, pour in enough (ninety-five per cent.) alcohol to somewhat more than cover them. Heat to near the boiling point of alcohol, until the soap is dissolved. Add now a small quantity of glycerine. The amount of the latter can be readily ascertained by pouring out a few drops of the warm mixture, and allowing it to cool. Without any glycerine the mass instantly congests into a white, friable substance, quite unfit for embedding; but as a proportion is gradually added, the mass hardens less and less rapidly, and becomes more and more transparent. For soft tissues, the mass may be made as transparent as glass; for harder substances, less glycerine must be used.

NOTES ON COMETS AND METEORS.

By W. F. DENNING, F.R.A.S.

NEW COMET.—A new comet was discovered by M. Giacobini, at Nice, on September 29th. It was situated in R.A. 246° 38′, Dec. 5° 10′ south, and its diurnal motion was 30′ eastward and 10′ northward. The comet is described as faint. At the time of its discovery its position was about 60° east of the sun, so that it set about four hours after that luminary. Elements have been computed by Möller and Giacobini, but they differ considerably. On November 2nd the position of the comet will be in R.A. 17h. 5m. 43s., Dec. N. 4° 26′.

HOLMES'S COMET.—This comet may possibly be seen in very powerful telescopes, but there is a singular dearth of observations of it, and there is little doubt that its extreme faintness has enabled it to escape general notice. In *Ast. Nach.*, 3595, Zwiers gives an ephemeris of the comet for the last three months of 1899, and from this the following positions are extracted :—

Greenwich Mean Midnight		R.A. α h.	m.	s.		Dec. δ °	′	″	Distance in Millions of Miles.
November 5	...	2	32	57	+	49	9	29	154
„ 10	...	2	27	0	+	48	54	30	155
„ 30	...	2	8	59	+	46	44	50	165
December 10	...	2	5	1	+	45	17	38	174
„ 30	...	2	7	45	+	42	29	6	196

The comet is travelling away from the earth and becoming fainter. On the evening of November 1st it will be about half a degree N. of the star θ Persei (mag. 4·2).

The Comet of the Leonids (Tempel. 1866 I.).—This comet was due to return in the spring months, but its position was very unfavourable, and it has eluded detection. Whenever its perihelion passage occurs in about November or December, the comet can be favourably observed from the earth, but this only takes place once in a century. At the close of 1965, and again at the end of 2065, this interesting object is likely to be presented under the best conditions.

Fireball of August 27th, 10h. 13m.—About eight accounts of this object have been received, and they indicate the radiant as situated approximately in 191° + 32°. When first seen the meteor was sixty-eight miles above Wigan, and at its disappearance forty-seven miles above Cambridge. Its length of path was one hundred and forty-three miles, and velocity about twenty-five miles per second.

Fireball of October 2nd, 8h. 20m.—A very brilliant and striking meteor was seen by Lieut.-Col. J. P. H. Boileau, A.M.S., at Trowbridge, passing very slowly from Corona Borealis to Ursa Major, where it disappeared below ϵ on a line drawn from γ to η. Its duration of flight was four or five seconds. Shortly before extinction, the nucleus divided into two very distinct bright stars, one following the other in the same line of motion. The meteor left an evanescent train of white nebulous light. The same object was seen by Mr. M. J. Nyhan, of Bristol, and he recorded its path as from about fifteen degrees below α Lyræ to twelve degrees above ζ Ursæ Majoris. The meteor moved with extraordinary slowness, its whole duration of visibility being estimated as eight seconds. Near the end of its flight the head broke into two portions, which were three-and-a-half degrees asunder when the meteor vanished. The radiant of the meteor was at 284° – 17° in the northern region of Sagittarius. Its height was from about sixty-seven to forty-five miles above the English Channel, thirteen miles W.N.W. from Ilfracombe to Knighton, Radnor. Length of path eighty-six miles, and velocity about thirteen miles per second. When the meteor disappeared, the distance between the two fragments into which the nucleus separated was about six miles.

The Expected Leonid Shower.—The moon will be full on the morning of November 17th, and her light will greatly moderate the brilliancy of any display that may occur. If, however, the maximum should take place on the morning of the 15th, just before sunrise, it ought to be well seen, as the moon sets at 4h. 54m. a.m. There will also be a little dark sky on the morning of the 16th after 6h. 13m. a.m. According to Drs. Stoney and Downing the most probable time for the middle of the ensuing shower is the 16th, at 6 a.m., when the moon is near setting, and the display ought to be seen to advantage if the calculations are justified by the event. In 1898 the shower, such as it was, occurred earlier than the time predicted, and in view of the uncertainty prevailing it seems desirable to watch the sky on the mornings of the 15th and 16th. Many attempts will be made to photograph the shower and determine the centre of the radiant from the trails impressed on the plates, so that observers, viewing the shower in the ordinary way, need not concern themselves with this feature. They will probably be more usefully occupied in noting the time of maximum, the number of meteors per minute near and at the period of maximum, and in recording the apparent paths of brilliant Leonids or of large meteors from other showers. If any observer decides upon fixing the place of the radiant this may be done with considerable accuracy by registering the paths near to it, and, for intervals of (say) half-an-hour, getting independent positions for it. The mean of eight or ten well determined places would probably be very accurate and agree very closely with the best positions ascertained by the photographic method. As the radiant of the Leonids does not rise until about 10h. 15m. p.m., observations must not, in any case, be commenced before that hour, and it is rarely that many of the meteors are seen before midnight.

THE FACE OF THE SKY FOR NOVEMBER.

By A. Fowler, F.R.A.S.

The Sun.—On the **1st** the Sun rises at 6.56, and sets at 4.32; on the **30th** he rises at 7.43, and sets at 3.54. Few sunspots are likely to be observed.

The Moon.—The Moon will be new on the **3rd**, at 10.27 A.M.; will enter first quarter on the **10th**, at 1.35 P.M.; will be full on the **17th**, at 10.18 A.M.; and enter last quarter on the **25th**, at 6.35 A.M. The following occultations are the most notable of those occurring during the month :—

Date.	Name.	Magnitude.	Disappearance.	Angle from N.	Angle from V.	Reappearance.	Angle from N.	Angle from V.
Nov. 12	κ Piscium	5·0	11.11 P.M.	136°	104°	11.29 P.M.	170°	137°
„ 17	A^1 Tauri	4·5	10.21 P.M.	54	83	11.29 P.M.	283	296
„ 19	Neptune	...	6.10 P.M.	95	129	7.1 P.M.	261	299

The Planets.—Mercury is an evening star throughout the month, but on account of his great southerly declination he is unfavourably situated for observation in our latitudes. He is at greatest easterly elongation of 22° 18′ on the **16th**, but even then he sets about fifty minutes after the Sun.

Venus is an evening star, but too low and too near the Sun for observation.

Mars, Jupiter, Saturn, and Uranus are also out of range. Jupiter is in conjunction with the Sun on the **13th**, and Uranus on the **30th**.

Neptune remains nearly midway between ζ Tauri and η Geminorum, and is above the horizon practically all night.

The Stars.—About 9 P.M. at the middle of the month, Gemini will be low in the north-east; Auriga and Perseus high up in the east; Taurus between east and south-east, with Orion below; Aries nearly south-east; Cetus nearly south; Andromeda and Pisces in the south; Cassiopeia almost overhead; Pegasus and Aquarius towards the south-west; Cygnus and Aquila in the west; Lyra a little north of west; Corona setting in the north-west; and Ursa Major towards the north.

Convenient minima of Algol occur on the **2nd** at 5.39 P.M., on the **19th** at 10.32 P.M., and on the **22nd** at 7.21 P.M.

Chess Column.

By C. D. Locock, B.A.

Communications for this column should be addressed to C. D. Locock, Netherfield, Camberley, and be posted by the 10th of each month.

Solution of October Problem.

Key Move—1. Kt to KB5.

Threat Variation.

2. R to K3ch.

2. . . . P × R, 3. Kt to Q6ch, etc.

2. . . . K to Q4, 3. B to B7ch, etc.

Defence A.

1. . . . K to Q4, 2. R × Pch.
2. . . . K to B5, 3. Kt to Q6ch, etc.
or 2. . . . K to K5, 3. B to B3ch (or Kt to Q6ch).

Defence B.

1. . . . P × P. 2. Q to Q4ch.
2. . . . K × Kt, 3. R to K3, etc.

Defence C.

1. . . . Kt to B7, 2. R to K3ch
2. . . . Kt × R, 3. Kt to Q6ch, etc.

Defence D.

1. . . . B × Kt, 2. R × QP.
2. . . . K × R, 3. Q to B3ch, etc.
or 2. . . . Kt moves, 3. B to B3ch, etc.
or 2. . . . P to B6, 3. B × Pch, etc.
or 2. . . . B to Kt5, 3. B to Kt6ch, etc.

Defence E.

1. . . . P to Q7, 2. R to QB3.
2. . . . P bec. Q, 3. Kt to Q6ch, etc.
or 2. . . . K to Q4, 3. B to B3 mates.
or 2. . . . P to B6, 3. Kt to Kt3 (or Q6) ch, etc.

Correct Solution received from J. Baddeley, who fails only in giving the correct attack in reply to P to Q7.

Six other solvers have attempted the problem, 1. Q to Q6 being the favourite beginning. This works very well against 1. . . . P × Kt, and even 1. . . . B to B4, but 1. . . . B to Ksq seems a valid defence. In fact, the amount of defensive work done by the Black Queen's Bishop in reply to many "tries," is a feature of the problem, which is probably one of the finest four-movers ever composed.

C. H. Schachel.—After 1. B to Kt6ch, K moves; 2. R × P, K to B5; 3. Q to R6ch, K × P, there is no mate. Probably also there are other defences at move 2.

W. H. Jones.—1. R × P seems all right if Black reply 1. . . . K to Q4 (as you give), or 1. . . P × Kt. But is there a mate in 3 after 1. . . . K × R? We have no time to examine it.

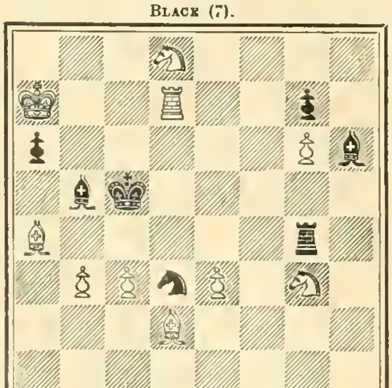
J. K. Macmeikan.—Many thanks for your problem, which appears below.

PROBLEMS.

No. 1.

By J. K. Macmeikan (Repton).

Black (7).

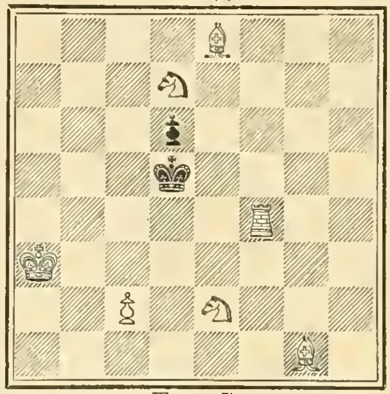


White (10).

White mates in two moves.

No. 2.

Black (2).



White (7).

White mates in two moves.

CHESS INTELLIGENCE.

There were twelve competitors in the Russian National Tournament, which was held recently in Moscow. M. Tchigorin won the first prize with the fine score of 10 out of a possible 11. M. Schiffers scored 7½, and took the second prize. The remainder of the competitors are probably unknown to English players.

In the tournament of the New York State Chess Association, Mr. Lipschütz has won the first prize, and proved clearly that his play has suffered no deterioration during his long retirement from the chess arena. The second prize resulted in a tie between Mr. Kemeny and Mr. F. J. Marshall, the winner of the "second tournament" in London last summer. Messrs. Halprin, Shipley and Bampton divided the fourth and fifth prizes.

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CONTENTS.

EDITORIAL.

With the single exception of the promised paper on the "Pitch Lake of Trinidad," we have been enabled, with the valued aid of our contributors, to carry out the programme of work which we set before our readers twelve months ago.

Turning to some of the more important projects in our new year's work, we have received the promise of some further Astronomical Plates from Dr. Isaac Roberts, to whom we are already so much indebted for numerous magnificent examples of Astronomical Photography. Mr. E. Walter Maunder is going out to Algeria for the purpose of observing the solar eclipse of May, 1900, and he will relate his experiences in our columns. Mr. Maunder is also at work upon a series of popular articles on "Astronomy without a Telescope," to commence with the January number. In this department of our work we hope to have the aid of Miss Agnes M. Clerke, Mr. J. Evershed, Mr. A. Fowler, Mr. J. E. Gore, and Prof. E. C. Pickering. Mr. W. F. Denning will again contribute a column during the year on Comets and Meteors, and Mr. Fowler will continue to conduct the column on the Face of the Sky.

We hope to publish at an early date an original drawing of the Planet Mars, which has been specially made for Knowledge by M. Eugene M. Antoniadi, who will also contribute a further paper on "Cloud Photography," to be illustrated by some more of his successful photographs of clouds.

An important series of Ethnological Studies from the facile pen of Mr. R. Lydekker will commence in our January number with a consideration of the native races of the Australian continent. These articles will be fully illustrated from a selection of interesting photographs which Mr. Lydekker has kindly placed at our disposal.

Our readers will be glad to learn that there is considerable prospect of Mr. Fred. Enock's return to our columns as a contributor of those delightful life-histories of minute insects, which have been too long absent from our pages, owing to great press of work upon the author.

Arrangements have also been made for the issue, during the year, of a series of original articles by Mr. H. H. W. Pearson, of the Royal Gardens, Kew, on "Plants and their Food," in which Mr. Pearson proposes to consider in detail the nutrition of the green plant. In addition, we hope to place before our readers several further sets of papers, for which arrangements are now in progress, and of these we may direct attention to the following:—A set of studies on "Scenery and Geology in Europe," by Prof. Grenville A. J. Cole; a series of papers on "Wireless Telegraphy," by Mr. G. W. de Tunzelmann; and an introduction to sociology and to the origins of history, under the title of "The Evolution of Simple Societies," by Prof. Alfred C. Haddon, who proposes to describe the hunters, fishers, herders, and tillers in typical communities, and to note the effects of environment and mode of life upon them.

The Rev. Thomas R. R. Stebbing will contribute two or three concluding chapters to his fascinating study of the *Crustacea*, with which he has delighted our readers during the past two years; Mr. Howard B. Little will contribute some articles on "Electricity as a Natural Force," in which he proposes to deal with thunderstorms, magnetic storms, and the Aurora Borealis; and, finally, Mr. William Shackleton informs us that he is now hoping to redeem his promise of last year in regard to the article on "The Pitch Lake of Trinidad."

We avail ourselves of this opportunity to offer our grateful thanks to our readers, our contributors, and to the Press, for the generous support accorded to our efforts, and our assurance that we intend to spare no labour in making the pages of Knowledge both useful and welcome all over the world.

ON THE TREATMENT AND UTILIZATION OF ANTHROPOLOGICAL DATA.

By ARTHUR THOMSON, M.A., M.B.

VI.—FACIAL FORM.

THE skeleton of the face, as one might reasonably expect from a knowledge of the living, displays many characteristic varieties of form. As was pointed out in a previous article,* the shape of the skull is to some extent dependent on the size of the jaws, and the development of the muscles which control the movements of the mandible. It will be obvious that the size of the jaws will be largely determined by the size of the teeth, and as in savage races the teeth are, as a rule, larger than in the more highly civilised peoples, it naturally follows that the architecture of the face will be modified by the massiveness of the jaws and their associated structures. The late Professor Sir William Flower was amongst the first to recognise this fact, and by comparing the length occupied by the upper molars and premolar teeth with the length of the cranio-facial axis (basi-nasal length) he determined the dental index by the following formula :—

$$\frac{\text{Length of 5 molars} \times 100}{\text{Basi-nasal length}} = \text{Dental index.}$$

In this way he was able to group the races of man according to the size of their teeth into three varieties :—

a b c
FIG. 1.

a b c
FIG. 2.

Figs. 1 and 2 represent Skulls with large, medium, and small Teeth. *a*, Macrodont; *b*, mesodont; *c*, microdont.

I.—The Microdont, with an index below 42, including mixed Europeans, ancient Egyptians, low-caste natives of India, and Polynesians.

II.—Mesodont, with an index ranging between 42 and 44, comprising Chinese, American Indians, Malays, etc.

III.—Megadont, having an index over 44. This group embraces Melanesians, Andamanese, and the Australian and Tasmanian races.

The reduction in the size of the teeth in the higher races is probably explained by a reference to the more common methods of preparing the food by cooking, etc., which renders unnecessary a powerful masticatory apparatus. On the other hand, the size of the teeth in the lower races is oftentimes much larger than might be at first assumed from a casual inspection of a large number of skulls. This fact was borne out during the discussion which took place on the remarkable fossil remains brought from Java by Dr. Dubois. These included a skull, a thigh bone, and two molar teeth, presumably all belonging to the same individual. We are not at present concerned with the skull or thigh bone, which the discoverer claimed, with much show of truth, belonged to an intermediate form between man and the higher apes, which he distinguished under the name of *Pithecanthropus erectus*, but rather to draw attention to the aspects of the case as determined by the teeth. These were of large size, and, among other points, it was urged that they were too big to be human. This assertion at once put all the anatomists who had large collections under their charge on the "qui vive," and many hundreds of specimens were examined with the object of determining this point. It soon became apparent that this argument against the Trinil teeth being human would have to be abandoned, as a number of instances were forthcoming in which undoubtedly human teeth equalled, if they did not excel, the fossil specimens in size. It would therefore appear extremely hazardous to express any opinion as to the limits of size within which we should regard teeth as human.

The teeth, which are embedded in the alveolar border of the jaw (we are speaking now only of the upper jaw) must, when large, occupy more room, and, necessarily, lead to the expansion of that part of the jaw which supports them; this need not necessarily produce an equal development of the entire bone, though doubtless, involving modifications of form, but will of course cause an expansion or projection of its lower part, comparable to the muzzle seen in many animals. The reader will at once appreciate the form of face dependent on this projection of the jaws if he studies the appearance presented by a typical negro, in whom, however, it is as well to bear in mind that the appearance is much exaggerated by the thickened and everted lips. To this projection of the muzzle attention was directed by a Dutch anatomist named Camper, who was the first to attempt to estimate it by a scientific method. He found that the angle formed by the intersection of two lines, of which one passed across the face, cutting the orifice of the ear posteriorly, and lying on the level with the lower edge of the septum of the nose in front, whilst the other was applied to the profile of the face, resting on the most prominent part of the forehead above and the anterior surface of the upper incisor teeth below, varied considerably, ranging from 62° to 85°, corresponding, in the first instance, with a projecting muzzle and a sloping face, in the latter with a profile more nearly approaching the vertical. On the living, Camper's method of determining the facial angle is still employed by the use of appropriate instruments, but in this country the method suggested by Flower is that more commonly made use of to determine the amount of projection of the upper jaw in the macerated skull. This method depends on the proportions which two measurements bear to one another—the basi-nasal length (*i.e.*, the distance from the anterior edge of the foramen magnum to the fronto-nasal suture) as compared with the

* KNOWLEDGE, October, 1899.

basi-alveolar length (*i.e.*, the distance from the anterior margin of the foramen magnum to a point on the alveolar border of the upper jaw between the two central incisors). Regarding the former as the constant, and the latter as the variable, we are in this way enabled to determine the gnathic or alveolar index :—

$$\frac{\text{Basi-alveolar length} \times 100}{\text{Basi-nasal length}} = \text{Gnathic index.}$$

The sub-division of the resulting indices into three groups is, of course, purely arbitrary. Flower classified his results as follows:—When the index falls below 98, it indicates that the jaw projects but slightly. Such crania are termed orthognathous, and include, amongst others, the mixed European races, ancient Egyptians, Veddahs, etc. When the index ranges between 98 and 103, the jaws are more projecting; this, the mesognathous group, comprises Chinese, mixed Polynesians, American Indians, etc. Whilst, when the index rises above 103, we have a very pronounced projection of the jaws, as indicated by the term prognathous applied to the group. Topinard takes exception to this classification, expressing the opinion that the range of Flower's mesognathous group (98–103) is too wide. He would limit it to indices ranging between 98 and 100 or 101, which would have the advantage of practically confining it to the yellow races. whilst all over 100 or 101 he would regard as prognathous. The reader will at once appreciate what this difference in classification entails, for the French anthropologists are in the habit of describing the Australians as a prognathous race, whilst we in England term them mesognathous, their average gnathic index being 101 (Duckworth). Whilst convenient to employ, it cannot be said that Flower's gnathic index is without objection, since it takes no account of the length of the third side of the triangle, viz., the naso-alveolar measurement, for on the length of this must depend the relative projection of the two sides of the triangle, viz., the basi-nasal and the basi-alveolar lengths.

In no respect is the novice so apt to be misled as in regard to this question of projection of the jaws. In handling and comparing skulls the utmost care must be exercised to place them in such a position that certain definite points all lie in the same horizontal plane. Nothing is easier than to convey an impression of prognathism by tilting forward the face of an orthognathous skull, whilst marked degrees of prognathism may be masked by inclining the face in a vertical direction. In the living this comparison of the face is much more easy. The natural position of the head may be said to be that in which the axes of vision of the two eyes lie in the same horizontal plane. If, therefore, we place the subjects under observation in the military position of "attention," with the heads in an easy position, and the eyes directed toward the horizon, the slope of their faces can be satisfactorily compared. In dealing with skulls we must find some substitute for the visual axis, and that most commonly adopted is to place the crania in such a position that a line passing from a point immediately above the external auditory meatus behind, and the lower orbital margin in front, falls in the horizontal plane. Fig. 3 illustrates this method of comparison. A glance at this figure will enable the reader to satisfy himself that without some such common basis of comparison it would be easy to place the skulls in such positions as to lead to erroneous conclusions.

A comparison of the dental and gnathic indices reveals the fact that prognathism of intermediate and pronounced degree is associated with large teeth, whilst the microdont races all more or less conform to the orthognathous type.

The shape of the nose in the living displays remarkable differences, the long and narrow nose of the European contrasts with the short and broad nose of the Negro,

a b c

FIG. 3.—Shows the varying degree of projection of the Upper Jaw Skull *a* is prognathous; skull *b* is mesognathous; skull *c* is orthognathous.

whilst the form of the nose in the Australian displays a very characteristic appearance, it is only necessary to mention those extremes in order to draw attention to the many intermediate varieties. The form of the nose depends on the disposition of the bones and cartilages which support it. At present, we are only concerned with the former. Perhaps no feature of the skull is more valuable in assisting the observer roughly to classify the crania which he is examining than the form of the nasal aperture.

a b c

FIG. 4.—Shows the three types of Nasal aperture. Skull *a* is leptorhine; skull *b* is mesorhine; skull *c* is platyrhine.

A reference to Fig. 4 will enable the reader to appreciate for himself as to the typical forms there represented. Usually described as of pyriform shape, the nasal aperture varies in the relative proportions of its width and height. This is expressed by the nasal index, which is determined by employing the following formula—

$$\frac{\text{Nasal width} \times 100}{\text{Nasal height}} = \text{Nasal index.}$$

The nasal width corresponds to the maximum diameter of the aperture, whilst the nasal height is estimated by the measurement from the nasion (fronto-nasal suture) to the sub-nasal point (middle of inferior edge at base of nasal spine).

The Leptorhine group includes those skulls with a nasal index below 48; the Mesorhine between 48 and 53; whilst the Platyrhine division comprises those crania with an index above 53. Each of these three groups is typical of the broad divisions of mankind into the white, the yellow, and the black varieties; thus the white races are leptorhine, that is, they are characterised by a narrow nasal aperture; the Mongoloid type, if we except the

Esquimaux, possess a nasal aperture of intermediate form, and are hence mesorhine: whilst the black races, including Negroes, Australians, Tasmanians, etc., are platyrhine, and have broad and open nasal apertures.

Here, again, we have an instance of the correlation of certain forms, the platyrhine type of nasal aperture is usually associated with the prognathous or mesognathous form of jaw; the most noticeable exception to this rule being the Bush race, which, although orthognathous, is extremely platyrhine (index 59, Flower).

The relation between the skeletal form of the orbits and the external appearance of the eye, denoting thereby the disposition of the eyelids, and the extent and direction of the palpebral fissure, is not nearly so pronounced as the association between the skeleton of the nose and its external shape. If we except the pronounced projection of the upper orbital margins which is so characteristic of some races, and which imparts to the features an undue projection to the eyebrows and a sunken appearance to the eye, it is doubtful if modifications in the shape of the orbital margins are at all recognisable on the living. We find, however, that in the skull the form of the orbit is subject to many variations. In order to estimate these differences use is made of the orbital index, which expresses the proportionate height of the orbit as contrasted with its width. $\frac{\text{Orbital height} \times 100}{\text{Orbital width}} = \text{Orbital index.}$

When the index falls below 84 the skull is described as Microseme—that is to say, it possesses an orbit of more or less oblong form, the height being much less than the width. When the index is above 89 the aperture is more circular in shape, and the skull displaying this form is called Megaseme.

The intermediate form with indices varying from 84 to 89 belong to the Mesoseme group.

Just as we have seen a correlation between the dental, the gnathic and the nasal indices, so we recognise a like tendency in regard to the orbital index, though not so marked.

This is borne out by an examination of the table prepared by the late Sir W. Flower, and published in the Osteological Catalogue (Man) of the Museum of the College of Surgeons. In no race in which the orbits are megaseme is the skull either prognathous or platyrhine; on the other hand, if we except Guanches and Bushmen, we find microseme skulls displaying both platyrhine and prognathous conditions.

There is some justification therefore for the assumption that, given a human tooth, preferably a molar, we might from a consideration of its size form some general idea of the architecture of the face of the individual to whom it once belonged.

Unfortunately the space at our disposal prevents us for the present from referring to many other points in connection with the disposition and arrangement of the bones of the facial skeleton.

SECRETS OF THE EARTH'S CRUST.

By Grenville A. J. Cole, m.r.i.a., f.g.s., *Professor of Geology in the Royal College of Science for Ireland.*

VI.—THE COMING OF MAN.

Man presents himself to the calm and enquiring eye of science in so many aspects, in so many fields of enterprise, that it is difficult to deal comprehensively with his career upon the earth, as we might with that of the cockle or the crayfish. He is so near us, even in the Malay or the Negro, that we are apt to place him in a category apart from the rest of animated nature. Even the young science of anthropology, by t very title, confesses that zoology cannot cope unaided with the details daily provided by the aberrant activity of mankind.

The geologist can make no claim to discuss the specific isolation of man, or the origin of his infinite resource. The "god-like apprehension" that gives us on the one hand the dynamite gun, and on the other the Society for the Prevention of Cruelty to Animals, may well stagger a philosopher. Most enquirers are content to retire from this field, observing "there is something in this more than natural, if philosophy could find it out." But the first appearance of man upon the earth, which was formerly regarded as a matter for historians, has become more and more a question of pure geology. Whether the archæologist desires it or no, he has already been forced to take counsel with the stratigrapher in his researches into the earth's crust.

When Sir C. Lyell, in 1863, issued his "Geological Evidences of the Antiquity of Man," a book that ran into three editions in ten months, he took the position that the principles of geology and palæontology must be applied to the solution of the question. He thus observed* that the shell-mounds accumulated by ancient dwellers on the Baltic contain shells of marine species of full growth, whereas those at present living in the adjacent sea have been dwarfed by brackish-water conditions. Or, again, he pointed out (p. 227) the identity of some of the mammalia of the Norfolk Forest-bed with those still contemporary with man, as indicating that we need not "despair of one day meeting with the signs of man's existence in the forest-bed." At that time, the occurrence of man in preglacial epochs was held to be in the highest degree improbable, and archæologists may be found at the present day who look upon Lyell's suggestion as still wild in the extreme.

The remains of man are notably subject to decay, and the signs of his former existence in this or that locality often depend upon the more enduring objects that his skill has left behind. Baked pottery, chipped stone implements, the very charcoal of his fires, may survive in places where his own bones are extremely rare. Much of our knowledge of early man is derived from interments conducted with careful ritual by his tribal fellows. Is it likely that, in a ruder age, when ceremonial burial may have been utterly unknown, the skeleton of man would have much chance of preservation?

Even more robust terrestrial animals may be little known in a fossil state, except in certain fortunate localities. Our acquaintance with the Lower Pliocene or Upper Miocene vertebrate fauna of Europe, to take one example, would be limited, were it not for the local accumulations of skeletons at the farm of Pikermi in Attica, and Mont Luberon in Provence. In neither of these cases is the deposit truly terrestrial; water has brought together the remains, and alluvial mud or gravel has entombed them. At Pikermi, the torrent which swept down the large bones has removed those of the numerous small animals, which must have existed equally on the soil of antique Greece. Hence, even here, the record of the fauna is imperfect.

Unlike many other mammals, early man was not compelled to collect in vast herds around the lakes and watercourses. His very intelligence, his variety of aim, made him a wanderer across the earth. Dying in the forest, or on the barren rock, or isolated in his log-canoe, his skeleton

* "Antiquity of Man," 3rd ed., p. 13.

was rarely covered over and adequately preserved. He was small in comparison with the giant carnivores, with which he competed for his food. Even if he died a natural death, the very fowls of the air could combine to scatter his remains.

Hence, as we work backward, from the present deposits to those of earlier days, the number of human skeletons discoverable decreases with extreme rapidity. Yet there are, up to a certain point, abundant evidences of the occupation of the earth by man. The conclusion is that the earliest types of humanity, without arts, and perhaps without tribal organisation, have probably left very few traces through the strata of the entire crust.

As all interested in the subject are aware, the remains now freely styled "prehistoric" were subjected at one time to the most searching criticism. Had such keenness of attack been directed, let us say, against the assertion that the molluscs of one stratum differed from those found beneath it, William Smith might never have laid the foundations of stratigraphical geology. But the succession of invertebrate life, when Smith was writing in 1815, seemed somewhat remote from human interest; on the other hand, the succession of human remains, in 1847, barely fifty years ago, excited the most lively controversy.* In that year, M. Boucher de Perthes, in his "Antiquités celtiques et antédiluviens," claimed a human origin for his series of chipped flints, found at Abbeville, in association with remains of the mammoth, the rhinoceros, and other mammals extinct in France, or even extinct throughout the world. These flints, from a stratum of ancient river-gravel, are now universally admitted to have been prepared by man, and to be excellent illustrations of the palæolithic stage of his culture in that particular region. If further proof of the association of man and extinct mammalia were wanted, it has been amply supplied by the incised drawing of a mammoth on a curved piece of ivory, found in the cave of La Madeleine, and by the discovery of human bones in the Pampas beds of South America, to mention no other of the pieces of evidence that have accumulated in support of M. de Perthes, the long-suffering pioneer.

It is hard to believe that the pendulum of opinion, as regards the antiquity of man, has now swung round without full reason. It is true that Sir J. W. Dawson, who held that man had existed in Europe for only some six thousand years, wrote, in 1880,† that the antiquity of man "is widely received, owing to the enthusiasm with which novel and startling discoveries, and especially those appearing to contradict old and received opinions, are welcomed at present." If this assertion was made seriously, it shows an amazing ignorance of the history of scientific criticism. In 1880, and down to the present day, archæologists and anthropologists combined to view with the greatest suspicion any new discovery of human remains for which a high antiquity was claimed. Proofs have been, and are, demanded in such cases, more stringent than the stratigraphical geologist is commonly called upon to give. If the coming of man can be clearly shown to have occurred prior to the glacial epoch, this conclusion will have been reached by the running of a blockade, under the search-lights of the scientific world. Again and again the blockade has resisted the attack; again and again the patient worker has had to confess that his evidence was weak and insufficient. It is not the controversialist, however, but the man who can produce his specimens, and who can invite inspection of his diggings, who is likely to succeed in altering the preconceived opinions of our time.

* *See* the full account in Prof. N. Joly's "Man before Metals" (1883), p. 35.

† "Fossil Men and their Modern Representatives," p. 247.

The investigators of the glacial epoch have been, unwittingly, a great bar to the rational treatment of the question. The emphasis laid on the devastation of northern Europe and America by the encroachment of land-ice has made some geologists, at any rate, forget that the "glacial period" or "epoch" is not the parallel of any period or epoch recognised in our stratigraphical nomenclature. Strictly speaking, it is an incident within a geological epoch, and its serious effects were confined to the northern part of the northern hemisphere. In this sense, the inhabitants of Java may assert that they dwell in a volcanic epoch; but life in most parts of the globe is not inconvenienced by the fact. The remains of man in Europe seemed, till recently, to be entirely post-glacial, and consequently the existence of man before the invasion of the ice was held to be highly improbable. But can we believe that man, any more than the mammoth, sprang full-armed from glacial furrows? Are there many who will agree with Sir J. Dawson's assertion* of the "abrupt appearance of man in his full perfection"? This phrase, which classes us with the palæolithic savage, may seem at first uncomplimentary; but perhaps we are asked to infer that the stone age was one of high civilisation. In that case, we shall be all the more inclined to seek farther back for the coming of the earliest man.

It is, however, improbable that we shall find him, or even relics of his race. In the first place, our view must go far beyond Europe, where the deposits of the ice-age have greatly obscured Pliocene terrestrial phenomena. It may also be urged that man originated in warm climates, and never entered Europe until the cold had passed away. Some believe, however, that the human race is an agglomerate of varieties of diverse origin, the present species having resulted from the parallel development of separate stocks, perhaps in separate continents. Such a view, if proved, would complicate the question, and would render the search for the earliest human centre far more difficult than before. In any case, what we now desire to know is the geological epoch of man's appearance and establishment on the earth. To this we can at any rate approximate.

If we listen to those who regard the glacial epoch as limiting the life of the whole globe, it is idle to push our enquiries back even into the Pliocene period. Certain statements, however, have been made from time to time as to the occurrence of Miocene man; and the fate of these has made some workers unduly cautious. The most famous case is that of the Abbé Bourgeois, who found curiously chipped flints in the Lower Miocene of Thenay, near Pont Levoy, in Loir-et-Cher. Figures of these will be found in various works, such as Zittel's "Handbuch der Palæontologie," Band IV., p. 720; but no satisfactory proof can be given of their human origin. It is asserted that the heat of forest-fires can split flint into similar forms; and Zittel compares them with the flakes produced by weathering on the surface of the Libyan desert. Prof. H. W. Haynes† visited Thenay with the Abbé Bourgeois in 1877, and also decides against the acceptance of the flakes, quoting similar occurrences as far back as the Eocene period. Their characters at Thenay, however, are such that some hesitation is allowable. Rather, however, than attribute them to the work of man, most authors will

* *Op. cit.*, p. 246.

† Appendix on Tertiary Man, in G. F. Wright's "Man and the Glacial Period" (1892), p. 370.

accept M. Gaudry's suggestion, supported by Prof. W. Boyd Dawkins,* that, *if artificial*, the flints of Thenay were the work of some intelligent anthropoidal ape. Dryopithecus, which inhabited France in Miocene times, is regarded as an anthropoid of composite type, and was probably about the size of the chimpanzee.† The fact that the apes of the present day, which are specialised along certain ape-like lines, do not chip stones to serve as weapons, in no way militates against the idea that their Miocene ancestors may have done so. The Thenay flints, at any rate, fail to prove the occurrence of Miocene man.

Certain broken flints, found by Ribeiro in the Upper Miocene of Otta, in the Lisbon district, have also been put forward; but they appear to be of doubtful character, when compared with the true flakes of human origin that occur, in the same spot, on the surface of the ground. The remarkable teeth from the Miocene of South Germany, possessing very human characters, are now referred to Dryopithecus, an animal of which the palæontologist has still very much to learn. A more complete series of the apes of Miocene times may come to us some day in the light of a revelation, comparable to that given by the Triassic ammonites, or by the mammals of the Puerco stage.

The soundest argument against the existence of Miocene man is that sustained by Prof. Dawkins, when he indicates the small number of mammalian genera that have come through to us unchanged from Miocene times. Is it likely that a being of such special and delicate organisation as man should be traceable back to a period when the horse, the giraffe, and the elephant, to name no others, were represented by far more generalised forms? As Gaudry points out,‡ the Miocene mammals fully justify the view that the higher types of animal life are more susceptible to variation than the lower. Thus the fresh-water molluscs of Pikermi, found beneath the mammalian layers, are identical with living forms; while the marine molluscs of Cabrières, which are somewhat older than the Luberon deposit, include fifteen species known in existing seas. No mammal at Mt. Luberon, however, is specifically the same as any living form; while many important genera, such as Deinotherium, Machairodus, and Hipparion, have already entirely disappeared. The use made of this argument in limiting the probable antiquity of man is perfectly reasonable and scientific; the true appeal, however, must be made to workers in the field, to observers of the actual crust, as exposed to us in each new section.

A remarkable record of the occurrence of chipped flints was made by Dr. Noetling,§ of the Indian Geological Survey, in 1894. Dr. Noetling's paper had a very modest title, but it was generally agreed that his specimens were of artificial origin. Dr. W. T. Blandford showed|| that the beds in which the instruments were said to lie were Lower Pliocene rather than Upper Miocene; but this did not diminish the interest of the discovery—on the other hand, its probability was increased. Mr. R. D. Oldham,¶ however, visited the locality with Dr. Noetling, and somewhat briefly recorded his opinion that the flakes had fallen from the surface of an adjacent plateau, and had become mixed with the layer of detritus on the Lower Pliocene bone-bed. The matter might have rested here, despite Mr. Oldham's admission that "ordinarily, there would be no hesitation in ascribing anything found in this layer of loose material to the underlying rock." Mr. Oldham felt that the case could not be decided by ordinary stratigraphical probability. Dr. Noetling, however, replied two years later* by asserting that there was no detrital layer to be dealt with; that chipped flints had been found embedded in the ferruginous conglomerate itself; and that similar flints occurred on the plateau above, but only along the outcrop of the self-same stratum. This implies that, since the implements were made, the stratum has been disturbed by earth movement.

To this unexpected vindication there appears to have been no reply; but, in the meantime, Dr. Dubois published his discovery of the remains of a man-like animal in Java, styled by him *Pithecanthropus erectus*, associated with extinct Pliocene mammals. This discovery, made in 1891, must rank among the greatest palæontological achievements; and, at any rate, it cleared Dr. Noetling from the charge of having rashly put forward an improbable proposition. The characters of the famous skulls of the Neanderthal and of Spy, which had already indicated the existence of a race of men of low cranial capacity, were here, as it were, carried a stage backward. Dr. Dubois,† however, declines to regard the Javan remains as more than anthropoidal; and yet they would indicate an anthropoid, allied to the gibbon, of exceptional zoological position, and probably of exceptional faculties.

If a giant gibbon (Hylobates) were thus endowed with a cranial capacity of 1000 cubic centimetres, *i.e.*, twice that of the existing large anthropoidal apes, it might be something very different in its habits from the long-armed and tree-haunting creature of to-day. Might not such an animal be capable even of chipping flints, or of anticipating in other ways the industries of primæval man?

The introduction of Pithecanthropus into the palæontological series is of the first importance for our present purpose. It probably limits the coming of man to the later Pliocene, or to some subsequent epoch. The arguments of Gaudry and Boyd Dawkins receive fresh justification. Human skeletons must now be sought for, since mere stone implements are liable to various interpretations. It seems probable, however, that Mr. W. J. Lewis Abbott‡ has brought to light, from the Cromer forest-bed, the work of late Pliocene man, and that thus the expectations of Lyell have been fulfilled. The rudely chipped flints, which this observer has discovered and has so carefully discussed, may have been prepared by man in Britain, before the growing ice-age forced him to move further southward. If the human skeletons recorded by Ameghino§ from the Pampas beds of Argentina, as contemporary with the Glyptodon and the Mastodon, are truly Pliocene, they may represent the type of man that produced the Cromer implements. A little further back, such men and Pithecanthropus may have met in serious rivalry; a little further yet, and the pithecanthropoids may have reigned alone, the highest members of creation.

Have we already advanced since Zittel wrote, in 1895,

* "Early Man in Britain" (1880), p. 68.

† *See*, for instance, R. Hartmann, "Anthropoid Apes" (1885), p. 286.

‡ "Les Ancêtres de nos Animaux dans les Temps Géologiques" (1888), p. 211.

§ "On the Occurrence of Chipped (?) Flints in the Upper Miocene of Burmah," *Records Geol. Surv. of India*, Vol. XXVII. (1894), p. 101.

|| *Nature*, Vol. LI. (1895), p. 608.

¶ *Natural Science*, Vol. VII. (1895), p. 201.

* *Natural Science*, Vol. X. (1897), p. 233.

† "On Pithecanthropus erectus," *Trans. Royal Dublin Soc.*, Vol. VI. (1896), p. 11, &c.

‡ "Worked Flints from the Cromer Forest-Bed," *Natural Science*, Vol. X. (1897), p. 89.

§ *See* Zittel, "Handbuch der Palæontologie," Bd. IV. (1893), p. 718.

"The problem, where man first appeared on the earth and from what form he sprang, has, in spite of all efforts of modern geology and anthropology, up till now found no solution"? If we have indeed advanced, along the lines indicated by the discovery of Dubois, it is but as yet a single step, founded upon a single skeleton. To some thinkers, however, this single step provides a field of vision surpassing all that went before; to others, the coming of man remains, to this day, one of the profoundest secrets of the crust.

THE MYCETOZOA, AND SOME QUESTIONS WHICH THEY SUGGEST.—VII.

By the Right Hon. Sir Edward Fry, D.C.L., LL.D., F.R.S., and Agnes Fry.

Their Relations in the Swarm Spore Stage.—Reproduction by *swarm spores* is by no means confined to the myxies. It plays a conspicuous part in the cycle of life in many of the Algæ and Fungi: or rather we should say conspicuous parts, for the functions of these simple pieces of motile protoplasm are most various. Sometimes the swarm spore is asexual and is of itself capable of reproducing a new organism—as in some of the Algæ and in the *Peronosporeæ*, for instance, amongst the Fungi. In some of the Algæ (*Florideæ* and *Phæosporeæ*) the swarm cells are sexual, and a conjugation between two of these moving bodies occurs before the production of a new organism. Sometimes the same organism (as in *Ulva*) produces two kinds of swarm cells—the megaspores with four cilia which germinate asexually, and the microspores with two cilia which germinate only upon conjugation. But more remarkable still is perhaps the case of the well known and beautiful Volvox—which appears to emit no less than four distinct kinds of swarm spores, (1) sterile swarm spores; (2) asexual spores, or as they are called *parthenospores*; (3) male spores; and (4) female spores. So marvellously complicated are the modes in which Nature is capable of differentiating and using to attain the same end by different roads that which seems the simplest thing in life—a minute piece of naked protoplasm.

In the swarm-spore state the myxies may thus seem to claim relationship with the Algæ and Fungi, but it is doubtful whether much stress can be laid on this suggestion, for (1) the existence of these cells as reproductive spores is a wide-spread fact, and occurring in remote groups of organisms, has perhaps but little value in classification; and (2) the mode in which myxies reproduce through swarm spores is entirely different from that pursued by any Alga or Fungus. It is, as we have already shown, neither by parthenogenesis of the ordinary kind, nor by conjugation, but by the fusion of a great number of swarm spores, whether from the same or different sporangia, into a single mass of plasmodium.

But if we turn towards the animal kingdom, we shall find that its claim to include the myxies in the swarm spore stage is very strong.

A mass of naked protoplasm, furnished with a nucleus and vacuoles, capable of pushing forward pseudopodia, and moving by these means, capable of including and digesting food, and also of encystment—this is a description which will fit indifferently the swarm-spore of a myxie and the well-known Amœba, and we are thus brought to see that close relationship, to which we have already referred, between the swarm spores and the large group of protozoa which naturalists generally place in the animal kingdom, and all of which may be said to consist of undifferentiated and naked protoplasm.

Their Relations in the Plasmodium Stage.—The motor power of the plasmodium seems to recall animal life, but we recollect that there are kindred organisms, like the Diatoms, which are generally regarded as vegetable, and retain a power of movement through life.

As regards food, it is a familiar fact that, generally speaking, plants feed on inorganic and animals on organic substances. So far as observations have hitherto gone, the food of myxies consists of bacteria, or minute particles of wood or fungi (and, in the case of *Badhamia utricularis*, of living fungi). No evidence seems to exist to show that they have any power of deriving nutriment from inorganic substances. The mode in which the myxies eject the undigested matter recalls animal rather than vegetable life. In the methods of digestion, therefore, they seem to lean distinctly towards an animal character.

The movement of the granules of protoplasm in the plasmodium is a phenomenon at least analogous to that found in plants, and even in plants with highly developed cells, but it is not unknown amongst the lower forms which are considered to be animals, for it appears to have been observed in some protista, and especially in the tentacular-like pseudopodia.

In the plasmodium condition, the relationship of the myxies seems on the whole rather with animals than plants.

Their Relations in the Sporangium Stage.—On the other hand, when we reach the sporangium stage, the absence of motion, the erect form, the stalk, the foot, the spores, all recall some of the Fungi; the elaters remind us of the Jungermanniæ.

The methods of opening the sporangia, sometimes by an indefinite rupture, sometimes by a distinct operculum, recall the distinction between the methods of opening which prevail in the mosses. On the whole, the facies of the sporangium stage is vegetable.

One other observation which relates to all the stages of development must be made. The two most characteristic of vegetable compounds are probably cellulose and chlorophyll: though neither is found in all plants, nor is absent from some animals. Of chlorophyll we have no trace in the myxies, and of cellulose very little. Nowhere do we find it as the wall of a true and living cell as we do in the most characteristic form of vegetable growth.

Their Relations Reconsidered.—On the whole it seems impossible to assign these minute organisms with any certainty to the one realm or the other. If, with Hæckel, we were, for purposes of classification, to speak of a new kingdom—a buffer state between the animal and vegetable realms, the *Regnum protisticum*—we should no doubt place the myxies there. But, if we retain the two ancient kingdoms only, then it almost seems as if the myxies were a vagrant tribe that wander sometimes on the one side, and sometimes on the other side of the border line—like nomads wandering across the frontier of two settled and adjoining States, to neither of which they belong. They would seem to begin life as animals and end it as vegetables—a life-history not without some sad analogies in human experience.

The absence of a satisfactory position for the myxies in the great network of organized beings leads one to think of them as a group which probably from very remote antiquity has stood aside from the great currents of evolution, whether in the animal or the vegetable world.

Distribution.—The species at present known of myxies are not very numerous. Mr. Lister figures less than two hundred in his monograph; De Bary speaks of them as numbering nearly three hundred. No doubt many species remain to be discovered.

Of the distribution of the myxies in time, nothing is known. The protoplasm is too delicate to leave its memorial in the rocks, and its lime particles are so small and so indistinguishable that it is no wonder that they have never been traced.

In space, the group, and many individual members of it, are cosmopolitan. A large number of the species are, says Mr. Lister, "found with identically the same characters in Europe, India, the Cape of Good Hope, Australia, and North and South America." What is implied in the identity of a species in Australia and England? Does it mean that the species have passed the great intervening oceans? or does it mean that the species were defined before the separation of the continents, and have continued in both seats unchanged ever since?

Suggestions for Study.—In the hope that some of our readers may be induced by what we have written to take up the study of these little organisms, we will say a few words as to how to begin the study of them. They may be found often in great abundance, and more or less in all times of the year, except in extreme cold or prolonged drought, on moist dead wood and dead leaves (hazel, holly, and beech leaves are very good); a wood yard near a country house, rotting stumps of trees, the dead stalks of last year's nettles, the wooden pillars and parts of gates and rails, the straw heaps in a farmyard—all these are likely places for the chase. Sometimes, too, as we have said, they leave the dead substances, which are their chief habitat, and climb over growing plants, as nettles, periwinkles, or moss. The eye wants some training to see them quickly, and there is no doubt but that young eyes are better than old ones. We know a case in which a young lady detected a Trichia growing on the roadside from her pony's back.

If it be desired to keep specimens for use, they should be preserved in dry boxes (the common lucifer match boxes, lined with white paper, make very good receptacles), into which they can be securely fixed by glue or pins attached to the wood or leaves on which they rest. For more minute observations recourse must, of course, be had to the pocket lens and the microscope. There are few more beautiful objects than some of the sporangia under a low power, or than the capillitium and spores of some kinds under a higher power: the *Trichia* with lemon-coloured hairs and spores are especially lovely to look upon. The spores should be examined under water to prevent shrinkage, and a little spirit is often useful in the examination of the capillitium, as it helps to expel the air.

The beginner will very likely at first sight mistake some of the small fungi for myxies, but a very little experience will enable him to distinguish the sporangium walls, the hairs, and the spores of a myxie from anything which he will meet with in the structure of a fungus.

A visit to the botanical department of the British Museum at South Kensington, and an examination of the microscopic slides and drawings prepared by Mr. Arthur Lister and his daughter, Miss Gulielma Lister, and presented by them to the British Museum, will be of great utility to the student.

To Mr. and Miss Lister all students of myxies are under the deepest obligations, and we are especially so by reason of their constant help, and not least for their kindness in reading this essay in manuscript. Mr. Lister has published two books which are indispensable to the English student. The "Guide to the British Mycetozoa exhibited in the Department of Botany, British Museum," is a little pamphlet, price threepence, written by Mr. Lister for the Trustees of the British Museum, and published by them. It can be obtained at the South Kensington Museum; but booksellers are often stupid about getting it, as we believe that they get no profit on it, and therefore if ordered through a bookseller particular instructions should be given to get it from the South Kensington Museum. This little book is very admirable, and by itself will enable a student to identify most or all of his specimens. Mr. Lister's other book, "A Monograph of the Mycetozoa," which is not confined to British species, was also published by the Trustees of the British Museum, but is sold by Longmans and other booksellers. The price of this book, which is beautifully illustrated, is sixteen shillings. Mr. Massee has also published a "Monograph of the Myxogastres," 1892, illustrated with coloured plates. De Bary's "Comparative Morphology and Fungi, Mycetozoa, and Bacteria," of which an English translation has been published by the Clarendon Press, should be consulted by the student who desires further knowledge. The text-books on general botany and on general cryptogamic botany, such as Sach's Text Book, Kerner's "Natural History of Plants," Bennett and Murray's "Cryptogamic Botany," and Dr. Scott's "Structural Botany, Part II.," may all usefully be consulted.

For the student who desires to go further into the literature of the subject, the following bibliography may prove useful:—

Cienkowski.—*Zur Entwicklungs-geschichte der Myxomyceten.* (*Prings. Jahr.*, 1863, 325); *Das Plasmodium, id.*, 400.

Lister.—"Notes of the Plasmodium of *Badhamia utricularis* and *Brefeldia maxima*" (*Annals of Botany*, Vol. II., 1888, pp. 1-24); "Notes on *Chondrioderma difforme* and other Mycetozoa" (*ibid.*, Vol. IV., 1890, pp. 281-298); "Notes on the Ingestion of Food-material by the Swarm-cells of Mycetozoa" (*Journ. Linn. Soc.*, Vol. XXV., Bot., 1890, pp. 435-441); "Notes on Mycetozoa" (*Journ. of Bot.*, Vol. XXIX., 1891, pp. 257-268); On the Division of the Nuclei in the Mycetozoa" (*Journ. Linn. Soc.*, Vol. XXIX., Bot., 1893, pp. 529-542); "Notes on British Mycetozoa" (*Journ. Bot.*, Vol. XXXIII., 1895, pp. 323-325); "A New Variety of *Enteridium olivaceum*" (*ibid.*, Vol. XXXIV., 1896, pp. 210-212); "On Some Rare Species of Mycetozoa" (*ibid.*, Vol. XXXV., 1897, pp. 209-218); "Notes on Mycetozoa" (*ibid.*, Vol. XXXVII., 1899, pp. 145-152.

Brefeld.—*Dictyostelium mucoroides Abhand. der Senckb., Ges.* VII., 1869; *Untersuchungen aus den Gesammtgebiete der Mykologie*, VI. Heft *Myxomyceten* (Leip., 1884).

De Bary.—*Die Mycetozoen. Zeitsch., fur Wissench Zool.* (Vol. X., 1860, p. 88).

Famintzin and Woronin.—*Über Ceratium Hydnoides* (*Mem. Acad. Peter.*, Vol. XX., No. 3, 1873).

Van Tieghem.—*Sur quelques Myxomycetes* (*Bull. Soc. Bot. Fr.*, Vol. XXVII., 1880, p. 317).

Wigand.—*Zur Morphologie und Systematik der Gattungen Trichia und Arcyria* (*Pring. Jahrb. Bot.*, 1863, p. 1).

TWO MONTHS ON THE GUADALQUIVER.

By Harry F. Witherby, F.Z.S., M.B.O.U.

V.—FLOWERY PLAINS AND BUSTARDS. LIST OF BIRDS.

Much has been written concerning the great bustard, but I cannot conclude these articles without a brief reference to this noble bird, once so common on our own downs and plains. In the south of Spain the great bustard is still abundant, and is always likely to remain so. We made two or three short expeditions in search of these birds and were always fortunate in seeing them, but only on one occasion were we lucky enough to bring one to bag.

The country by the river, just below Seville, is admirably suited to the habits of the bustard. The land here is a level plain, like the true *marismas* which lie further down the river, but unlike the barren *marismas*, the soil of this land is fertile and produces luxuriant crops of grass and corn. The grass and corn, besides providing them with ample food, form admirable cover for the great bustards when they most need it—in the breeding season.

To this country, then, we devoted a day in the hope of seeing this, the noblest of game birds, at close quarters; but to get to close quarters was no easy task. The stalking horse, our deadliest weapon in the *marismas*, was of no avail, and other methods had to be used. Our men rode the horses, while we walked behind them. We passed through enormous expanses—one cannot call them fields—of pasturage, with great patches of white and yellow flowers blazing and dazzling in the brilliant sun. Just as we were nearing a vast stretch of corn, one of our men stopped his horse, and shading his keen eyes from the glare, exclaimed, *abutarda*—bustard. He pointed, and we stared, but it was some time before we could make out a group of bustards. When we had once made them out, they appeared so big and brown in the grass, that we wondered why we had not seen them before. A careful scrutiny through the binoculars revealed a band of eight—some squatting and only visible when they raised their heads, some standing sleepily, and some pecking at the ground here and there in a desultory fashion. We watched the birds some time, and then, after a careful study of the surrounding land and a brief council of war, we all turned off to the right. The bustard pays little attention to a man on horseback, and will often allow him to approach within two or three hundred yards, but a man on foot is no sooner seen than avoided. We accordingly kept well hidden behind the horses until we had put some high corn between us and the birds. Here our men left us, and while we lay hidden behind the corn, some hundred yards apart, they galloped round in a wide circuit with the object of getting behind the bustards and driving them over us. Crouched behind the corn we waited, but waited in vain, no bustards appeared. At last one of the men rode up saying that the birds had made off to our right before they could get round them. Luckily they did not fly far, and we soon found them again. The same tactics were resorted to, but were again a failure, and worse still the birds flew so far that we failed to mark them down. Indeed it is no easy matter to drive such wary birds and powerful flyers to a definite point on an immense plain.

We went on again, and at length found four other bustards in a more advantageous position for a drive. We hid in a deep ditch, and had the advantage of being able to keep the birds in view the whole time. Our men took a wide circuit, and getting well behind the bustards, closed up quickly. The birds seemed to be very drowsy as they squatted or walked about, but suddenly their heads went up, and as they saw the horsemen advancing they ran a few yards, and then quickly got on the wing. They had looked brown before, but directly they opened their wings, a whitish patch caught the eye, and as they came on with heads outstretched, they looked more like heavy storks than anything we had ever seen. The four birds flew seemingly slowly, but in reality at a great pace, and steered straight for my friend, who fired at the largest as it passed over his head. Down came the great bird an awful crash behind him. We ran up to it and found that it was a young male, perhaps a year old, weighing about fifteen pounds (old males sometimes scale over thirty pounds), and wanting the beautiful "whiskers" which adorn the full-grown male. It was only winged, but made no attempt to run away, and when we approached, it pecked at us, and uttered a hissing sort of bark.

We spent another day after bustard, far from the river, in a country studded with small round-topped hills, covered at the time of our visit with clover and stubble. Bustards seemed plentiful here, and we soon found a party of thirteen and another of four. We lay flat in the stubble on the slopes of the hills, while the men rode round to drive the birds. But the drive was not successful, and owing to the long flight taken by the bustards, and the nature of the ground, it was impossible to mark them down.

Our last experience with bustards was late in May. We left our boat and the river and proceeded to ride across a vast plain, covered with short, brown, sunburnt grass. We had gone some distance when a great sheet of water suddenly appeared in front of us. The sun was behind us and covered with clouds, and the distance was remarkably clear. Miles beyond the water we could see trees and houses, and further off still a low range of hills, all of which were clearly reflected, while a large herd of cattle, about a mile away, seemed to be standing knee-deep in the water—so perfect was the reflection.

We pointed it out to our men, but they laughed and said there was no water for miles. "Nonsense," said we, "there it is; can't you see it?" They laughed again. We took our binoculars, and still saw water clearly, but the glasses showed it further away instead of nearer. We rode towards our lake, but it receded and receded until it disappeared altogether, and the burnt-up plain appeared as dry and parched as before.

On this plain were a number of sandgrouse. They were very wild and difficult to get near. Their sandy colour harmonised so perfectly with the brown grass that it was impossible to see them until they flew up and away like rockets, and so we could not use the stalking horse to approach them. However, several flocks allowed us to come near enough for us to identify them—the black-bellied sandgrouse* by its black belly, which is very conspicuous when the bird is flying, and the pin-tailed sandgrouse† by the long pointed feathers in its tail.

At length we reached a great field, strongly fenced, and overgrown with rank grass and weeds as high as our horses' withers. Here we hoped to find the little bustard,‡ but careful search was difficult owing to the swarms of horse flies, as large and as yellow as hornets, and with a bite that was villainous even through our clothes. Moreover, the field contained a number of magnificent black bulls of famous fighting breed, which were enraged by the flies and required constant discouragement with stones or clods of earth. After half-an-hour's search we found a little bustard, which ran swiftly through the long grass and then flew up about a hundred yards away. In general colouring it reminded us of the willow grouse in autumn, by reason of its brown back and conspicuously white wings, but the flight was altogether peculiar. The bird never seemed to raise its wings above its body, but keeping them arched downwards, beat them rapidly, and so flew in an even slope until high up in the air.

After further search we surprised a great bustard, which also ran from us, and so effectually hid itself in the thick tangle of vegetation that we failed to induce it to fly or to find it again. This bird may have been a female with eggs somewhere in the field, or it may have been a male incapable of flight. Towards the end of May the great bustard loses its quill feathers for a time, and has then to

* *Pterocles arenarius.* † *Pterocles alchata.* ‡ *Otis tetrax.*

seek safety in running and hiding. This fact may have given rise to the notion that the bird always runs and can be hunted with dogs. Except just at the time of the moulting of the old quills and the growing of the new, the great bustard could scarcely be coursed with dogs since it takes to its wings on the slightest alarm, and is capable of powerful and sustained flight.

On our return route to the river we passed through field after field of rich pasturage containing bulls of every age, all jet-black, of the finest fighting breed in Spain—that of the Marques del Sartillo.

In concluding these papers on our trip to the Guadalquiver, I have thought that a list of the birds which we found would be interesting, and perhaps of some value, to the systematist or to the future traveller in the district. Only those birds which we identified beyond all doubt have been inserted, and dates considered as interesting have been added. In noting these dates it must be borne in mind that April 2 was the first date we began collecting, April 4 was the first date in the *marismas*, and May 19 the last.

The district includes the country within a few miles of the Guadalquiver from Seville to its mouth at San Lucar.

LIST OF BIRDS: GUADALQUIVER, APRIL AND MAY, 1898.

NOTE.—*In the following list an asterisk signifies that the bird was obtained, and a dagger that the eggs were found.*

* * *Turdus musicus*, Song Thrush.—A few seen. Latest date (bird), April 11.
* *Turdus merula*, Blackbird.—Not common.
* * *Saxicola albicollis*, Black-eared Wheatear.—Local.
* * *Pratincola rubetra*, Whinchat.—One pair only April 14.
* * † *Pratincola rubicola*, Stonechat.—Abundant. Fresh eggs and fledged young, April 2.
* * *Ruticilla phoenicurus*, Redstart.—Very few. Latest date (bird), April 30.
* *Ruticilla titys*, Black Redstart.—A few.
* * *Daulias luscinia*, Nightingale.—Very common. Earliest date (bird), April 2.
* * *Sylvia cinerea*, Whitethroat.—Common. Earliest date (bird), April 2.
* * *Sylvia atricapilla*, Blackcap.—Common.
* * *Sylvia hortensis*, Garden Warbler.—A few. Earliest date (bird), April 11.
* * *Phylloscopus sibilatrix*, Wood Warbler.—One only April 29.
* * *Phylloscopus trochylus*, Willow Warbler.—Fairly common.
* * *Sylvia subalpina*, Subalpine Warbler.—Fairly common.
* * *Aëdon galactodes*, Rufous Warbler.—Fairly common. Earliest date (bird), May 5.
* *Acrocephalus streperus*, Reed Warbler.—One only seen and two nests found, May 21.
* * † *Acrocephalus turdoides*, Great Reed Warbler.—Abundant. Earliest dates—(bird), April 4; (eggs), May 18.
* * *Acrocephalus aquaticus*, Aquatic Warbler.—One only April 13.
* *Cisticola cursitans*, Fantail Warbler.—A few seen.
* *Parus major*, Great Tit.—A few seen.
* *Parus cristatus*, Crested Tit.—Two seen, April 16.
* * *Moticilla flava*, Blue-headed Wagtail.—Abundant.
* * *Anthus campestris*, Tawny Pipit.—Small flocks, April 30 and May 1.
* * *Oriolus galbula*, Golden Oriole.—Not common. Earliest date (bird), April 16.
* * † *Lanius meridionalis*, Southern Grey Shrike.—Local. Nestlings and fresh eggs, April 2.
* * † *Lanius pomeranus*, Woodchat.—Abundant. Earliest dates—(bird), April 2; (eggs), May 11.
* *Muscicapa grisola*, Spotted Flycatcher.—Abundant. Earliest date (bird), May 2.
* * *Muscicapa atricapilla*, Pied Flycatcher.—Abundant. Earliest date (bird), April 11, latest date (bird), May 5.
* *Hirundo rustica*, Swallow.—Abundant.
* *Chelidon urbica*, House Martin.—Abundant.
* *Cotile riparia*, Sand Martin.—A few.
* *Ligurinus chloris*, Greenfinch.—A few.
* *Carduelis elegans*, Goldfinch.—Abundant.
* *Passer domesticus*, House Sparrow.—Abundant in villages.
* *Fringilla cœlebs*, Chaffinch.—A few.
* * *Emberiza miliaria*, Corn Bunting.—Abundant in cultivated districts.
* * *Emberiza hortulana*, Ortolan Bunting.—One only April 30.
* * † *Sturnus unicolor*, Sardinian Starling.—Fairly common. Fresh eggs, April 28.
* * † *Pica rustica*, Magpie.—Common locally. Earliest date (eggs), April 26.
* * † *Cyanopica cooki*, Spanish Magpie.—Abundant locally. Earliest date (eggs), May 11.
* * † *Corvus monedula*, Jackdaw.—Common locally. Earliest date (eggs), April 22.
* † *Corvus corax*, Raven.—Fairly common. New and empty nest, April 11; fresh eggs, April 26; incubated eggs, May 11.
* * *Galerita cristata*, Crested Lark.—Abundant in cultivated districts.
* * *Alauda arvensis*, Sky Lark.—One only April 8.
* * *Alauda arborea*, Wood Lark.—Two only April 16.
* * *Calandrella brachydactyla*, Short-toed Lark.—A few.
* * † *Calandrella bœtica*, Andalucian Short-toed Lark.—Abundant in *marismos*. Earliest date (eggs), April 4.
* * † *Melanocorypha calandra*, Calandra Lark.—Abundant. Earliest date (eggs), April 4.
* *Cypselus apus*, Swift.—Abundant. Large migration. May 6.
* *Cypselus melba*, Alpine Swift.—Many seen April 2.
* * *Caprimulgus ruficollis*, Red-necked Nightjar.—Common. Earliest date (bird), May 3.
* * *Jynx torquilla*, Wryneck.—One only April 15.
* * *Gecinus sharpii*, Spanish Green Woodpecker.—Common locally.
* * *Coracias garrulus*, Roller.—Common.
* * *Merops apiaster*, Bee-eater.—Abundant. Earliest date (bird), April 5.
* * *Upupa epops*, Hoopoe.—Common.
* * *Cuculus canorus*, Cuckoo.—Fairly common.
* *Coccystes glandarius*, Great Spotted Cuckoo.—Local.
* * *Strix flammea*, Barn Owl.—One only.
* * *Athene noctua*, Little Owl.—Common.
* *Gyps fulvus*, Griffon Vulture.—Common.
* *Vultur monachus*, Black Vulture.—Rare.
* * *Neophron percnopterus*, Egyptian Vulture.—Common.
* * † *Circus aeruginosus*, Marsh Harrier.—Fairly Common. Earliest date (eggs), April 5.
* * † *Circus cineraceus*, Montagu's Harrier.—Abundant. Earliest dates—(bird), April 5; (eggs), May 13.
* * † *Aquila adalberti*, Spanish Imperial Eagle.—A few.
* *Circaëtus gallicus*, Serpent Eagle.—Fairly common.
* * † *Milvus ictinus*, Kite.—Very common. Young in down, April 16.
* * † *Milvus migrans*, Black Kite.—Abundant. Earliest date (eggs), April 22.
* * *Falco peregrinus*, Peregrine.—Two only, April 9 and 23.
* * † *Falco tinnunculus*, Kestrel.—Common.
* * † *Falco cenchris*, Lesser Kestrel.—Common. Fresh eggs, May 21.
* * *Ardea cinerea*, Common Heron.—A few. Latest date (bird), April 13.
* * † *Ardea purpurea*, Purple Heron.—Abundant. Fresh eggs, April 5 and 23.
* * *Ardea garzetta*, Little Egret.—Common locally.
* * *Ardea bubulcus*, Buff-backed Heron.—Very common.
* * *Ardea ralloides*, Squacco Heron.—A few.
* * † *Ardetta minuta*, Little Bittern.—A few. Earliest date (eggs), May 21.
* † *Ciconia alba*, White Stork.—Abundant.
* * *Plegadis falcinellus*, Glossy Ibis.—Common locally.
* * *Platalea leucorodia*, Spoonbill.—Fairly Common.
* * *Phœnicopterus roseus*, Flamingo.—Abundant.
* * † *Anas boscas*, Mallard.—Common.
* * *Anas strepera*, Gadwall.—A few. One shot April 30.
* * *Nettion crecca*, Teal.—A few. One shot April 6.
* * *Mareca penelope*, Wigeon.—A few.
* * † *Anas angustirostris*, Marbled Duck.—Very common. Earliest date (eggs), May 18.
* * *Columba palumbus*, Ring-dove.—Common.
* * *Turtur communis*, Turtle-dove.—Very abundant. Earliest date (bird), April 23.
* *Caccabis rufa*, Red-legged Partridge.—Common.
* *Pterocles alchata*, Pin-tailed Sandgrouse.—Local.
* *Pterocles arenarius*, Black-bellied Sandgrouse.—Local.
* * *Rallus aquaticus*, Water-rail.—A few.
* * *Gallinula chloropus*, Water-hen.—A few.
* * † *Fulica atra*, Coot.—Abundant.
* * *Otis tarda*, Great Bustard.—Common.
* * *Otis tetrax*, Little Bustard.—A few.
* * † *Oedicnemus scolopax*, Stone-curlew.—Common.
* * † *Glareola pratincola*, Pratincole.—Very abundant. Earliest dates—(bird), April 7; (eggs), May 17.
* * *Aegialitis hiaticula*, Ringed Plover.—Very common. Seen on last day in *marismas* (May 19.)

* *Aegialitis curonica*, Lesser Ringed Plover.—One only.
* † *Aegialitis cantiana*, Kentish Plover.—Abundant.
* *Squatarola helvetica*, Grey Plover.—Abundant. Earliest date (bird), April 27. Seen on last day in *marismas* (May 19).
* † *Vanellus vulgaris*, Lapwing.—Abundant.
* † *Recurvirostra avocetta*, Avocet.—Common.
* † *Himantopus candidus*, Stilt.—Abundant.
* *Tringa alpina*, Dunlin.—Common. Latest date (bird), May 14.
* *Tringa minuta*, Little Stint.—Common.
* *Tringa subarquata*, Curlew Sandpiper.—Common. Seen on last day in *marismas* (May 19).
* *Calidris arenaria*, Sanderling.—Fairly common. Latest date (bird), May 15.
* *Machetes pugnax*, Ruff.—Fairly common. Latest date (bird), May 3.
* *Totanus hypoleucus*, Common Sandpiper.—Common. Seen on last day on river (May 23).
* *Totanus glareola*, Wood Sandpiper.—A few. Earliest date (bird), April 12. Latest, April 25.
* † *Totanus calidris*, Redshank.—Very abundant.
* *Limosa belgica*, Black-tailed Godwit.—Several flocks. Large flock seen on last day in *marismas* (May 19).
* *Numenius arquata*, Curlew.—Fairly common.
* *Numenius phæopus*, Whimbrel.—Fairly common. Latest date (bird), May 5.
* † *Hydrochelidon nigra*, Black Tern.—Very common. Earliest dates—(bird), April 9; (eggs), May 17.
* † *Hydrochelidon hybrida*, Whiskered Tern.—Abundant. Earliest dates—(bird), April 9; (eggs), May 17.
* *Sterna anglica*, Gull-billed Tern.—Fairly common.
* † *Sterna minuta*, Lesser Tern.—Common. Earliest dates—(bird), April 13; (eggs), May 18.
* *Larus ridibundus*, Black-headed Gull.—One only May 17.
Larus fuscus, Lesser Black-backed Gull.—Fairly common on sea coast.
Larus marinus, Great Black-backed Gull.—Fairly common on sea coast.
* *Larus gelastes*, Slender-billed Gull.—Not common.

HIPPALUS AND ITS SURROUNDINGS.

By E. Walter Maunder, F.R.A.S.

The district of the moon represented in our plate, which is reproduced by the kind permission of Messrs. Loewy and Puiseux from their magnificent *Atlas Photographique de la Lune*, is one of especial interest. It shows us the region lying between the Mare Nubium and the Mare Humorum, and presents a great number of features which are of peculiar value in determining the relative ages of the different types of lunar formation.

The more westerly of the two seas, the Mare Nubium, is one of the larger of the great lunar plains, and only a small portion of it is included in the plate, yet that is sufficient to bring into prominence some of its most characteristic features. Thus its surface is seen diversified by numerous isolated ring-plains and broken by long ridges; whilst, as the photograph indicates with great clearness, it is further marked by long light streaks.

The most easterly sea, the Mare Humorum, is also only shown in part, but though much smaller than the Mare Nubium, the portion of it here seen is of great interest. The Mare Humorum is one of the smallest of the lunar seas, having an area about equal to that of England and Wales. Like the Mare Crisium in the western quadrant, to which it shows some features of resemblance, its borders are, for the most part, distinctly marked. The features, which in the photograph are the most striking, though they are usually by no means easy objects in the telescope, are the long ridges of sinuous form by which the gradual descent from the mountain borders of the sea to its lowest levels is broken up into terraces.

Between the two seas stands the wrecked walled-plain Hippalus, forming in its present condition a sort of bay or extension of the Mare Humorum. A spur of hills continues the rampart of Hippalus in the south-western direction, and connects it with a very distinct ring-plain Campanus, some thirty miles in diameter. The centre of this spur of hills is marked by a bright crater, Campanus A, which occupies as nearly as may be the centre of the plate. Beyond Campanus to the south-west again is another ring-plain, the twin of Campanus as to size and distinctness, but distinguished from it by its level interior, whilst Campanus shows a bright central peak and two crater pits, both clearly marked in the photograph.

Mercator and Campanus, and the mountains, which prolong their general line of direction to the south-west, divide the Mare Nubium from a small Mare, sometimes described as the Sinus Epidemiarum. This plain would be nearly rectangular in shape, and one hundred and eighty miles long by one hundred miles broad, if it were not for the invasion of a very striking ring-plain, seen in the centre of the south-side of the plate, Capuanus. To the east, the plain is bordered by a broad confused mountain chain, whilst to the north-east, a bright mountainous region, intersected by winding valleys, separates it from the Mare Humorum. A very striking promontory projects from this last mountain chain far out into the Mare Humorum, three chief peaks of the promontory being lettered as belonging to the Hippalus region, Hippalus α, μ, and B.

Proceeding north from Hippalus, the barrier between the Maria Nubium and Humorum consists of a mountain chain continuing in the same straight line the general direction marked by Mercator, Campanus, and Hippalus. This mountain region derives the names of its chief peaks and craters from the irregularly shaped walled plain, Agatharchides, on the north-west side of the range.

The principal features of the remaining part of the margin of the Mare are the three contiguous formations on the south-east. These are the two partially wrecked walled plains, Doppelmayer and Lee, and a bright and strongly ramparted ring-plain, Vitello.

The chief portion therefore of the region represented in the plate is lowland, and the various formations with which the plains are diversified stand, for the most, in clear relief, without confusion from crowding by neighbouring masses. And, as the eleventh day of the month was well advanced at the time the photograph was taken, the sun having just risen on Doppelmayer, the sunlight throws up most of the objects into the most favourable relief.

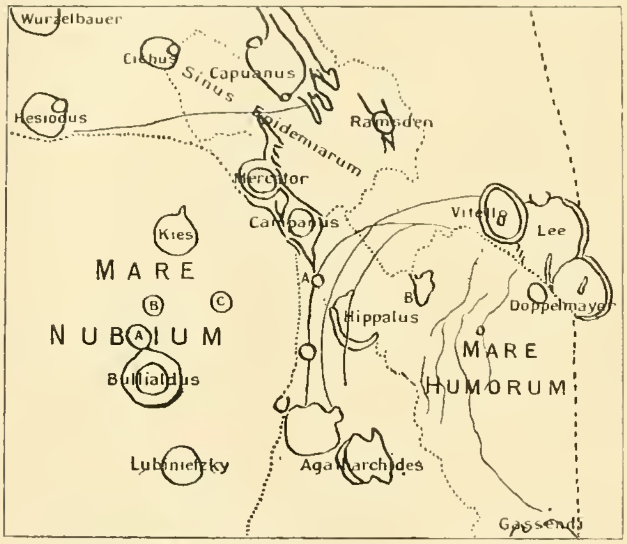
Here, as everywhere along the margins of the great plains, we are at once struck with the way in which the matter composing the surface of the plain has attacked, and more or less completely dissolved, the "seaward" rampart, if we may use the expression, of the great walled plains that border it. Hippalus, the fort that holds the border line between the Sea of Clouds, and that of Humours, is a conspicuous example. The south-eastern wall has been destroyed, and the floor brought to the same level as the invading plain. Lee and Doppelmayer on the other side of the Mare Humorum have also suffered, though less severely, and Capuanus on the Sinus Epidemiarum, though it has preserved the entire circle of its rampart, yet shows the influence of the invasive matter, in the way in which the western wall has sunk down; the entire formation seeming as if tilted over on its side like a stranded boat.

More striking still we have in the Mare Nubium two examples of ring-plains, Kies and Lubiniezky, which would appear to have sunk bodily in the invasive fluid; so low are their walls, and so complete the levelling of their interiors with the surrounding plain. Yet, that it is not always an essential that a ring should be overwhelmed by the substance of the plain we can see in the great ring-plain Bullialdus, with its three satellites A, B, and C, all with bold unbroken ramparts, and all with their floors many hundreds of feet below the level of the *mare*.

With the reservation then of Bullialdus and its satellites it appears clear that generally speaking the great rings preceded the "seas" in order of time. The six rings mentioned above, Hippalus, Lee, Doppelmayer, Capuanus, Kies, and Lubiniezky, are amongst the relics of the earlier moon.

Dealing with the *maria* next, the succession of ridges on the Mare Humorum point out clearly what has happened there. The lines which these follow, however sinuous in detail, are manifestly circular and concentric in general type, and the crevasses which cut through Hippalus, and the country beyond, seem to carry on the same curves on a wider radius. It is scarcely possible to avoid the conclusion arrived at by Messrs. Loewy and Puiseux that the ridges and crevasses have a common origin.

It appears, then, that the basin now constituting the Mare Humorum has taken its present form by a series of



Sketch Map of Hippalus and its surroundings.

subsidences. Each subsidence was marked at its circumference by a crevasse, or fault, roughly circular in shape, and those crevasses which were formed earliest nearest the centre, and which surrounded the deepest subsidences, gave egress to the liquid or viscid matter of the interior, which welled up through them, filling up the crevasses, and forming ridges upon them. These outflows would naturally become less and less the further the crevasse was from the centre of the subsidence, and the less the depth to which the sinking at the crevasse had taken place, until at length a distance is reached at which no filling up of the crevasse takes place.

The crevasses, or "rills," then, are more recent than the "seas" as they are than the rings. That the rills are more recent than the rings is clearly shown by Hippalus itself, a deep crevasse cutting completely through it.

But the rills are not the most recent formation of all. As mentioned above, a bright crater, Campanus A, occupies the centre of the photograph. This crater stands right upon a rill, and completely interrupts it; and a more conspicuous crater, Agatharcides A, interrupts it further north. Neison, indeed, considers that it can be traced, greatly narrowed across both craters, but the photograph does not seem to bear this out.

The relation between the rills and the mountain masses is less clear. Neison describes this rill, and the one immediately to the east of it, as commencing at a small crater, Campanus *g*, east of Campanus. On the photograph, the influence of the rill can be traced quite unmistakably to the east of the crater, amongst the broken highlands which border the south of Mare Humorum, almost to the walls of Vitello. These highlands, therefore, are also earlier than the rills.

Another instance of a late ring-plain is seen in Ramsden, the peculiarly distinct ring-plain on the floor of the Sinus Epidemiarum. Three well-marked rills, in the form of a capital N, are clearly seen on the photograph to the north of the ring, and two of these are very distinctly prolonged beyond the ring to the south. Ramsden, therefore, like Campanus A, may be looked upon as one of the younger formations of the district.

The finest rill of the entire region can be traced on the photograph, but, from the illumination, is less evident than the rills of Hippalus. This is the great Capuanus rill, ϕ. It starts from the most easterly of the three great spurs thrown out from the north-east rampart of Capuanus, and strikes nearly due west in a right line, cutting through the mountain range connecting Cichus and Mercator, and extending to the wall of Hesiodus, a course of two hundred miles.

The great depth of the floors of Bullialdus and its satellites below the level of the *mare* would seem to show that they were formed later than the grey plain itself. If this be so, it may be inferred that the Mare Nubium was an older formation than the Mare Humorum, since the former had been completed whilst the internal forces were still powerful enough to give rise to so fine a ring as Bullialdus, on so much larger a scale than the little craters marking the ridges of the Mare Humorum and studding its lowest basins. And an attentive study of the district immediately around Hippalus, which separates the two "seas," will, I think, confirm this view.

Two other lines of structure shown in the plate may be alluded to. The first is the well-marked tendency to alignment in a S.W. and N.E. direction. The line through Cichus, Mercator, Campanus, and Hippalus, and carried on to Gassendi, the south wall of which is just seen on the edge of the photograph, seems fundamental to the whole region. It is plainly seen in Capuanus, both in the spurs projecting from the rampart outward, the markings on the floor, and the clefts through the wall. It characterises the general trend of the mountains east of the Sinus Epidemiarum, and bordering the Mare Humorum. It probably indicates the lines upon which the earliest lunar configurations were based.

Next in time, probably, come the great rings, so many of which are ranged on these fundamental S.W. and N.E. lines. Then come the subsidences which created the grey plains—that of the Nubium, probably considerably earlier than the Humorum. On these plains we find the lines of ridges and crevasses, the innermost indicating where the earlier sinkings took place. These were followed by the formation of ring-plains and craters along the lines of fault, and in other weak regions of the crust. Lastly, we find the white streaks—those in the present plate are for the most part of the system with Tycho for its centre—passing over all the preceding formations indifferently.

Letters.

[The Editors do not hold themselves responsible for the opinions or statements of correspondents.]

IS THE STELLAR UNIVERSE FINITE?

To the Editors of Knowledge.

Sirs,—I fear Mr. Burns will draw down on his devoted

HIPPALUS AND ITS SURROUNDINGS.

From a Photograph taken 1896, April, 23d. 8·1h. Greenwich Mean Time, with the great Equatorial Coudé of the Paris Observatory.
Scale—Diameter of Moon = 42 inches; Moon's Age, 10d. 15·7h.

head all the vials of your reviewer's wrath for indulging in speculations so similar to my own. He has, however, overlooked one hypothesis which I mentioned, viz., that the ether is finite; for, of course, if the ether be finite we could not receive either heat or light from stars situated beyond its limits. But if gravitation is independent of the ether, our motions might be dependent on these invisible bodies.

The thinning out of stars as we proceed to a considerable distance from the solar system could also be explained by supposing that the sun forms one member of a cluster of stars, and that the apparent thinning arises from our approaching the limits of this cluster or passing beyond them. But an infinite universe of luminous bodies ought, I think, to give us more light than we receive from the sky, if this light is transmitted to us without absorption, even though we were in the centre of the densest cluster.

Mr. Maunder, in his comment, is, I think, correct in stating that an infinite stellar universe does not imply that a right line drawn in any direction must ultimately meet a star. The infinite universe might, for instance, all be comprised within what I may call a moderate distance from the Galactic Plane, so that it would be easy to draw right lines towards the region of the Galactic Poles without encountering a star at any distance. But can this take place over the whole sky on the hypothesis that we are considering? Suppose the distribution of stars in any direction to be fairly uniform, the total light of the stars of the $n + 1$th magnitude will always exceed the total light of those of the nth magnitude, until the sky gets so covered with them that there is a very appreciable loss of light owing to one star getting in the way of another. If then the distribution continues to be fairly uniform (in a given direction) to infinity, must not the sky in that direction appear as one blaze of light?

W. H. S. Monck.

THE SEAS OF THE MOON.

To the Editors of Knowledge.

Sirs,—Towards the end of his interesting paper which appears in your issue of November (p. 251) under the above title, Mr. J. G. O. Tepper says, "the finest, lightest dust must remain eternally undisturbed, except by the rude shock of a colliding meteor, or when ploughed aside by such, if gliding along after a very oblique impact." No mention is made of this sentence containing—if Mr. Tepper's theory be accepted—a most probable explanation of the "rays." The evidence appears particularly strong in view of the following facts:—

(1) The moon is without atmosphere, and therefore all meteors which collide with her would be unbroken and solid (not converted to gas) until they strike her surface;

(2) The "rays" cast no shadows;

(3) They appear brightest at full moon.

If this corollary to Mr. Tepper's theory is of any value, these "rays" should be gradually increasing in number, and particularly when, as will shortly be the case, the Leonid swarm of meteors is encountered.

I should be glad to hear whether the latter is the case, and of any evidence for or against the formation of the "rays" in the manner described.

Strathmore, Chiswick. Laurence B. Tappenden.

TREES STRUCK BY LIGHTNING.

To the Editors of Knowledge.

Sirs,—Some years ago a tree in the grounds of my house, on the Brisbane River, in Queensland, was struck by lightning, with effects which bear out one of the views of your correspondent, Baron N. Kaulbars, of St. Petersburg, on the behaviour of trees struck by lightning. The tree was a Moreton Bay pine *(Auracaria Cunninghami)*, over one hundred feet high. About twenty-five feet from the ground an old piece of rope encircled it, the loose ends of which projected a few inches from the stem. This arrested the stream of rainwater flowing down the tree and drained it clear of the lower part of the trunk, the surface of which thus remained dry. At this stage of the storm lightning struck the tree but did no damage to the wet part of the trunk above the circlet of rope. But between the rope and the ground a groove was cut out of the tree. A strip of solid wood, about three to four inches deep and as many broad, together with the superimposed bark (and following a slight twist of the fibre of the wood), was burst out by the explosive force of the instantaneously superheated sap. The outward direction of the disruptive force was very clearly shown by still adherent splinters of wood.

The tree failed gradually, but did not quite die till nearly three years after receiving its paralysing stroke.

P. de Jersey Grut.

National Liberal Club, Whitehall Place, S.W.,
26th October, 1899.

Obituary.

By the death of Mr. Grant Allen on the 25th October, 1899, science loses one of her most popular exponents. Born at Wolfe Island, Canada, in February, 1848, he received the elements of a liberal education at various places—United States, France, Birmingham, and ultimately entered Merton College, Oxford, where he graduated B.A. in 1870. Embarking on an active career in life, Mr. Allen spent a few years in Jamaica as Principal of a college intended for the higher education of the negro. Returning to England, he settled in London and adopted literature as a profession, devoting most of his energy at this period of his life to science, always a favourite study with him to the last. While Mr. Allen was still heroically struggling to make popular science a vehicle for bringing grist to the mill, the late Richard A. Proctor founded our magazine, and in the earlier volumes of Knowledge may be found a great many of his most attractive papers—"Ants and Aphides," "Concerning Bats," "About Variation," "Among the Grasses," "The Dispersion of Seeds," "Plant Evolution," "The Stone Age Men," "A Naturalist's Year," and indeed a complete round of subjects which are of perennial interest to all lovers of nature, and they are comprised within the years 1881-1886. Among Mr. Allen's published scientific works may be mentioned "Physiological Aesthetics," "The Colour Sense," "Vignettes from Nature," and "The Evolutionist at Large." Fiction, however, was kinder to him than science from a commercial standpoint, but it is fair to say that although Mr. Allen frankly wrote such works as "The Woman who Did" and "British Barbarians" to suit the market in order to produce an income, he was always a man of science at heart, and he found a medium for the exercise of his great aptitude as a popular exponent of science in many illustrated monthlies. Prof. Yorke Powell, writing to the Editor of the *Oxford Magazine*, says: "Grant Allen was my friend for thirty years, and of the men I have known well, I have known few who were so fixed in their convictions, so absolutely true in their lives to these, and, at the same time, so tolerant and generous-minded toward those that differed from them. Allen was always ready to sacrifice himself for others, and his kindly help, whether of brain or purse, was prompt and ungrudging. To my mind he has, in spite of many interruptions caused by the necessities of life, done something to advance the studies to which he gave his heart very early in his career. He was obliged to give much of his time to popular exposition, and he loved teaching. The ease and facility of his papers for general readers sometimes, I think, concealed from his readers the amount of care and thought he had given to the subjects he was treating. It has long been to me regretful that Allen had not the leisure that would allow him to pursue learning rather than romance; and I know that it was a real regret to him, though he was the last man to grumble at fate. He would have laughed at anyone who would have described him as in any way perfect, but he was an honourable man, a steady friend, and a good citizen, a sincere seeker after truth, and an honest worker, and to those who have known him his loss will assuredly be deeply and continually felt."

Conducted by Harry F. Witherby, F.Z.S., M.B.O.U.

The Food of the Hobby.—It is well known that the Hobby Falcon (*Falco subbuteo*) is an insectivorous bird, but it is known to persecute the *hirundines*, and even to catch the Swift itself. The true nature of the Hobby's food was, however, made pretty clear on the ground beneath a nest of these birds which I visited when away from home this summer. There was no doubt as to the identity of the species, for the old birds were well known to the people at the place. While I was there one of the old ones returned, and we heard a young one calling to it from a big tree. The castings under the nest were composed almost wholly of insect remains and short fur, presumably that of mice. There were a few feathers of other birds under the tree, but these may have been blown there from a distance, for they included rook and magpie feathers, and these large birds could hardly fall victims to a Hobby. A great quantity of the castings had been trampled by cattle resting in the shade, with the result that in places the ground was actually covered with the remains of beetles. The old Hobbies were accustomed to take a short flight, together with their young, to a clump of trees on a near hill, but at evening they all returned to the tree which held the nest.—Charles A. Witchell, Charlton Kings.

The Marsh Tit's Sense.—I grew some sunflowers this year for my fowls. Tits, of course, came for the seeds. I tried to scare them harmlessly, but in vain. I then set some horsehair nooses on the seed-heads. After several nooses had been broken, I caught a Marsh Tit (one of a solitary pair), and the same day a Great Tit. The latter was left hanging as a scarecrow, and two days later the surviving Marsh Tit came and perched within a foot of the corpse and within two yards of myself. It then took a seed from the seed-head from which the dead bird was suspended. Up to the time of writing this Tit has remained solitary. It still comes to the flowers. But the Great Tits left them alone after the hanging.—Charles A. Witchell, Charlton Kings.

Barred Warbler (*Sylvia nisoria*) in Lincolnshire.—I was fortunate enough to shoot, on October 17th last, an immature female of this species. It was on a nearly bare thorn bush, not far from the coast, at Marshchapel, and was not at all shy. A strong migration was in progress, grey crows, rooks, larks, and starlings, passing over to north-west all day, and the hedges and other cover along the coast were full of robins, goldcrests, redwings, great and blue tits, and other migrants. The weather had been fine, and the wind from the east since the 15th of October.—G. H. Caton Haigh, Grainsby Hall, Great Grimsby.

Young Cuckoo ejecting Young Meadow Pipit.—At the meeting of the British Ornithologists' Club, held on October 18th, Mr. Scherren exhibited interesting photographs of a young Cuckoo, taken at two separate stages of its work of ejecting a young Tit-lark from a nest. The nest was found and watched by Mr. John Craig, and the photographs were taken by Mr. Peat Millar, of Beith, N.B. These photographs are of considerable interest, as although the fact of the ejection of the offspring of its foster-parents by the young Cuckoo is well established, many people are still disbelieving, and a photograph forms incontrovertible evidence.

Two-barred Crossbill (Loxia bifasciata) in Sussex (Ibis, October, 1899, p. 647). At a meeting of the British Ornithologists' Club, held on June 21st, Mr. N. F. Ticehurst exhibited an example of *Loxia bifasciata* which had been obtained in East Sussex on February 23rd, 1899.

The Occurrence of the Sociable Plover in Ireland. By Edward Williams (*Irish Naturalist*, November, 1899, pp. 233-4). The claim of this bird to a place on the British list has hitherto rested upon a single example shot in Lancashire in 1860. Mr. Williams now records the occurrence of a second example shot on August 1st last at Robinstown, near Navan, County Meath. Mr. Williams considers the bird a female, in second year's plumage. *Vanellus gregarius*, which is closely allied to the Lapwing, inhabits the steppes of the Crimea and Turkestan, while in winter it travels to India, Ceylon and North-East Africa.

Fungoid Disease in Razorbill (*The Field,* October 7th). Mr. T. H. Nelson has sent a Razorbill, shot at the Tees mouth, to the editor of *The Field.* The bird's mouth showed a disease which, the editor remarks, is "closely analogous to, if not identical with, that which occurs so frequently in domestic fowls and pigeons, and resemble the diseases in trained hawks which is known to falconers as 'fromice.' It is a deceased condition of the mucous membrane in the head and throat." As far as we are aware, the occurrence of this disease in a wild bird has never before been recorded.

All contributions to the column, either in the way of notes or photographs, should be forwarded to Harry F. Witherby, *at 1, Eliot Place, Blackheath, Kent.*

Science Notes.

Mrs. Farquharson, of Haughton, is carrying on an active crusade in favour of admitting women to the full membership of learned societies. Although not agreeing with all Mrs. Farquharson's tenets, we see no reason why women should not be admitted to membership of the learned societies, provided always that they remain as ordinary members, and are debarred from executive positions.

An astronomical and scientific society, which is destined, we hope, to do some good and useful work, has been started under the presidency of Mr. Edward Bond, M.P., at Hampstead. The membership already numbers over eighty, and a reflecting telescope of ten and a half inch mirror, the gift of Colonel Heberden, has been erected for the use of the members in a small observatory on the East Heath. Mr. B. W. Martin, of 7, Holly Place, Hampstead, is the honorary secretary.

Notices of Books.

The International Geography. By Seventy Authors. Edited by Hugh Robert Mill, D.SC. Illustrated. (George Newnes.) 15s. Many books are now published on every branch of scientific knowledge, but it is rarely that a volume appears having characteristics which place it distinctly in advance of others of the same class. Such a volume is, however, now available for the student of geography in the work before us; no impartial critic, familiar with geographical literature, will hesitate to express this conviction. In his position as Librarian to the Royal Geographical Society, Dr. Mill has exceptional opportunities of knowing trustworthy authorities on the geography of any part of the world, and on the subjects of earth structure affecting the physical environment of man. The admirable discrimination he has used may be seen by a glance at the list of contributors to the present volume. With one or two exceptions it may be said that every page of the one thousand and fifty two which make up the descriptive portion of the book is the work of a leading geographer, distinguished above others for the special knowledge he possesses of the subject with which he deals. The list of contributors is so long that it cannot be enumerated here, but the value of the foregoing remark will perhaps be better appreciated when we say that Dr. Downing, the chief of the *Nautical Almanac*, deals with mathematical geography, Prof. J. Arthur Thomson with the distribution of living creatures, Prof. Grenville Cole with Ireland, Sir John Murray with the oceans, the Right Hon. J. Bryce with the South African Republic, and Dr. Nansen with the Arctic Regions, to mention only six of the seventy authors. Dr. Mill has not only edited the volume, but has written a number of the sections and has translated several of the chapters by foreign contributors. He has evidently spared no pains in designing the work and securing uniformity of treatment, and has succeeded to a degree which would almost have seemed impossible to anyone familiar with editorial difficulties. The illustrations are not of a pictorial character, being sketch maps and diagrams to assist the reader to understand the special features described in the adjacent text. In this respect, as in others, the editor has acted wisely, for if an attempt had been made to combine atlas, picture book and text book, the resulting work would certainly have been unsatisfactory. To indicate the scientific scope of the volume, we may add that Dr. Mill defines geography as "the exact and organized knowledge of the distribution of phenomena on the surface of the earth, culminating in the explanation of the interaction of man with his terrestrial environment." Geography only becomes a science when this broad conception of it is taken; and the present volume will help to educate the public to recognize that principle. But putting aside educative influences, we confidently state that the work is a unique contribution to geographical literature, and if a library had to be limited to a single work on geography, this ought to be the selected book.

An Illustrated Manual of British Birds. By Howard Saunders, F.L.S., F.Z.S., etc. Second edition. (Gurney & Jackson.) Illustrated. 21s. This book, which has been issued in monthly parts, to which we have already drawn attention, is now completed. In this second edition of the well-known "Manual" Mr. Saunders' task has been to sift a mass of evidence regarding a number of birds claimed to be new to the British list since the first edition was published ten years ago. Of these seventeen have been accorded places, thus bringing the total up to three hundred and eighty-four. Besides this the whole of the book has been brought up to date, which has entailed a great deal of rewriting—an exceedingly difficult task when the description of each species is limited to two pages. Another new feature in the book is the re-drawing of many of the figures. This was a much-needed reform, and Mr. G. E. Lodge has done his work on the whole well, many of the drawings being most beautiful, but in some cases, and notably in the figure of the Caspian Plover on page 537, we are sorry to note a marked falling off from the painstaking and accurate detail which are generally such a characteristic of Mr. Lodge's drawings. Although there are a great number of new figures there are still many old ones which should never have found a place in the second edition. Of these bad drawings we would especially draw attention to the figures of the Long-eared Owl (p. 293), the Sparrow Hawk (p. 333), and the Arctic Tern (p. 649). One of the most valuable portions of the book is the comprehensive account of the geographical distribution of each species. This feature makes the book of great use to the traveller. In a few cases the author might have given us a few words more, as for instance in the case of the Common Sandpiper, concerning the distribution of which north of the Arctic Circle he tells us nothing. The statement on p. 192 that the Lesser Redpoll is unknown on the Continent to the north of the Baltic is difficult to understand in conjunction with a statement made by Mr. Harvie-Brown in the *Ibis* for 1873, p. 64. Mr. Harvie-Brown, in writing of the birds of the Archangel, said that the Lesser Redpoll was "perhaps the most abundant bird in the Archangel district . . . . breeding plentifully in the gardens in the town." Mr. Saunders has no space to tell us much of the habits of birds, but the essential points are introduced. In this connection we should like to draw his attention to two small points. On p. 560 he says of the oyster-catcher that "on rocky coasts each pair inhabits a certain district." This is not according to our experience. On the west coasts of Scotland and Ireland we have found a great many breeding in close proximity on small rocky islands, the "nests" in some cases being within a few yards of each other. It is mentioned that the Sandpipers often perch on trees and posts, but it is not mentioned that the whimbrel, godwit and others do so, although with them the habit seems just as usual. In conclusion, we may point out that to write such a book as this on British birds is no mean task, and as the best proof of how accurate and full of information it is we may say that the first edition became quite indispensable to every British ornithologist. We are quite certain that this second edition will become equally so, and we heartily recommend everyone interested in birds who does not know the book to immediately procure it.

The Process Year Book for 1899. Edited by W. Gamble. (Penrose & Co.)

Photograms of the Year 1899. Compiled by the Editors of *The Photogram*, assisted by A. C. R. Carter. 3s. net. (Dawbarn & Ward.)

That each of the two books before us is so excellent, both in its examples of photograms and its reproduction of them, relieves the obtrusive fact that the year 1899 has not given us much that is new in photography. We can safely say that we have not seen more beautiful illustrations than some of those contained in these two annuals. The superiority of colour over black and white is manifested in the "Process Year Book," which contains several very successful tinted illustrations, a green tint, for instance, lending a distinct charm to some rustic scenes. On the other hand, the three-colour work shown is very poor indeed—no advance on that of former years. On the whole "The Process Year Book" is a wonderful production, and the numerous articles on all manner of process work are very profitable reading. No one will regret that "Photograms of the Year" is double the size of the four previous issues, for hardly an unworthy photogram has been admitted. The articles are fragmentary, but good, and the criticisms painstaking. The use of a substitute for "Art printing paper" has had the unfortunate effect of destroying pure high-lights in the majority of the illustrations, a result much to be deplored in a book of this kind.

The Soluble Ferments and Fermentation. By J. Reynolds Green, SC.D., F.R.S. (Cambridge University Press.) 12s. No more instructive example of the gradual growth of modern views on scientific questions is to be found than that provided by the repeated modification of theories put forward to explain the various problems connected with the phenomena of fermentation. As the results of researches have shown that explanations previously accepted were inadequate to account for all phenomena, the old theories were either discarded or reformulated. In early times fermentation meant any process accompanied by a copious evolution of gas, and some old writers went so far as to class under fermentation the effervescence which characterises the action of a mineral acid on a carbonate. But we have moved very far since then. To adequately recapitulate all the changes in the opinions held by chemists and physiologists of the nature of fermentation, and to provide a satisfactory account of modern work on this interesting study, it is necessary, as Prof. Green's book shows, to have a volume of nearly five hundred pages. The aeration of dough and the common production of alcohol were very early correctly associated with fermentation, and towards the end of the sixteenth century putrefaction was seen to have much in common with the other two processes, but it was not recognized till 1659 that they all differed widely from mere effervescence. The deposit observed as an invariable accompaniment of fermentation was first microscopically examined by Leuwenhoek about 1682, but he failed to recognize its vegetable nature—it was not till about 1825 that Cagniard de Latour made this quite clear. This distinguished observer concluded that the globules he saw under the microscope disengaged carbon dioxide and fermented the liquid by some effect of their vegetation. Meyen, later, pronounced the organism a fungus. The more satisfactory views of Pasteur followed, and after much research by many workers, in 1833 Payen and Persoz extracted from germinating barley the now familiar diastase which they distinguished as an "unorganized" ferment. In 1845, Mialhe prepared diastase from saliva. In 1836, Schwann demonstrated the existence of pepsin in gastric juice. And so the idea of two classes of ferments was led up to—"organized" ferments and enzymes—that is, unorganized or soluble ferments. Prof. Green traces at some length all these stages in the history of the study of fermentation, and shows that the present definition of the process must be "the decomposition of complex organic material into substances of simpler composition by the agency either of protoplasm itself or of a secretion prepared by it." Though of necessity written in somewhat technical language, the earnest student will find in this well printed volume a clear and interesting account of the chemistry and physiology of most important processes in the economy of the organic kingdom.

The History of the European Fauna. By R. F. Scharff, B.SC., PH.D. (Walter Scott.) 6s. An example from Dr. Scharff's introductory chapter will indicate the nature of the questions with which he deals in this very readable volume. The Arctic hare "is in the British Isles confined to Ireland and the mountains of Scotland; and if it were not for the fact that its bones have been discovered in a cave in the south-west of England, we should never have known that, formerly, it must have inhabited that country as well." Its bones have not been found in Southern Europe, but the nearer we get towards the North Pole the more abundant its remains become. Hence it has probably reached its present habitat from the north. Throughout the book geology and zoological distribution, as we know it to-day, are both utilised in explaining the history of typical European fauna. It is demonstrated that the former distribution of land and water is intimately connected with the origin of the animals under consideration, and these changes are traced by observations on the actual areas occupied at the present time by mammals, snails and earthworms. The larger problem is approached by a preliminary careful consideration of British fauna, then after reviewing the Arctic fauna, the great migrations known as Siberian, Oriental, and Lusitanian are explained and detailed, and the book concludes with an account of the Alpine fauna. The maps which indicate in a general way the extent of former seas and continents are not intended to be strictly accurate, but admirably serve to illustrate the broad features of the distribution of land and water during the chief geological epochs. Dr. Scharff's book will provide anybody who wishes to learn with a clear and instructive account of the distribution of the various forms of animal life in time—a subject quite as fascinating as the kindred one of their distribution in space.

The Birds of Breconshire. By E. Cambridge Phillips, F.L.S., M.B.O.U. (Brecon: Edwin Davies.) Illustrated. Books dealing with the avi-fauna of a county—and now there are many—are always useful and instructive, and the one now before us is no exception to the rule. Mr. Phillips has been a careful recorder of the birds found in his county for many years past. Seventeen years ago he printed for private circulation a list of the birds of Breconshire, of which the present book may be called a revised and enlarged edition. It is very encouraging to learn that since the first edition appeared, several birds, and among them some which are becoming rare in this country, have increased in numbers in Breconshire. On the other hand it is deplorable that a fine bird like the red kite, which was once very common in England and Wales, now, in the words of the author, "hardly holds its own in Breconshire," and where is it to be found in England? The harriers, too, once common, are now nearly extinct in Breconshire. The book is provided with a summary and a sufficient index which becomes a necessity owing to the somewhat strange classification adopted. Residents in the county taking any interest in birds should certainly procure the book, while ornithologists generally will find it a useful and interesting addition to other county avifauna.

The Wheat Problem. By Sir William Crookes, F.R.S. (Murray.) Paper, 2s. 6d.; cloth, 3s. 6d. Sir William Crookes dwelt, in detail, on the wheat problem in his address before the members of the British Association in September, 1898, and the severe criticisms hurled at him since that time have resulted in inducing Sir William to issue this book—partly in self-defence, and to some extent as an amplification of the views expressed in his address. "Having pondered disputed points," says Sir William, in the preface, "I cannot in any material degree modify my estimates of the future producing capacity of the wheat fields of the globe. . . . If at the end of another generation of wasteful culture my forecast is invalidated by the *unforeseen*, I cheerfully invite friends and critics to stone me as a false prophet." The first fifty pages contain the original address; twenty-five pages are occupied with a review of our present and prospective food supply; about eighty pages set forth replies to various critics. Quite apart from controversial matters, however, the book is a useful one to all interested in the production of wheat both from the commercial and scientific points of view. Although the author has given us an imposing array of facts, there are also some statements intermingled therewith that will not withstand the criticism of those whose business brings them into close relations with the soil and the markets where produce is distributed. For many years back it has not been worth while to bring new land under cultivation in England, or to farm high in other countries. But let prices rise, make it worth the farmer's while, and, even with present knowledge, the starvation which Sir William so confidently predicts can be kept at bay for long years to come.

Energy and Heat. By John Roger. (Spon.) Illustrated. 2s. This little book, comprising some thirty-six beautifully printed pages, in all the glory of cloth boards, has been on our table for some weeks now. It came to hand at an unfortunate time—a time when we were suffering from too great an intensity of heat, and, in consequence, seemed to be without energy. In the second line of the introduction we note the expression "so-called latent heat," and our thoughts fly back to a period prior to our own existence; in fact we remember that Cavendish objected to the use of the term. In the first chapter—"Heat"—we read: "It may, however, be transmitted readily from one body to another, the tendency being to preserve a uniform degree of pressure"!! and, later: "Therefore it may be said that heat is elastic, or compressible." One of Davy's very earliest works would set Mr. Roger right on this point. Chapter II. is headed exactly in this way: "Temperature (*Pressure*)." Now which is which? We tackle the chapter, hoping to find out. The "*Theory* of the sponge," otherwise known as the Caloristic doctrine among the ancients, continues to hold the floor, with just one improvement—pressure means temperature!! In Chapter III. we have "As a thermometer is a measure of the temperature." Now, common sense at once tells us that it is the *reading* of the thermometer which is this, and Mr. Roger, to be consistent, should have written pressure here for temperature. But that latter error crops up more than once; we never know whether he has or has not abandoned his convention for the moment. The concluding sentence of this chapter refers to the latent heat of steam, and we find: "The heat, therefore, has not become latent, but has simply been diffused over a larger volume." In other words, the sponge theory is clung to tenaciously. Following on, and, indeed, based on all this a determined effort is made to show that the steam engine is a more efficient apparatus than we usually deem it. Later—page 35—it is suggested that frictional heat is due to induced electrical currents. Finally, if Mr. Roger is a very young writer, we would suggest his trying again, but if this hypothesis be not correct, he is certainly a very careless writer, and should bring himself to admire the "policy" as well as the theory "of the sponge." Our remarks are longer than they need have been but for one fact—there is just enough of sense in the book to make it really dangerous.

Bird Life in an Arctic Spring. The Diaries of Dan Meinertzhagen and R. P. Hornby. (Porter.) Illustrated. This book is a very interesting and touching memorial of a young naturalist cut off at the very beginning of a career which was full of usefulness and had promise of considerable distiuction. The book is chiefly composed of young Meinertzhagen's diary, published just as it was written during a three months' ornithological trip to Finnish Lapland. The diary is completed by R. P. Hornby, the friend who accompanied him. It is very interesting, and shows what a keen and intelligent field naturalist the young author was. A chapter is added on his life at home and at school, and a description is given of the wonderful collection of living eagles and other raptores which Meinertzhagen formed at Mottisfont Abbey, the residence of his father. Perhaps the chief interest in the book is contained in the drawings of birds, which have been reproduced from paintings and careful pen and ink drawings by Meinertzhagen. Some of them are faithful copies from the works of well-known bird painters, but most are original drawings from Nature. They are all excellent, and had the young artist lived we feel certain that his work would have rivalled that of the most famous bird painters.

Little Auks, from "Bird Life in an Arctic Spring."

Report of the Australasian Association for the Advancement of Science, held at Sydney, 1898. Edited by Dr. A. Liversidge, F.R.S. Our scientific friends at the Antipodes, in this formidable volume of addresses, reports of research committees, extracts from the minutes of meetings, lists of officers and members, objects and rules of the association, and so on, show their appreciation of the modes adopted for the advancement of science in the mother country—they apparently adopt our methods without an effort to modify the effect by shearing the prototype of its many faults. And so we are having additional periodical volumes, each about the size of a family Bible, embracing every imaginable subject, arranged, or disarranged, higgledy-piggledy, for the hungry student to browse upon at his own sweet will, or have the will squeezed out of him by the ever-increasing avalanche of weighty tomes, the matter of which is too often duplicated and rough-hewn, instead of well-sifted and polished. It would have been to the lasting credit of our scientific workers over the sea if they had infused more of the original, and adopted less of the imitative, element in publishing their proceedings. As they are, however, the volumes, like our own reports, will be more ornamental than useful in our libraries. The keenest thirst for knowledge, and the most determined effort are needed for the extraction of all the available information on any given subject from these heterogeneous records of scientific research.

Birds. By A. H. Evans, M.A. (Macmillan.) Illustrated. 17s. This book forms Vol. IX. of the now famous library known as the Cambridge Natural History. The author has endeavoured, and we think successfully, to give a "short description of the majority of the forms in many of the families, and of the most typical or important of the innumerable species included in the large passerine order." The book only contains some six hundred pages, printed in large clear type, so that one cannot expect a detailed description of the birds mentioned, and of course to include even the names of all the known species would have been an impossibility. Mr. Evans has arranged his book very cleverly, and imparts a great deal of sound information in a very small space. An introductory chapter deals briefly with the structure of birds, their classification, geographical distribution, and migrations. The birds are then dealt with in groups, an ascending scheme of classification being adopted, and a brief summary of the general structure and habits of each group being prefixed. When dealing with a family or genus, the author has been wise in first giving a fairly detailed description of the species best known to English readers, and then proceeding to show how other species differ from it. Mr. Evans has performed a very difficult and laborious task admirably the information imparted being, both as regards selection and accuracy, all that could be desired in such a book. To ornithologists generally, and especially to the travelling ornithologist, it should prove extremely useful, and giving as mentioned brief descriptions of the plumages of birds, it might be used as a companion to Prof. Newton's well-known "Dictionary of Birds." The drawings, almost all by Mr. G.E. Lodge, must be classed amongst the best work done by that accurate and painstaking artist.

Notes upon the Romano-British Settlement at Chigwell, Essex. By J. Chalkley Gould. (Epping Forest Museum: Chingford.) Illustrated. 6d. This little pamphlet contains a description of urns and various other vessels which have been found at Chigwell, an early Roman settlement of the period, probably 43-410 A.D. The pottery is mostly in fragments, but here and there vessels were found carefully placed, and may have contained funeral remains after cremation of the body. Coins were scarce. The illustrations are excellent, and the little brochure will therefore be valuable to those interested in archæology.

The Geography of Mammals. By William L. Sclater, M.A., and Philip L. Sclater, M.A., PH.D., F.R.S. (Kegan Paul.) 12s. net. The political divisions of the earth's surface become so firmly fixed in the mind as the result of the ordinary school instruction in geography that it generally comes as a surprise to the ordinary person to hear that more logical boundaries than those decided by historical events are forthcoming. The distribution of animals and plants on the land areas of the globe has been found to afford quite a different partition from that which political geography recognises. "Europe, for instance, the most important of all the continents politically speaking, is for zoological geographers, as well as for physical, but a small fragment of Asia." Taking the amount of similarity and dissimilarity of animal life as their guide, and for this purpose selecting the mammals, as the "most highly organised and altogether the best known group of the animal kingdom," the authors examine the geographical distribution of this class of animals over the world's surface, and by this means arrive at regions widely different in extent and significance from those of the school. In this way a division of the land-area of the globe into six areas is obtained. This division into the regions known as Australian, Neotropical, Ethiopean, Oriental, Nearctic, and Palæarctic, was proposed by Dr. P. L. Sclater in 1857, and though not universally adopted, is pretty generally recognised as a good basis for a classification of the geographical distribution of animals. The book provides a good account of all six regions, of each of which a clear and coloured map is supplied. Separate chapters deal *seriatim* with the distribution of the chief mammalian orders, and the abundant illustrations greatly add to the attractiveness of what should prove a very useful addition to scientific literature. The tables of genera with which the chapters are provided have been prepared with the assistance of Messrs. Beddard and De Winton.

Cries and Call Notes of Wild Birds. By C. A. Witchell. (Upcott Gill.) 1s. This little book, which has been on our table some time, has unfortunately been overlooked. It merits a notice if only on account of the author being the pioneer and one of the only systematic students of bird-song. The purpose of the present book is "to so describe the notes of our most familiar birds that the reader may easily acquire a tolerably intimate knowledge of them, and thus be led to make independent observation." The book is divided into four portions, dealing with town birds, woodland birds, upland birds, and waterside birds. Only the commoner species are dealt with, and the reader is often helped with musical notation. With the town and woodland birds our author deals at some length, and in a very interesting way, and for his useful and instructive notes on these species the book is certainly one to be invested in by every bird lover. But Mr. Witchell is evidently little acquainted with the cries and call notes of the shore and sea birds.

The December number of *The Studio* will include a sixteen page supplement devoted to illustrated reviews of the most important new books of an artistic character.

We have on our table a Diary for the year 1900. It contains a monthly ephemeris, celestial phenomena for the year, astronomical summary, principal observatories and refractors of the world, and all the tables ordinarily required in the observatory, as well as postal and other information of general utility. The Diary affords writing space to the extent of one whole page per day, and although published especially for the Royal Navy, will be found exceedingly useful to all who are interested in astronomy. The book may be obtained of the publishers of "Lean's Royal Navy List," 326, High Holborn, London, and the price is three shillings.

Messrs. Lumière & Son's photographic plates and papers are well known to, and appreciated by the photographing public, but possibly their chemicals have not hitherto had a like appreciation. This, however, ought not to be, and we imagine that such names as diamidophenol, diamidoresorcine, hydramine, paramidophenol (which glare at us from Messrs. Lumière's catalogue), will soon be as familiar to the photographer's ear, and we trust as facile to his jaw, as his old friend pyro. Messrs. L. Gaumont & Co., 25, Cecil Court, are sole agents for Great Britain.

BOOKS RECEIVED.

The Structure of the Brain. By Albert Wilson, M.D. (Elliot Stock.) Illustrated.

Experimental Physics. By Eugene Lommel. Translated from the German, by G. W. Myers. (Kegan Paul.) Illustrated. 15s. net.

A System of Ethics. By Freidrich Paulsen. Edited and translated by Frank Thilly. (Kegan Paul.) 18s. net.

The Reliquary and Illustrated Archæologist, 1899. Edited by J. Romilly Allen, F.S.A. (Bemrose.) 12s net.

Newton's Laws of Motion. By P. G. Tait, M.A. (Black.) 1s. 6d. net.

Practical Physiology. By M. Foster and J. N. Langley. (Macmillan.) Illustrated. 7s. 6d.

Art-Enamelling on Metals. By Henry Cunnyghame. (Constable.) Plates. 6s. net.

Liquefaction of Gases. By Willett L. Hardin. (Macmillan.) Illustrated. 6s.

Chemistry for Organized Science Schools. By S. Parrish and D. Forsyth. (Macmillan.) Illustrated. 2s. 6d.

Report and Transactions of the South-Eastern Union of Scientific Societies, 1899. (Taylor & Francis.) 2s.

The Teaching of Geography in Switzerland and North Italy. By J. B. Reynolds, B.A. (Camb. Univ. Press.) Illustrated. 2s. 6d.

Human Nature. Part II. By Physicist. (Churchill.) 2s. 6d.

Sylvia in Flowerland. By Linda Gardiner. (Seeley.) Illustrated. 3s. 6d.

The Standard Intermediate-School Dictionary. By James C. Fernald. (Funk and Wagnalls Co.) 4s.

Schilling's Spanish Grammar. Translated by F. Zagel. (Francis Hodgson.)

Introduction to Physical Chemistry. By James Walker. (Macmillan.) 10s. net.

Catalogue of Optical and Scientific Instructions, and Lantern Slides. (Newton & Co.) 6d.

Egyptian Magic. By E. Wallis Budge. (Kegan Paul.) Illustrated. 3s. 6d.

Star-Land. New Edition. By Sir Robert Ball. (Cassell.) 7s. 6d.

Mr. Blackburne's Games at Chess. By P. Anderson Graham. (Longmans.) 7s. 6d. net.

The Student's Standard Dictionary. (Funk and Wagnalls Co.) Illustrated. 10s. 6d.

The Strength of Materials. By J. A. Ewing, F.R.S. (Camb. Univ. Press.) 12s.

Classified Catalogue of New Film Subjects. (Warwick Trading Co.)

Crystallography. By W. J. Lewis, M.A. (Camb. Univ. Press.) Illustrated. 14s. net.

The Wonders of Modern Mechanism. Third Edition. By Chas. H. Cochraue. (Lippincott.) Illustrated. 6s.

Handbuch der Astronomischen Instrumentenkunde. By Dr. L. Ambronn. Two vols. (Berlin: Julius Springer.)

Designing and Drawing for Beginners. By Charles Godfrey Leland, M.A. (Dawbarn & Ward.) 6d.

The Studio. November. 1s.

THE KARKINOKOSM, OR WORLD OF CRUSTACEA.—XII.

By the Rev. THOMAS R. R. STEBBING, M.A., F.R.S., F.L.S., F.Z.S., *Author of "A History of Crustacea," "The Naturalist of Cumbrae," "Report on the Amphipoda collected by H.M.S. 'Challenger,'" etc.*

A BREATH OF WATER.

"ONE must live," said the tramp. "No," replied the cynical alderman, "I don't see the necessity." But, at all events, in order to live, one must breathe. This is indispensable alike to tramps and aldermen and crabs, and to every item of the animal world. Some minute organisms may be desiccated by heat or frozen by liquid air into a state of suspended animation, and a stuffed lion in a museum, or an embalmed Pharaoh in a pyramid, may out of courtesy still be called an animal, though each ceased to be one as soon as the breath was out of its body. Breath being so essential, respiration, like perspiration, all over the surface, wears the aspect of an advantage. It is, in fact, not to be despised, and, such as it is, this advantage is enjoyed by several animals, and among them by some of the crustacea. But with increasing complications of structure and existence, more than one consideration comes into play, as the greedy boy, who wished that he was all mouth, would speedily have discovered. Nature, in her more elaborate efforts, utilizes division of labour, and allots special organs to special functions. Anyone who has used a hammer for cracking open the claw of a crab, will understand how unsuitable a surface for respiration would be afforded by that stony water-tight integument.

In bringing to perfection her wonderful karkinokosm, Nature certainly did not begin by making crabs, but rather in that line of business produced them as the crown of her operations. To follow Nature, then, we must not begin by investigating the breathing apparatus of a crab, but follow down the line till we come to something simpler. Pause, then, at the amphipods. Specimens can be had without cost. Certain species have been already portrayed in earlier chapters (III., IX., XI.). An amphipod might be familiarly described as a lobster in a short jacket. It differs from the lobster in that its eyes are not movable on jointed stalks. With its whole body so small and nimble, separate ocular mobility could scarcely be needful to it. Otherwise, in the general inventory of its kit, this little campaigner agrees with the lordly lobster, thus:—Antennæ, two pairs; one upper lip, one lower; one pair of mandibles; maxillæ, two pairs; maxillipeds, three pairs; and five pairs of trunk legs. By all means catch a *Gammarus pulex* in the rivulet that runs through your park, or a *Gammarus locusta* that slidders under weeds and stones on almost any sea-shore, to see whether I have counted right. In doing this you cannot fail to observe that in the *Gammarus* the first of the five pairs of trunk-limbs are feeble walking legs, whereas in the lobster they carry the well-known

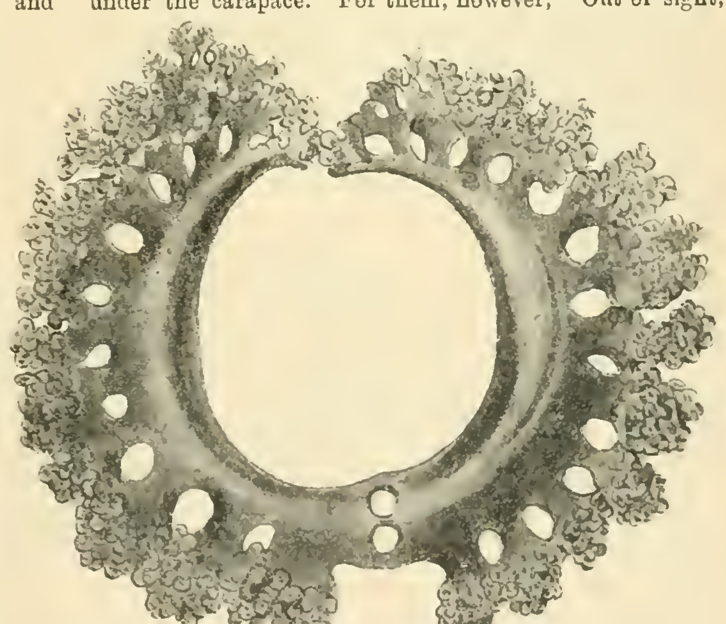
Second gnathopod of Amphipod, *Pardalisca abyssi* Boeck, with the branchia and marsupial plate.

powerful claws. Also you will find that the second and third maxillipeds are not here consolidated at their bases with the other jaws, and that they have exchanged their Latin name for a Greek one, gnathopods, which means exactly the same thing, only it sounds better, more oracular and Demosthenic.

Not only in name and function, however, do these gnathopods of the Amphipoda differ from the homologous maxillipeds of the lobsters, crabs, and shrimps. In all the latter groups, speaking generally, it will be found that the animal's coat, or carapace, covers the segments belonging to all the mouth-organs, and to all the trunk-limbs. On the contrary, in the amphipod it is a mere jacket. It stops short at the segment bearing the first maxillipeds, leaving exposed the segments that carry the two pairs of gnathopods and the five pairs of walking-legs. This is a very essential difference, and implies that the Amphipoda are at a much more primitive stage of development than those crustaceans which have gathered their segments more closely under shelter, and devoted more of their limbs to the service of the mouth.

High up on the second gnathopods, and some or all of the following limbs of an amphipod, there will be found attached semi-pellucid vesicles, a kind of small bags, sometimes flattened, sometimes dilated, sometimes crumpled or twisted, sometimes with other modifications. These are the breathing organs. They hang freely in the water. They are sometimes reduced to a couple of rod-like pairs; but whether more or fewer, they are no doubt nicely adapted to the owner's requirements. When a living amphipod in water is viewed under the microscope, at more or less transparent parts of its skin a number of little globules can be seen, chasing one another merrily about its body. It is, or should be, the ambition of each of these little colourless globules to traverse sooner or later one or other of the branchial vesicles. In such a passage, whether in circuit or struggling through the labyrinth of transverse canals, it will gather from the outside water a new supply of oxygen. Then it will pass into a chamber surrounding the heart, called the pericardium. There it will craftily bide its time. Presently the little side-doors of the heart are opened, and it will pass through with its companions into the august sanctum, thence in turn to be sent forth, through one of the aortic portals, on a fresh career of usefulness. Harvey discovered the circulation of the blood; he didn't invent it.

With the branchial sacs of the Amphipoda it looks as if Nature had been trying a series of experiments, first using a small, simple form, then enlarging the surface, puffing it out, adding a fold or two, and finally pleating the whole into a row of leaflets. The object aimed at is to expose as large a permeable surface as possible for procuring oxygen from the external water. In the higher crustaceans, the experimentation conducted on the bodies of the lower bears its fruit. It becomes no longer a question of simple branchial sacs. The forms are described as arborescent, leafy, or hairy—dendrobranchiate, phyllobranchiate, trichobranchiate. Each branchia is divided up into an immense number of compressed and closely adpressed leaflets, or still more finely sub-divided so that the filaments are comparable to hairs, or there may be a mixture of the two, or a kind of cross between them, with hair-like fringes to a leaf-like base. These more elaborate organs are worth a little extra care, and in the Brachyura and Macrura they are all neatly arranged out of sight under the carapace. For them, however, "Out of sight,



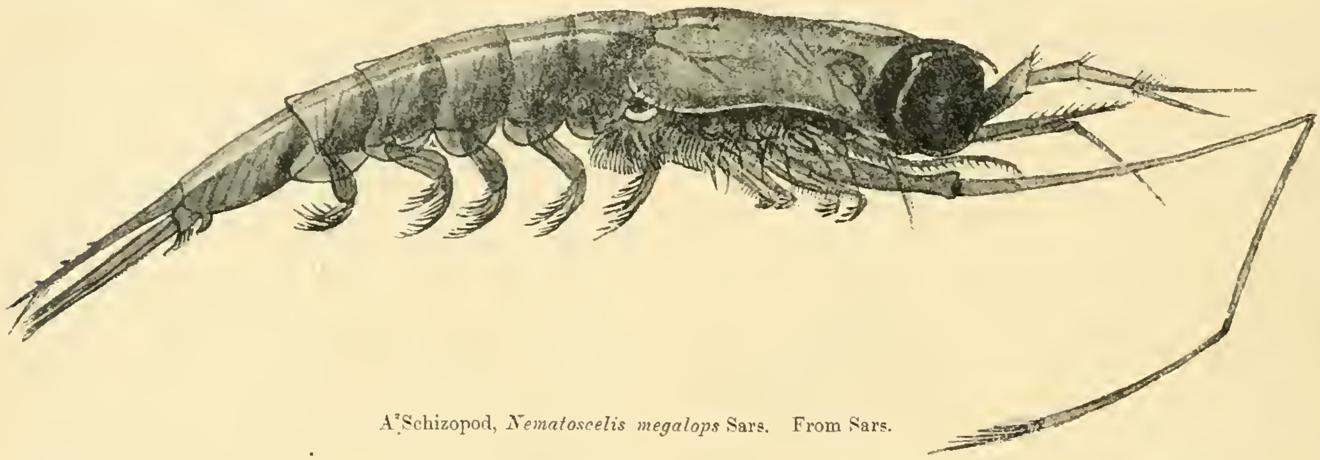
Branchial Plume, seen in section, of Deep-sea Prawn, *Plesiopenæus armatus* Bate. From Bate.

out of mind," would be a very inapplicable motto. Careful order is taken, so that by appropriate orifices water may flow in upon these sheltered branchiæ, and may, when it has served its turn, by other orifices flow out again. In this business, the second maxillæ are adapted to play a highly important part, supplying a sort of lock-gates or valves, which, in rhythmic beats, regulate the inflow and efflux of the respiratory stream. Here, too, as elsewhere in nature and art, circumstances alter cases. Thus, Mr. Walter Garstang has shown that the Masked Crab (*Corystes cassivelaunus*), when buried in the sand under water, reverses the usual current. This is almost a necessity of its situation. The water-pipe which connects it with its reservoir, the superincumbent ocean, is formed by its long setose antennæ. By utilizing this for the intake instead of as a discharge pipe, the crab obtains good water from above and allows the used-up supply to filter away into the absorbent sand around it. Various crabs have made experiments in the art and mystery of an open-air life. You do not, perhaps, realize the heroism of such an adventure to creatures formed for aquatic respiration. It is something like our sailing in a balloon over Mount Everest. A little economy of resources becomes expedient. To this end some of the little sea-quitting crabs show a pretty adaptation. Instead of having the carapace smooth on its under surface, they have it minutely furrowed and cross-furrowed. Fritz Müller explained the reason of this ornamentation. The crab, on leaving the water, can take a supply of that element with it in its branchial chamber—a supply, but a strictly limited supply. After expelling this through the efferent orifices at the sides of the mouth, the crab, in the ordinary condition of things, would begin to gasp for want of a breath of water. But the little crabs in question can let the exhaling stream trickle through the network of their stomacher, or waistcoat, as one might call it, and it will take up oxygen from the outside air and be fit for breathing over again in the branchial chamber.

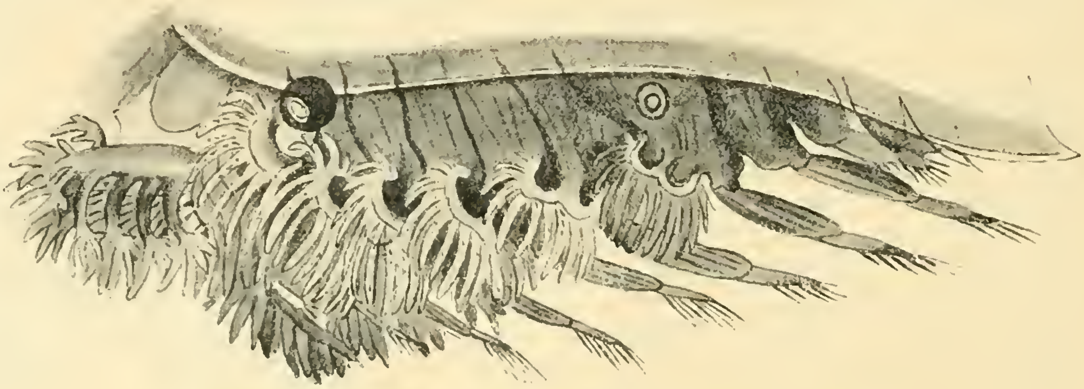
It is, perhaps, in the deep-sea prawns that the branchial plumes, as they are called, attain their highest elaboration and beauty. The explanation is that in the great depths the supply of oxygen is very scanty, and therefore greater and greater sub-division of the branchiæ becomes desirable for increasing the absorbent surface.

Very striking also are the branchial organs in the Schizopoda, and these animals are not at all chary of displaying them. The sides of the carapace are not jealously folded round but coquettishly raised, as though the creature were saying to itself, "It is a pity you should not see my graceful curls." It is just such a contrast as we find in the harbours of the world, some of which are suspiciously guarded against inspection, while others invite and demand the admiring gaze of every fresh beholder.

All the crustacea above mentioned, with one or two peculiar groups to boot, may be said to form a series strictly interconnected in respect to their respiratory system. But important divisions of the Malacostraca remain, which breathe, not indeed in an entirely different way, but with an entirely different part of the body. Hitherto we have been exclusively concerned with the head and trunk of the animal, leaving the tail to take care of itself. There is sometimes a difficulty in persuading people that a crab has a tail, because the fashion among crabs is to wear it so very thin and small, and to tuck it underneath with a sort of deprecatory air, as if to say, "Oh, no, we never mention it in our family, leastways, not out of the family." In lobsters, on the other hand, and prawns, and a great host of crustaceans which have no English names, the tail is muscular and powerful, and might often be called the predominant partner. Still, it does not carry the breathing organs. But when we turn to the rapacious Squillidæ, we find a new development.



A Schizopod, *Nematoscelis megalops* Sars. From Sars.



Branchiæ of *Nematoscelis megalops*, more highly magnified. From Sars.

Here the tail is massive and muscular as in any lobster or crawfish. But it is something more. It is the home of the respiration. On its swimming-legs, filamentous branchiæ are developed, adding one more singularity to the many which distinguish the appearance and character of this strange set of animals.

In having a caudal system of respiration, the Squillidæ are companions of a widely different, and far more extensive and varied division, the Isopoda. These are dispersed over all oceans. They track the footsteps of mankind in every land, or scale the mountains and explore the wilderness in advance. To them the common woodlouse belongs, and many an uncommon woodlouse. By their sessile eyes, and their short jackets, and often by the general aspect of their legs, they seem to be akin to the Amphipoda, and with them they have another link of connexion in the simplicity of their breathing organs. Nevertheless, those organs in the Isopoda, instead of belonging to the legs of the trunk, belong to the pleopods, or legs of the tail.

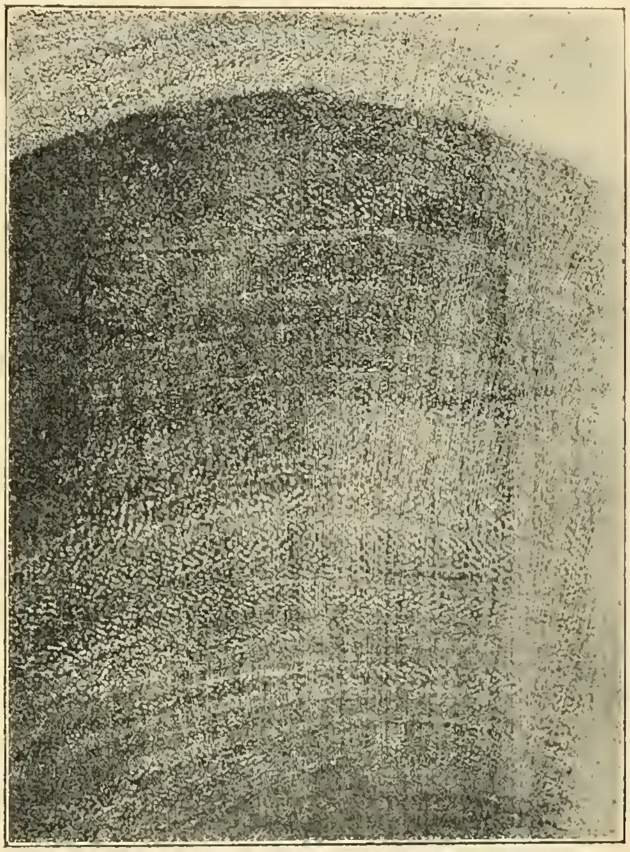
By name and nature, size and shape, a woodlouse makes little appeal to our romantic feelings. It may claim respect for antiquity of lineage. In some species it shows a willingness to march with the times, by adapting its branchiæ to a sort of tracheate respiration, such as suits a subaerial, as distinct from an aquatic existence. But by extraordinary variety of form and structure, its oceanic cousins, the Isopoda in general, afford a study of remarkable interest. They are seldom, it is true, very large, condescending sometimes to the twentieth of an inch, though ranging at others up to three or four inches of length by an inch of breadth. Till about twenty years ago, these were the monsters of the isopod order. But then, to the astonishment of carcinologists, there was hauled up from a depth of about one thousand fathoms, *Bathynomus giganteus*, four inches broad and more than nine inches long. It is a true isopod, with nearly four thousand facets in each of its great sessile eyes, and with the normal appendages according to rule. Only in one point it is exceptional. To assist the breathing in this great deep-ranging carcase, arborescent branchial appendages have grown out from the laminæ of its pleopods, parallel after a fashion to what has been described in the Squillidæ. So, in various ways, does Nature provide for the welfare of all her children. So thinking, Linnæus prefixed to his Systema, the saying, "O Jehova, quam ampla sunt Tua opera! quam sapienter ea fecisti! quam plena est terra possessione Tua!"

Microscopy.

By John H. Cooke, F.L.S., F.G.S.

To the current issue of the *Transactions of the Botanical Society of Edinburgh*, Mr. R. A. Robertson contributes a practical paper on the "Photomicrography of Opaque Stem Sections—Recent and Fossil." Mr. Robertson's method has much to recommend it to all who are engaged in research work or teaching, and who need a method of reproducing accurately the diagnostic characters of timber as seen in transverse and longitudinal sections. Micro-sections as usually made do not present enough surface to exhibit, typically, all of the characteristic appearances. Large areas are therefore necessary, and it is to a demonstration of the best method of obtaining these that this paper is devoted. No sectioning is necessary, as only the specially dressed opaque surface of the block of wood is micrographed. This is a distinct advantage where museum specimens are concerned, as the micrograph may be taken without in any way damaging the preparation.

A photo-micrographic camera, which is capable of working either vertically or horizontally, is best adapted for the purpose. The microscope accessories are removed and a half-plate lens is fixed to the front of the camera. The wood specimen is propped up in position in front of the camera so that the plane surface is at right angle to the optic axis of the apparatus. Focussing is arranged by means of a Welsbach incandescent gas light, which stands on one side of the apparatus, and finally by means of a focussing glass and magnesium wire. The radiant for exposure is a magnesium ribbon apparatus, arranged like the Welsbach on the opposite side. Mr. Robertson's experiments show that eight inches from the surface of the wood is the best position for the light when exposing. The time of exposure varies with the plate, intensity of light, and colour of the wood. With slow Ilfords forty seconds has been found to give very satisfactory results. The accompanying micro-photograph of a transverse section of a stem of *Acacia catechu* was taken by this method by Mr. Robertson.



Micro-Photograph of *Acacia catechu* (transverse section).

For obtaining photo-micrographs of smaller areas of surface under a somewhat higher magnifying power, a microscope is used with a low-power objective in place of the photographic lens. A lens fitted with an iris diaphragm, on the same principle as a photographic lens, is the best adapted for the purpose. The ocular is removed, and a tube of mat-black paper is substituted. The microscope is then bent over into a horizontal position, and connected with the camera. Illumination, focussing, and exposure are the same as before, but greater care, if possible, is required.

The practical value of a knowledge of common crystals, and of the modifications that they undergo when subjected to various modes of treatment, has been frequently brought home to the chemist and mineralogist when engaged on the determination of unknown substances. No microscopist can consider himself fully equipped for his work who has not made himself familiar with the commoner kinds of crystals prepared from alcoholic and aqueous solutions, saturated and dilute; by spontaneous drying and crystallization; and by rapid crystallization with the aid of heat. It was whilst pursuing the study of this branch of microscopical research that Dr. Sorby made some of his most startling discoveries. One of these was the determination of the nature of the liquid which fills the minute cavities, either wholly or in part, of many gems and crystals. A fine sapphire in his collection contained a cavity of a tubular form. This cavity was so regular in its bore that it served the purpose of a natural thermometer. It was a truly microscopical instrument, measuring only one-fourth of an inch in length, and about one-eighteenth of an inch in diameter. On experimenting with this gem it was found that the liquid which half filled the cavity at fifty degrees Fahrenheit, expanded so rapidly that its volume was doubled at eighty-nine degrees Fahrenheit. This increase of bulk within such narrow limits of temperature excluded all ordinary liquids, and on further investigation, Dr. Sorby decided that the liquid was nothing less than liquid carbonic acid.

Problems connected with the tillage of the soil have, hitherto, been looked upon as belonging to the domain of the physicist and chemist. It is only quite recently that it has come to be recognized that the soil teems with myriad minute forms of life—useful, harmful, and neutral, and that therefore it is necessary to look for a solution of the problems not to the chemist and physicist alone, but also to the biologist. Soil bacteriology has been engaging the attention of Mr. R. Stewart MacDougall, and in a communication to the Botanical Society of Edinburgh, he briefly summarized the methods that are employed for a microscopic examination of the bacteria contained in a sample of any given soil. One gramme of the earth is weighed, placed in a quart of sterilized water, and thoroughly mixed with it by shaking. A glass tube, containing gelatine which has been rendered germ free by repeated heating in a steam bath, is prepared; and the gelatine, when liquefied by a gentle heat, has added to it by means of a sterilized pipette 1 c.cm. of the mixture of water and earth. After a thorough mixing, the entire contents are poured out of the tube on to a gelatine plate. In a short time the bacteria begin to grow and multiply by fission, and soon each gives rise to a colony. To get a pure cultivation of a particular species, a small part of a colony is removed with a platinum needle, and is introduced into a fresh gelatine tube.

NOTES ON COMETS AND METEORS.

By W. F. DENNING, F.R.A.S.

GIACOBINI'S COMET (discovered September 29th) passed its perihelion at the middle of September, and is now receding from both the sun and the earth. At present, the position of the comet is unfavourable, being low in the western sky after sunset, and the object itself being faint, it will be practically invisible in December even in the largest telescopes. At the beginning of that month the distance of the comet from the earth will be no less than two hundred and fifty millions of miles.

HOLMES'S COMET has been exceedingly faint at its recent return, and will soon pass altogether out of reach. It appears to have been very little observed, and it is very fortunate that Messrs. Perrine and Aiken secured a series of observations between June 10th and September 9th. These were obtained with the 36-inch refractor, and are the only ones published, so that it is fair to conclude that some of the other large telescopes failed to show the comet.

PERIODICAL COMETS.—In 1900 the return of several of these interesting bodies will be due. Finlay's comet ought to arrive at perihelion at the end of February, while De Vico-Swift's comet (1844 I. and 1894 II.) is expected in August. Barnard's comet (1884 II.) is due in September.

FIREBALL OF SEPTEMBER 2ND, 12H. 4½M.—A meteor much brighter than Venus was seen at this time by the writer at Bristol, and by Mr. Ivor F. H. C. Gregg at Great Malvern. It left a streak for one minute. At Bristol the path was recorded as from $40°+67°$ to $37°+74°$, while at Great Malvern it was from $15° + 45°$ to $345° + 40°$. A comparison of the two observations shows that the radiant was at $46°+42°$, so that the meteor belonged to the α–β Perseids ("General Catalogue of Radiants," XLIII.). The height of the object at its first appearance was eighty-six miles over Shipston, and at its disappearance sixty miles over Tewkesbury. Its earth point was at Aberdare, and its observed length of path twenty-eight miles. The meteoric stream from which it was derived has been previously observed as follows :—

1887,	August	30	... $46°+43°$	W. F. D.
,,	September	1–13	... $45°+40°$	Heis.
1870	,,	5	... $48°+41°$	Tupman.

It sometimes furnishes brilliant fireballs. One of the meteors which I recorded from it in 1887, August 30th, was equal to Venus. It appeared at 14h. 27m., and traversed a path of 18½° from $19°+27°$ to $5°+14°$.

FIREBALL OF OCTOBER 2ND, 8H. 20M.—This fine object, referred to in last month's Notes, was also seen by Mr. W. S. Price, at Wellington, Somerset. He says it moved with exceptional slowness, even for a meteor travelling from W. to E. Its apparent brightness was scarcely equal to that of Jupiter at opposition, and it exhibited a deep yellow colour. Towards the end of its path it divided into four distinct fragments, all of which moved in the same line.

FIREBALL OF OCTOBER 8TH, 6H.—A splendid meteor was reported as seen at Epsom, West Norwood, Hayward's Heath, and other places. It passed from S.W. across the zenith to N.E., and its duration of flight was variously estimated as eight, ten, and ten to twelve seconds. Its colour was a glistening primrose yellow, and it left a momentary trail. At Epsom, Mr. W. Nash says he was fortunate in seeing the meteor from the start to the finish, and that it travelled from one horizon to the opposite one. The object was a very interesting one, being evidently derived from a radiant in Scorpio or Libra near the horizon. It must have passed over the English Channel and South of England, but the descriptions already to hand are not sufficiently definite to enable exact calculations to be made as to its real path in the air.

THE SHOWER OF LEONIDS IN 1899.

The expected display has come and gone, and it seems very probable, from the descriptions already to hand, that the meteors have again disappointed expectation. But the weather is in a measure responsible for this, for at many places the nights following November 14th and 15th were densely overcast. At some stations, however, the sky was partly clear, and a few Leonids were seen in the moonlight, but only in very moderate numbers. A brilliant display, such as that of 1799, 1833 or 1866 was entirely wanting. The following is a summary of some of the reports received :—

November 10th, 13h. to 15h. 30m., 19 meteors mapped, but no Leonids.—A. S. Herschel.

November 10th, 11h. 25m. to 14h., 13 meteors mapped, but no Leonids.—W. E. Besley.

November 10th, 12h. 40m. to 14h. 40m., 13 meteors mapped, but no Leonids.—W. F. D.

November 10th, 26 meteors but no Leonids.—T. H. Astbury.

November 11th, 14h. 30m. to 16h. 30m., 10 meteors seen, including 2 Leonids.—W. F. D.

November 12th appears to have been overcast nearly everywhere. At Slough, 17h. 30m. to 18h., Prof. Herschel observed 2 meteors, one of them a Leonid.

November 13th, 17h. 15m. to 18h., 5 meteors seen, including one Leonid. Sky only one-fifth clear.—W. F. D.

November 14th, 50 Leonids seen in three hours.—Oxford University Observatory.

November 14th, 10h. 30m. to 18h., 98 meteors (66 Leonids) seen, including a splendid non-Leonid, at 17h. 40m., leaving a train visible for five minutes.—Sir W. J. Herschel.

November 14th, 13h. 30m. to 14h. 15m., one Leonid seen.—A. S. Herschel.

November 14th, 14h. 30m. to 18h., 28 meteors seen, including about 24 Leonids.—R. I. Ryle.

November 14th, 16h. 3m. to 17h. 53m., 25 Leonids registered, and about a dozen others seen. There was a considerable amount of fog.—T. H. Astbury.

November 15th, 20 meteors seen during the whole night, including 15 Leonids.—Robert Service.

Reports for the night of Nov. 16th either speak of the overcast state of the firmament or announce that comparatively few meteors were seen.

A telegram from New York states that the observers at Vanderbilt University were rewarded with a brilliant meteoric display on the night of Nov. 14th. Meteors passed at intervals of a minute or two, and radiated from the constellation Leo. At Brown University fifty-five Leonids were counted.

On the whole the shower seems to have been decidedly poor, and goes far to prove that the earth has not yet encountered the really dense section of the cometary meteor-stream. It will be remembered that there were fine displays in each of the years 1866, 1867, and 1868. The next two years 1900 and 1901 may well be expected to witness their recurrence. But the parent comet of the meteors (Tempel I., 1866) passed through its perihelion last spring, and the earth must have recently travelled through a part of the orbit much nearer the comet than the sections it will encounter in the next two years.

THE FACE OF THE SKY FOR DECEMBER.

By A. Fowler, F.R.A.S.

The Sun.—On the **1st** the Sun rises at 7.44, and sets at 3.54; on the **31st** he rises at 8.8 and sets at 3.58. Winter commences at 1 a.m. on the **22nd**, when the Sun enters Capricornus. There will be an annular eclipse of the Sun on the **2-3rd**, invisible at Greenwich; the annular phase will only be visible in the Antarctic regions, but a small partial eclipse will be seen in New Zealand, Tasmania, and South-western Australia.

The Moon.—The Moon will be new on the **3rd**, at 12.18 a.m.; will enter first quarter at 9.3 p.m. on the **9th**; will be full at 1.31 a.m. on the **17th**; and will enter last quarter at 3.57 a.m. on the **25th**.

There are no striking occultations at convenient hours during the month, but it may be mentioned that Neptune will be occulted on the morning of the **17th**; disappearance at 3.36 a.m., at 150° from the north point (118° from the vertex); reappearance at 4.11 a.m., at 222° from the north point (180° from the vertex).

There will be a partial eclipse of the Moon commencing just before midnight on the **16th**. The magnitude of the eclipse is 0·995, so that it is very nearly total. The contacts are as follow, Greenwich mean time:—

First contact with penumbra,	Dec. 16th,	10h. 33·7m.	P.M.
„ „ shadow	„	11h. 44·6m.	„
Middle of Eclipse ...	Dec. 17th.	1h. 25·9m.	A.M.
Last contact with shadow	„	3h. 7·2m.	„
„ „ penumbra	„	4h. 18·1m.	„

The first contact with the shadow occurs at 66° from the north point of the Moon's limb towards the east, the last 59° towards the west; in each case for direct image.

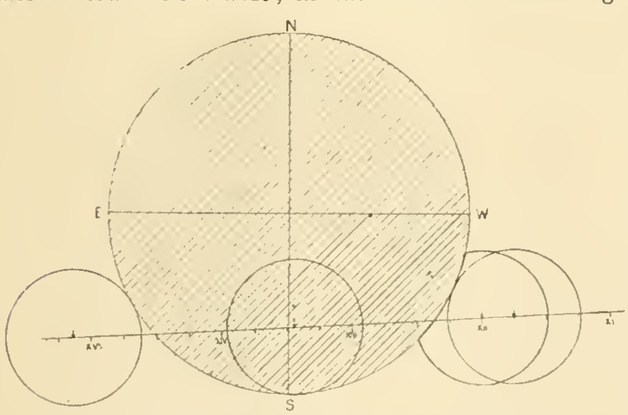


Diagram showing the Moon's path through the Earth's shadow, Dec. 16-17th, and the phase of eclipse at midnight.

The path of the Moon through the shadow of the Earth is illustrated in the accompanying diagram, in which the scale indicates the position of the Moon's centre at corresponding times.

The Planets.—Mercury is in inferior conjunction on the morning of the **6th**, and is afterwards a morning star, reaching greatest western elongation of 22° 5′ on the **25th**. On account of his southerly declination, however, he will not be well placed for observation in our latitudes.

Venus is an evening star, but is still badly placed for observation.

Mars, Jupiter, Saturn, and Uranus may all be considered unobservable.

Neptune is in opposition on the **17th**, and during the month describes an arc nearly a degree in length, with a westerly motion. His path lies almost midway between ζ Tauri and η Geminorum.

The Stars.—About 9 p.m. at the middle of the month, Cancer, Gemini, and Canis Minor will be towards the east; Auriga high up towards the east; Taurus and Orion towards the south-east; Perseus and Cassiopeia nearly overhead; Aries and the head of Cetus on the meridian; Andromeda high up towards the north-west; Pegasus a little south of west; Cygnus and Lyra towards the north-west; and Ursa Major a little east of north.

Convenient minima of Algol occur on the **12th** at 9.3 p.m. and on the **15th** at 5.52 p.m.

Chess Column.

By C. D. Locock, B.A.

Communications for this column should be addressed to C. D. Locock, Netherfield, Camberley, and be posted by the 10th of each month.

Solutions of November Problems.

(J. K. Macmeikan.)

No. 1.

1. P to K4, and mates next move.

No. 2.

1. R to B7, and mates next move.

[There is an unfortunate dual after 1. . . . K to B3.]

Correct Solutions of both problems received from E. Servante, Alpha, W. de P. Crousaz, H. S. Brandreth, G. C. (Teddington), J. Baddeley, Captain G. A. Forde, K. W., H. Le Jeune, F. B. L. (Devonport), Rev. H. J. Riddelsdale, Gerald F. Todd, J. E. Lelliott, W. d'A. Barnard, J. Neville.

G. F. Todd.—If you would send the key you gave, we shall be glad to point out Black's defence. We fancy it was Kt to Kt5, or a move with the Bishop.

J. T. Blakemore.—Too late to acknowledge last month. You will have seen that your second attempt at the four-mover was quite correct. It seems that ten only, out of the thirty regular solvers of the "B. C. M." problems, proved equal to this very difficult production.

E. Servante.—The game enclosed shows that you are cultivating a brilliant style, but your opponent's play is too weak to enable any correct idea of your strength to be formed. At move 16 it would have been prettier to mate with the Bishop instead of the Queen.

J. Baddeley.—Certainly it is better to solve from the diagram if possible. In the case of two-movers there is no excuse for not doing so, and the same may apply to fairly simple positions in three or four moves, especially those in which the Black King is confined. It is doubtful, however, whether the majority of solvers can really appreciate the beauties of a complicated three-mover or four-mover without setting up the position and moving the pieces, but, of course, the problem *may* previously be solved from the diagram alone.

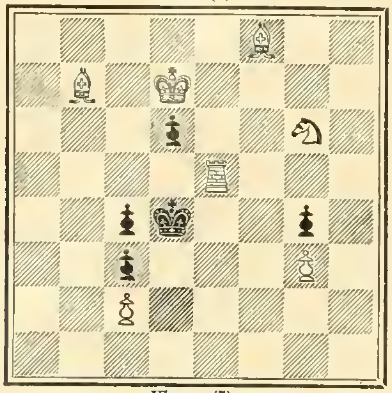
Gustav v. Broecker.—Many thanks for the programme.

PROBLEMS.

By C. D. Locock.

No. 1.

Black (5).

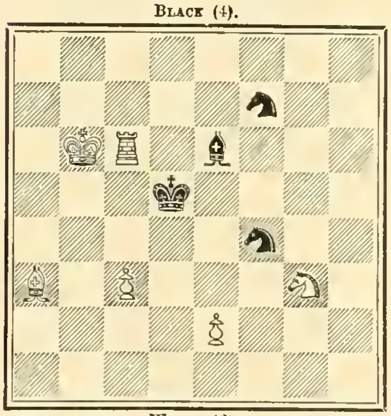


White (7).

White mates in two moves.

No. 2.

Black (4).



White (6).

White mates in two moves.

[The publication of Editorial compositions signifies, as usual, that the stock of problems sent in by the solvers of Knowledge has once more become exhausted. Can the deficiency be supplied?]

CHESS INTELLIGENCE.

Messrs. J. L. Cope and J. W. Russell, joint hon. secretaries of the recent London Tourney, inform us that "the gold medal presented by the Ladies Chess Club for the winner of the most brilliant game in the recent Masters' Tournament, has been awarded to Mr. Lasker for his game against Mr. Steinitz in the second round. The prize of Ten Guineas presented by Mrs. F. H. Lewis and Mr. Harry Lewis for special brilliancy in any game played in the recent Masters' Tournament, has been awarded to Mr. J. H. Blackburne for his game against Mr. Lasker in the first round."

The Janowski-Lasker match appears to have fallen through, owing to failure in agreement as to the number of games to be played. M. Janowski may perhaps play a match with Mr. Showalter. Failing that, Messrs. Steinitz and Showalter will play a "series" of games.

The International Tournament next year will take place, as might have been expected, at Paris. It will be a one-round contest, limited to twenty-four players.

The appended game was played in the recent London Tournament:—

"Ruy Lopez."

White (D. Janowski).	Black (M. Tchigorin).
1. P to K4	1. P to K4
2. Kt to KB3	2. Kt to QB3
3. B to QKt5	3. Kt to B3
4. Castles.	4. B to K2
5. Kt to B3	5. P to Q3
6. P to Q4	6. Kt to Q2
7. Kt to K2	7. Kt × P
8. Kt × Kt	8. P × Kt
9. Kt × P	9. Castles
10. Kt to B5	10. B to B3
11. P to QB3	11. Kt to B4
12. Kt to Kt3	12. B to R5
13. P to B3	13. B × Kt
14. P × B	14. B to Q2
15. B to K2	15. Q to K2
16. P to KKt4	16. KR to Ksq
17. R to B2	17. QR to Qsq
18. B to K3	18. B to B3
19. P to QB4	19. P to QR4
20. Q to B2	20. Q to R5
21. Q to Q2	21. P to B3
22. Q × RP	22. P to R4
23. P × P	23. R to K4
24. P to KKt3	24. Q × Pch
25. R to Kt2	25. Q to R6
26. Q × P	26. Kt to K3
27. R × Pch	27. Kt × R
28. Q × Rch	28. Kt to Ksq
29. B to B4	29. R × P
30. K to B2	30. Q to R5ch
31. K to K3	31. K to B2
32. R to KKtsq	32. R to Rsq
33. P to B5	33. Resigns.

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