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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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CONTENTS.

THE KARKINOKOSM, OR WORLD OF CRUSTACEA.

By the Rev. Thomas R. R. Stebbing, m.a., f.r.s., f.l.s.,

Author of "A History of Crustacea," "The Naturalist of Cumbrae," "Report on the Amphipoda collected by H.M.S. 'Challenger,'" etc.

DAN CHAUCER'S well of English undefiled being at the disposal of the naturalist, it is often thought that only out of pedantry or sheer perverseness he fills his story with names and terms borrowed from alien tongues, framing uncouth compounds out of dead Greek and Latin. Instead of saying that the subject now before us is Carcinology (pronounced Karkinology), or the science of Crustacea, it may, therefore, be more acceptable to declare that the discussion will turn on the nature of barnacles, water-fleas, fish-lice, scuds, hoppers, slaters, hodmandods, shrimps, prawns, hermits, lobsters, crayfish, crawfish, and crab-fish. The explanation is not quite so compendious as the word "Crustacea." It is much longer, and yet does not mean so much. It tries to be explicit, and yet remains vague. For, on the one hand, many of the popular names above given are misleading, since no crustaceans are fishes, and some water-fleas and fish-lice are not crustaceans; and, on the other hand, there are several important groups which, because they are seldom seen unless expressly sought for, and because they make no direct appeal to the pleasure or convenience of mankind, have been passed over without receiving any colloquial designation. The truth is that no branch of natural history can be handled with any degree of thoroughness to the exclusion of its own appropriate terms of art; and, as these are intended for cosmopolitan use, there is an advantage in deriving them from the languages of ancient Greece and Rome, which can provoke no international jealousies in the breasts of modern students.

The class Crustacea, omitting one controversial group, may be conveniently divided into three sub-classes called Malacostraca, Entomostraca, Thyrostraca. Of these names the first is primeval, and the second of long standing. Their meanings have ceased to be of importance; it is only the application of them that is important. No one thinks that General Wolfe was especially ferocious, or Charles James Fox exceptionally cunning, or that Bishop Butler had charge of his master's wine-cellar, whatever the circumstances may have been which in the past gave rise to their family names. On the same principle the term Entomostraca (*see* Fig. 1), meaning insects with shells, may well be retained, although the animals intended are no longer classed among insects, and many of them are totally devoid of shells. There is a natural craving for descriptive names in science—for names that teach something. That this craving is so seldom gratified is not due to ill nature on the part of the naturalists. Attempts to indulge it are generally failures. The most ingeniously constructed name can scarcely be expected to enshrine more than one striking characteristic of the group it denominates. Now, research is provokingly progressive, and in its progress it is quite fond of showing that the character specified in the ingenious name either does not belong to all the members of the group, or that it belongs also to the members of several

Fig. 1.—*Estheria gihoni* (Baird). A Phyllopod of Palestine.

other groups. Thus the intention of the descriptive word is defeated, and, instead of teaching, it leads the unwary learner astray. A name like Malscostraca, signifying soft-shelled, which at one time may have usefully distinguished lobsters and prawns from the oyster and the whelk, is no longer instructive in an enlightened age which could not dream of confusing a tasteful crustacean with a succulent mollusc. Moreover, some Malacostraca have very hard shells, far surpassing in induration those of the Entomostraca and of many Mollusca. The name Thyrostraca, meaning shells with doors or valve-shells, gives a small item of information about cirripedes, while the latter more familiar name refers to the fact that the cirri or legs of a barnacle have some resemblance to ringlets or tresses of hair (*see* Fig. 2). None the less, some of the group have no shells and no valves and no cirri.

FIG. 2.—*Lepas anatifera* (Linnæus). A pedunculated Cirripede.

In this opening chapter it would be highly proper and methodical to define the class under discussion in such a way that any schoolboy, or a poet, or a journalist, on coming casually across a *Notopterophorus papilio*, for example, might, under the guidance of the definition, be able at once to exclaim, "Lo! here is a crustacean!" But nature, rejoicing in the penumbra and the twilight, and abhorrent of every hard line, takes a pleasure in setting definitions at defiance, varying the characters within a group, and adding here and subtracting there, till there is pretty well nothing left which all the confederated members can claim to have in common. What if some of the Crustacea are endowed with a crustaceous integument: with gills for breathing; with a heart; with eyes and brain; with segmented body and limbs; with bilateral symmetry and with powers of locomotion? There are others which are soft-skinned, without gills, eyeless, brainless, heartless, shapeless creatures, in a state of fixation (*see* Fig. 3). The difficulty of defining natural groups may be illustrated in this way. Suppose that three sets of animals have characters so combined that they may be represented respectively by the letters *ab*, *bc*, *ca*, or by the colours red and yellow, yellow and green, green and red. The symbols indicate that each set has half its characters in common with each of the other sets. Yet there are no characters common to all three sets, so as to be available for defining a higher group embracing them all. When in such circumstances a definition has to resort to negative and alternative characters, it may be logically exact, but it loses the quality of helpfulness. The beginner, therefore—perhaps the resentful beginner—must say what he pleases, and make what he can of the statement that the division of the Arthropoda called Crustacea have a segmented body and limbs at some stage of life; that either they have gills or else they breathe in water through their skin; that they have no proper neck; that they never have wings; and that they are born in locomotive freedom. Like insects, they have an integument composed of a substance called chitine. This may be extremely flexible, or, passing through various degrees of tough and brittle, may, by the copious addition of chalky material, attain the hardness of bone or brick.

Having come to a provisional agreement with ourselves that an almost indefinable congress of startlingly incongruous-looking creatures are all to be admitted to the honourable title of crustaceans, we are next tempted to ask what natural bond of union, if any, exists for such an assemblage. Were they all separately invented just as we find them, with their striking contrasts and innumerable gradations and subtle resemblances; or, have they been evolved in ramifying lines from a common root? The first hypothesis would leave us rather idiotically gaping at what must seem to be the effects of an unfathomable caprice. Probably, therefore, most thinking men would now prefer to explain the genesis of the "Karkinokosm," as we know it, on the principle of evolution. By this we mean that all the forms, now so amazingly unlike one another, are nevertheless descended from common ancestors. No one denies that animals are capable of reproducing their kind. No one denies that children are more or less unlike their parents and unlike one another. That these unlikenesses can be to some extent accumulated has been proved. That in the course of nature they are capable of an accumulation so extended and so permanent as to separate a man from a mouse, or the great *Cardisoma guanhumi*, figured on the next page, from the worm-like parasite *Lernæolophus sultana*, is yet awaiting proof. To the principle of evolution it matters not how the variations are produced, so long as some of them can sometimes be secured against reversion to the ancestral pattern. So far as the principle is concerned, it is indifferent whether the changes result in exalting or degrading the character of a species. To explain the existing constitution of the class Crustacea, it must be supposed that some of its members have risen, and that some have, after rising, fallen. If it cannot be proved that all have been evolved from a common stock, something can be said for the probability of it; and those who are dissatisfied can only be asked to provide some other explanation that will better fit the phenomena.

FIG. 3.—*Lernæolophus sultana* (Nordmann). A Copepod, parasitic on Fish.

For the purposes of a natural classification it is the history of evolution that is most wanted. We need to trace back the ancestry of different forms to the point of junction, just as we follow the twigs of a tree to the branch from which they spring, and the branches to the common stem. Clearly this can only be done by help of the palæontologists. What the rocks have as yet revealed as to the succession in time of crustacean forms has recently been represented by Dr. Henry Woodward in a kind of fossil tree. Of the undisputed Crustacea he recognizes eleven principal branches, and all these he draws as running parallel down to the Carboniferous period—a period so ancient that in calculating its age imagination and arithmetic have to play a drawn game, and yet so modern that in it the merry cockroach is already in evidence. The disappointing inference is that any

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* *See* his Presidential Addresses to the Geological Society of London, 1895, 1896.

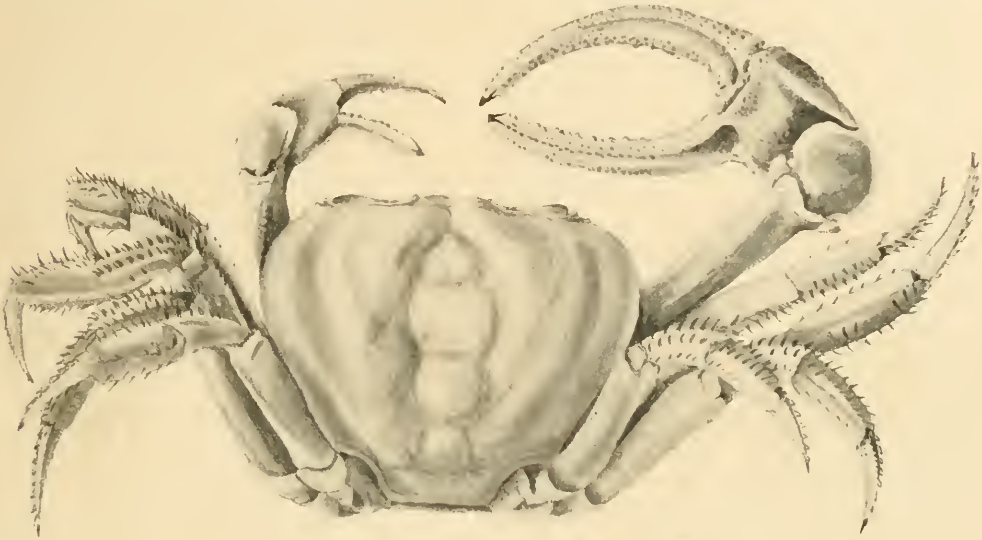

Fig. 4.—*Cardisoma guanhumi* (Latreille). A West Indian Land Crab.

common starting point for all the Crustacea must lie indefinitely further back; and in fact it is not till the pre-Cambrian period that all the branches are made to join the central stem, while of the earlier points of junction between the branches themselves it must be admitted that most are highly conjectural. The true affinities of a modern species are often only discovered by careful dissection, and such a process is rarely possible with mangled remains in an obdurate fossil. Sometimes, when the rock specimens are exceptionally clear, the characters displayed are distressingly like those familiar to us in living forms. Thus, according to Dr. Ortmann, a fossil crawfish from the Upper Chalk is more nearly related than any extant species to the modern *Linuparis trigonus* (De Haan) of Japanese waters. It is ungracious to find fault with nature. Perhaps the researches of geology are in fault, or perhaps there are rays, yet waiting to be discovered by the physicist, which will penetrate the secrets of an obliterated past. Properly to attest the work of evolution in nature we sorely need to recover a series of lost pictures. They should be a kind of dissolving views carrying us back to the dawn of life, with the features of all existing forms not abruptly but gradually fading away, till they melt into an undifferentiated original. Some generalized forms are indeed quoted from the record of the rocks, but they are few and obscure compared with the desires and expectations of the evolutionist.

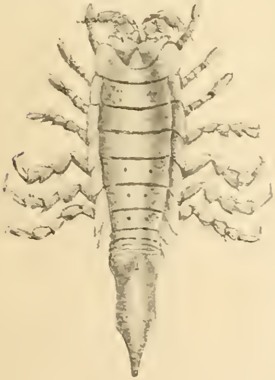

Fig. 5.—*Glyptonotus sabini* (Kröyer). An Arctic Isopod.

In a future chapter an attempt will be made to show how a belief in the unity of the class Crustacea may be founded on the internal evidence of extant species. That this is not, on the face of it, a very simple task, might be inferred from the few illustrations here brought together. They represent a decapod, an isopod, a phyllopod, a parasitic copepod, and a cirripede or cirrhopod, thus ranging from the highest to the lowest ranks of the crustacean commonwealth. Since nature has ordained that the writer of "Hamlet" should have personal identity in common with a speechless babe, a land crab need not be too proud to own a barnacle for its distant cousin.

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A DROWNED CONTINENT.

By R. Lydekker, b.a., f.r.s.

As many of our readers are doubtless aware, deep boring operations are being undertaken in the island of Funafuti, in the Ellice group of Polynesia, with the primary object of ascertaining the depth to which coral rock, or limestone of coral origin, extends. If it were found that such coral-made material extended to depths far below the level at which living coral can exist, there would be evidence that the island on which the experiment was conducted had subsided. And if subsidence were thus proved to have taken place in a single island selected almost at random, the conclusion could hardly be resisted that the greater part, if not the whole, of Polynesia must likewise be a subsiding area, or, in other words, the remnants of a drowned continent, some of the higher lands of which are indicated by the atolls and other islands of the Coral Sea. It is, therefore, a favourable opportunity for a few words in regard to the permanence or otherwise of the great oceanic basins and continental areas of the globe. This subject, it need scarcely be said, has not only an intense and absorbing interest of its own—for it is difficult for anyone except a geologist to fully realize that the solid ground on which he stands may have been buried fathoms deep beneath the water—but is also one of the utmost importance in regard to many puzzling problems connected with the present and past geographical distribution of terrestrial animals and plants on the surface of the globe.

Although it might well have been thought that opinion in matters scientific would be unlikely to veer suddenly round, and after tending strongly in one direction incline with equal force in the one immediately opposite, yet there are few instances where the swing of the pendulum of opinion to one side has been more swiftly followed by its oscillation to the other than has been the case in the problem of the permanency of continents and oceans. When geology first began to take rank among the exact sciences, and it was demonstrated that most of the shells and other fossils found in the solid rock of many of our continents and islands were of marine origin, it was a natural, if hasty, conclusion that land and sea had been perpetually changing places, and that what is now the centre of a continent might comparatively recently have been an ocean abyss. Accordingly, when any difficulty in finding an adequate explanation in regard to the geographical distribution of the animals or plants of two or more continents or islands occurred, the aid of an "Atlantis" or a "Lemuria" was at once invoked without misgiving, and a path thus indicated across which the inhabitants of one isolated area could easily have passed to another.

This was one swing of the pendulum. But as the methods of geological observation and investigation became more exact and critical, it was soon obvious that, in many areas at least, the alternations between sea and land could not have been so frequent or so general as had been at first supposed. It was, indeed, perfectly true that many portions of some of our present continents had for long periods been submerged, or had been at intervals alternately land and sea. But at the same time it began to be realized that the fossiliferous marine deposits commonly met with on continents and large islands were not of such a nature that they could have been laid down in depths at all comparable to those now existing in certain parts of the basin of the Atlantic. Even a formation like our English chalk, which had been supposed to have analogies with the modern Atlantic deposits, appears to have been laid down in a sea of much less depth and extent, and probably more nearly comparable with the modern Mediterranean. Then, again, it was found that large tracts in some of our present continents, such as Africa and India, had existed as dry land throughout a very considerable portion of geological time. Moreover, it was asserted that no formations exactly comparable to those now in course of deposition in the ocean abysses could be detected in any of our existing continents or islands; while it was further urged that in none of the so-called oceanic islands (that is, those rising from great depths at long distances from the continental areas) were there either fossiliferous or metamorphic rocks similar to those of the continents and larger continental islands.

This was the second swing of the pendulum, and for a long period it was confidently asserted that where continents now exist there had never been any excessive depth of ocean; and, conversely, that in the areas now occupied by the great ocean abysses there had never been land during any of the later geological epochs. It was, indeed, practically affirmed that wherever the sounding-line indicates a thousand fathoms or more of water, there sea had been practically always, and that no part of the present continents had ever been submerged to anything like that depth.

Almost as soon as the pendulum of opinion had attained the full limits of its swing in this direction (and this swing had been largely due to the influence of geologists and physicists), there began to be signs of its return to a less extreme position. It was, in the first place, proved that a few deposits—and these of comparatively recent date—analogous to those of the ocean abysses, do occur in certain areas. And, in the second place, it was shown that a few oceanic islands do contain rocks like those of the continents, and are not solely of volcanic or organic origin. Zoological and palæontological discoveries were at the same time making rapid advances; and the students of these branches of science, who had been among the foremost in giving the swing of the pendulum on the side of continental instability its first impulse, now began to press their views—only in a more moderate manner—in the same direction. Evidence had long been accumulating as to the identity of certain freshwater formations and their included animal and plant remains occurring in South America, South Africa, India, and Australia; and it was urged that during the Secondary period of geological history not only was Africa connected with India by way of Madagascar and the Seychelles, but that land extended across what is now the South Atlantic to connect the Cape with South America, and that probably India was likewise joined to Australia by way of the Malay archipelago and islands. In fact, there seems good evidence to indicate that at this early epoch there was a land girdle in comparatively low latitudes encircling some three-fourths of the earth's circumference from Peru to New Zealand and Fiji.

Even taking into account the comparatively early date of its existence, this girdle of land, the evidence in favour of which can scarcely be shaken, gave a heavy blow to the adherents of the absolute permanency of continents and oceans, as it clearly indicates the comparatively modern origin of the basin of the South Atlantic. But this is not all. South America, which there is good evidence to believe was long cut off from the northern half of the New World, shows certains indications of affinity in its fauna with that of Europe in early Tertiary times, and to a certain extent with that of modern Africa; and the only satisfactory way of explaining these relationships is by assuming either the persistence of the land connection between the Cape and South America across the South Atlantic till a comparatively late geological epoch, or that such connection took place further south by means of the Antarctic continent. There are several objections, which need not be considered here, in regard to the latter alternative; and since there is other evidence in favour of the comparatively recent origin of the South Atlantic depression, the persistence of a land connection in lower latitudes seems the more probable explanation.

In addition to all this, there is evidence of a more or less intimate relationship between the land faunas of Australasia and South America; and as similar types are not met with in Africa, and several of them belong to groups unlikely to have endured Antarctic cold, it has been suggested that America and Australasia were in connection at no very remote epoch by way of the Coral Sea. It is known, for instance, that some of the Australian marsupials are more or less closely allied to others which inhabited South America before it was connected with North America; and as no kindred types are met with either in the latter area, in Europe, or in Africa, a land connection by way of the South Pacific, and that at a comparatively recent epoch, offers almost the only satisfactory explanation of the means of transit, if the Antarctic theory be rejected. And it may be mentioned in passing that the acceptance of even the latter would imply a large modification from the existing distribution of land and water in the southern hemisphere.

But the evidence for a land connection by way of the Pacific does not by any means rest on the testimony of marsupials alone. Passing over certain groups, it may be mentioned that the earthworms of Australia and New Zealand are strangely like those of Patagonia, and have no very near relatives in Africa; while an almost equally strong affinity is stated to exist between the Patagonian and Polynesian land slugs. Neither of these groups of animals are fitted to withstand the cold of high latitudes, and it is difficult to see how the members of the second, at any rate, could have reached the two areas by any other means than a direct land connection.

Turning now to the brief reports hitherto received as to the results of the Funafuti boring, it appears that this has been carried far below the limits of coral life, and is still in coral limestone. So far, therefore, the advocates of the theory that Polynesia is the remains of a sunken continent have scored a great triumph; and although there is still the possibility that some of the atolls in this vast area may prove to be perched on the denuded summits of extinct submarine volcanoes, even this would not interfere with the general conclusion. If deeper borings should result in touching rocks more or less similar to ordinary continental sedimentary deposits or metamorphic crystallines, an even firmer basis would be afforded to the hypothesis of subsidence which has now received such striking confirmation.

As the result of the boring it appears, then, that there is a possibility that the community between the South American and Australasian faunas may admit of being explained by means of a direct land connection between the two areas at a comparatively recent geological date. Even, however, if this explanation receive future support and acceptation, there are, as in all similar cases, still many difficulties with which to contend. One of these is the practical absence of all non-volant mammals from Polynesia, with the exception of the Solomon group, where a few cuscuses and rats are found. But the case of the West Indies—where there is every probability that there was formerly a large mammalian fauna, the majority of which were drowned by submergence—may very likely afford the solution of the difficulty. Worms and slugs would probably find means of survival in circumstances where mammalian life would disappear. This explanation will, however, clearly not apply in the case of New Zealand, where, if mammals had ever existed, their remains would almost certainly have been discovered. It must be assumed then that, if Polynesia was the route by which the faunas of Australia and Patagonia were formerly connected, New Zealand was at that time isolated. And, indeed, seeing that the hypothetical land connection between the areas in question must have existed at a comparatively late epoch, it is most likely that the ancient Polynesian land was already broken up to a considerable extent into islands and archipelagos, so that the main line of connection may have been but narrow, and from time to time interrupted. Indeed, it must almost of necessity have been but incomplete and of short duration after the introduction of modern forms of life, as otherwise the types common to Australia and Patagonia would be much more numerous than we find to be the case. Hence there is no improbability in the suggested isolation of New Zealand during the period in question.

But, putting these interesting speculations aside, the results of the Funafuti boring indicate almost without doubt that Polynesia is an area of comparatively recent subsidence; and it has already been mentioned that there are good reasons for regarding a large part of the basin of the South Atlantic as of no great antiquity, while the area of the Indian Ocean appears to have been considerably enlarged during the later geological epochs. Apparently, therefore, the great extent of ocean at present characteristic of the southern hemisphere is a relatively modern feature.

Hence it is clear that the extreme views prevalent a few years ago as to the absolute permanency of the existing continental and oceanic areas clearly stand in need of some degree of modification. And what we have now to avoid is that the pendulum should not once more take too long a swing in the opposite direction.

So far as the great continental masses of the northern hemisphere are concerned, it would appear that portions of these have always existed to a greater or lesser extent as land. But the great extent and homogeneous character of formations like the Mountain Limestone, the Chalk, and the Nummulitic Limestone, suggest that sea was much more prevalent in this area than it is at present, and that, so far as the Old World is concerned, the continental area has been growing. The North Atlantic, and probably also the North Pacific, may apparently be regarded as basins of great antiquity. On the other hand, in the southern hemisphere, although Africa, parts of Australia, and at least some portions of South America, are evidently land surfaces of great antiquity, they, together with the islands of the Coral Sea, seem to be mere remnants of a much more extensive southern continent or continents. Conversely the southern oceans have gained in area by swallowing up these long-lost lands. Obviously, then, although true in a degree, continental permanency has by no means been the only factor in the evolution of the present surface of the globe.

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IS WEATHER AFFECTED BY THE MOON?

By Alex. B. MacDowall, M.A.

The history of science, in its relation to popular beliefs, often affords on both sides curious illustrations of the old adage, *Humanum est errare.* Certain ideas as to the causation of natural phenomena are widely prevalent. Science steps in to examine them. She tests and measures; sees them to be very faulty; puts them aside as worthless and vain. But there comes a time when this judgment has to be revised, and considerable grains of truth are found among the rubbish.

There are at present signs, if I mistake not, that the denial of lunar influence on weather has been made too confidently.

If we ask any working gardener, or fisherman, or sailor, whether he thinks the moon has anything to do with weather, he will probably reply with a ready affirmative. He may enlarge, in his own wise way, on what weather we have to expect if the change of the moon is at this hour or that; if the moon is high or low; if the new moon is on her back or standing up, and so on. Popular weather lore on this subject is, we all know, plentiful; and in reading a collection of those sayings we are not exactly impressed with their harmony or consistency. The pages of Aratus, of Virgil, of Bacon, witness to the venerable character of this class of "saws." And the

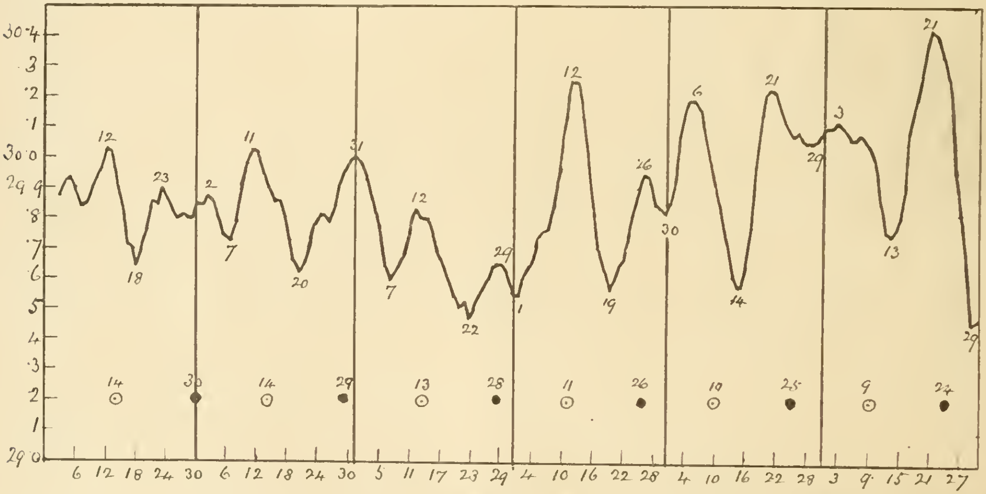
North American Indian of to-day considers the position of the moon's horns with the same practical interest as the Scottish peasant.

Over all this, it would appear, science shakes her head doubtfully. Lunar influence may be probable, but it is not proven. Some would even go further. Let us listen to a few authoritative utterances on this point.

In 1895 I find the head of the United States weather service remarking that "Lunar periods [in weather] . . . have all failed to get a foothold in scientific respect, though much time has been put upon them, and they appear theoretically probable."

Prof. W. Morris Davis, author of one of the best recent books on meteorology, says: "The control of the weather by the moon has long been a favourite idea, but it has not been found to bear the test of accurate comparisons of weather and lunar phases, except in a very faint and imperfect manner."

Once more, Sir Robert Ball, in his "Story of the Heavens," says: "Careful comparison between the state of the weather and phases of the moon has quite discredited the notion that any connection of the kind really exists."



Curve of Daily Barometer, Greenwich, June to November, 1897 (smoothed with Five-Day Averages).

Nevertheless, further study is being given, and will doubtless continue to be given, to this interesting question. Of recent work upon it, may be mentioned that by M. Garrigou-Lagrange, described in a series of papers to the Paris Academy. He attributes to the moon's influence certain periodical oscillations of the pressure and gradients between the Pole and the Equator observed in the meridian of Paris. These are superposed on others which he considers due to the sun; and the effect is different according as the moon is in a northerly or southerly position.

A simple and direct way of seeking light on the subject of lunar influence is to plot a number of curves of daily barometric pressure, and see whether any extensive correspondence with the moon's phases can be made out. Having recently done this with the Greenwich data, I would invite attention to some facts which appear to me to be highly suggestive. We seem to find this state of things: a certain definite relation to the moon's phases (speaking roughly, a barometric wave to each new and each full moon) appears from time to time, and persists, perhaps half a year, or more. Then it may disappear (from some cause or other), to reappear later on.

The half-year closing with November, 1897, is, it so happens, a very good example. In the accompanying diagram the curve is that of the daily barometer at Greenwich from June to November, smoothed with averages of five; that is, each day point of the curve represents the average of five daily values (*e.g.*, that of the 3rd of June, the five days, one to five, and so on).

This curve presents, it will be seen, a series of waves corresponding remarkably with the moon's phases. Are we prepared to affirm that so many coincidences are merely fortuitous?

This correspondence still persists at the date of writing (December 7th), and readers of KNOWLEDGE may be interested to watch further developments. Doubtless, it will be masked or obscured ere long; and it may, of course, be argued that those intervening periods of irregularity (or, in some cases, a different kind of regularity) suffice to overthrow the evidence of casual connection in periods like that here considered.

Going back as far as 1879, curves of the same type as that here given, and of similar extent, will be found in 1883, 1884, 1889, 1893, and 1894. Why the correspondence should come out more clearly at these dates I am unable to say. Perhaps some astronomical cause can be assigned.

It is easy to see how an experience of long and regular recurrences in weather like that of the years indicated may have given rise to a popular conviction that the moon influences weather; and, on the other hand, the fact of irregularity subsisting and alternating with regularity might account for the negative results often arrived at by meteorologists when they have superposed the weather data for a long series of lunations.

The presumption of continuance in the type of weather indicated, which the above facts appear to warrant, in a measure might afford some useful help in forecasting.

SERPENTS AND HOW TO RECOGNIZE THEM.

By Lionel Jervis.

The casual visitor to the Zoological Gardens should have little difficulty as a rule in identifying a snake. The name is written underneath in Greek or Latin, or half in Greek and half in Latin, or in a latinization of local names, as, for instance, in the case of the hamadryad, *Naja bungarus*: *Naja* being, I take it, an adaptation of "nâg," which is the Hindi for cobra, and *bungarus*, I suppose, originates in the *bungarum* of Russell's "Indian Serpents."

For all that, the scientific names are better than the local ones. Take, for example, the *Lachesis lanceolatus*. Perhaps *Bothrops* or *Trigonocephalus* are more familiar titles than the comparatively recent *Lachesis*, but everyone knows what the *Lachesis*, *Bothrops*, or *Trigonocephalus lanceolatus* is; it is, of course, the *fer-de-lance*. Combining the nearly related *Lachesis atrox* (the difference between the species is so slight that even specialists are unable to differentiate offhand), let us see how many local names we can find. First there is the *fer-de-lance*, then follow the rat-tailed pit-viper, the lance-headed viper, the deadly snake ("deadly" is a "very vile" prefix, quite unworthy of the Zoological Society, who, if I am not mistaken, were guilty of it), the jararaca, the yellow viper, the whip snake, the Labarri snake, and I dare say that there are half a dozen other names in Tropical America for this serpent. Nevertheless it is, I think, better to leave the local English name alone than to invent one. Look at the shielded death adder (*Notechis scutatus*), till recently known as the short-death adder (*Hoplocephalus curtus*). The colonists call it, very happily, the tiger or brown-banded snake—a look at the serpent will show you why. But here we have "death adder." Why "death adder"? The death adder of the colonists, the "unqualified" death adder of Regent's Park—the *Acanthopis antarcticus*—is about as unlike a tiger snake as it well can be. The tiger snake has a cylindrical body, tapering into a respectably proportionate tail; the body of the death adder is bloated, and terminates in a short compressed tail with a spike at the end of it. In both the head is distinct from the neck: that of the tiger snake, which resembles a cobra's, very slightly; that of the death adder, which resembles a viper's, very markedly. The prefix "shielded" is good enough, but "short" is not so happy, considering that the *Notechis* is about twice the length of the *Acanthopis*. Again, why "purplish death adder" instead of "black snake"? Why not confine "death adder" to the *Acanthopis* instead of applying it aimlessly to almost every poisonous snake in Australia?

Just one more warning as to the danger of trusting to the accuracy or sense of either the English or scientific title. Everyone has heard of the beautiful and venomous coral snake of Tropical America. It is very brilliantly marked with rings of black and red, with thin whitish edges to the black rings, and from this the Spanish-speaking inhabitants very happily named it the "corràl" or "ringed" snake. Some naturalistic genius gets hold of this, and, forcing the local name into Latin, calls it *Elaps corallinus*, thereby misleading people into the idea that it is a bright red snake, and called *corallinus* from its resemblance to coral.

Nevertheless the descriptive label furnishes the accepted name, such as it is; but labels are very little use when there are two or three different species in one case, as snakes cannot be expected to remain opposite their respective descriptions, any more than monkeys. How, then, are we to identify them? Coloration is not always a sure guide. Look once again at the *Lachesis lanceolatus*. It may be of one uniform colour above—grey, brown, yellow, reddish, or olive, or it may be any of these colours with regular or irregular dark markings, or almost any combination of the foregoing.

In a short article, or even in a small pamphlet, it would be impossible to give a "ready recognizer," even for snakes which are easily distinguished by specialists. I shall therefore content myself with giving an object lesson from the small genus *Ancistrodon*,* of the sub-family *Crotalinæ*, or pit-vipers.

The first distinguishing feature is the pit in the loreal region, between the eyes and the nose. This pit characterises a group of poisonous snakes the bite of which is sure to entail very unpleasant, often fatal, consequences. This group falls into two main divisions—those which have rattles on their tails and those which have not. Of course a snake with a rattle on its tail is a rattlesnake, and when you see a serpent of this kind you are quite safe in saying: "That is a poisonous American serpent"; and if it is described as *Crotalus terrificus*, you may, if you like to take a slight risk, add: "That is the only one of the kind found south of Mexico." But there is a pitfall here, as you are quite likely to find the South American rattler described as "*molossus*" or "*horridus*," and "*terrificus*" has been applied to the water-rattle. Oh for an universal classification!

The pit-vipers which have no rattle, again, fall into two subdivisions: those in which the head is covered with scales, the *Lachesis*, and those in which the head is shielded by nine symmetrical plates, the *Ancistrodon*. So, then, if you find a serpent with a pit between the eyes and the nose (not with two or more pits in the upper lip shields), with the head covered with nine shield-like plates, and with no rattle on its tail, you have an *Ancistrodon*.

Of course the most satisfactory state in which to examine a poisonous snake is when it is dead and pickled. If alive, the best thing to do is to secure its neck in a snake-loop. Failing this, you must content yourself with looking at it through glass or wire or from a safe distance. The first part of the following descriptions will, therefore, apply when the snake can be examined minutely; the second when it can be seen only under comparative difficulties. In some cases the colour pattern, together with the data already given as to the pit, etc., will be sufficient to identify the serpent.

First I select the only species of the subdivision in which the second upper labial forms part of the border of the loreal pit and the sub-caudal shields are in pairs.

A. hypnale.†—By these features you cannot fail to recognize the snake on close examination; otherwise it is not so easy to identify. It is only a little bit of a snake, with a turned-up nose. The colour is generally dark—usually greyish or brown—with or without spots, and the markings on the head are ill-defined. The internasals and præfrontals, it is true, are broken up into scales, but you usually require a magnifying glass to make this out. The local name on the west coast of India and in Ceylon, where it is found, is the "carawila." As far as I know, there is but little danger attending the bite.

A. piscivorus.‡—The first of four species in which the second upper labial forms part of the border of the pit, and some of the sub-caudals are single, some in pairs.

Remarkable for being the only one of the *Ancistrodon* in which the loreal is absent. The sub-caudals are sometimes

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* Greek: "fish-hook toothed." † Greek: "sending to sleep."

‡ Latin: "fish-eating."

all single; the third upper labial is very large, and usually enters the eye.

You are at once struck by the bluntness of the muzzle and the closeness of the eye to the nose, which gives it a very vicious appearance. The colour is generally sombre—usually a dark slaty brown—with darker cross markings. It is said to be of a quarrelsome disposition (some former naturalists qualified it as *pugnax*), and it will certainly fight with anything that is put into the same case, be it rat, snake, or stick. For all that, I have heard that it is easily tamed, and becomes, for a snake, quite affectionate. It attains a length of about four feet, and is very heavy and bulky for its size. It is plentiful in the south-eastern United States, where, under the names of "cottonmouth," "water mocassin," and "water viper," it enjoys a very bad reputation, which was confirmed in my mind by a sad story I heard the other day from a trustworthy source. A certain good sportsman, while fishing in Florida, had made his camp near the water; and finding, after supper, that he had left something in the boat, he desired his servant to go and fetch it. The servant, who was native to the country, hesitated, saying that he heard a mocassin out fishing; but his master, after listening for some time and hearing nothing, pooh-pooh'd the idea. The poor fellow reluctantly obeyed, and on his way to the boat was struck, and died in a few hours. I gathered from my informant that these serpents are quick to resent any trespass on their riparian rights, especially at night.

Second, *A. bilineatus*.[*]—Easily to be identified by the markings on the head. Round the canthus (the sharp upper edge of the snout) is a fine yellow line, which usually broadens out as it passes behind the eye to its termination on the neck: immediately above the mouth, but not actually touching it, a broader yellow line, finely edged with black, runs along the upper lip from the nostril to the corner of the mouth; there is a similar vertical line on the rostral and symphysial shield, which, being interpreted, means that a yellow black-edged line runs from the tip of the snout to the chin.

Very little is known of this handsome snake owing to the detestable climate of its home in Central America. There is no big game there to attract sportsmen, to whom our collections are so much indebted; and he is a bold naturalist who, in search of rare plants, insects, or reptiles, ventures into that fever-striken wilderness.

Third, *A. contortrix*.[†]—Easily to be recognized on sight by its coloration. The ground colour is a bright burnished light copper, with darker cross bands of a rich reddish brown, which are broad at the base and contract as they approach the dorsal ridge, thus giving the light interspaces the appearance of being broad on the back and narrowing on the sides; the head is generally lighter than the ground colour.

This snake, the copperhead, is probably the most dreaded creature in North America, as well as being one of the handsomest serpents known—that is, in my opinion; the general effect being more pleasing than the varied hues of other more brilliant snakes. It has been classified as *A. mokasen*, and as a good deal of error is connected with the name "mocassin,"[‡] I will take this opportunity to endeavour to clear it up. There is the true mocassin, *Tropidonotus fasciatus*, a harmless snake of sombre colour; the water mocassin already described; and the upland mocassin or copperhead, which is smaller and more lightly built than its congener: the two last are often called the "mocassin" simply.

The only accident from a copperhead bite which I ever heard from an eye-witness, terminated fatally in a few hours, putrefaction setting in almost immediately after death.

Fourth, *A. acutus*.[*]—The sharp point which projects horizontally from the tip of the snout makes it impossible for anyone to mistake this pit-viper. The upper part of the head is very dark brown—the lower, yellow—the two colours being sharply divided by a black line which runs through the eye; the general hue of the body is a dark or light brown, with very dark diagonal cross bars which intersect each other on the dorsal ridge.

Very little is known about this serpent. There are, I believe, only a few specimens in this country, and for these we are indebted to the indefatigable Mr. Pratt, who obtained them in China. Those that I have seen show it to be a heavy, bulky snake; and as the biggest of these specimens is about five feet long, and about as thick as my arm, I imagine it to be considerably the largest of the group. I have been able to ascertain nothing at all about the virulence of the poison; but, I should think, from the length of the fangs and the size of the poison channel, that a bite would be very dangerous.

Finally, there are three species in which the upper labials are separated from the loreal pit, and the subcaudals are in pairs.

First, *A. halys*[†] (with which I combine for the purposes of this article the *A. blomhoffi* and the *A. intermedius*).—The snout is blunt and turned up; running from the eye along the temple is a dark band with lighter edges, which is a little broader than the eye; on the snout is a dark spot, on the top of the head are two more, and on the back of the head are two slanting streaks. Really about the best way of recognizing this variety that I can suggest, is a negative one. If it has not the characteristic marks of one of the other species, then it is a *halys*. It is a small, pale, dirty-looking viper, usually grey or brown, with no very distinctive features. It is found from the coast of China to the Caspian Sea, and is the only European pit-viper.

Second, *A. Himalayanus*.[‡]—Somewhat resembles the *halys*, but is much darker in colour. On close examination it can easily be distinguished by the size of the last two upper labials, which are very large and are merged into the lower temporals. I have always found a very thin black line, with a fine white edge, running from the eye to the corner of the mouth, surmounted by a band of a darker shade than the ground colour.

I have not been able to get much information about this snake, but it is probably not very dangerous. It is found at even greater heights than its near relation, the *Lachesis monticola*,[§] specimens having been seen at an elevation of ten thousand feet.

Third, *A. rhodostoma*.[‖]—A light band runs from the eye to the corner of the mouth, below which is a broader dark streak with a black edging. This black edging skirts the upper border of the posterior upper labials in small curves or festoons; the colour of the lips, from which the name is derived, is pink or yellowish. The head, viewed from the side, somewhat resembles that of the *bilineatus*; but a closer inspection will show that the resemblance is only apparent, and an examination of the snout will clear up all doubts, as the *rhodostoma* has

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[*] Latin: "two-lined."

[†] Latin: "twisting."

[‡] Mocassin is pronounced "Mokkesin."

[*] Latin: "sharp."

[†] A title formerly of a group of East Indian pit-vipers.

[‡] Himalayan, latinized.

[§] Latin: "living in the mountains."

[‖] Greek: "rosy-mouthed."

no vertical line on the rostral shield. The ground colour is soft red, brown, or grey, with dark, angular, black-edged spots, very elegantly arranged.

In brilliancy and harmony of colour it is, perhaps, the most beautiful of the *Ancistrodon*, though I prefer the more sober copperhead; and it is probably the most venomous. An acquaintance of mine brought a very bad account of the *rhodostoma* from Java, to which island it appears to be confined; and Dr. Gunther relates that Kuhl saw a man succumb to the bite in a very few minutes, but I can find no record of any experiments with the venom. In this respect the *bilineatus*, which also lives under the line, may be a possible rival; but, as I have said, I can get no information—that is, reliable information—on the point. The peculiar virulence of the venom of the *rhodostoma*, which is not by any means a large snake, is rather remarkable, as the majority of the East Indian pit-vipers do not appear to be very dangerous.

I have only suggested the lines for a rough-and-ready "recognizer," which might be applied to any family of serpents. At the same time I can assure those who are interested in ophidians that a more minute study of this or any other genus, will well reward the student; and that during its pursuit they will naturally and easily become acquainted with those more striking features which I have endeavoured to illustrate.

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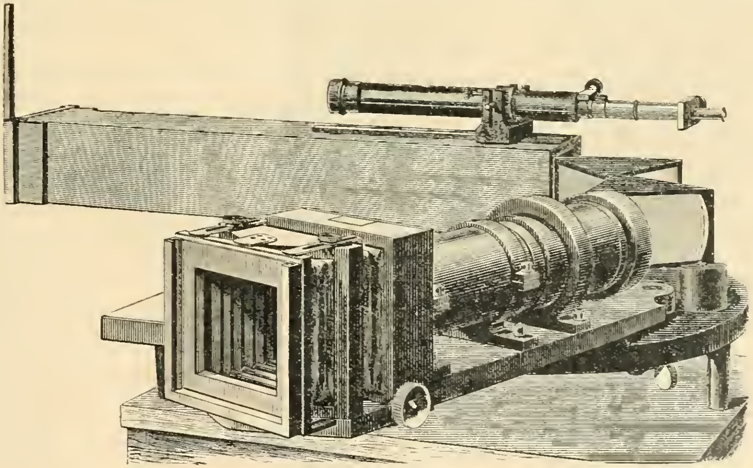
THE PRISMATIC CAMERA DURING TOTAL ECLIPSES.

By Wm. Shackleton, f.r.a.s.

Now that the last eclipse of the century is close upon us, and at nearly every observing station a prismatic camera is to be employed, it may be interesting to give a brief account of some of the results which the revival of its use during total eclipses has elicited for us. Just in the same way that Fraunhofer's method of observing stellar spectra has been applied to photographing the spectra of stars with amazing results, so the same method of placing a prism in front of the telescope and observing the sun when totally eclipsed has, with the aid of photography, given equally important information.

The prismatic camera as used during eclipses is simply an ordinary camera (with a lens of from two inches aperture and upwards) in front of which is placed one or more prisms, so that, instead of photographing the sun directly, the light has first to pass through the prism, which differentiates the composite light of corona, prominences, and chromosphere into the many monochromatic images of which it is composed; and if sufficient dispersion be used these are so separated as not to interfere with each other, but are perfectly distinct.



Prismatic Camera, used in Brazil.

The advantages of using this slitless spectroscope over one with a slit during a total eclipse is self-evident, for by it all the phenomena round the dark moon can be analyzed at once with a maximum aperture, whilst in the case of an ordinary spectroscope only the small portion which the slit crosses can be brought under observation.

That this is a desideratum one may see when it is remembered that it is only possible by intermittent glances to observe the eclipsed sun for about two hours in a lifetime. Fortunately, however, the chromosphere and prominences, which were enigmas for nearly two centuries, have, since the discovery of Lockyer and Janssen in 1868, been possible to observe and photograph without an eclipse.

When we come to the corona the story is a sadder one, for it must have been observed from the time of primeval man; indeed, we have hieroglyphical records of it by the ancient Egyptians and Babylonians, and yet we know least of all about this the greater bulk of the sun. Hence the prismatic camera, for giving us a large survey of its chemical constitution, is again the most advantageous instrument to employ.

Not only for quantity, however, but for quality also, is it paramount. When photographs are taken with a slit spectroscope it is really the slit that is being photographed, and any light, no matter how it reaches there, is what is being investigated. Generally an image of the particular part that is required to be studied is focussed on the slit by a condensing lens, and this gives the principal effect; but besides this there is a general illumination from all the other parts, for the light from these is scattered and reflected by minute dust particles in our atmosphere, so that in addition we have the integrated light from these superposed on what we wish to investigate, and, of course, the brightest of these extraneous sources gives the greatest additional effect.

In the case of the prismatic camera, however, it is only the real images of the eclipsed sun that are focussed on the photographic plate, and the general illumination of the atmosphere, although equally passing into the camera, has no definite outline, and therefore no image can be formed; so it is more scattered still by the prism, and only goes to give a slight general fogging of the plate. Evidently, therefore, if we wish to truly sift out the light of the corona from that of the prominences the latter instrument must be employed.

Although the prismatic camera has been used during eclipses at various times since 1875, it was not until 1893 that sufficient dispersion and accurate focus were secured in order to make use of the differentiation referred to above, or it might be that the plates were not sensitive enough to record the exceedingly delicate monochromatic rings from the lower parts of the corona, which is the only part left sufficiently bright after the great deduction that must be made for the light giving only a continuous spectrum. During the total eclipse of 1893 photographs were taken in West Africa by Mr. A. Fowler, and in Brazil by myself, which showed that the coronal light gave rise to no H or K radiations of calcium—that the prominences on the sun at that time had no 1474 K light; and although this line, sometimes seen in eruptive prominences, might be accounted for by supposing that it really is the base of the corona which is being observed, or that coronal matter has got entangled with the great disturbances taking place, still in one such prominence during that eclipse no trace of it could be found. Again, in the eclipse of 1896, more than three years later, the photographs show the same thing; so we await with interest the results of the coming eclipse, to see if in passing from a maximum to a minimum sunspot period any change takes place in the constitution of the corona.

If a comparison be made of the K (calcium) and 1474 K rings with a picture of the eclipsed sun, it is clearly seen that 1474 K is truly coronal, and that H and K, which are identical with each other, are solely due to the prominences.

Had these facts been sufficiently well established in 1893, M. Deslandres might not have tried in vain to determine the rotation of the corona by photographing the relative displacement of the H and K lines on opposite limbs of the sun. In the last number of Knowledge it was stated that Mr. Newall is going to try to make the same observation, using a "bright line near G, of whose coronal nature there can be no doubt." Let us hope he has consulted the records of the prismatic camera before doing this, for although one such line was tabulated at λ 4232·8 by Schuster in 1886 as being the brightest in the photographical region, the results of 1893 and 1896 show that a bright line near H, λ 3987, is more intense than this, and in fact is the next strongest line to the coronal line (1474 K) itself. This will be seen on examining the photograph taken near mid-totality, and reproduced here in the plate by the kind permission of the Royal Society.

So far we have examined the capabilities of the prismatic camera for giving us information about the parts of the sun comparatively well removed from the photosphere; let us now turn our attention to see what can be done with it for the investigation of those vapours which lie closer in, in order to test Kirchoff's theory "that the absorption which produces the dark Fraunhofer lines takes place in a thin stratum, or *reversing layer*, as it has often been called, adjacent to the photosphere."

In a total eclipse of the sun, at the moment the advancing moon just covers the sun's disc, the solar atmosphere of course projects above the dark edge, and at that moment the reversing layer will be isolated for only a very few seconds. If, now, at this precise instant, a photograph be taken with the prismatic camera, we shall have the spectrum of this shallow layer, chromosphere and corona; but from the form of the arcs and their appearance or non-appearance in later photographs, we shall be able to separate the integrated effect into its individual parts. From the very nature of this layer and the inequalities in the moon's position, the difficulties in the way of making the exceedingly fine adjustment of placing a *slit* upon this *point* of disappearance are almost insurmountable; in fact, so great are they that it was not until the application of the prismatic camera, which requires no such nicety of adjustment, that there was any permanent record of this low-lying stratum.

Except at an eclipse it has not yet been found possible to observe this bright line spectrum, because it is overpowered by the aërial illumination of our own atmosphere so spectroscopists are the more anxious to make the most of every eclipse to settle at least this one point. With this end in view many prismatic cameras have been directed to the eclipsed sun, but it was not until 1893 that anything like the base of the sun's atmosphere was photographed.

The difficulties of placing a slit on a point have been mentioned previously, but not only is there that to contend with, but also, no matter what instrument be used, the exposure must be made at the precise moment the sun's disc is covered. To do this, Sir Norman Lockyer, during the eclipse of 1896 in Norway, instituted a "running plate," which took a series of snapshots just before and going on till the critical moment had passed—in fact, a sort of kinematograph arrangement. Unfortunately, however, the weather was unfavourable to let us see what results this method would give. Mr. Evershed, also, in clouded-out Norway, and myself, in Novaya Zemlya, relied more on the exact determination of the proper instant, and then making a short exposure. What such a photograph is like, and how far it agrees with a reversed solar spectrum, can be gathered from the plate, which is a reproduction of the Novaya Zemlya photograph. Of course any comparison must be made with a spectrum obtained by a similar instrument, for it would obviously be fallacious to compare a spectrum taken with only a moderate-sized spectroscope, making clear to us only a few hundreds of lines, with such a spectrum as that taken with a Rowland grating, which reveals *in the same sunlight* as many tens of thousands of lines. Therefore, the only way of absolutely proving that every fine dark line is reversed would be to photograph this layer with a Rowland grating, which, with our present appliances and the short duration of visibility, is nearly impossible; but this is to be tried by Prof. Michie Smith during the forthcoming eclipse. Still, notwithstanding these difficulties, the investigation of the lines in the photograph is proceeding at the Solar Physics Observatory, South Kensington; but, probably, before it is finished we shall have many such photographs, with more powerful instruments, from India, where the sun will be bombarded, not by one only, but by at least half a dozen prismatic cameras.

With such possibilities in an eclipse, no wonder during such times that the sun monopolises the attention of astronomers, not only for the secrets he has to divulge of himself, but also for the key he may possibly give to cipher the constitution of other countless suns more remote.

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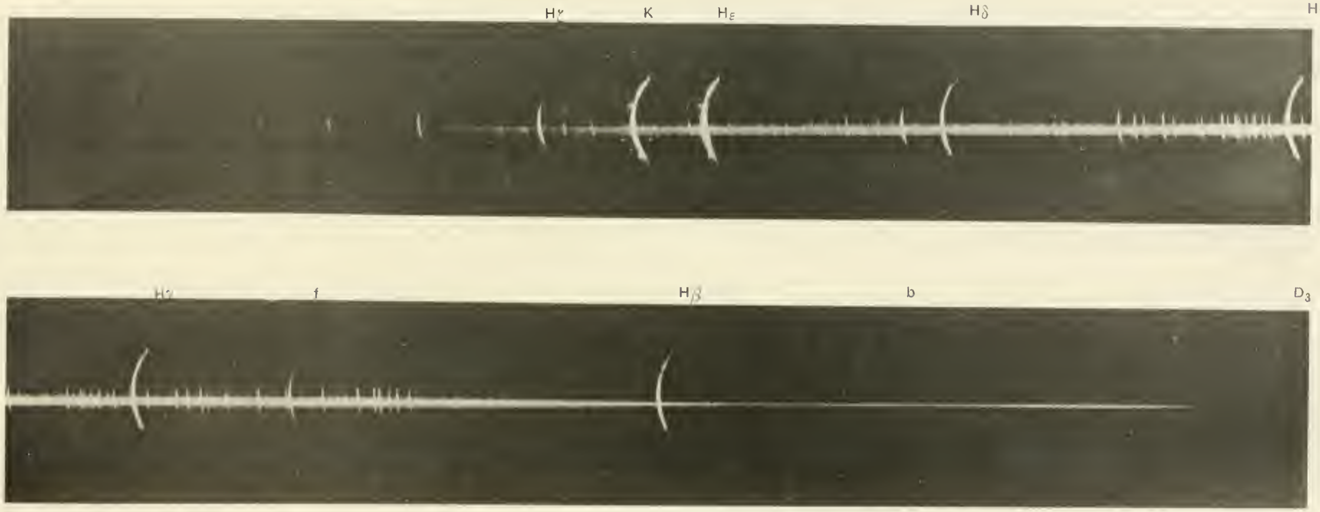
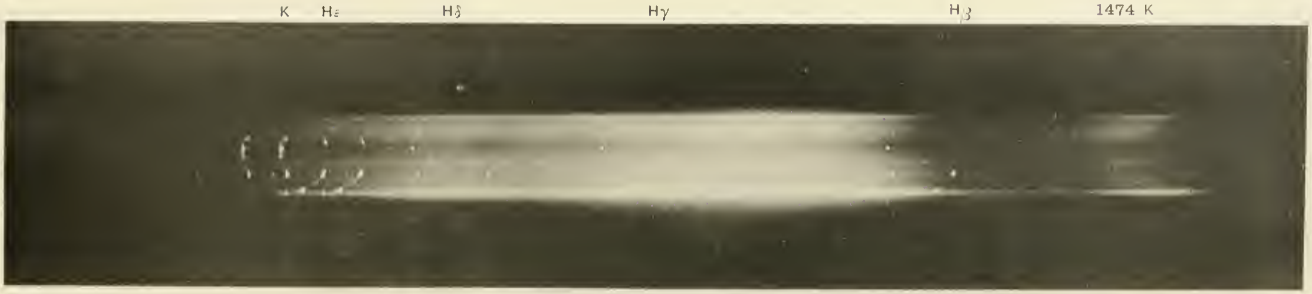
NOTES ON COMETS AND METEORS.

By W. F. Denning, f.r.a.s.

Comets.—1897 has afforded only one new comet—that discovered by Perrine on October 16th. When first seen, the comet was placed in the south-east region of Camelopardus and moving north-west; it has since traversed Cassiopeia, Cepheus, and Draco. Early in January,



Photograph of the "Reversing Layer," in Two Portions.



Photograph near Mid-Totality, showing Coronal Ring in 1474 Light.

Reproduced by permission of the Royal Society.

1898, the comet will be almost stationary at a point six degrees south by east of γ Draconis, its apparent displacement being only ten minutes of arc per day. Its brightness will be 0·4, as compared with that (adopted as 1·0) at discovery. The elements show its inclination to be sixty-nine degrees, whence we may infer that its orbit does not deviate much from a parabola. The physical aspect of the comet has been interesting, for it presented a nucleus, coma, and tail. On October 25th, as observed by Mr. F. W. Longbottom, at Chester, with an eighteen and a half inch Calver, the total length of the tail was twenty minutes of arc, and the comet was estimated not quite equivalent in brightness to a ninth magnitude star. The tail was tapering, not fan-like, and stars showed brightly through it on October 30th.

Several periodical comets were due in 1897, but only one of these was observed, viz., D'Arrest's, which was picked up by Perrine on June 28th, more than a month after its perihelion passage. Spitaler's comet of 1890, and Tempel-Swift's comet of 1869-80, also returned to perihelion in the spring, but the conditions were too unfavourable for them to be observed.

In 1898 five periodical comets are due. Pons-Winnecke's arrives at perihelion in March, Encke's in May, Swift's (1889, VI.) and Wolf's in June, and Tempel's (1867, II.) in September. The circumstances attending the return of these several objects are by no means good, and in most cases they are likely to escape observation unless some of the large telescopes at present in use are employed in searching for them.

Mr. C. Hildebrand gives the following ephemeris of Pons-Winnecke's comet :—

1898.		R.A. H. M. S.	Dec.
January	2	15 18 24	− 3° 55·3′
,,	6	15 32 53	− 4° 52·3′
,,	10	15 47 58	− 5° 49·3′
,,	14	16 3 40	− 6° 46·1′
,,	18	16 20 0	− 7° 42·1′
,,	22	16 36 59	− 8° 37·0′
,,	26	16 54 36	− 9° 30·3′
,,	30	17 12 49	−10° 21·3′

The diurnal motion is therefore about one degree eastwards, and during the month it carries the comet through Libra and Opiuchus.

It is remarkable how the stream of cometary discovery runs continuously on. No sooner do one or two successful sweepers leave the field than others step in and pursue the work. Messier, Mechain, and Caroline Herschel, in the latter part of the last century, were succeeded by Pons early in this. He in turn was followed by Tempel, Winnecke, Borrelly, Coggia, and Swift. Then Barnard and Brooks almost monopolized the field for twelve years. To-day Perrine may be regarded as the comet finder *par excellence*, for he has worthily emulated Barnard's former discoveries at the Lick Observatory, and has found five new comets within the last three years.

Meteors.—The November Leonids of 1897 very generally disappointed expectation. Cloudy weather and moonlight were certainly responsible in a great measure for this, and, moreover, there is no doubt that an exaggerated idea as to the probable intensity of the display was encouraged by the majority of those who looked for it. On the basis of reports supplied by eye-witnesses of the phenomena of 1831 and 1864, it was predicted that the shower might equal a rich return of the August Perseids, furnishing, perhaps, one hundred meteors per hour for an observer. The time of maximum was mentioned as uncertain, but as sure to be included in the mornings of November 14th and 15th. As events happened the first of these periods was partly clear, while the next morning was cloudy nearly everywhere. Meteors were comparatively rare during the whole night of the 13th, and clouds hid those visible during the following night. In France and America, as well as in England, the experience appears to have been very similar. At a few places, where the sky was clear on the morning of November 15th, the Leonids were both numerous and brilliant. At Dumfries, two observers (ignorant of the expected display) were struck at the extraordinary prevalence of shooting stars, and estimated the visible number as ten per minute. Another observer, at Loughborough, saw a considerable number of meteors, including five of great brilliancy, and the time of their maximum frequency seems to have been at about 5 A.M. A third observer at Dumfries had his attention arrested by the surprising frequency of meteors, and states that more than five per minute were perceptible. At Derby meteors were so abundant as to cause special remark. Eighteen fine ones were noticed between 3h. 30m. and 5h. A.M., and these included two nearly as bright as the full moon. Prof. Lewis Swift also reports from Echo Mountain, California, that "the Leonids made their appearance on the morning of November 15th, ninety-seven having been counted by one person." From these and other corroborative accounts it is certain the shower was quite as abundant as expected, and, at places were the sky was clear, sufficiently striking to attract particular attention notwithstanding the moonlight. The idea that the display failed to present itself is due to a misapprehension. On the preceding night the experience of observers seems to have been practically unanimous in describing the meteors as scarcely more numerous than on an ordinary November night.

Prof. E. C. Pickering, of Harvard, states that the observers at the observatory at Cambridge, Mass., counted only ninety meteors during the night of the 13th, but that these were nearly all Leonids. Prof. O. Stone, of Richmond, Va., says that on November 13th several meteors were seen from the direction of Leo ; one of them was several times brighter than Venus, and travelled along an arc of ninety degrees, leaving a streak forty degrees in length. The following night was cloudy, and nothing could be seen. Prof. Barnard, at the Yerkes Observatory, saw nothing on November 13th and 14th, as clouds and rain prevailed each night. In England a few meteors were seen on November 13th, but they call for no special remark. Dr. W. J. S. Lockyer, of South Kensington, recorded a number of paths, and others were registered by Mr. Salmon, of South Croydon, and Mr. Besley at Westminster. These materials show that, though the Leonids returned on the night of November 13th, the shower was very feebly represented. These and many other observers were baulked by clouds in their efforts to secure observations on the night of November 14th. At Bristol the sky was overcast throughout, though at 5 A.M. on the 15th the clouds became thinner, and the moon shone faintly through them, but no meteors could have been observed unless they were of great brilliancy.

Observers of meteors will be interested in watching for the January shower from Quadrans, usually visible on the 2nd of that month. The moon will, however, partly interfere in the evening, and the best time to observe the display will be between 3 and 6 A.M. on January 2nd. The radiant is at 230°+52°, and the shower is often a conspicuous one, furnishing rather swift, long-pathed meteors.

RICHARD PROCTOR'S THEORY OF THE UNIVERSE.

By C. Easton.

Richard Proctor, the founder of this magazine, amongst the other services that he has rendered to science, deserves the credit of being the first to offer a solution of the problem of the structure of the heavens by studying it from a general point of view, whilst at the same time basing his theory on direct observation. Huyghens, Thomas Wright, Kant, Lambert, and others, had already touched on this great problem, but they had to content themselves with reasonings; they misused the arguments *per analogium*, having very few facts to go upon. The two Herschels collected an enormous quantity of facts and precise data relating to the problem, but they were reluctant to draw from them any definite conclusions. Sir William Herschel himself abandoned a considerable number of his early ideas on the structure of the heavens, although he did not declare in a definite manner what changes must be made in it. As for his son, he demonstrated the untenability of the *cloven disc theory*, and of the fundamental suppositions made by his illustrious father, especially in the face of the evidence drawn by Sir John himself from his telescopic observations of the Milky Way. Contrary to what has been often said, Sir John Herschel has stated expressly and exclusively—at least in his books—the theory generally[*] attributed to him of the galactic ring, although he seems to have found in this theory the fewest obstacles to the explanation of the phenomenon.

From the beginning, Proctor insisted, when discussing the conceptions of Sir John Herschel, that neither the cloven disc theory nor the theory of a galactic ring could adequately explain the observed facts. In the case of the second theory, Proctor only indicates its insufficiency in a general manner. Even the principal features of the Galaxy, he says, offer too great difficulties for the annular theory, and he boldly sketches a more complicated figure, which, he says, replaces with advantage Sir John Herschel's theory explaining the principal details of the Milky Way.

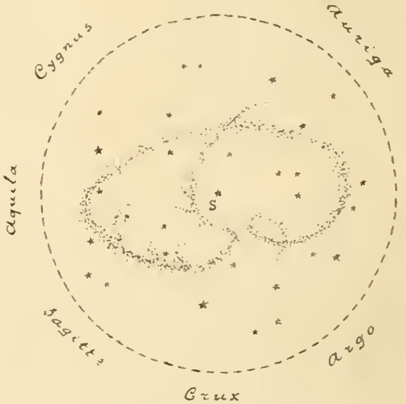
Whilst recognizing that the extreme complexity of the details in the Milky Way may never perhaps allow of a complete solution, Proctor was convinced that "the bolder and more striking features of that circle may be studied with a better hope of their being successfully interpreted."

He has been reproached with too much audacity, and, indeed, one hesitates to subscribe with Proctor to "the spiral curve, which [as] depicted seems so satisfactorily to account for several of the more striking features of the Milky Way as to suggest the idea that it corresponds somewhat closely to the real figure of that star-stream." But it seems to me that the advantages of his researches are much superior to the disadvantages. Those who approach with hesitation and prudence by far other ways will not be led astray by the errors of Proctor's method; and, on the other hand, pioneers of science such as he exercise a great moral influence—their digressions, though sometimes overbold, refresh and stimulate the zeal of others.

This gigantic arch of the Milky Way, spreading out before all eyes the sublime enigma of its starry ramifications, seems to defy the indefatigable seekers bending over their calculations. Let others strive to draw some evidence of the aspect of the Milky Way from its chief outlines.

However, Proctor would doubtless himself recognize to-day that his theory does not now correspond with the actual state of science; and it is strange that in treatises of astronomy his well-known drawing is reproduced as if the theory could still be accepted, although more than one judicious remark of Proctor's preserves his reputation. At the period when he formulated his theory, Proctor had not at his disposal, in short, any but the results obtained by the two Herschels and by F. G. W. Struve; and, besides, the work of the latter was soon reduced by Encke to its just proportions—that is to say, to a negative result, or one nearly so. Almost all the modern work in this branch of astronomy has been done since Proctor's time—that of Heis, Houzeau, Gould, Celoria, Kapteyn, Ristenpart, Plassmann, etc.; and in particular, though basing his researches on the constitution of the Milky Way, he could not consult either the admirable photographs of Barnard, Wolf, Roberts, Russell, nor the modern drawings of it—that is to say, that he possessed scarcely any facts about the whole northern half of the zone.[*]

Also, the explanation furnished for the figure imagined by Proctor could not be considered as satisfactory to-day, even for the main lines of the Galaxy. Many of his observations, however, are still valuable. When he says that where the line of sight is directed tangentially to either loop, the Milky Way may be expected to have greater width than elsewhere, he furnishes the best explanation of the curious fan-shaped expansions of the Milky Way on each side of the no less remarkable gap in Argo. His explanation of the Coal Sack in Crux—"the apparent inter-



The Milky Way according to Proctor.

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[*] " . . . . the Galaxy, which . . . . would come to be regarded as a flat ring, *or some other re-entering form* of immense and irregular breadth and thickness . . . ." (Sir John Herschel, "Outlines," § 788.) He prefers to represent the Milky Way as of an annular form, but he takes care not to pronounce definitely on this. " . . . an impression amounting almost to conviction that the Milky Way is not a mere stratum, but annular; *or at least* that our system is placed within one of the poorer or almost vacant parts of its general mass . . ." (Mary Somerville, "The Connexion of the Physical Sciences," 1846, p. 419.)

In speaking of the lateral offsets which quit the main stream of the Milky Way, and which he regards as the "convexities of curved surfaces viewed tangentially, or planes seen edgeways" ("Outlines," § 792), he evidently does not trouble to bring them into accord with the theory of a galactic ring.

[*] Sir John Herschel, although he described with much particularity the southern half of the Milky Way, treated rather lightly the northern parts. Thus he says in his "Cape Observations," p. 386, speaking of the region in the Eagle, which is nevertheless curious: "After which [λ Aquilæ] this main stream runs northward through Aquila without any further distinguishing feature. . . ."

crossing of the two contorted streams which really are at different distances from the eye"—is possible but not very probable, I think, after the evidence furnished lately by Gould and Russell. I do not think it was necessary in this case to turn aside from Sir John Herschel's opinion that the Milky Way in the neighbourhood of the Coal Sack is just "a distant mass of comparatively moderate thickness, simply perforated from side to side," or as an oval vacuity which is seen "foreshortened in a distant foreshortened area." ("Outlines," § 792.)

There is doubtless much truth in Proctor's supposition of the branches which are detached from the main stream of the Milky Way, and which penetrate into the neighbourhood of the sun, and of the less important ramifications which spring up at different points of the galactic course. But as regards the general reasoning followed by Proctor in comparing his figure with the aspect of the Milky Way, he is fundamentally in error; and this is an interesting point, since Sir John Herschel had already made a similar mistake. Herschel says that the brilliant and well-defined part of the Milky Way about Argo and Crux "conveys strongly the impression of a greater proximity"; and he deduces from this that the sun occupies an excentric position in the interior of the Milky Way, which is nearer to the southern than to the northern part of its circuit. Taking up this argument and amplifying it, Proctor admits that the stream grows gradually fainter with increase of distance towards Canis Minor and Monoceros; and in speaking of the brilliant portions of the Galaxy in Aquila and Sagittarius he is satisfied that "this part, which is so very bright, corresponds to the part which my spiral brings *so very near* to the sun."

But we should see precisely the opposite in this case. Sir John Herschel and Proctor have been too much taken up with the idea of a stream, of a "distant mass," which they represent as continuous, like a band of cloth, whose details are perceived with more clearness the nearer they are. But the phenomenon of the Galaxy is of quite a different nature. As long as the brightness of each individual star is of great importance, and their mutual distances which we see projected are insignificant, the reasoning of Sir John Herschel and of Proctor holds good. But it is, above all, the closeness, in projection, of the small stars in the Milky Way which produces the optical phenomenon of a galactic gleam. The individual brilliancy matters little. This can be easily demonstrated. From the gauges of Sir William Herschel and from the star-counts of G. Celoria, it follows that the number of stars sufficiently brilliant (seventh to eleventh magnitude) which take part in the formation of the lacteal light, is much more considerable in the region of Monoceros than of Aquila, and in spite of the fact that the Milky Way is, without gainsay, much more luminous in the latter portion of the sky than in the former. Then, the abundance of stars in certain lacteal regions (Scutum, Cygnus, etc.) is so great that the relatively bright stars form but an insignificant part of it distributed here and there among the multitudes of small stars. But, whatever may be the number of stars necessary for this, the stars are sufficiently near each other in perspective for their collective light to produce a strong enough impression on the extremity of our optic nerve and give us the impression of the lacteal gleam—an impression that could not be produced by stars each much more brilliant than the others united, but their projections too distant for their images to fall on the same nerve bundle in the retina.

The same thing is seen when a celestial object is resolved into stars which had until then appeared nebulous. Thus the parts of the Milky Way which are nearest to us would appear by the same rule vague, large, and rich in stars relatively bright, whilst the distant portions of the zone would appear more crowded and better defined—more luminous in themselves, though numbering fewer brilliant stars. One could easily represent this appearance by imagining oneself within a huge circle of trees, nearer to one part of the circumference than to the rest. In the near part the trees do not form a continuous band, whilst they are confounded in one straight dark line in the further portions of the circle.

The Milky Way according to Celoria.

I have written at some length on this point because it undermines the reasoning of Proctor in more than one particular, and also demonstrates that one remark of Sir John Herschel, often quoted, rests on an erroneous argument, and that to my knowledge these points have been raised before.

After what I have just said it would be superfluous to criticise in detail the "spiral" of Proctor. For the rest, even if they furnished a perfect explanation of all the principal features which Proctor finds in the Milky Way, they could no longer serve, now that the principal features of the galactic zone in the two hemispheres—thanks to the drawings and to the photographs,* and in despite even of the differences that may be perceived there—appear to us under quite a different form. Must we, then, return to the theory of a cloven disc or to that of a galactic ring? Certainly not. Proctor has, without doubt, been right in giving up these premisses: that the theory of a stellar stratum in form could not be defended in these days, and that the phenomenon of the Galaxy is due to a distribution of the stars of a much more complicated character than could be produced by a ring, however irregular.

Without entering into details which would take too much space here, I hope to give a summary of what has led up to the result that the most modern researches (after Proctor) have established with sufficient certainty.

The visible universe, stars and nebulæ (with the exception of nebulæ properly so called), is extended in a flat layer irregularly condensed. The stars differ extremely, not only as regards their volume, but also as regards the

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* Drawings of Heis, Houzeau, Davis and Thome (Gould), Boeddicker, Easton, and others; photographs of Barnard, Wolf, and Russell. The readers of Knowledge have often had prints of these admirable photographs of the Milky Way.

intrinsic brightness of their surface. The mode of distribution of the stars is not the same in different regions of the stellar layer, but the distribution of the great stars is not independent of that of the small ones. The stars of the spectral type—named "solar type"—are condensed about a point which, in comparison with the extent of the whole system, is not very far removed from the sun.[*]

Proctor looked upon the Milky Way as "the condensed part of a spiral of *small* stars" amidst the sidereal system. This theory is incompatible with the results recently obtained, in particular with those of Kapteyn and of my own concerning the distribution of stars of differing magnitudes in some parts of the Milky Way (*see* Knowledge, August, 1895). In the galactic belt the large and small stars are most certainly intermingled.

But modern researches have not yet touched upon a new theory of the Milky Way—a theory which can at least explain, as Proctor wished to do, the bolder and more striking features of the Milky Way. Giovanni Celoria alone, at the Observatory of Brera in Milan, has ventured as far as could be at his time (1878). From his painstaking and most interesting researches[†] he did not evolve a complete theory, but the comparison of his star-counts with the gauges of William Herschel and the "Bonn Durchmusterung" led Celoria to conclude that the "Milky Way is composed of two branches, two distinct rings, of uninterrupted circumference. One of these rings is represented by the continuous feature of the Milky Way, crossing the sky in Monoceros, Auriga, Sagitta, and Aquila; the other begins in the brilliant stars of Orion, passes through the Hyades, the Pleiades, Perseus, Cygnus, and ends in Ophiuchus. The two rings cross each other, and are perhaps confounded in one system in the constellation of Cassiopeia; and separating, one part passing through Cygnus and the other through Perseus, they make an angle of abont nineteen degrees."

I do not need to say that the second ring of Celoria, crossing Orion and Ophiuchus, is identical with the belt of bright stars of Sir John Herschel and of Gould; but, in the course of his research, Celoria found that there existed in this region a veritable galactic branch, with many stars relatively brilliant although telescopic, and few stars of the inferior order of brightness—at least in the sections studied by the Italian astronomer.

Although there is doubtless much truth in the conclusions drawn from this great work, it is impossible, in the actual state of our knowledge of the composition of the Milky Way, to accept the "due anelli distinti, nè mai interrotti nel loro corso" of Celoria. Even if the two rings are tenable, it must be recognized that there are lacunæ, interruptions, and, in a word, manifest complications.

If one would rest on the solid ground of fact, one cannot go beyond this conclusion—at least as regards the great problem of the structure of the heavens: great irregularities of detail, traces of at least partial regularity in the principal features. But I hope in another paper to venture a little further in this tempting region, without, however, quitting a firm hold of observed facts.

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

A New British Gull.—The Mediterranean Herring Gull (*Larus cachinnans*).—The past autumn has been exceedingly unproductive of the rare migrants which usually visit the east coast; it is therefore especially gratifying to be able to rescue from oblivion a rare bird which has been unrecorded since the month of November, 1886. Mr. Cole, the well-known bird preserver, of Norwich, recently called my attention to a Gull which was shot on Breydon Water, near Yarmouth, on the above date, by the noted gunner John Thomas, and sent to him. The late Mr. Henry Stevenson examined it in the flesh and stated his opinion that it was an example of the Mediterranean Yellow-legged Herring Gull (*Larus cachinnans*); but, somehow, it passed out of notice till Mr. Cole called my attention to it recently, when a careful examination of the bird convinced me that Mr. Stevenson's opinion was correct. This has since been confirmed by Mr. Howard Saunders. The bird is a male by dissection, and differs from the common Herring Gull in having the mantle darker, the base ring round the eye deep orange-red, and the legs lemon-yellow. The resemblance to the common Herring Gull is, however, so great that it might easily be overlooked. The month of November seems to be a very unlikely one for the occurrence of this southern species on our coast, but I find that the weather at that time was exceptionally mild and pleasant. It is also remarkable that in the following month another Mediterranean species, *Larus melanocephalus*, was killed in the same locality.—Thomas Southwell, Norwich.

Ferruginous Duck (*Fuligula nyroca*) in West Meath.—Mrs. Battersby, of Cromlyn, informs me that a bird of this species was shot by Colonel J. R. Malone, at Baronstown, Balinacarghy, West Meath, on January 17th, 1897. The bird was stuffed by Mr. E. Williams, Dame Street, Dublin, who informs me that it was a mature female. This specimen does not seem to have been recorded before, and, as the species has only been identified four or five times in Ireland, the occurrence is worthy of record, although the bird was shot a year ago.—H. F. W.

A Norfolk Great Bustard.—Through the kindness of Prof. Newton I was enabled a few months ago to purchase a remarkably fine male example of the old local race of this magnificent bird. The result of my inquiries amply established its history, which is briefly as follows:—The bird was shot on Swaffham Heath about the year 1830 by a gentleman named Glasse, who then resided at Vere Lodge, Raynham, near Fakenham, Norfolk. It remained in his possession and in that of his daughter until, on the death of the latter at Bournemouth, early in the present year, it was sold by auction with the rest of her effects, and is now in the collection of Mr. Connop, of Rollesby Hall, Great Yarmouth. This superb old male

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[*] For further particulars, *see* among others—Gould, *Uranometria Argentina*, 1879 Schiaparelli, *Pubbl. del R. Osservatorio di Brera*, XXXIV.; Celoria, *idem*, XIII.; Plassmann, *Jahresbericht d. Westfahlia, Pr. Vereins*, 1886; Ristenpart, *Ber. Sternw. in Karlsruhe*, 1892; Kapteyn, *Versl. Akademie v. Wet. Amsterdam*, 1892 and 1893: Gore, "Visible Universe," etc.; Ranyard, Knowledge, June, November, 1894; Maunder, Knowledge, February, November, 1895. February, 1896; Easton, *Astron. Nachr.*, 3270. *Compare also* Knowledge, October, December, 1891; May, 1892; April, 1893; October, 1894; January, August, 1895.

[†] Giovanni Celoria. "Sopra alcuni scandagei del cielo et sulla distribuzione generale delle stelle nello spazio." *Pubbl. del R. Osserv. di Brera*, XIII., Milano, 1878.

in magnificent plumage, is even larger than the grand male in the beautiful group of seven of these birds in the Norwich Castle Museum; and from the date of its death is not unlikely to have been the last male of the Swaffham drove, the females of which were not finally exterminated until the year 1838, when the last of the Norfolk-bred Bustards was killed.—Thomas Southwell, Norwich.

Waxwings (*Ampelis garrulus*) at Scarborough.—There are quite a lot of Waxwings at the present time (November 4th, 1897) in this locality, upwards of half a dozen having been shot and sent to me for preservation. The birds which have been captured were found feeding on the berries of the mountain ash and alder, and were so tame as to allow their executioners to walk beneath the bush whilst they sat on the top of it quite undisturbed.—J. Morley, King Street, Scarborough.

Variety of the Common Guillemot at Scarborough.—A beautiful variety of the common Guillemot was caught on December 4th, 1897, in Scarborough Harbour. Its head and entire under parts are white, whilst its back and wings are of a whitey-brown colour, and its bill, legs, and feet yellowish white. A bird of this description is extremely rare; a similar one was obtained a few years ago at Filey. The writer has visited Speeton Cliffs for many years during the breeding season, and amongst the hundreds of thousands of birds that annually resort there for breeding purposes, has seen but one creamy coloured Guillemot.—J. Morley, King Street, Scarborough.

House Sparrows and Pigeons.—That Sparrows should singly pursue Pigeons—white birds for preference—and snatch feathers from the breast and sides, is, I imagine, no news to the majority of your readers, though I have more than once met with doubt when alluding to the practice. Never before, however, have I observed this robbery in mid-air before March; and it may seem to you a sufficiently interesting sign of the abnormal state of things this year—though to-day is cold enough—that I have this morning seen four feathers taken in this way from the white Pigeons next door. This haste for warm lining for the nest points, without doubt, to very forward domestic arrangements.—F. G. Aflalo, Bournemouth, December 4th, 1897.

[Sparrows commonly take feathers to their roosting places during the winter. The fact of their carrying feathers about at this time of year does not, therefore, necessarily point to early nesting.—H. F. W.]

Occurrence of a Colony of Jackdaws having Domed Nests.—My boys having told me that for several years they had found in the neighbourhood of Moddershall, Staffordshire, Jackdaws with nests like Magpies, on the 14th May Dr. McAldowie (author of "The Birds of Staffordshire") and I went to verify this strange occurrence. On our arrival at the spot indicated to us—a group of Scotch firs on a bank rising from a large pool—we found five large nests, and saw flying round overhead four old Jackdaws. On a later day, accompanied by one of my sons, I paid another visit to the colony. One nest was placed at a height of fifty-eight feet, in the highest fork of a tree. The nest was a very bulky one, two and a half feet in diameter and of a like depth, constructed of sticks: the nest cavity, which was ten inches across, being filled with cow hair and wool, of which there was a large quantity, and the whole covered and protected by a strong dome of thorny sticks, which a hedge at the side of the plantation had no doubt supplied, it having been recently cut and the cuttings left on the ground. There was one entrance at the side of the dome. The nest was empty, and from the absence of dirt and castings was evidently one of this year. Two other nests were placed in similar positions in other trees; one contained four young birds about a fortnight old, and the other was an old one. We found some egg shells under another tree, but did not climb it. I have made inquiries, but cannot hear of these trees ever having been occupied by Rooks; and the absence of earth and clay, with which Magpies invariably line their nests, makes it improbable that these birds were the builders. I am therefore compelled to believe that the Jackdaws built these nests. There are two other colonies of Jackdaws in the neighbourhood, both in sandstone cliffs, and a mile or so from the colony I have described. I shall be extremely obliged if any of the readers of Knowledge who may have met with a similar occurrence will describe it.—W. Wells Bladen, Stone, Staffs.

[It seems difficult to prove that these nests were not old Magpies' nests relined and restored by the Jackdaws. The earth and clay of the Magpies' nests would probably wash away in the course of time. It would be very interesting if, during the coming spring, Mr. Bladen should be able to incontestably prove that these Jackdaws do build domed nests.—H. F. W.]

Notes on an Expedition to Rockall. By R. Lloyd Praeger, B.E. (*Irish Naturalist*, December, 1897, pp. 309 to 323.)—This is a brief diary of ten days spent in twice visiting the oceanic islet of Rockall, and forms the "day-by-day experiences of the party sent out in June, 1896, by the Royal Irish Academy, to investigate the natural history of this little known and inaccessible rock and of its vicinity." Unfortunately the expedition was unsuccessful in attaining its main object—that of landing upon the rock.

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.*

Note.—The first issue of Knowledge containing British Ornithological Notes was that for October, 1897.

Science Notes.

Mr. Walter Siche, the traveller and florist, has returned from an expedition to the Cilician and Cappadocian Taurus with a large number of alpine plants, and ten thousand examples of various species of the asphodel family, with varieties of fritillary, galanthus, colchicum, iris, and many other plants. Mr. Siche has been the means of introducing many new flowers to the domain of English horticulture.

Lieutenant Peary, of the United States Navy, in his recent address before the Royal Geographical Society, said that to-day Greenland had no interior—it was simply a great white snow shield. On that frozen surface the traveller sees but three things—an infinite expanse of snow, an infinite expanse of sky, and the stars. One thing of interest to glacialists which he mentioned was the transportation of snow by the wind, which was almost always blowing there. Referring to his location of the famous iron mountains of Sir John Ross with their nuggets of iron, he intimated that the Eskimo legend in regard to these nuggets was that they were originally an Eskimo woman and her dog, which were thrown out of high heaven and landed in that inhospitable region. A woman six thousand pounds in weight was the source from which the Eskimo obtained their iron supply for generations!

Sir John Lubbock, lately lecturing on "Ants," said that the lives of these creatures were much longer than is generally supposed. He had kept many for several years, two queens having reached the age of fifteen years, and these were by far the oldest insects on record. Several species kept aphides which they milked like cows; and he had found that in the autumn they collected the eggs of the aphides and kept them all through the winter, although they were of no use, and the young aphides hatched from them gave none of the sugary fluid till the following May or June, so that the ants showed more thrift and forethought than many human beings. Their instincts, though so wonderful, were very limited; and yet, when the ants were watched building their nest, feeding their young, tending their domestic animals, and, in some cases, their slaves, it was difficult to believe that they were unconscious automata.

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We are pleased to observe that a scheme is shortly to be submitted to Parliament involving the expenditure of upwards of three millions for the better housing of the national collection of art treasures in and about South Kensington Museum. The Bill for this purpose is to be brought before Parliament next Session, and there will shortly commence to be built a series of exhibition rooms and galleries, to concentrate in one area the many works of art and objects of interest now scattered in various extempore structures. It is to be hoped that among the innovations there will be a replacement of those wooden huts—called by courtesy an observatory, but bearing a much closer resemblance to a hen farm—by something more in keeping with the long purse of a Government with such resources as ours.

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A great undertaking, namely, the measurement of a degree of latitude in the Polar regions, leading to a more exact knowledge of the form of the earth,[*] appears to be on the eve of accomplishment. The solution of this question has long been the chief aim of Swedish Polar exploration, and Prof. E. Jaderin has now proposed to the Government for a preliminary expedition to be sent to Spitzbergen next summer, and that Russia should be invited to co-operate in the final measurement of a degree in 1899 and 1900. The task of the preliminary expedition—which it is intended should start in May and return in September—would be to complete the investigations already made as to the facilities for the necessary triangulation, to reach the summits of hitherto unclimbed mountains, to set up signal posts, and so on.

◆

Dr. Campbell Morfit died last month at South Hampstead. An American by birth, he had for many years past been a London resident. He was the author of "Chemical and Pharmaceutical Manipulation," "Arts of Tanning and Currying," "Oleic Soaps," and, with Dr. James C. Booth, was joint editor of the American "Encyclopædia of Chemistry"; and in the industrial utilization of waste products, as well as the chemistry of food substances, his researches have been of the utmost service to the general public.

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The November Number of the "Archives of the Roentgen Ray," which is now the organ of the Roentgen Society of London, contains an excellent report of the presidential address delivered by Prof. Silvanus Thompson, F.R.S., to the Roentgen Society at St. Martin's Town Hall, on November 5th, 1897. The number also contains five large skiagraphic plates and other interesting matter. A supplement entitled "Radiography in Marine Zoology," by R. Norris Wolfenden, M.D., is added. This supplement treats of the Echinodermata, and is illustrated with thirty-six excellent skiagraphs and photographs.

Letters.

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

"THE LIFE-HISTORIES OF THE BRITISH MARINE FOOD-FISHES."

To the Editors of KNOWLEDGE.

SIRS,—Kindly allow me a few words to conclude the correspondence on this subject. I have not denied, as your reviewer states, that "the work of St. Andrews is put more prominently forward than work done elsewhere," in our book. Such is, no doubt, the case; and it is, as he remarks, "not unnatural," considering that by far the greater proportion of British "fishery" work has been done there, or in direct connection therewith. This is a different matter from "ignoring" the work done elsewhere.

Your reviewer's statement that "Mr. Cunningham led the way" in the subject of the growth-rate of fishes has no foundation of truth. This worker published his first paper upon the subject in 1890, and at periods varying from five to twelve years prior to this the works of Dr. McIntosh, Captain Dannevig, and Dr. Meyer had appeared. Without further instance, your readers may be reminded that the two latter still stand as the best known authorities upon the growth-rate of the cod and herring respectively.

"The credit of the discovery of the hermaphroditism of *Myxine*" is not "given to Dr. Nansen." A passing reference to Dr. Nansen's work is mentioned in a *quotation* from another paper, in connection with which the reasons for its selection were given.

The life-history of *Myxine* did not fall within the scope of our work, or, of course, the labours of W. Müller, Cunningham, Weber, etc., would have been referred to.

With regard to *Nature*, my remark was to the effect that Dr. Lankester was allowed, under pretext of reviewing our work, to make certain false statements outside the pale of legitimate criticism, judged by the widest standard; and that the editor, in the opinion of a great many of his readers, showed a partiality in not allowing a contradiction.

Your reviewer considers my remarks "hardly in good taste" because Mr. Cunningham was similarly denied on a prior occasion. Surely this fact, which could not have been known except to Mr. Cunningham himself and his most intimate friends, merely corroborates my remark that your contemporary has been "not unknown" for such unfair treatment of authors. Mr. Cunningham has reason, judging from your reviewer's statement, to complain of his treatment, and still more to complain of the invidious position in which your reviewer has attempted to place his work.

In conclusion, I must now leave it with your readers to judge for themselves how far your reviewer has established his position that we have ignored the work of others in our labours.

The University, St. Andrews. A. T. MASTERMAN.

[In my notice of "British Marine Food Fishes," I remarked: "Between the marine biologists of the North and South there is something of a spirit of rivalry, the result being that each school is inclined to ignore, more or less, the work of the other—or, at any rate, not overburden it with praise." No impartial critic, familiar with the facts, could deny that every word of this sentence is true. It will be noticed that I did *not* assert that Dr. McIntosh and Mr. Masterman had "ignored the work of others in their labours": but surely the first paragraph of Mr. Masterman's letter justifies my position.

Mr. Masterman (p. 291) asked for an instance of "Mr. Cunningham's work which had not been alluded to and

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[*] *See* article, "Measurement of the Earth," KNOWLEDGE, June, 1897, p. 148.

freely acknowledged." I gave him the case of the work on the growth of fishes, referred to in a cursory manner which deprives it of any importance. Of course, Mr. Masterman may be permitted to have an opinion of his own as to what work is important, but marine biologists are also at liberty to challenge it.

With regard to the hermaphroditism of *Myxine*, the quotation is from a paper by Mr. Masterman himself, and the words used are: "We may cite Nansen's observation of the protandric hermaphrodite condition of *Myxine*." This certainly gives the idea that the hermaphroditism was discovered by Dr. Nansen.

As to *Nature*, Mr. Masterman distinctly ascribed "partiality" to the editor in the matter of the review of his book. He knows that Mr. Cunningham's work was treated in exactly the same way that the work of Dr. McIntosh and himself was treated, and yet he has not the good grace to withdraw his charge of partiality. I cannot say that Mr. Cunningham sent a reply to the criticism of his own work, but I know that no reply was published in *Nature*, any more than was Mr. Masterman's reply to Prof. Lankester's review. It is a pity that there are authors like Mr. Masterman ever ready to resent fair criticism and impugn editorial actions.—The Reviewer.]

TESTING MULTIPLICATION AND DIVISION.

To the Editors of Knowledge.

Sirs,—The properties of "the mystic number three," and its square *9*, referred to by your correspondents on page 292 of your magazine, bring one back to the earliest recollections of one's school days, when the multiplication sums were tested by "casting out the nines," as it was then called. The property that the sum of the digits of any integer, divided by *9*, gives the same remainder as if the number itself were divided by *9*, is a natural consequence of our decimal notation. Had the notation been duodecimal, *11* would have possessed the same property; and, even in the decimal notation, 11 may be used with almost equal ease, and is a safer test. Beginning with the units, add the alternate figures, and, carrying to the tens, add the other alternate figures; then add what is over to the units of the sum. If the number thus obtained be divided by 11, the remainder is the same as if the whole number were divided by 11. This can be easily shown from the obvious fact that every even number of nines is divisible by 11. These properties are well known, and hardly need illustration. They are mentioned as introductory to what follows.

Some years since, I had to do with the multiplication and division of very large numbers, consisting of sixty figures and upwards. Finding that neither 9 nor 11 was a sufficiently reliable test, I was led to seek for something safer. The numbers, for distinctness, were arranged in periods of five figures each, beginning of course at the right. My test was to be adapted to this arrangement, and I soon found that 11111, consequently 99999, is divisible by 41; therefore 99999 99999, etc. It follows that if the sum of the periods, taken as separate numbers and carrying what is over to the units' place, be divided by 41, the remainder is the same as if the whole number were divided by 41.

The division by 41 may be abridged thus:—

Let the sum of the periods, found as above, be 37529
Subtract the largest multiple of 11111 contained therein ... 33333
41)4196 remainder 14,

showing that, if the whole number were divided by 41, the remainder would be 14.

Years afterwards I was requested by the late Prof. Cayley to verify some results, involving also very large numbers, but arranged in periods of three figures each. To this also it was judged expedient to use a test specially adapted to the arrangement. I saw that 111, therefore 999, is divisible by 37; and consequently that if the sum of the periods of three figures, taken as above, be divided by 37, the remainder is the same as if the whole number were divided by 37.

Take, for example, any number at random, say—

45 286 507 613 941
The sum of the periods is 2 392
and, adding 2, the unit of the second period in the sum, to the first period, we obtain finally 394
Subtract the largest multiple of 111 therein 333
The number thus obtained 61 divided by 37, leaves the same remainder, 24, as if the whole number were divided by 37.

A. Graham.

Cambridge Observatory,
14th December, 1897.

ARTIFICIAL SUNSPOTS.

To the Editors of Knowledge.

Sirs,—With regard to Mr. East's experiments and your remarks in the December Number of Knowledge, is it possible that in the sun's surface we have anything similar?—that is, are the rice grains really the only partial consolidated matter that we see?—all the interior of the sun being in a gaseous state, under such conditions of extreme heat and pressure as to make chemical combination and luminosity impossible. I should like to see some remarks in your journal on this head. It seems to me one of impossibility; the photosphere would then be the very first stages of a crust formation on the sun.

December 10th, 1897. Thos. J. Haddy.

RARE BIRDS.

To the Editors of Knowledge.

Sirs,—Your issue for December contains an account of the shooting of four rare birds. Most probably each of these rare birds had mates and would have continued the race if let alone, but the collector comes with his gun and endeavours to make the rare bird an extinct bird. Of course, his specimen would become more valuable if this species of bird became extinct in this country, while if he allowed the bird to escape he would have no specimen at all. But is this a sufficient reason for shooting a bird that is doing no harm and is not intended to be eaten, and whose only crime is that very few like it are to be found in this country? Our object should be to preserve—not to destroy—such rare specimens. This would be admitted if they were domestic animals. It is only when an animal is wild that he is shot because there are few like him. If the shooting goes on there will soon be none.

It is time that we had a society for the preservation of rare animals and birds—unless, of course, they are mischievous like the wolf, which has now died out in the British Islands.

Every zoologist will admit that utility is not the only thing to be looked to as regards the preservation or destruction of a race of animals; and, if there is no reason for the extirpation of any peculiar species, why should we seek to extirpate them merely because they appear to be dying out of their own accord? I would rather preserve them as long as possible.

The dying out of a race of animals, when natural, may often indicate a gradual change of climate or other physical conditions, the history of which it will be desirable to trace hereafter. The arrival of a new race may afford similar indications to the student of science. But if we ruthlessly shoot down every member of a race that is dying out and every new arrival on our shores, landmarks of this description will be lost. The "footprints on the sands of time" wear out soon enough without intentional obliteration.

W. H. S. MONCK.

[The killing of rare birds has of late formed the subject of innumerable letters in the daily press. These letters are invariably written by persons not sufficiently acquainted with the details of the subject to form an accurate opinion as to whether the killing of any particular bird is to the advantage or disadvantage of the study of British birds. By this we mean that unless certain birds are killed ornithology will not advance. Glance, for instance, at the second part of Mr. Howard Saunders's manual (just published). There are at least six birds out of the twenty-four there described which would never have been known to have visited the British Islands had they not been shot.

With regard to the birds mentioned by Mr. Monck, these were all stragglers, and we can confidently say that none of them would ever have bred in Great Britain had they been allowed to live, and certainly three of them would never have been identified unless they had been shot. We do not wish our readers to infer from the foregoing remarks that we uphold the killing of every rare bird. Far from it. We consider it an act of ignorant greed to destroy in Great Britain a bird such as a Golden Eagle or Osprey, which were formerly fairly plentiful as breeding species, but have now become very rare. We would remind Mr. Monck that the Society for the Protection of Birds, which has often been referred to in KNOWLEDGE, has been established some years, and has done and is doing very good work in the prevention of that very ignorant destruction to which Mr. Monck so properly objects.—EDS.]

MOVEMENT IN SPACE.

To the Editors of KNOWLEDGE.

SIRS,—I saw it stated the other day that one of our astronomers had made a calculation that the rate of movement of our sun in space was twelve miles a second.

This idea of "movement in space" is to me incomprehensible. What we call "movement" is a relative state of matter, and can only be measured against something "at rest." For instance, we call an object fixed or stationary on the earth, when really it participates in the earth's motion; so it is quite possible that a fly on the woodwork of a railway carriage may consider itself "at rest" when it pauses in its walk, although the train is travelling at its usual speed.

As it would appear from our limited knowledge of the universe that a state of absolute rest is impossible, it would be interesting to know how this movement of the sun can be measured with anything approaching accuracy.

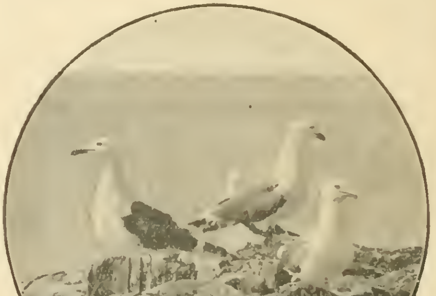
If you consider this a suitable subject to appear in your very interesting magazine, you would much oblige,

IGNORAMUS.

["Ignoramus" is quite right in supposing that motion in space can only be measured by taking some origin which we suppose fixed. In deducing the solar motion we assume that the group of stars which we employ for the purpose have, as a whole, no tendency to drift in any direction—or, in other words, that their centre of mean position is at rest. This centre of mean position is thus the fixed origin to which the solar motion is referred. The whole system of stars under discussion, including our sun, may have a common drift in some direction, but this we are unable to determine.]

Notices of Books.

With Nature and a Camera. By Richard Kearton, F.Z.S. Illustrated from Photographs by Cherry Kearton. (Cassell.) 21s. Perhaps we expected too much of Mr. Kearton, judging from reports which reached us before the publication of his book. However that may be, we are disappointed. There are many good things in the book, but it is our candid opinion that the author has been too hasty in putting his work before the public, for it bears unmistakable signs of "padding." A number of the photographs are not of sufficient interest for publication, while to others a great deal too much space has been given, making the book large, expensive, and annoying to the reader. The most glaring examples of "padding" are two full-page illustrations of a rabbit burrow closed and a rabbit burrow open (pages 178 and 179), a common enough sight to everyone. If the photographs had been "pictures" we should, perhaps, have excused the author, since his book is mainly a "picture book"; but they are by no means pictures, and are made additionally hideous by a large bottle in the foreground. The letterpress also is by no means free from "padding." A number of the facts—some of them here set down as extraordinary—have been published scores of times before. It is well known that the song thrush sings occasionally on fine nights; yet the author, who has had some experience, was "astonished to hear a thrush commence to sing" one moonlight night, and considers that in this fact he has "unmistakable proof" that "birds may, upon occasion, mistake the rising of the moon for the coming of another day." The author gives a detailed account of an old shooter and his favourite "setter" bitch, and on page 161 he gives a



Lesser Black-backed Gulls. (From "With Nature and a Camera.")

photograph of the two; but the "setter" is an unmistakable pointer. Having said so much of what we consider to be bad judgment and error, we gladly pass on to the good points in the book. These are chiefly to be found in the photographs, a great number of which are exceedingly fine. We would especially draw attention to the following :— Barn owl, photographed by flashlight (page 243), kingfisher (page 357), cormorants and guillemots (page 251), common gull's nest (page 269) ; and to those which we have been able, by courtesy of the publisher, to here reproduce. Mr. Cherry Kearton, who has taken the photographs for his brother's book, has had many perilous adventures, as all who climb cliffs—and especially those who carry a camera with them—must; but we cannot help thinking that Mr. Kearton has often run into unnecessary dangers. Many of the things he has photographed in difficult places could have been found in more accessible situations. We recommend the book with the qualification that if the author has not made "much ado about nothing," he has certainly made too much of not a very great deal.

Ornamental Design for Woven Fabrics. By C. Stephenson and F. Suddards. (Methuen.) Illustrated. 7s. 6d. We are not by any means convinced that the authors of this handsome-looking book have succeeded in their laudable desire to "bring the necessary knowledge within a narrower focus, and thereby make it more easily accessible." In attempts like this to find the path of least resistance to a useful knowledge of a science or an art, there is always a danger of retarding progress by, in a manner, increasing friction—making the pathway too constricted for one to get through with comfort. For example, although a knowledge of elementary geometry is assumed, a single plate is given showing the construction of the most simple, and at the same time useful, figures, and then in a few pages their application to the design of woven fabrics is dispensed with. The authors, indeed, exhibit a clear insight as to the way in which such figures are utilized in the designer's office; but a beginner would be all at sea in practice if only equipped with such knowledge as is here so over condensed as to be nearly, if not quite, indigestible. Coming to the main part of the work, however, we find a different state of affairs. Dealing with the laws of composition, plant forms in textile designs, limitations imposed, drop-pattern, repeats, and so on, as well as in the arrangement of the warp-threads and their sequence in rising and falling in order to attain any given pattern, all is clear, and in the highest degree commendable. The book is in every way handsome, and the illustrations are of first-rate quality.

The Rise of Democracy. By J. Holland Rose, m.a. The Victorian Era Series. (Blackie & Son.) 2s. 6d. This is a wholly inadequate treatment of a great subject, due in a large measure to the laudable desire of the author to compress a vast amount of historical detail into a small compass. The result is a more or less disjointed catalogue of names and incidents, often incomplete, and always lifeless. Admittedly circumscribed in the space at his disposal, Mr. Rose has persistently stood in his own way, and filled valuable space by recounting his own interpretation of the facts, so that his reader is often unable to appreciate the picture by reason of the obtrusive nature of the showman. However interesting the author's opinions may be to Mr. Rose, he should remember they are of no value to his reader. Some haste, too, is apparent in the text, where we find Sir Francis Burdett, the famous member for Westminster, figures as Sir Thomas Burdett, and Richard Carlile as Carlisle ; while the alleged "toning down" of John Stuart Mill is, of course, an entire misapprehension of the facts. Then we do not like to find such phrases as the "immense vogue" of Darwin, or the "viewy schemes" of Owen, in a book which promised in the preface to be "scholarly." The index, too, is hasty, incomplete, and lacking in method. Yet, notwithstanding these defects, Mr. Rose's little book will be found to be an interesting sketch of the growth and expansion of representative institutions in England, as well as of the patient doggedness and prescience of our countrymen. But it leaves the task yet unfulfilled of writing the history of the rise of democracy.

Guillemots on Cliff. (From "With Nature and a Camera.")

An Introduction to Geology. By Wm. B. Scott. (Macmillan.) Illustrated. 8s. net. New strata of books, so to speak, are being continually superposed on pre-existing books of the same kind, and it too frequently happens that they contain no fossils, as it were, to invest them with special characteristics sufficient to differentiate them from their predecessors. In a sense, Prof. Scott's work is of this kind—that is to say, the book is not of any particular value to English students, but rather a class-book for American students of geology. The principles of the science are elucidated in a manner closely corresponding with our own standard works on the same subject. To those, however, who have advanced beyond the confines of an acquaintance with first principles, and are prepared for fresh fields and pastures new, we may say there is here much that is worthy of careful study—matter to fill many a gap, confirm or accentuate doubtful points, and, above all, a panorama of familiar phenomena in a new and attractive dress, which will lend a more extensive, more diversified, and more persuasive view to the mental eye.

John Hunter: Man of Science and Surgeon. By Stephen Paget. (Unwin.) Portrait. 3s. 6d. Among the greatest men that England has produced must be reckoned those who have built up the science of medicine in its broadest sense, and among savants of this kind Hunter was head and shoulders above his contemporaries—one of the master builders of the Temple of Hygiea. The whole secret of his extraordinary achievements in life can be expressed in a few words: "Don't think—try; be patient—be accurate." A great deal, it is true, may be learnt by thinking; but when experimental facts are brought to bear upon a certain theory, more exact conclusions can be deduced than by mere speculative opinion without the foundation stones of exact observation. As a boy, Hunter was an observer of nature, and did not care much for his school books; and when he came to London to work with his brother William, he studied hard for three years, spending his time mainly in the dissecting rooms night and day. Thus far, Darwin and Hunter, in so many ways alike, went both of them along the same high road; here the road divides at a narrow angle. Hunter went forward from human anatomy to all anatomy and physiology, and from these to medicine and surgery, and from all of them together to a profound study of life, alike in health and disease, in all structures, at all stages. To the medical student of the present day the correspondence here given between Hunter and his famous pupil, Jenner, must present a strange picture. Our museums now supply all the requisites for study, but in Hunter's time every student had to cater for himself: find specimens for dissection where he could; get his chemical knowledge from one source, anatomy from another, and so on; all outside the hospitals, which were not organized for complete instruction. The book is one of a series—"Masters of Medicine"—and will include among others: Harvey, Jenner, Simpson, Helmholtz, Stokes, Bernard, Brodie, and Sydenham. Provided subsequent volumes are of equal merit with this one, the series will form a most delightful record of the development of the healing art.

Recent and Coming Eclipses. By Sir Norman Lockyer. (Macmillan.) Illustrated. 6s. net. By this time Sir Norman Lockyer may be regarded as a veteran eclipser. During the last quarter of a century he has captained many expeditions, and anything he has to say on eclipses will be sure to command the attention of all interested in such phenomena. In describing what he saw in 1871 the author gives us some idea of the imposing grandeur of an eclipse in these words: "There, in the leaden-coloured, utterly cloudless sky, shone out the eclipsed sun—a worthy sight for gods and men. There, rigid in the heavens, was what struck everybody as a decoration—one that emperors might fight for—a thousand times more brilliant even than the Star of India, where we then were; a picture of surpassing loveliness, and giving one the idea of serenity among all that was going on below; shining with a sheen of silver essence; built up of rays almost symmetrically arranged round a bright ring above and below, with a marked absence of them right and left, the rays being composed of sharp radial lines, separated by furrows of markedly less brilliancy." Although the author, according to the title page, purports to give in his book notes on the eclipses of 1893, 1896, and 1898, considerable space is taken up with the subject of eclipses generally. Seeing that the sun itself is essentially a star, we quite expected to find ample reference to stellar researches—a sort of discussion on the comparative anatomy of suns—but we are of opinion that such allusions as that found on page 105 are quite out of place in a popular book. Sir Norman says: "I am glad to see that Sir William Huggins, who appears to be ignorant of my quarter-of-a-century-old work, has quite recently arrived independently at the same conclusion." The arm-chair astronomer doesn't want condiment of that sort. As regards the great diversity of work to be carried on during the precious moments of totality, we have in this handy book an admirable description such as could only emanate from one thoroughly conversant with every aspect of the phenomenon. Difficult as the subject is, we can readily follow the master through every labyrinth. The heterogeneous mass of facts gleaned by a multitude of observers in all parts of the world during eclipses spread over half a century, are here put through the intellectual mill and worked into a shape which one can appreciate. We see how the sun and stars are, as it were, comparable to the several orders of animals, all more or less alike, and differing from one another only in detail. The large section dealing with the coming eclipse, however, appears to us foreign to the general reader, and fitted only to the wants of the few who actually take part in eclipse work. It bears a closer resemblance to printed instructions from a leader to his followers than literature on a popular subject for the million. The illustrations are of very unequal merit.

Electricity in the Service of Man. By R. Wormell, D.SC., M.A. Revised and enlarged by Mullineux Walmsley, D.SC. (Cassell.) Illustrated. 7s. 6d. Perhaps the best evidence of the worth of this work is its continued issue, time after time, in improved form. Evidently no expense has been spared in making the book a thoroughly reliable exposition, in popular phraseology, of the principles which underlie all the practical applications of electricity in everyday life. The publishers, in this case, certainly give a maximum of value for a minimum of outlay—a circumstance which will be sufficiently apparent when we point out that there are a thousand printed pages and as many illustrations.

The Method of Darwin. By Frank Cramer. (Chicago: McClurg & Co.) This book is an analysis of the scientific method of Charles Darwin. Darwin's works have been chosen as a basis on account of—"(1) the desire to confine the discussion to the writings of a single author; (2) the fact that his works cover a wide range of subjects; and (3), above all, the fact that Darwin's investigations, and the reasoning based upon them, have furnished the biological sciences with their dominant principles"—and also because "Darwin's custom of presenting all sides of a case very frequently led him to expose the original course of his thought and the order of his discoveries." The author has chosen an excellent and certainly a neglected subject.

In Darwin's works he has the best foundation possible for a study of scientific method, and above all he has planned his book well and written it lucidly.

After a brief explanation of logical processes we have the following chapters, each one being discussed in connection with well-chosen examples from Darwin's works:—Darwin's Views of Method, Starting Points, Exhaustiveness, Negative Evidence, Classification, Analogy, Induction, Deduction, Unverified Deductions, Erroneous Deductions, General Discussions, Logical History of the Principle of Natural Selection, and Conclusion.

We have given an idea of the scope of the book and heartily recommend it, especially to those who are starting out on scientific work of whatever kind. Our only complaint is that the book is not larger and more exhaustive.

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BOOKS RECEIVED.

Bureau of American Ethnology—Sixteenth Annual Report. (Government Printing Office, Washington.)

The Sun's Place in Nature. By Sir Norman Lockyer. (Macmillan.) Illustrated. 12s.

By Roadside and River—Gleanings from Nature's Fields. By H. Mead Briggs. (Elliot Stock.) Frontispiece. 3s. 6d.

The Journals of Walter White, formerly Assistant Secretary of the Royal Society. With Preface by William White. (Chapman & Hall.) Portrait. 6s.

Observational Astronomy. New Edition. By Arthur Mee. (*Western Mail*, Limited, Cardiff.) Illustrated. 2s. 9d. post free.

Modern Architecture. By Heathcote Statham. (Chapman & Hall.) Illustrated.

The Encyclopædia of Sport. Edited by the Earl of Suffolk and Berkshire, Hedley Peek, and F. G. Aflalo. Vol. I. (Lawreuce & Buller.) Illustrated. 25s.

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Obituary.

We regret to record the death of Dr. F. A. T. Winnecke, at Bonn on the 3rd December, 1897, in the sixty-third year of his age. Curiously enough, the comet which bears his name, and having a period of 5·818 years, is expected to return to perihelion almost at any time in the early part of the present year. He was born in Hanover on 5th February, 1835, and received his education at Berlin. After assisting Encke (Encke's comet, period 3·303 years, is also expected about May of this year) at the observatory there, and afterwards Argelander at Bonn, he accepted an appointment in Russia, and many years of his greatest scientific activity were spent at Pulkowa. In 1868 Dr. Winnecke took charge of the observatory at Carlsruhe, and in 1872 he was nominated Professor of Astronomy at the newly founded University of Strasburg. He was elected an Associate of the Royal Astronomical Society in 1863. Cometary astronomy always had for him great attractions; besides the periodic comet which bears his name he found several others, receiving the prize of the Vienna Academy of Sciences for his cometary discoveries.

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BOTANICAL STUDIES.—I.

VAUCHERIA.

By A. Vaughan Jennings, F.L.S., F.G.S.

The study of plants has till recent years occupied a somewhat different position from that of its sister sciences. When geology was rousing the interest of the intellectual world by its conclusions as to the history of the earth, and while zoology formed, mainly, the battle-ground of the evolutionists and their adversaries, botany still remained a science of the collector and the classifier. Only comparatively lately has it been able to take its place as a philosophic science on a level with zoology. Its acquirement of this position has been due to the increasing number of capable students, and the improvement of microscopic methods of research. It is possible that a recognition of the importance of microscopic study has sometimes led botanical teachers too far in contrasting their work with that of the earlier students of the field and the herbarium. There may be room for a protest against the predominance of micro-technicality, but the work of the microscope in giving botany its proper position in the life sciences can never be seriously exaggerated.

The discovery of the life histories of lower plants, of the details of the reproductive processes in higher cryptogams, and the demonstration of the relationship between them and those of the flowering plants, form one of the most striking chapters in the history of biological research.

Though these results have been arrived at only by long labour, by the employment of high magnification and refined methods of preparation, it is yet by no means impossible for the amateur microscopist to see for himself a great number of the more important phenomena in question in this line of investigation. It is proposed to call attention to a few important types, which form, as it were, landmarks in the world of plants.

As a starting point we may select a common and easily obtainable plant in which the reproductive processes are simple and readily observed. The species of the genus *Vaucheria* form green velvet-like patches on damp ground or thick felted masses of threads in ponds and ditches. With a low-power pocket lens only, the branched and interlacing threads can be distinctly seen, and it may be observed that some carry small rounded excrescences on the side, while others may be darker in colour and enlarged at the tip.[*] If a specimen is mounted in water and examined with a low power of the microscope, it will be found that the whole plant consists of a cylindrical tube of protoplasm enclosed by a delicate cell wall;[†] but there are no transverse walls crossing the tubes. If the green colouring matter, or chlorophyll, is dissolved out by soaking in alcohol, and the specimen treated with iodine solution, or other suitable stain, it will be found that the protoplasm contains numerous small specialized portions or nuclei which are deeply coloured.[‡]

The plant is thus a protoplasmic body with numerous nuclei, but the division of these nuclei is not followed by formation of new cell walls, and the plant remains unicellular.[§] There is a wrong impression produced if we speak of the higher plants as aggregations of cells, as if they were so many bricks; and the group of algæ to which *Vaucheria* belongs is of special value in reminding us of the fact that the cell walls are of secondary importance in comparison with the protoplasm and nuclei. It is the great series of the *Siphonaceæ* which includes a large number of marine seaweeds often of considerable size and complex structure. To it belong such varied types as the green furry *Codium*, common on the piles of our sea-coast piers; the feathery *Bryopsis* of our rock pools; the polymorphic *Caulerpa* and the calcareous coralline-like *Halimeda* of warmer climes; and the quaint little umbrella-like *Acetabularia* of the Mediterranean. Such variety of form and wide distribution suggest a great antiquity for the group, and there is little doubt that in the Eocene *Dactylopora* and *Ovalites*, and the Triassic *Gyroporella*, we have

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[*] *Vaucheria* plants are often sterile; and the enlargement of the ends should be looked for after the plant has been some time in darkness.

[†] By adding a weak (two per cent.) solution of common salt the protoplasm will contract away from the wall owing to the abstraction of water. ("Plasmolysis.")

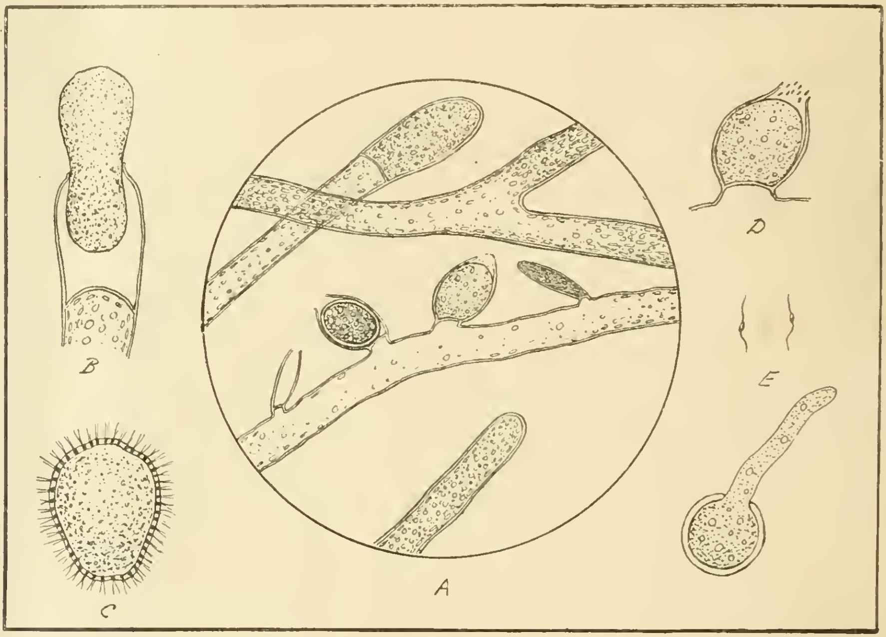
[‡] It is not always easy to demonstrate them by such simple staining, and special methods may have to be employed.

[§] The term "cœnocyte" for such large multinucleate cells is a convenient one, and coming into general use.

direct evidence of its geological age. These questions are outside our present object, but indicate how far the green weed from the garden path might lead us.

The special feature we want to observe is the mode of reproduction of the plant, and it will be found that it propagates itself by two distinct methods.*

In the first case there is an aggregation of the protoplasm at the ends of certain threads, and in time this specialized portion makes its way through the terminal wall and swims about by means of vibrating cilia, which occur in pairs all over its surface. In time this liberated mass of protoplasm loses its cilia, settles down, develops a cellulose wall, and passes into a resting stage. Later on, it germinates and grows directly into a new *Vaucheria* plant. This process of renovation of physiological energy in a special part of the protoplasm is termed "rejuvenescence."



A.—*Vaucheria aversa.*—The filament in the centre shows two Oogonia and two Antheridia. The Antheridium on the left is empty, and the fertilized Oosphere in the corresponding Oogonium has developed a thick wall. In the upper filament the protoplasm is aggregated at the apex, and shut off by a septum prior to the formation of a Zoogonidium. B.—The Cœnocytic Zoogonidium of *Vaucheria* passing out from the apex of a filament. C.—The Cœnocytic Zoogonidium of *Vaucheria*, showing numerous peripheral nuclei, with pairs of Cilia opposite each. D.—An Oogonium, with Antherozoids passing through the mucilaginous apical area. E.—Antherozoids (or Spermatozoids). F.—Germination of an Oospore or Oosperm.

For the other and more important method of reproduction, one must examine the small protuberances which occur here and there on the sides of the threads. These will be found to be tubular or oval outgrowths from the filament enclosed by a cell wall continuous with that of the main axis. Their contents are, however, cut off from the latter by a transverse wall or septum. The larger inflated bodies contain each a rounded protoplasm mass which is the oosphere or egg-cell. The narrower tubular structures are the antheridia, and at the right stage will be found full of minute antherozoids formed by repeated subdivision of the protoplasm and nuclei. These antherozoids or spermatozoids are minute oval bodies each with a pair of cilia, by means of which they move.

They escape from an aperture at the apex of the antheridium, which in most species curves round so as to approach the top of the oogonium.* The wall of the latter becomes gelatinous at this point, and the antherozoids pass through and effect the fertilization of the oosphere. Subsequently the oosphere surrounds itself with a thick protective wall, passes through a period of quiescence, and in time germinates, growing at once into a new plant.

Such is a brief summary of the life history of this common but no less interesting plant.

The type has been selected as affording a simple example of oogamous reproduction; and the important

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* It should be noted the type of oogamous reproduction here described occurs in *Vaucheria* only. In the other genera the process of reproduction is in some cases still unobserved; in others it takes place by conjugation of similar, or slightly dissimilar, free swimming "gametes."

* The number and distribution of the oogonia and the form of the antheridia differ in the various species. The one chosen for the illustration is a fresh-water species, and was collected in a pond near Croydon. The commoner *V. sessilis*, on damp earth, has the curved antheridium; as also *V. hamata*, *V. racemosa*, and others. The type here shown is the simplest of all, and has not been figured in the usual text-books.

points to note in connection with our present purpose are, firstly, that the "fruit" is only the fertilized oosphere without any accessory or surrounding growths; and, secondly, that when this "oospore" germinates it produces a new plant like that on which it grew.

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THE FACE OF THE SKY FOR JANUARY.

By Herbert Sadler, F.R.A.S.

A few small spots may still be occasionally detected on the solar surface.

Conveniently observable minima of Algol occur at 11h. 49m. P.M. on the **16th**, at 8h. 38m. P.M. on the **19th**, and at 5h. 27m. P.M. on the **22nd**.

Mercury is in inferior conjunction with the Sun on the **6th**. During the last third of the month he is visible as a morning star, but under very unfavourable conditions in these latitudes, owing to his great southern declination. On the **21st** he rises at 6h. 23m. A.M., or about one hour and a half before the Sun, with a southern declination at noon of 20° 51′, and an apparent diameter of 7¾″. On the **31st** he rises at 6h. 25m. A.M., or about one hour and a quarter before the Sun, with a southern declination of 21° 47′, and an apparent diameter of 6½″. He is at his greatest western elongation (25°) on the **29th**. While visible he describes a direct path in Sagittarius without approaching any conspicuous star.

Venus is too near the Sun to be observed, as is also the case with Mars.

Ceres is still in an excellent position for observation. She souths on the **1st** at 11h. 35m. P.M., with a northern declination of 28° 4′, her stellar magnitude being about 7¼″. On the **10th** she souths at 10h. 40m. P.M., with a northern declination of 28° 37′. On the **20th** she souths at 9h. 51m. P.M., with a northern declination of 29° 5′. On the **31st** she souths at 9h. 7m. P.M., with a northern declination of 29° 27′, her stellar magnitude being about 7½″. During the month she describes a retrograde path in Auriga.

Jupiter is now beginning to be fairly well placed, as regards his times of rising, for the amateur. On the **1st** he rises at two minutes before midnight, with a southern declination at noon of 2° 32′, and an apparent equatorial diameter of 39″. On the **11th** he rises at 11h. 22m. P.M., with a southern declination of 2° 43′, and an apparent equatorial diameter of 40″. On the **21st** he rises at 10h. 44m. P.M., with a southern declination of 2° 47′, and an apparent equatorial diameter of 40¼″. On the **31st** he rises at 10h. 4m. P.M., with a southern declination of 2° 43′, and an apparent equatorial diameter of 41″. During the greater part of the month he describes a very short direct path in Virgo, without approaching any conspicuous star. He is stationary on the **25th**.

Both Saturn and Uranus do not rise till long after midnight during the month, and they are both very badly placed for observation in these latitudes.

Neptune is very well situated for observation, rising on the **1st** at 2h. 28m. P.M., with a northern declination of 21° 44′, and an apparent diameter of 2½″. On the **11th** he rises at 1h. 48m. P.M., with a northern declination of 21° 43′. On the **21st** he rises at 1h. 2m. P.M., with a northern declination of 21° 42′. On the **31st** he souths at 8h. 32m. P.M., with a northern declination of 21° 42′. During the month he describes a short retrograde path in Taurus, in a region barren of naked-eye stars.

January is a favourable month for shooting stars, the most noted shower being that of the *Quadrantids*, the radiant point being in R.A. 19h. 12m. and 53° north declination, the greatest display being visible during the morning hours of January **1st** to **3rd**.

The Moon is full at 0h. 24m. A.M. on the **8th**; enters her last quarter at 3h. 44m. P.M. on the **15th**; is new at 7h. 25m. A.M. on the **22nd**; and enters her first quarter at 2h. 33m. P.M. on the **29th**. Many of the larger stars of the Pleiades will be occulted on the evening of the **3rd**.

There will be a partial eclipse of the Moon on the evening of the **7th** and early morning of the **8th**. The first contact with the penumbra takes place at 9h. 11m. on the **7th**; the first contact with the shadow at 10h. 57m. P.M., at an angle of 169° from the Moon's limb towards the east (viewed for direct image). The middle of the eclipse will occur at 11h. 45m. P.M., about $\frac{16}{100}$ths of the disc being obscured. The last contact with the shadow takes place at thirty-two minutes after midnight on the **7th**, at an angle of 143° from the north point of the Moon's limb towards the west. The last contact with the penumbra occurs at 2h. 18m. A.M. on the **8th**. There will be a total eclipse of the Sun on the morning of the **22nd**, but it will be invisible in the British Islands.

◆

Chess Column.

By C. D. Locock, B.A.

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

Solutions of December Problems.

(By W. J. Ashdown.)

No. 1.

1. Q to R4, and mates next move.

No. 2.

1. R to B2, and mates next move.

Correct Solutions of both problems received from Alpha, J. T. Blakemore, J. M'Robert, W. de P. Crousaz, J. E. Gore, G. Coules, E. C. Noton.

Of No. 1 only, from H. H. Thomas, A. H. Doubleday, Capt. Forde, W. Clugston, G. M. Norman.

Of No. 2 only, from G. G. Beazley.

No less than four solvers gave 1. R to B3 for No. 2, overlooking the reply 1. . . . B to K8. The correct key, it will be observed, prevents the dual after 1. . . . B × P.

H. H. Thomas.—In No. 2, if 1. B to Kt3, Kt to B5 (!), and there is no mate. It is a magnificent "try."

G. G. Beazley.—If B × P, Black retaliates (ch).

A. E. Whitehouse.—In No. 2, B × Kt is met by the Queen moving on to the Rook's file. B × KtP in No. 1 loses a piece.

H. S. Brandreth.—You will have seen that your solution of Mr. Challenger's three-mover was correct; not so that of Mr. Slater's insidious two-mover.

W. Clugston.—Thanks for the problems, which shall be examined, and if, as we expect, found worthy, receive early publication.

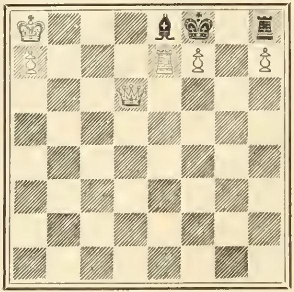
G. Coules.—Thanks for the three-mover. The only obvious drawback consists in the two "short mates" after two of the King's moves, which look as if they should lead to main variations, and lead, therefore, instead, to disappointment. The problem, we think, could be improved by abolishing the two Rooks, and, if possible, utilizing the KB more.

PUZZLES.

By C. D. Locock.

No. 1.

BLACK (3).

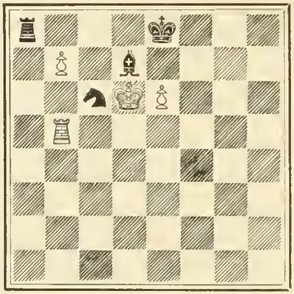


WHITE (6).

White compels Black to mate in two moves.

No. 2.

BLACK (4).

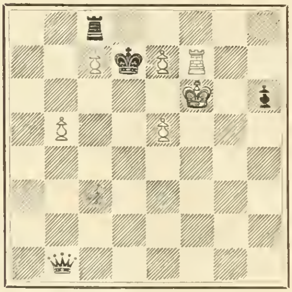


WHITE (4).

White, with Black's assistance, is mated in two moves.
(The Black King has not moved).

No. 3.

BLACK (4).



WHITE (6).

White to play and draw.

[The solution of these positions requires what is known as a " liberal interpretation " of the laws of chess, particularly that relating to Pawn promotions. They are not serious studies, but possibly not devoid of amusement.]

CHESS INTELLIGENCE.

M. Janowski defeated Herr Walbrodt in their match at Berlin by five games to three, a very creditable performance considering that the score at one time was three to one in favour of Herr Walbrodt, who had only to draw one of the next two games in order to win the match. When the score reached three all, the match was prolonged for another three games according to the conditions arranged, and M. Janowski winning the first two of these became the victor.

The Amateur Championship Meeting will be held this year at Belfast. The experiment is a novelty, and the distance from London may militate against a very representative entry. The Irish amateurs, however, will have a good opportunity of testing their strength.

Under the title of " Pollock Memories," a selection of the games of the late W. H. K. Pollock will shortly be issued. A biography and portrait will be included, and the games will be annotated. The price to subscribers will be two shillings and nine pence post free. Address Mrs. F. F. Rowland, 6, Rus-in-Urbe, Kingstown, Ireland.

We regret to announce the death of the Rev. E. J. Huntsman, president of the Sheffield Chess Association, and formerly a well-known figure at the meetings of the Counties' Chess Association.

It is stated that Mr. Lasker, who has abandoned chess lately in favour of science, will return to England in the summer aud renew his former pursuit.

In the Championship Tournament of the City of London Chess Club the best scores so far have been obtained by Dr. Smith, Mr. H. W. Trenchard, and Mr. W. Ward.

A four-handed chess match, played on December 13th between the British Chess Club and the Four-handed Chess Club, resulted in a draw, each side scoring one game.

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CONTENTS.

THE FLOOR OF A CONTINENT.

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

WHEN we consider the thickness of the sedimentary deposits that lie beneath us at any point on the surface of the earth, and compare them with the depth of four thousand miles that separates us from the earth's centre, we may come to regard the whole stratified series as a mere blanket on the true substance of the globe. Ever since the crust became solid—ever since the atmosphere cooled and the rain began to fall—the earth's surface has been subject to denudation, and the dust and mud of it have been carried into the shallow depressions that have formed in it from time to time. Wrinklings of the crust have uplifted these layers of earth-dust, and have folded them, together with more fundamental matter, into mountains and continental margins. In the sections thus revealed, the sweepings of the earth—the sedimentary series—assume to our eyes magnificent proportions; but every now and then we have a glimpse of the real body of the earth (or, rather, of its real skin), cleaned from this dust of ages. In no spot on the globe have all the stratified rocks that are known to us been piled continuously one upon another; but, even if this had been the case, they would have formed a layer less than twenty-five miles thick. If we represent the earth's radius by ten inches, this layer would appear, on the same scale, as less than one-sixteenth of an inch.

Where, indeed, denudation has long been active, as in the northern regions of Europe and America, we find ourselves in the presence of a vast bared surface, in which there is little to remind us of the sediments of ordinary geological periods. Here and there, isolated relics, like the marine Jurassic beds of the island of Andö, suggest to us the coating of stratified rocks that once spread over much of this denuded area; but the main masses are of Pre-Cambrian age—that is, they underlie the beds that contain the oldest clearly recorded fauna on the globe. Here, then, we seem to be in touch with the true substance of the crust—with the floor on which our filmy continental or oceanic accumulations rest.

Without entering into microscopic details, we may see that there is a remarkable uniformity of character in the rocks that form this floor. Gneisses, resembling granites, but with a "streaked out" and even banded arrangement of their constituents, form the largest portion of the mass. Their chemical composition* almost always shows a high percentage of silica, and the alkalies amount to five or even eight per cent. Their essential structure, the "foliated" arrangement of their mineral constituents, may have been induced in them by pressure after they had become practically solid, or by the flow of the whole mass while the crystals were still in course of construction. The larger constituents thus possess a lenticular form, as if drawn out at their edges; and these lenses lie in similar positions throughout considerable masses of the rock. The smaller constituents seem to have flowed round about them, streaming on in fairly parallel layers; and thus "foliation-planes" have been set up, along which even coarse-grained gneisses tend to split when struck.

In many gneisses there are distinct rock-bands, some bands, for instance, resembling mica-schist, while others resemble fine-grained granite, rich in quartz and felspar (Fig. 1). In such cases it is quite possible that one type of rock has intruded into another in fine parallel sheets,† or that a viscid mass of varied composition has been pressed out underground, and so has received a gneissic structure.‡

Sometimes above the typical gneisses, and sometimes associated with them, there is usually a series of crystalline rocks of much finer grain and of greater variety of composition. Foliation is present in them, and they are classed collectively as schists. Mica-schist, a foliated mixture of quartz and mica (usually muscovite), and commonly accompanied by red-brown garnet, is the type most extensively developed. The schists present many analogies with sedimentary rocks, and many mica-schists have undoubtedly arisen from the extreme alteration of sediments under heat and pressure; but the planes of foliation only rarely correspond to those of original deposition, and the crystalline character of the constituents

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* See, for instance, Roth, "Allgemeine und chem. Geologie," Bd. II., p. 397.

† Compare A. C. Lawson, "A Multiple Diabase Dyke," *American Geologist*, Vol. XXVI., p. 296.

‡ See Sir A. Geikie and J. J. Teall, "On Banded Structure of Gabbros in Skye," *Quart. Journ. Geol. Soc.*, Vol. L., p. 657, and Plate XXVI.

has been, to say the least, intensified during alteration. Modern observation in this matter has supported the views of that master geologist, Charles Darwin, who opposed his opinion to that of Sedgwick, Lyell, and most of the teachers of his day.[*]

The present tendency is to regard the ancient schists and gneisses as a complex mass of formerly molten materials, which have successively intruded through one another, and which have been, as a whole, deformed and foliated by subsequent pressures.[†] Sir A. Geikie suggests that the "overlying graphite-schists, mica-schists, and limestones of the Gairloch and Loch Carron may thus be surviving fragments of the stratified crust into which these deep-seated masses were intruded," the latter masses now forming the Lewisian gneiss of Scotland.

In almost every area of ancient gneissic and schistose rocks, there is found a series of true sediments, deposited across the worn-down edges of the foliation-planes, but still earlier than the fauna known as Cambrian. Examples are the Huronian deposits of North America, and the little-altered Torridon sandstones that form the bulwark of western Sutherland. The occurrence of fragments of the fundamental rocks in this overlying series shows that the essential structures of the old complex gneissic group had been impressed upon it long before Cambrian times. Prof. Bonney[‡] is so struck by this fact that he regards the banding of the gneisses as due to conditions which have not repeated themselves since ordinary sediments began to be deposited upon the globe. Whether we adopt his view, or the more rigidly uniformitarian one of Sir Archibald Geikie, we must see in the complex floor of schists and gneisses the oldest rocks accessible to us in the earth's crust. For our present purposes they are "fundamental."

FIG. 1.—Block of Gneiss, twenty centimetres long, from Co. Mayo, showing (i.) curving upper surface formed by fracture along a foliation-plane; (ii.) dissimilar materials in different bands, the lighter ones consisting of quartz and felspar, and the darker ones being rich in dark mica; (iii.) a lenticular mass at the right-hand end, with the darker layers flowing round it.

Yet the upper boundary of the fundamental gneiss presents difficulties when it comes to be surveyed in detail. At times, subsequent pressures have obliterated the discordances between the gneissic surface and the overlying stratified deposits; the great earth-mill has rolled all these rocks out together, and has produced a community of structure, and even an appearance of continuity.[§] So that there is little wonder that the older geologists saw a complete passage from sediments into schists, and from schists into gneisses, and urged that gneiss was the ultimate stage of the alteration of ordinary sediments.

At other times the fundamental gneissic mass is found to send off dykes and veins into the overlying rocks, which we have hitherto regarded as being far younger than the gneiss. Sometimes these appearances may be due to the intrusion of a granite through both series, its close resemblance to the gneisses allowing it to lie among them undetected. But another solution has been offered, which presents us with a new aspect of the continental floor. Mr. Joseph Nolan,[*] in 1879, suggested that granitic intrusions might arise from the depression and remelting of an ancient metamorphic series. This series would remain for the most part "fundamental"; but its offshoots would, of course, be later in age—*i.e.*, in date of consolidation—than the rocks invaded by them. Prof. A. C. Lawson[†] has attributed much of the structure of the Laurentian gneisses of Canada to this second period of flow, and has provided us with excellent photographs of gneiss including fragments of the overlying series. Similar phenomena are recorded by Dr. Gregory[‡] at the junction between what was regarded as "fundamental gneiss" and the schists of the Western Alps; and the conclusion is arrived at that these central gneisses of the mountain-chain are as recent as Miocene and even Pliocene times. M. Michel-Lévy,[§] as is now well known, has proved that the gneiss-granite of Mont Blanc is intrusive in the schists surrounding it; so that here again we fail to recognise the true continental floor in its new guise of an igneous invader. General McMahon, again, sees in the gneissose granite of the Himálayas a rock of late Eocene age, and regards its foliation as the result of pressure acting while it was still a viscid mass. It is doubtful, indeed, if the gneissic cores of mountain-ranges ever represent the oldest rocks of the chain. Probably they have no age but that of the folding of the strata. The complex arch of stratified rocks was formed, and fused material (often derived from the continental floor) was forced into it as it rose.

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[*] "Geological Observations on South America," Minerva Library edition, pp. 439 and 440.

[†] Compare Sir A. Geikie, "Ancient Volcanoes of the British Isles," Vol. I., p. 117; and C. R. Van Hise, "North American Pre-Cambrian Geology," *Sixteenth Annual Report, U.S. Geol. Survey*, 1895, p. 753.

[‡] "The Foundation-Stones of the Earth's Crust," *Nature*, Vol. XXXIX. (1888), p. 92. Compare a very interesting paper on crystalline gneisses, by J. Lomas, F.G.S., *Geol. Magazine*, 1897, p. 537.

[§] See Van Hise, *op. cit.*, pp. 730 and 752.

[*] "Metamorphic and Intrusive Rocks of Tyrone," *Geol. Mag.*, 1879, p. 159.

[†] "Geology of the Rainy Lake Region," *Geol. Surv. of Canada, Ann. Report*, 1887, pp. 130-140.

[‡] "The Waldensian Gneisses and their Place in the Cottian Sequence," *Quart. Journ. Geol. Soc.*, Vol. L., 1894, pp. 235, 261, 270, and 273.

[§] *Bull. des Services de la Carte géol. de la France*, No. 9 (1890). See also Gregory, "Geology of Western Alps," *Science Progress*, Vol. III., p. 169.

Proc. Geol. Assoc., Vol. XIV. (1895), p. 93, and *Geol. Mag.*, 1897, p. 304, etc.

If doubt hangs round these masses, which were once thought to be ribs of the primordial earth, but which appear to be often of very modern origin, we may look with more respect upon the fundamental rocks exposed in broader areas. Scandinavia and the north of North America have already been referred to; but bosses of the continental floor appear in many places, entirely surrounded by the deposits of later days. In most of these cases the surrounding areas have subsided, leaving the resisting ribs and pillars of the old crust standing firmly. As the floor of the continent must also have subsided, to allow of the falling in of the upper layers, it is very likely that some contrary upward movement was at the same time given to these bosses and plateaux which now stand above the general level. While subsidence predominated, owing to the contraction of the earth's interior, we may conceive a buckling of the floor, some parts rising as others fell. The sediments slipped into the new hollows from the flanks of the masses across which they once had stretched; so that a series of dislocations (faults) now surrounds the exposed and elevated portions of the floor.

FIG. 2. Ridge of Ancient Rocks, seen from Church Stretton, Shropshire, showing their prominence in the landscape. (From a photograph by Mr. J. J. Cole, F.R.A.S.)

Suess[*] and Neumayr[†] have emphasized most strongly the part played by subsidence in bringing the resisting knots of the continental floors to light. The word "horst," used by Suess for a ridge left upstanding between two adjacent areas of subsidence, has become extended so as to include any old mass bounded by faults, along which younger strata have slipped down. Favourite examples are found in the Black Forest and the Vosges, which are bold highland areas composed mainly of "fundamental" rocks. The Feldberg in the former still rises 4901 feet above the sea, and the Hoheneck near Gérardmer gives us 4580 feet. On the north-east we have to cross the Danube to the Bavarian forest, and on the south-west we must reach the central plateau of France, to find the compeers of these high irregular masses.

In the uplands of Bohemia we find a wide exposure of the floor of Europe, giving us a strange undulating granite land. Every hollow is set with lakelets, beside which the villages are placed. One may travel day after day across the plateau, at heights of eleven hundred to thirteen hundred feet above the sea. Now one ascends a gentle swelling upland, but the towers of the town in the next hollow can already be descried across the ridge. The descent is thus similarly gentle; and the broad surface of the ancient rocks is only occasionally broken by a valley.

The central plateau of France presents very different features. It is far more broken, far more cut into; and portions of it, rising above the general level, are covered with heather, and seem to form independent moorland ranges. But, when we enter fairly on it, we soon recognise the old uniform surface of the plateau, though hundreds of streams have carved deep hollows, into which we descend from time to time. Thus, in the western portion of the plateau, we cross river after river running to the Atlantic, notably the lordly Vienne at Limoges, the Briance among the mountains of Pierre-Buffière, the Vézère at the foot of the steep street of Uzerche, and many other minor streams, until we drop from the rim of these antique highlands into the great valley of the Corrèze. The roads are carried, however, as far as possible along the ridges between adjacent valleys; we catch no glimpse of the streams until we actually cross them, lost as they are in the deep brown cuts that they have made; and looking across country from one high-perched village to another, the upper surface seems wonderfully level — a plateau undisturbed by structural lines. It is as if we could sweep Sutherland clear of the Torridon sandstone and other stratified masses, the rubbish heaps of the early days of denudation, and reveal the still older floor of fundamental gneiss and granite upon which these strata were laid down.

Upstanding blocks, then, in some places, vast denuded areas in others, reveal to us, across a continent, the nature of the floor on which it lies. The British Isles, as so often happens, serve us as a model of these larger geological features. If the Outer Hebrides recall to us the worn-down surface of North America, from the great lakes to Hudson's Bay, the hills east of Church Stretton (Fig. 2), the Malvern range, and the little plateau of Charnwood Forest are excellent examples of the "horsts." Formerly these masses were held to be igneous, and later than the rocks through which they now protrude. The patches of old strata upon their flanks were not unnaturally regarded as altered products of the easily recognisable beds on either hand. But more detailed mapping has shown that the floor of Europe is here brought to our notice through the covering of strata that once stretched uniformly from Wales to the eastern counties.[*] Old ridges, which were buried even in Cambrian times, have reasserted themselves, their horst-like nature being often evidenced by the great faults that can be traced

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[*] "Das Antlitz der Erde," Bd. I. (1883), pp. 167, 265, etc.

[†] "Erdgeschichte," Bd. I. (1886), pp. 309, 327, 331, etc.

[*] See, for instance, Geologists' Association, *Record of Excursions*, p. 412.

along their flanks. The fine range of the Malverns—the backbone of the English Midlands—may thus owe much of its pre-eminence to the subsidence of the country to the east, whereby the Trias now forms a lowland which is easily flooded by the Severn; while the Carboniferous rocks, which cause such mountainous country further north, are safely hidden away far below the reach of denudation.

The floor of a continent is, then, a reality—something that supports this wrinkled film of scarps and furrows, of level plains and axial ridges, on which we spend our lives. If we cross a continent and an ocean, we say that we have seen something of the world—much as a fly who should contemplate St. Peter's from the weathered surface of the dome. The true world lies beneath us; and as yet the only certain clue that we possess as to its constitution is its well-determined mean specific gravity. This figure is 5·6, as against 2·6 or 2·7 for the mean specific gravity of the accessible crust. Denser masses than those familiar to us in the crust thus seem to form the great body of our planet; and it is very likely that our continental floors are really portions of the lightest layer on the globe. Processes of denudation, acting on the surface, have separated the constituents of this layer; have collected, for example, the heavy iron-ores at some points, or have formed carbonates and sulphates and hydrous compounds, of various densities, at others; while heavier materials, forced up through fissures from below, have added sheets of basalt or bosses of gabbro to the manifold rocks of the outer film. Nor must we forget that the remelting of the old crust has locally enabled it to absorb masses above it, and has thus increased its mineral complexity. The general mass of the "floor," however, has remained much as it was—a series of granites and gneisses and highly siliceous schists of comparatively low specific gravity.

We must refer in conclusion to Mr. Osmond Fisher's "Physics of the Earth's Crust"* for a discussion of how this light siliceous layer is probably thicker beneath the continents and thinner beneath the oceans. Both the plumb-line and the pendulum tell the same tale. The former should be drawn out of the perpendicular by the attraction of high continental land; and from a survey of the mass of land that stands, in any case, above the level of the sea, the theoretical amount of deflection of the plumb-line can be calculated. But the actual deflection has been found, by experiments in India, to be less than the calculated amount. Archdeacon Pratt, after much labour, arrived at this conclusion; and Sir George Airy, in 1855, pointed out its probable explanation. The attraction of mountain-masses, and consequently of continents as a whole, is deficient, because the light crust is actually thickened beneath them; hence, for every great anticlinal ridge or bulge upon the surface a corresponding ridge or bulge seems to be formed downwards, displacing the more dense and basic matter below. Mountains have "roots," therefore, and tablelands are similarly thickenings of the light outer crust. If there is even a thin liquid layer—to make the smallest demand—beneath the consolidated crust, it is easy to see how lateral pressure in the crust may produce a bulge in two directions, both upwards and downwards. The continental floor, on these grounds, becomes still more real to us, and may be compared to the mass of concrete on which buildings are floated in equilibrium when foundations have to be laid in oozy mud or sand. The formation of these knots in the crust need not be opposed to our view of the instability of continents and ocean-basins; for the lower layers of a continental mass may become melted off, in accordance with Mr. Fisher's own "theory of the earth," while the thinner ocean-floor may become thickened in its turn by compression. Most of us, however, must be content to return from these somewhat speculative regions to the continental floor itself; and in the relations of the rocks that form it, in their mode of consolidation, their interpenetration, and the deformations suffered by them, we shall find absorbing problems for a lifetime.

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ECONOMIC BOTANY.

By John R. Jackson, A.L.S., etc., *Keeper of the Museums, Royal Gardens, Kew.*

INTRODUCTORY.

The first and by far the most important attempt, in this and perhaps in any other country, to elucidate and make popular the economic side of botanical science was begun by the late Sir W. J. Hooker, when in 1847 one room of the building now known as Museum No. 2 in the Royal Gardens, Kew, was fitted up for the purpose to which it has ever since been devoted.

The foundation and progress of the collections now contained in the three Museum buildings in the Royal Gardens is certainly remarkable. It was in the year just mentioned that the building, which had hitherto been used partly as a storehouse for fruit, "was added by command of Her Majesty to the Botanic Garden proper." The nucleus thus formed consisted of the Director's private collections, presented by himself. To quote from the official guide to the Museums: "No sooner was the establishment and aim of the Museum generally made known than contributions to it poured in from all quarters of the globe, until in a few years the ten rooms of the building, with its passages and corners, were absolutely crammed with specimens. Application was therefore made to Parliament by the Chief Commissioner for a grant to defray the expense of an additional building for the proper accommodation of the objects, and the house occupied by Museum No. 1, opened to the public in the spring of 1857, is the result."

From that time the collections have gone on increasing in importance and value till at the present time they stand unrivalled all the world over. Besides this, in almost every botanic garden at home and abroad, as well as in most teaching centres and in large towns, museums on the system of those so well known at Kew have been established.

The result of all this has been the diffusion of a knowledge of economic botany, so that at the present time the subject is taken up even by our elementary schools, most of which have their own small collections for teaching purposes. It must be confessed, however, that until the last ten or twelve years the subject did not command that attention its great importance deserved. The structure of plants, their affinities, their geographical distribution, and similar points attracted the attention of the scentific worker, who gave no consideration to their properties and uses. The connection, however, between the purely scientific and the economic sides is very apparent upon a moment's consideration. Thus, in some natural orders there is a distinct property running through the plants which constitute the order, which may serve as an indication of their botanical affinities and also prove them to be of economic value or otherwise. Such, for instance, we find in the *Malvaceæ*, where the inner barks for the most part abound in long soft fibres, and the roots and fruits of many are mucilaginous—the roots of the marsh

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* Second edition (1889), pp. 124, 195, 204, etc.

mallow (*Althæa officinalis*) and the fruits of gombo or ochra (*Hibiscus esculentus*) being illustrations—while in the allied order, *Sterculiaceæ*, the fibrous inner barks are interlaced. Again, in *Gentianeæ* all parts of the plants abound in a bitter principle, which makes them valuable as tonic or febrifugal medicines. Further, some natural orders abound in milky juices, some of which are wholesome while others are poisonous; and others, again, upon solidifying become elastic and form caoutchouc or india-rubber, and in this connection may be mentioned such orders as *Artocarpeæ*, *Euphorbiaceæ*, *Apocynaceæ*, and *Asclepiadeæ*. A knowledge, then, of the properties of the several natural orders, or of any group or genus of plants, is not only of assistance in their determination, but is also of much help in deciding their economic or commercial value. As a proof of this we may give but one illustration. It not unfrequently happens that new oil seeds make their appearance in the Liverpool or London markets, and, being unknown to the brokers, do not find buyers until their botanical affinity is determined, and their harmless or poisonous nature thus known. Serious consequences might otherwise arise if the seeds were allowed to be crushed, and the cake sold for feeding cattle. This is only one example of the importance of a knowledge of economic botany in connection with trade and commerce. That it is a great factor in the development of the resources of the vegetable kingdom all over the world we hope to show in succeeding articles, in which we propose to treat of the principal products in this great kingdom of nature.

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FROM A HOLE IN THE MUDFLATS.

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

In the months of December, January, and February the mudflats of our tidal rivers are not nearly so attractive to the ornithologist as in the autumn. Then the birds are much more numerous in species if not in numbers, owing to a great influx of migrants staying here and there for a brief visit on their way to the South. Amongst this host of migrants there may always be the chance of picking up a rare bird, and it is this chance, and the variety of the birds, which makes shore-shooting so much more interesting in autumn than in winter. Then, again, unless there is a hard and continuous frost, the birds become much wilder, and therefore much more difficult to obtain as the season advances. For instance, in August, when the young knot, godwit, sanderling, and others have just arrived from the North, they will often allow you to approach them on the open mudflat to within a few yards. In December these same birds will not allow you to come within two hundred or three hundred yards of them in the open. In the winter, therefore (except, as has been said, during a frost), the shore-shooter has to work very hard and resort to many stratagems to obtain the birds he wants.

There are many ways of getting within gunshot of these wary birds. They may be stalked if there is suitable cover, and the birds are near enough to it. This method entails careful marking down, generally a large amount of crawling, absolute silence, and frequent disappointments. The joy of one success, however, will compensate for a dozen failures. Another method is to hide behind a bank or in some suitable place near the high-water mark, and wait for the tide, which, as it advances, drives the birds before it and gradually within range of the hidden gun.

Yet another way, if you know the ground well, and have studied the flights of the birds over the land at high tide, is to lie hid in one of these lines of flight and take your chance of their flying within shot.

It will be easily seen that all these methods are very uncertain, and that their success or failure is influenced greatly by the element of luck.

There is no method known to me in shore-shooting that is certain to be a success, but perhaps the best all-round way of obtaining shore birds in the winter is to dig a hole in the mud, sit in it, and wait. This plan certainly does not appear a very cheerful one at first sight, but to anyone who is a really keen ornithologist it will soon prove a most interesting occupation, notwithstanding the cold, the cramped position, and the slimy mud.

As many of the readers of Knowledge have probably never either dug or occupied a hole in the mudflats, a brief description of how it should be done may prove acceptable. I was taught the art by a Yorkshireman, one of the best 'longshore-shooters I have ever known.

Carrying our guns, game bags, field glasses, a long-handled wooden spade, and a bundle of straw, we arrived at the river bank just as the tide was at its lowest ebb. It would be, I think, impossible to successfully dig a hole where the mud is a dead flat, because the mud thrown out of the hole is black, and being scattered about on the brown surface would scare the birds away for a mile round. There is, however, usually on every extensive mudflat a part which is more or less broken up into a wavy sort of formation.

We made our way to an excellent place of this sort about a mile from the shore, where long parallel ridges about three feet wide were separated from each other by troughs full of water. We selected a good wide ridge, flanked on either side by fairly deep ditches, and commenced operations. The bundle of straw was put on the mud, and on it were balanced my friend's gun and game bag, and his coat, for digging a hole in the mud is warm work on the coldest day. First of all a circle was marked out, and then the digging commenced, and the mud as it came out was thrown into the troughs at the side. The mud stuck, every now and then, even to the wooden spade, which had to be continually lubricated in the water to make it run

Low Tide.

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[*] If the shore-shooter is lucky enough to be living on the spot, he may think it worth while to sink a tub in the flats, and thus make things more comfortable; but few have the chance of doing this.

smoothly. Having dug a hole about three feet in diameter and three feet in depth, half the area was dug out another two feet in depth. When this was done, and the straw was put in and arranged round the sides, there was a capital and snug retreat, if a little dirty, with a good seat and plenty of room for the legs.

The hole should be dug to such a depth that when sitting in it the eyes are just above the surface of the mudflat. Of course the shape of the hole can be varied to suit its position. The water will not ooze through the mud, and a well-dug hole will keep quite watertight until the tide flows into it; but sometimes the stratum of mud is not very deep, and when the sand at the bottom is reached the water will immediately come through and soon flood the hole. A shallow oblong hole, of the same depth all over, can easily be made in this case. The plan then is to sit at the bottom and stretch the legs out, but this is a more cramped position than the other, and shooting is consequently made more difficult. Before getting into the hole, great care should be taken in levelling and hiding as far as possible the mud that has been thrown out, and the fewer the footmarks near the hole the better.

Birds, and especially the wading birds, have wonderfully keen eyes, and the slightest elevation or dark spot can be seen at a long distance on a mudflat.

Once seated in the hole the first thing is to make yourself comfortable. If the weather is cold the more straw you have and the thicker your clothes the better. Little "pockets" can be gouged out of the sides of your retreat, and filled with straw, forming convenient receptacles for cartridges and field-glasses. Cartridges should always be handy, because it is not easy to get at coat pockets when crouching in a hole. Next a few little wisps of straw should be stuck here and there round the rim of the hole on which to rest the gun. Great care should be taken over this simple precaution. In the excitement of the moment—say, when a big flock of birds is approaching—the muzzle of the gun is apt to be stuck into the mud, and when the gun is pulled away the barrels are securely "corked." The result is a damaged gun and perhaps a great opportunity missed.

When everything is arranged to your satisfaction you begin to look about you. You have the same view as a bird would have when it is sitting upon the mud—and an extraordinary view it is. Nothing but a flat expanse of mud stretching for miles all round. There is nothing to guide the eye—there is no correct idea of size or distance; a small stake a mile away looks enormous and quite near. There is no living thing to be seen—nothing but miles and miles of mud rolling away to your limited horizon, where the water can now and again be made out as it sparkles in the rays of a winter sun. Suddenly there is a swish of wings behind you, and a little dunlin appears like magic, and settles down within a few yards. Then comes another and another, until there is a small flock of them. Dunlin are silly little birds, and quite unlike the other birds of the mudflats. They never see danger until it is too late to escape. So these birds come and settle down within a few yards of a deadly gun, and, without looking round, immediately begin to feed. Common, tame, confiding, inconspicuous, low-bred little birds, they might appropriately be termed the sparrows of the mudflats. Nevertheless, they are very interesting to watch when they are near, and ignorant of the presence of a human being. They feed very industriously—running up and down the mud, probing with their slender bills here and there, and singing in a soft and pleasing way all the time. Now and again a couple will have a little dispute about some dainty morsel, which results in all sorts of little antics. There is never a stand-up fight, but just a little bickering and pushing and dancing about and the affair is over; one of them gets the tit-bit, and the feeding goes on as peaceably and assiduously as ever. The birds will walk all round you, but sooner or later one comes within a foot of your face, and then suddenly his terrible danger dawns upon him. He is startled out of his life, and flies up with a "tchurr," uttered as though he had a sudden catch in the breath. The others follow suit, and you are once more left in solitude.

The Bar-tailed Godwit. Photographed from Life by R. B. Lodge.

Now is the time to use the field-glasses. Ever so far away there is a huge black mass on the mud—it is a flock of, perhaps, six or eight thousand knot. Although to the naked eye it looked like a great black cloth spread out upon the mud, if you look carefully with the glasses you will see that it is continually moving. Every moment a bird flies up to change its ground, and shows its white under-side, which looks like a flake of snow against the black mass. Beyond this flock there are a number of large dark objects moving about. By their shape and the manner in which they feed you can tell they are curlew, although they are too far off for you to see their long curved bills.

Five fair-sized birds have risen from the mud and come flying towards you. At first you cannot make them out, but as they come nearer their long and slightly upturned bills and light brown plumage can be seen, and you put them down as godwit. Now, if you are on the east coast it is not every day you will see a godwit in the winter, so you are particularly anxious to get one of these birds. As ill luck will have it they seem to be passing right out of range, so you whistle "whee-whaup-whaup, whee-whaup-whaup." They have heard it and round they come. You keep on whistling and crouch low, and the silly birds come right over your head. Bang! bang! You have got one but missed the other, and you consider yourself lucky that they answered to the call.

Mr. R. B. Lodge, who is well known as a very successful bird photographer, has very kindly allowed me to here reproduce a photograph of a living godwit. When the unapproachable nature of shore birds (on account of their shyness and the want of cover) is taken into consideration, this photograph may be regarded as a triumph of skill and patience. I might here advise Mr. Lodge to try photographing birds from a hole in the mudflats. I feel sure it would prove a success.

After retrieving the godwit, and when you are once again settled down, you find that the tide has been slowly but surely creeping up, and as it comes so it drives in the birds with it. There are usually dunlin, grey plover, ringed plover, and a few other birds (according to the time of year), fairly near the shore even when the tide is right out; but the big flocks of knot, the flocks of duck and geese, the parties of curlew and others, generally feed right at the edge of the water. When the tide was far out, and there were a number of square miles of uncovered mud, it was just a chance if a flock, or a single bird even, came within the limited range of your gun; but now, with the tide well up, the feeding grounds circumscribed, and the flocks on the move, you will have the best chances of the day.

Lucky indeed is the man who, as he crouches in his hole, hears a deafening roar and rush of wings, and looks up to find one of those vast flocks of knot sweeping along, forty yards above his head. It is an impressive sound and a thrilling sight, and neither will be forgotten.

If the hidden gunner is not overpowered by the spectacle, and has the presence of mind to fire, he will pick up a score or two of birds than which none are better eating; but the sight and sound alone will be a rich reward for many hours of cold and dreary waiting.

It is, indeed, rare to be so close to one of these enormous flocks on the wing, but there are other good things that will come to the man who perseveres, even in sitting in a hole on the mudflats.

The curlew—one of the wariest of birds—may be watched at close quarters and brought to bag.

I well remember one winter's day. I had been watching and waiting without success for four hours in a hole which had taken some labour to dig, as more than one blistered finger testified. The tide was rapidly approaching and all chances of sport would soon be over for the day, when eighteen curlews suddenly appeared and settled down within two hundred yards of me. They commenced feeding, and to my disgust I soon saw that they were slowly walking further and further away. As a last resource I began to whistle softly "courlieu cur-cur-courlieu." They heard me and stopped feeding. I whistled louder and louder. They did not seem quite satisfied, but nevertheless they turned and began to slowly walk towards me, feeding as they came. I continued to whistle, and as they got nearer I could see them plainly and watch their every action: the leisurely way they fed—walking along in a stately fashion, and every now and again looking round or stepping aside to probe their long curved beaks up to the very base in the soft mud. Their manner struck me as a great contrast to that of the dunlin, with his dumpy little body, his quick run and eager probing here, there, and everywhere. But I soon began to wish the curlew would walk a little faster. I was becoming tired of whistling, and the tide was getting very near and would soon flood me out. At last one of the curlew was well within range and several more were fairly near. The water began to trickle into the hole, so I jumped up and made sure of the bird nearest to me, but missed with the second barrel. Had I been an older hand I should have done as a friend of mine once did. There was a flock of Brent geese walking towards him. He waited patiently until one of the birds actually came to the edge of the hole, and was naturally surprised to see a man there. The man jumped up and shot a goose a little distance off, and then bowled over the one which had been so near to him, and had by that time flown away about forty yards.

One has to be careful when walking off the mudflats at night. The ridges of mud are slippery and deceptive. I once fell full length into two feet of water, and drove my gun into the mud up to the breech. A friend of mine once stepped into an old hole which was full of water. Luckily, he went in feet first. Had it been head first, it is unlikely that he would have got out again.

A carefully dug hole will last two or three days before it either falls in or becomes silted up. Of course it fills with water and has to be baled out before it can be occupied again, and however dry it is baled it is never so comfortable as a freshly dug one.

In conclusion, let me recommend ornithologists to make a trial of "holeing in the clays." A close acquaintance will be made with a number of very wild birds, and many pleasant hours will be spent studying their ways. Moreover, there is certain to be some sport, and there may be such a chance as comes to the ordinary man but once in a lifetime.

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LIQUID FLUORINE.

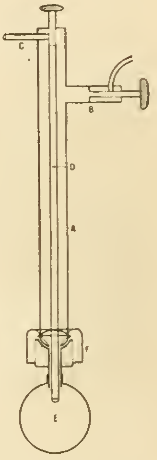
By C. F. Townsend, F.C.S.

THE alchemists of the middle ages believed that somewhere in the universe was to be found an universal solvent, which would dissolve the most refractory substances as readily as water dissolves sugar. They named their solvent liquor *alkahest*, and what time they could spare from the search after the elixir of life and the philosopher's stone was spent in the endeavour to obtain it. Science has yet to prove, by the way, that there was not more method in the madness of the alchemists than is generally supposed, for in the remarkable substance, fluorine, chemists possess a material that approximates very closely to an universal solvent. Its chemical energy is so fierce that, except gold and platinum, nothing can resist it; and even gold and platinum succumb to fluorine in time. The mere contact of most substances with fluorine is sufficient to cause, not mere solution, but light, flame, and fierce detonations. Dull, inert flint takes fire when exposed to fluorine vapour and becomes a brilliant incandescent mass. Lampblack bursts into flame, whilst charcoal burns with bright scintillations. Only the diamond is able to resist this powerful solvent, to which it does not succumb even at high temperatures. The similar element, silicon, which can be obtained in a crystalline form closely resembling the diamond, gives a magnificent display in the presence of fluorine, the crystals becoming white-hot and throwing showers of fiery spangles in all directions. The heat is so intense that the crystals melt, showing that their temperature has reached one thousand two hundred degrees Centigrade. Phosphorus combines fiercely with fluorine. Prussian blue, on account of the cyanogen it contains, burns with a beautiful pink flame; whilst from a crystal of iodine placed in fluorine vapour a heavy liquid distils with a pale flame. This liquid—an iodide of fluorine—etches glass, and if thrown into water hisses like hot iron. The last-named metal becomes white hot when exposed to fluorine; even iron-rust behaves in a similar manner. Nearly all metals are raised to vivid incandescence in a current of the gas, many appearing very beautiful, especially aluminium and zinc. If the latter be slightly warmed it bursts into a white flame too dazzling to gaze at or describe.

Although it has been known in various states of combination for many years, having been first discovered by Schwankhardt, of Nuremburg, in 1670, and rediscovered by Scheele in 1771, fluorine was not obtained as fluorine in the free state until about six years ago, when the French chemist, Moissan, succeeded in isolating it by employing a current of electricity from twenty-six or twenty-eight Bunsen batteries. The current was passed through the compound of fluorine and hydrogen known as hydrofluoric acid, which is similar to hydrochloric acid. To improve the conductivity of the hydrofluoric acid it was necessary to dissolve another fluorine compound in the liquid. As will readily be imagined, it is not so difficult to obtain free fluorine as to keep it when obtained. Every part of the apparatus used by M. Moissan was made of platinum, with screw joints and washers of lead, which swell on contact with fluorine; all the stoppers being of fluor-spar. Fluorine has a powerful affinity for silicon, one of the principal constituents of glass, so that it was impossible to use glass vessels or tubes to contain the gas.

As regards the chemical nature of fluorine, it is a gas at ordinary temperatures, and is the lightest member of the series of elements containing chlorine, bromine, and iodine. The attraction of fluorine for hydrogen exceeds that of chlorine, and is so great that if a slow current of fluorine gas be passed into a tube of fluor-spar containing a drop of water, a dark fog is produced, which changes presently to a blue vapour consisting of ozone—the condensed form of oxygen. The last-named substance appears to be one of the few materials which has no affinity for fluorine; nothing is observed to take place between them even when they are heated up to one thousand degrees Fahrenheit.

So far all experiments had been conducted with fluorine gas, which, at the time it was isolated, resisted all attempts to reduce it to the liquid state. Six years ago, however, there was no laboratory—such as that at the Royal Institution—having powerful machinery for producing liquid air or liquid oxygen, at the command of the investigator; in fact, liquid air itself was practically unknown. By the aid of this weapon, Professors Dewar and Moissan have succeeded in liquefying fluorine. At the extremely low temperature of liquid oxygen it was found that fluorine did not attack glass, and it was possible to use glass vessels to hold the newly liquefied element. The apparatus consisted of a small glass bulb, E, fused to a platinum tube, A, which contained another similar smaller tube, D. Each of the platinum inlet and outlet tubes, B and C, was fitted with a screw valve, so arranged that at any moment communication could be cut off, either with the outer air or with the current of fluorine. The whole of the little apparatus was placed in a cylindrical glass vacuum vessel (not shown in the figure) containing liquid oxygen, and connected with a vacuum pump and a manometer. On entering, the fluorine gas passed into the annular space and then down the tube, D, into the glass bulb. At the temperature of boiling liquid oxygen (–180° C.) the gas passed right through the apparatus, but without attacking the glass. As soon as the air pump was worked and the liquid oxygen boiled vigorously, a yellow mobile liquid—fluorine—was seen condensing in the bulb.



Apparatus for Liquefaction of Fluorine. (From the *Proceedings of the Chemical Society*.)

Although at this very low temperature (–185° C.) silicon, boron, carbon, sulphur, phosphorus, and iron, previously cooled in liquid oxygen and placed in the liquid fluorine, remained unattacked, a fragment of frozen benzene or oil of turpentine was acted upon with great vigour, accompanied by incandescence, showing that the great affinity of fluorine for hydrogen still remained.

Professors Moissan and Dewar noticed that if the liquid fluorine came into contact with liquid oxygen two layers were formed, the fluorine being at the bottom. If the oxygen was not quite dry they found that a white flocculent precipitate, which they believe to be an hydrate of fluorine, fell to the bottom. This could be filtered off, and detonated violently as soon as the temperature rose.

From the experiments it was found that the boiling point of fluorine is very close to –187° C., being identical with the boiling point of argon. This appears to be the first example of two gaseous elements boiling at the same temperature.

By boiling the liquid oxygen surrounding the fluorine at a very low pressure by the help of an air pump, the temperature was lowered to –210° C., but the fluorine showed no signs of solidifying. Nevertheless Moissan and Dewar hope to produce a still lower temperature by causing the liquid fluorine itself to boil vigorously at a low pressure.

The specific gravity of liquid fluorine was determined by dropping in small pieces of solid bodies, including wood, caoutchouc, etc., previously cooled in liquid oxygen. It was found that amber rose and fell in the liquid, so that the specific gravity of the liquid fluorine must be about the same as that of amber, namely, 1·14. No specific absorption bands were visible in the spectroscope.

These experiments, which are more than interesting, seem to show that there is no limit to the knowledge (of the material universe at all events) that mankind may hope to secure by patience and increase in mechanical skill, for the work just described has been carried on within sixty-three degrees of absolute zero, where, if our present knowledge is of any worth, the life of the universe itself would be extinguished.

Letters.

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

IS WEATHER AFFECTED BY THE MOON?

To the Editors of Knowledge.

Sirs,—I have been reading with much interest the article with the above title by Mr. A. B. MacDowall, M.A. There is one difficulty in connecting the barometric curves with the moon's age and position which he appears to have overlooked. It is this. His map of the curves is for London, but taking the meridian of London, and proceeding north or south, the pressure varies greatly on the same day. Thus there may be very high readings in London, whilst very low ones prevail over Scotland and the South of France, or *vice versâ*, according to the position of anticyclones or storm centres.

The same may be said regarding places having the same latitude. Storms cross the Atlantic in about a week, though they vary much in their rate of progress and the direction in which the centre of the cyclone advances. May not this be influenced by the increase or decrease of the moon's declination? If this is so, it would help to explain much which is obscure in the way the moon affects the weather.

Near the Equator one would expect to find evidence of any change of pressure caused by the moon's attraction, as twice monthly it passes directly over those regions. This, however, does not seem to be the case. In Southern India the barometer readings scarcely vary for months, excepting the daily tides, and a slight fall during the south-west monsoon.

The spread of this monsoon and the rainfall which accompanies it in Northern India has, I believe, been supposed to be affected by the moon's action, but I do not know on what data. During the monsoon there are usually breaks at intervals of about a fortnight, which would tend to support that theory. L. Paxton.

Lavant, Chichester.

[I did not overlook the point raised as a difficulty by Colonel Paxton. While I rather think the smoothed Greenwich curve might be taken as fairly representative for a considerable region (perhaps the greater part of these islands), I should not be surprised to find at some more distant stations either (1) an equally good correspondence, but with the waves retarded or advanced somewhat, or even opposite in phase to the Greenwich waves; or (2) a correspondence imperfect or obscured, or no proper correspondence at all. In the former case the evidence of lunar influence would, I consider, be strengthened, and in the latter I do not see that it need be seriously shaken. In a science so little advanced as meteorology, and dealing with such a "complex" of natural causes, we should be extremely chary, I think, about asserting what should or should not happen in this place or that on the hypothesis of some influence of astronomical nature. Our business as students of natural law is primarily with facts, and the interpretation of facts. And in the weather of any region, it seems to me, we may find so large an amount of regular correspondence with some astronomical cycle (that of the moon, *e.g.*), that it becomes more difficult to think all this agreement purely fortuitous than to believe there is a causal nexus between the phenomena. I do not assert it is so in the present case, though I may be inclined to hold it as a "pious opinion." If we find a good correspondence in one region and not in another, may there not be something in the peculiar position of the former region which tends to render the supposed influence apparent? And, similarly, if we find a good correspondence in certain years and not in others, may we not find this due to something special in the relative positions of the moon and the earth in the former case? Colonel Paxton's suggestion that the path of depressions may be influenced by the moon's declination seems to be well worth consideration.—Alex. B. MacDowall.]

To the Editors of Knowledge.

Sirs,—With reference to the article in your issue for January this year, entitled "Is Weather affected by the Moon?" may I be permitted to make a few remarks? As the writer states, the periods of concurrence between the barometrical curves and the various phases of the moon are irregular; or, to put it otherwise, he sometimes observes that they coincide. *Si post hoc, non ergo propter hoc*, is an excellent maxim in meteorology, as in other things. R. A. Proctor, in an essay called "Sunspot, Storm, and Famine," says as follows: "That for countless ages the moon should have been regarded as the great weather-breeder, shows only how prone men are to recognize in apparent changes the true cause of real changes, and how slight the evidence is upon which they will base laws of association which have no real foundation in fact. . . . And as the weather is always changing, even as the moon is always changing, it must needs happen that from time to time changes of the weather so closely follow on changes in the moon as to suggest that the two orders of changes stand to each other in the relation of cause and effect. Thus rough rules came to be formed; and as (to use Bacon's expression) 'men mark when such rules hit, and never mark when they miss,' a system of weather-lore gradually comes into being which, while in one sense based on facts, has not in reality a particle of true evidence in its favour—every single fact noted for each relation having been contradicted by several unnoted facts opposed to the relation."

Furthermore, I would like to know if pressure alone constitutes weather? G. E. E.

January 16th, 1898.

[While it is well to remind ourselves of the tendency above spoken of, the applicability of Proctor's remarks to the present case may fairly, I think, be doubted. We have to account for a barometric rhythm (similar to the lunar), persisting for the greater part of a year at one time. I have not represented that "pressure alone constitutes weather."—Alex. B. MacDowall.]

VEGETATION OF AUSTRALASIA.

To the Editors of Knowledge.

Sirs,—It is with some diffidence that I again venture to trespass upon your valuable space, but I can hardly allow Mr. W. B. Hemsley's remarks upon my letter in the September issue of Knowledge to pass unchallenged. It seems absurd to me—as it must also to anyone who read Mr. Hemsley's article in the May issue of this journal—that he should deny having written the statement I attributed to him, and accuses me of not having read the opening sentence carefully. In this Mr. Hemsley errs, for I read and re-read it, as I could scarcely credit my senses after a first perusal that a botanist of Mr. Hemsley's world wide reputation could be guilty of such a misstatement. Mr. Hemsley twits me with making a general statement *re* the genus *Ficus*, and characterizes it as misleading; it would have been an easy matter to have cited the forty species of this genus, but *cui bono?* If I may make the retort, Mr. Hemsley is still more misleading in his statements. "The Vegetation of Australasia" is the subject of his paper. Queensland forms a large part of

Australia, and Mr. Hemsley now acknowledges that it is much richer in useful plants, and especially in plants yielding edible fruits, than any other part of Australia. Mr. Bailey (and who knows better ?) says that Queensland is especially rich in plants of economic value; therefore Mr. Hemsley's general statement that "Australia contains comparatively few plants yielding products of economic value" is misleading on the face of it. It is very like begging the question to say that Queensland contains a relatively large Asiatic element, as distinguished from the characteristic Australian vegetation; this is not the point at all. The plants are in Australia and form part of its flora; their origin in this case matters not. In conclusion I trust Mr. Hemsley will not think I am playing the part of a carping critic, but I must join issue with him once more. His statement that "the aborigines use the bark *thrown off*" from gum trees, etc., for shelter (*ante*, p. 162), is incorrect. The bark thus shed or thrown off is utterly useless for the purpose assigned to it by Mr. Hemsley, being too brittle, very thin, crumbling almost to the touch, curled up by the sun, and only shed in pieces absolutely too small for any practical purpose whatever. The bark used by the aborigines, and by many colonists at the present time, is the true cortex, stripped from the tree by human agency—not nature's. Diagonal cuts are made round the circumference of a tree about a foot or so from its base, and another series of cuts, also round the circumference, about six to eight feet from those below; an incision is then made down the length of the trunk, the bark is tapped gently with an axe on the severed part, and, if the sap is well up, the result is a broad strong sheet of bark peeled right off from round the trunk. Needless to say, this operation kills the tree. I forgot to mention that Mr. Bailey is indeed surprised to hear that the produce of the plants named is known to commerce, and would be pleased to have more information on the point.

Taringa, viâ Brisbane, FRED. WHITTERON.
Queensland, 29th October, 1897.

[As Mr. Whitteron has renewed his accusation that I had stated that "the flora of Australia contains comparatively few plants yielding products of economic value," I will repeat here the opening sentences of my article (KNOWLEDGE, May, 1897, p. 118), which to my mind convey a very different meaning from that portion of a sentence he quoted in his first letter (September, p. 212):—"The popular impression respecting the Australian flora is that it contains comparatively few plants yielding products of economic value, and this is a correct impression so far as edible fruits and vegetables are concerned; but it should be remembered that this is true of most countries. Fruits and vegetables that come to our tables are the result of long generations of cultivation. Take the crab, carrot, parsnip, celery, or almost any of our fruits or vegetables in a wild state, and we should get very little satisfaction out of them. This, however, is a little digression. Australia is by no means poor in vegetable products, and other countries have been greatly enriched by importing and cultivating some of them."

I maintain that the foregoing sentences fairly express the actual facts, and that Mr. Whitteron's wild fruits, with few exceptions, would only be eaten by aborigines or persons in extremities. Returning to the forty species of *Ficus* or fig: Mr. Maiden, in his "Useful Native Plants of Australia," enumerates only three species, two of which he says are used as food by the aborigines; and of the third he cites a traveller who pronounced the fruit "very good," and a writer who states that the fruit is not edible; adding himself that the appetites of explorers frequently become voracious and not too discriminating.

I do not pretend that Mr. Maiden's book is complete and perfect, and I think it is very probable that there are better figs than he was aware of when he wrote. To give another example. In Sir Joseph Banks's recently published "Journal," p. 299, is the following passage:—"We had still fewer fruits; to the southward was one resembling a heart cherry (*Eugenia*), only the stone was soft. It had nothing but a slight acid to recommend it. To the northward we had a kind of very indifferent fig; a fruit we called plums, and another much like a damson, both in appearance and taste. Both these last, however, were so full of a large stone, that eating them was but an unprofitable business. Wild plantains we had also, but so full of seeds that they had little or no pulp."

Here, again, I do not assume that Sir Joseph Banks and his party, with all their knowledge and much as they needed such things, found all or the best the country yielded; but who has read the narratives of the many subsequent explorers in the same and different districts knows how little they found that served to keep body and soul together. Therefore I think the general and qualified manner in which I wrote is fully justified by the facts.—W. BOTTING HEMSLEY.]

* * *

EGG COLLECTING IN ITS RELATION TO SCIENCE

To the Editors of KNOWLEDGE.

SIRS,—In connection with Mr. Field's article in your December issue under the above title, I beg to ask the following questions:—(1) Why a light-coloured egg so persistently appears in the clutches of the eggs of some birds and very rarely or never in others? (2) Why are the eggs of some birds coloured at or around the smaller end, whilst those of others are scarcely ever so coloured? Never having accepted the theory that when a light-coloured egg appears in a clutch it is owing to exhaustion of the pigment, I paid considerable attention to this subject in the spring of 1889, taking the blackbird into my confidence.

The following observations, I think, clearly demonstrate that the exhaustion theory cannot be supported by facts:—

March 19th.—Eggs, four; all light in colour; first and third the lightest; all infertile.

March 25th.—Eggs, four; three dark eggs, one light. This brood died in the nest, probably from the cold. One infertile egg.

March 25th.—Eggs, three; the first the lightest coloured egg. All these were fertile.

April 15th.—Eggs, five; four eggs of the normal colour, one very light.

April 15th.—Eggs, five; three dark, two light. In this clutch the lightest coloured eggs weighed one hundred and twenty grains each, the dark ones one hundred and eighteen grains each.

April 20th.—Eggs, three; one egg light in colour; all fertile.
April 20th.—Eggs, five; three dark, two very light.
April 20th.—Eggs, four; three dark, one light.
April 22nd.—Eggs, three; second egg laid the lightest.
April 24th.—Eggs, four; first and fourth light eggs.
April 28th.—Eggs, four; first and fourth light eggs.

May 6th.—Eggs, four; the three first laid light in colour, the fourth darker and very much flecked; this egg infertile.

May 13th.—Eggs, six. In this clutch the first four were typical eggs of the blackbird; the fifth egg very light in colour; the sixth egg dark, and very much coloured at the small end. These eggs were all fertile excepting the fourth, which showed no signs of fertility. This clutch was laid by the same bird, and in the same nest, as the clutch dated March 25th.

The light-coloured eggs are, as a rule, a few grains heavier than the dark, and a dark egg often followed a warm moist day.

Again, in 1890, I watched a nest from day to day and obtained a clutch of five eggs—which I have before me. The first four laid are typical eggs of this bird, but the fifth—the last laid—has a beautiful pale green ground, with flecks and blotches of rich brown. This clutch would be considered by the votaries of the exhaustion theory as a fine illustration of their theory; but inasmuch as the flecks and blotches are numerous on the pale egg, there must be as much colouring matter on it as on any of the others.

The smaller end marking of eggs is a physiological enigma well worthy of the attention of oologists. This departure from the usual larger end marking is much more frequent among the eggs of the *Falconidæ* and the *Corvidæ* than among those of any other birds; and in looking through a series of twenty clutches of the sparrow-hawk—now before me—I see thirty per cent. of the eggs exhibit this peculiarity. Then, on the other hand, the six hundred clutches of the common house sparrow I have in my cabinet, exhibit less than a dozen examples.

Another question may be asked. Why do two birds of the same genus, namely, the corn bunting and the yellow bunting, oppose and support this style of coloration? I have a very long series of the clutches of both birds before me. In the former there are a very few examples of smaller end marking, whilst in the latter there is a large percentage; and in some of the clutches all the eggs have a circlet of fine lines around the smaller ends, leaving the crown quite bald.

I dare not trespass further upon your space beyond expressing a hope that some of the scientific contributors to your journal may write more fully upon this subject.

Royston, Herts. JOSEPH P. NUNN.

A BRILLIANT METEOR.

To the Editors of KNOWLEDGE.

SIRS,—It may interest you to know that an unusually brilliant meteor was observed from here in *daylight* at 5h. 7m. o'clock, Dublin time, this afternoon. It was seen by several persons. My companion and I saw it first about E.S.E., at a low altitude, perhaps twelve or thirteen degrees above the horizon. It appeared to travel slowly across the sky in an almost horizontal line, slightly inclining earthwards, and disappeared behind a cloud and the hills to the S.E.

The nucleus was very brilliant and large, and was surrounded by a glowing greenish colour; the tail tapered to a point, and was pink along the margins and glowing pale green on the central line. My companion describes the colour as sparkling green. Another observer at a distance from us (of five hundred yards or so) also observed the green colour. Our point of observation was about forty feet above mean sea-level; our view eastwards down the valley was unobstructed. Across the river to the S.E. hills rise about five hundred feet high, and over these some clouds rested; otherwise the sky was clear, and there was *good* daylight. No noise was heard. The wind was about S.W. and light; thermometer 52°.

Carrick-on-Suir, J. ERNEST GRUBB.
Jan. 21, 1898.

DISSOCIATION OF THE ELEMENTS.

To the Editors of KNOWLEDGE.

SIRS,—Dr. Emmens, of New York, has just published a book in which he says that he has obtained a new substance from iron and nickel, and the same substance also from cobalt. He also says that he has converted silver into a substance that cannot be distinguished from gold and which appears to be gold. Is not this an argument in favour of Sir Norman Lockyer's theory with regard to the pre-nebular condition of matter? He describes it as being matter too fine to receive a chemical name, which curdles and produces H. or something allied to H. Further curdling goes on and the dust of Mg., C., O., Fe., Si., and S. is produced, etc., from which I infer that he considers all the so-called elements to be derived from one kind of matter. If the same substance can be obtained from Fe. and Ni., and also Co., does it not appear as if these so-called elements are derived from one and the same kind of matter, or that they are compounds?—which latter is improbable.

Again, if one element can be converted into another, does it not seem probable that each so-called element had one and the same origin? Of course, we know that An. and Ag. belong to the same group of elements, also Co., F., and Ni.; but might not this grouping of the so-called elements point to the same conclusion that they have been built up from the same kind of matter? Might it not also be possible on further investigation to find relations which have not yet been recognized between the different groups of the so-called elements! It appears to me that there is a law, as yet not recognized by chemists, having some connection with temperature, in accordance with which law these so-called elements are built up from one and the same kind of matter. W. H. COCK.

THE BRITISH TRAP-DOOR SPIDER.

To the Editors of KNOWLEDGE.

SIRS,—In connection with the extremely interesting life history of *Atypus piceus sulz.*, the so-called trap-door spider of Britain, by Mr. Fred. Enock, in your November and December, 1897, issues, it may interest some of your readers to know that the Hastings colony is no longer nameless from the want of a mature male. On October 17th, 1897, I accidentally discovered the colony, and on the 31st obtained a mature pair, since determined by the Rev. O. Pickard-Cambridge to be *Atypus piceus sulz.*, the same unfortunately as all the other known colonies in Britain. I have since found several strong colonies in this district, widely distributed, but all *A. piceus.*

52, Tackleway, Hastings. H. G. JEFFERY.

THE URANIA STERNWARTE.

To the Editors of KNOWLEDGE.

SIRS,—I think the following extract will be of some interest to those of your readers who desire to see established, either in the metropolis or in some other large town of England, a similar institution to that now existing at Berlin, viz., the Urania Sternwarte, an institution referred to in KNOWLEDGE for September, 1897. I may add that I came across this extract quite accidentally, shortly after reading Mr. Lavalette's letter on this subject in KNOWLEDGE for August, 1897.

The following is the extract, which was in the *Penny Magazine* for September 25th, 1833.

> "PUBLIC OBSERVATORY.—A correspondent, who signs himself 'A Man of Kent,' says: 'Last week, for a shilling, I was able to make acquaintance with an aquatic world whose existence I, till then, had never been aware of. The "hydro-oxygen microscope" convinced me that a dewdrop may be as full of moving beings as Almack's. But I have been all my life, or half my life—that is, all the nights of it—desiring a nearer acquaintance with the stars; and I wish that my honest shilling could procure me admission to some observatory, where I could contemplate those enormous evidences of the Creator's power with as much ease as I did the minute atoms whose existence I had never known of before.' The hint appears to us well worthy the attention of those who have capital and enterprise. We have little doubt that the prevailing desire for knowledge would render a cheap observatory one of the most attractive objects in the metropolis."

If, sixty-four years ago, such an opinion was expressed, how much more now is there need for such an observatory!

IVO F. H. CARR-GREGG.

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

Wigeon nesting in Yorkshire.—On May 12th, 1897, whilst on a birdnesting expedition in a locality not very far from Scarborough which is largely frequented by waterfowl, I flushed a duck from the ground. A short search sufficed to find the nest—not very carefully concealed amongst some nettles at the foot of a small birch tree. The nest consisted of a hollow in the ground, thickly lined with down from the parent's body, mixed with small pieces of dead nettle stems and dry grass, these latter materials being sparingly used, and conveying the impression that their presence was more or less accidental. The nest contained nine cream-coloured eggs, which I immediately imagined could be no other than Wigeon's; but, being under the impression that this bird did not breed in England, I dismissed the idea as preposterous. As, however, if not a Wigeon's, I could not determine the species to which the nest belonged, I concealed myself, and after a short wait had the pleasure of seeing the parent return, accompanied by the male bird, and was able to see, beyond any doubt, that they were Wigeon. My delight at this unexpected verification of my surmise only an ardent ornithologist can conceive, and I lost no time in getting the camera to work, the result being two pictures—one of which is here reproduced. On June 2nd I was fortunate enough to find a second nest of the same species, containing nine young ones, near the same place. As the locality was not far from the private lake of a gentleman who keeps a large number of waterfowl of various species, I took the first opportunity of inquiring if there was any probability of the parents having strayed from his place; and was informed that although his birds were pinioned, frequently their progeny escaped in the spring, and that, very possibly, those I had found were some of the home-bred birds. At the same time, during the winter months, the lake and adjacent river are visited by very large numbers of perfectly wild birds, most of which leave in the spring; but it is possible that one or two pairs, attracted by their pinioned companions, suitable surroundings, freedom from molestation, and a plentiful food supply, may have stayed to breed.—Wm. J. Clarke, Scarborough.

[The Wigeon breeds in the North of Scotland, and in a few places in Ireland, but it has never yet been known to breed in a wild state in England. Mr. Clarke's note is of great interest, since it proves that the nest of this bird may now be looked out for in England, with a fair possibility of success. It is unfortunate that semi-domesticated birds were in the vicinity; and taking this into consideration, it is impossible to accept these birds as truly wild ones, and, on this evidence, to add the Wigeon to the birds which breed in England.—H. F. W.]

Hoopoe in Sussex.—An immature female Hoopoe was shot in the Paternoster Wood, Hartfield, Sussex, on December 14th. I cannot find that one has ever been recorded so late in the year before; and as they have been known to breed in the southern counties, is it possible the bird is a native and not a migrant?—Emma L. Turner, December 25th, 1897.

[The Hoopoe occasionally visits us in winter. If the Hoopoe were not so persistently persecuted it would, without doubt, become a regular breeding species in England; but it is never likely to stay here during the winter.—H. F. W.]

Early Nesting of Birds.—An interesting effect of the continued mildness of the weather this season has been the extraordinary fact that several birds have been observed with nests and eggs in December. In the *Field* we find records of Wild Ducks with nests and eggs in the middle of December, and a Robin with a nest and egg on December 16th.

On Hybrids between the Capercailie and the Pheasant. By W. Eagle Clarke (*The Annals of Scottish Natural History*, January, 1898, pp. 17-21).—The fourth example of this curious hybrid is here recorded and described. The bird, which is a male, was obtained in September last at Stronchullin, Blairmore, south-east Argyllshire, where it had been observed for eighteen months, and was sent to Mr. Harvie-Brown by Mr. G. H. Black. The author also describes and gives the history of the other three examples known to science.

Rose-coloured Pastor in West Ross-shire (*Annals of Scottish Natural History*, January, 1898, p. 49).—A bird of this species is recorded by J. A. Fowler as having been obtained on August 16th, 1897, at Inverbroom.

Sabine's Gull in Arran (*Annals of Scottish Natural History*, January, 1898, p. 52).—John Paterson records the capture of an immature specimen of this bird on the shore at Sliddery, Arran, on September 22nd, 1897.

Montagu's Harrier breeding in Ireland.—Correction. (*The Zoologist*, January 15th, 1898, p. 24.)—Mr. John H. Teesdale, who reported the shooting of a specimen of this bird from a party of six in County Kerry (*see* Knowledge, November, 1897, p. 257), now writes to *The Zoologist* that, after further examination, Dr. Sharpe has pronounced the bird to be a young male of the Hen Harrier.

Pectoral Sandpiper in Norfolk. (*The Zoologist*, January, 1898, p. 25.)—An adult female of this species is recorded by J. L. Newman as having been procured on Breydon, Norfolk, on August 18th, 1897.

The Red-crested Pochard (Fuligula rufina) *in Westmoreland* (*Ibis*, January, 1898, p. 176).—The Rev. H. A. Macpherson writes that an immature male of this species was shot in a small tarn in the neighbourhood of Haweswater, Westmoreland, on the 9th of October, 1897.

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.*

Note.—The first issue of Knowledge containing British Ornithological Notes was that for October, 1897.

Science Notes.

A portion of a roadway, believed to be of Roman origin, has recently been discovered at Reigate. The path—fourteen feet wide, and five feet below the surface—is composed of flints, the edges of which have been trimmed to fit, and is altogether of a very even character. By some local archæologists the path is considered to be a continuation of the noted Pilgrims' Way to Canterbury Cathedral, which passes through the town of Reigate; while others contend that it formed part of the old Roman road from Winchester to London.

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The Council of the Royal Astronomical Society have awarded the Gold Medal of the Society for this year to Mr. W. F. Denning, "for his meteoric observations, his cometary discoveries, and other astronomical work." The medal will be given to Mr. Denning at the annual general meeting of the Society next month.

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The Geological Society's medals and funds this year are awarded as follows:—The Wollaston medal to Prof. F. Zirkel, the Murchison medal and part of the fund to Mr. T. F. Jamieson, the Lyell medal and part of the fund to Dr. W. Waagen, the balance of the Wollaston fund to Mr. E. J. Garwood, the balance of the Murchison fund to Miss J. Donald, the balance of the Lyell fund to Mr. Henry Woods and Mr. W. H. Shrubsole, and a part of the balance of the Barlow-Jameson fund to Mr. E. Greenly.

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The want of an independent water supply has long been felt at the Zoological Gardens, and recently it was decided to put down an artesian-bored tube well. The results have been, as was anticipated, the tapping of powerful springs of pure water in the chalk, at the depth of four hundred and fifty feet, yielding two hundred and forty thousand gallons per day.

◆

Sir William Gowers, F.R.S., is one of a very few who can trace their success in the world to the accidental influence of shorthand. It was his skill in this art which determined that he should stay in London instead of going into an obscure practice at Bournemouth; it was shorthand which gave him the post of secretary to Sir William Jenner. Those who have been influenced by his books should know that they owe to shorthand every word of them—not one of them would have been written had Sir William been ignorant of shorthand. He contends that that which is secured by the use of shorthand, even at a low speed, is this: in a given time there can be twice the amount of record that is possible with longhand, and yet twice the time in which to observe; and thus transient phenomena can be adequately described which would elude entirely the slow pursuit of longhand. Without the use of writing the facts that pass before him will leave only transient furrows on the sands of unaided memory, vanishing for the most part when new facts disturb the surface; and only immediate record can preserve from these dangers the personal science on which depends the work of those who apply their knowledge to the welfare of the race. It is a prevalent idea that shorthand can be written but cannot be read. On this head Sir William says: "The popular error that it is illegible is due to the immense number of shorthand writers who learn only to write and to immediately transcribe, and who have taken no pains to secure the ability to read. Because reading is not a spontaneous result of writing, it is assumed to be impossible. The ability to read shorthand can indeed be acquired perfectly without any ability to write it, and is sometimes acquired."

Notices of Books.

Light, Visible and Invisible. By Silvanus P. Thompson, D.SC., F.R.S. Illustrated. (Macmillan & Co.) 6s. net. There can only be one opinion upon this book, and that opinion is that the book is excellent in every respect. A course of Christmas lectures at the Royal Institution has to fulfil several conditions, chief among which are: language simple enough to be understood by people who are not engaged in scientific work, experiments numerous and striking, and attention to recent work of importance. Given these conditions and a capable lecturer, and you evidently have the material to construct a work of science at once popular and authoritative. Prof. Silvanus Thompson's book had such an origin, and we have no hesitation in saying that it is one of the best works of its kind ever put before an intellectual public. The student of optics will learn more from it than from half a dozen examinational text-books; the teacher will find inspiration for many instructive experiments; and the general reader whose mind has not been vitiated by indulging in a pabulum of scraps of science will find the whole book a source of mental pleasure. The general facts and principles of the science of light are first described, then the spectrum and the eye, and afterwards follow in succession chapters on polarization, the invisible spectrum (ultra-violet and infra-red parts), the invisible spectrum and Röntgen radiation. The treatment of polarization—a difficult subject to grasp thoroughly—is lucid in the highest degree. The illustrations rank among the best specimens of half-tone process work, and the whole volume is a delightful example of the way in which science should be presented to intelligent readers.

Studies in Psychical Research. By Frank Podmore, M.A. (Kegan Paul & Co.) Before entering on a brief criticism of the contents of this book it is only fair to state that Mr. Podmore deals with his material in what, according to his light, is a perfectly impartial mind. His object throughout appears to be to get at the bottom of the subject, and he sifts the evidence on both sides.

Faith—that's the word—and in it lies the explanation of most spiritualistic phenomena. But it is not given to all of us to see things with an eye of faith, or to be the fortunate percipients of any phenomena which cannot be explained by physical laws or be referred to a derangement of the mental faculties. Mr. Podmore shows that many of the so-called spiritualistic manifestations are due to trickery. Upon a hardened physicist, who has never seen a ghost or heard noises which could not be accounted for physically, who has never been worried in a haunted house or deluded by theosophical revelations, Mr. Podmore's narratives do not make the faintest impression. We learn science through individual experience nowadays, and the results obtained can be tested by anyone who so desires. Is it any wonder, then, that when a set of phenomena which we cannot reproduce at will is brought before us, we are apt to regard it with incredulity?

A number of cases are given of visions received within a few hours of the death of the persons represented. With reference to all of these we say that the evidence is in many cases very weak, and that the accounts of the visions were generally written after the event, whereas they should have been set down before. It is not following a scientific method to select cases when the visions have come true, and leave out of consideration those which have not. Very many people see visions and dream dreams and forget all about them; and we venture to assert that the number of visions and dreams which go unfulfilled far outweigh the few which are afterwards found to have some relation to subsequent events. With regard to cases of secondary consciousness, when two distinct individualities are represented in one person, they are due to mental aberration, and furnish subject for inquiry by students of neurology rather than by psychical researchers. Hallucinations of various kinds may also often be found to have their origin in disorders of the optic nerves.

The Reliquary and Illustrated Archæologist. Vol. III. 1897. (Bemrose.) 12s. net. Another annual volume of this luxurious quarterly has been forwarded to us. The illustrations, which constitute the principal attraction, will afford an immense treat to those who delight in antiquarian research. A noteworthy feature is the inclusion of a plate depicting a corner of Chancery Lane as it appeared in the year 1798. We are informed that Isaac Walton lived in one of these houses from 1627 to 1644. The frontispiece is a plate giving a presentment of His Satanic Majesty -the Prince of Darkness—as he is represented at Notre Dame Cathedral, Paris. Other features are no less absorbing; and, of course, the illustrations are accompanied by articles written by experts on the several subjects, the whole forming a most artistic book.

Problems of Nature; Researches and Discoveries by Gustar Jaeger, M.D. Edited and Translated by Henry G. Schlichter, D.SC. (Williams & Norgate.) This selection from the papers of Dr. Jaeger—better known by his hygienic clothing than for his scientific work—are worth publication. The papers cover a variety of subjects in zoology, physiology, anthropology, etc.; and though they were first published between twenty and thirty years ago, many of the ideas contained in them have been justified by discoveries made since their appearance. The essays on Darwinian principles reveal a mind familiar with organic life in many aspects, and acute enough to solve some of the problems involved in it. They would have been given additional value if not only the date of publication, but the organ of publication, had been given at the head of each.

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SHORT NOTICES.

Practical Physiology. By Alfred F. Blaisdell, M.D. (Ginn & Co.) Illustrated. 5s. Of all works on physiology that we have perused none seem to approach nearer to the ideal text-book than this one. Physiology as a science is usually taught in schools as a mere catalogue of facts, and very little attention is, as a rule, devoted to its usefulness from the hygienic point of view. One may learn all about the heart, brain, and skeleton of the human body, and yet not be a bit wiser as to the way in which diseases of the human subject may be combatted or prevented. Dr. Blaisdell steps into this breach, and supplies abundance of advice for every emergency. Numberless experiments are given, and chapters on accidents and first aids to injured persons are included. The illustrations, two hundred in number, are excellent.

Reform of Chemical and Physical Calculations. By C. J. T. Hanssen. (Spon.) Illustrated. One great drawback in the interest of chemists and physicists for the last hundred years has been the non-uniformity of the standards of calculations adopted by different nationalities. An attempt is here made to mininize this confusion by adopting a method of calculation which avoids long rows of decimal fractions—discordant values attributable to the variation of the acceleration of gravity in different latitudes. The idea is to establish a chemical and physical observatory on the west coast of Italy, and to take as standards the results of observations made there. The international weight of oxygen—a cubic metre of which weighs, at lat. 45°, 1·42909 kg., and at lat. 52°, 1·43003 kg.—at this place comes out to a very simple figure; and as hydrogen is proposed to be the unit adopted, the exact weight of one cubic metre can be ascertained. The author calls places of the same latitude the "circle of international gravity," which will be to chemists and physicists what Greenwich is to astronomers.

The Story of Germ Life—Bacteria. By H. W. Conn. (Newnes.) Illustrated. 1s. We have already noticed other books in this handy series, and this one in particular is welcome, as it deals with an important branch of modern medicine. It aims at imparting a clear and popular account of these low forms of life, and, as the author remarks in his preface, to enlighten the public as to their power of doing good and bad service to mankind. For example, it may interest consumers of the fragrant weed to know that the different flavours of the various grades of tobacco are probably due to fermentation set up in the curing process by different kinds of bacteria. The inclusion of more illustrations would have enhanced the attractiveness of the book.

We have received a copy of the Thornton-Pickard 1898 catalogue. This issue is in no way inferior to previous ones, either in the way in which it is "got up," or in the value and novelty of the matter which it contains. We especially note particulars of a new shutter at a cheaper rate than hitherto, and a five-by-four Amber camera. We doubt not that these instruments will maintain the high standard of excellence set up by this firm.

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BOOKS RECEIVED.

Photo-aquatint and Photogravure. By Thomas Huson. (Dawbarn & Ward.) Illustrated.

Status of Birds in the British Isles and in Devonshire. By H. M. Evans. (Brendon & Son, Plymouth.) 1s.

An Illustrated Manual of British Birds—Parts II. and III. By Howard Saunders. (Gurney & Jackson.) Illustrated. 1s. each.

A Treatise on Chemistry. By H. E. Roscoe, F.R.S., and C. Schorlemmer, F.R.S. Vol. II., Metals. Revised Edition. (Macmillan.) Illustrated. 31s. 6d.

First Year of Scientific Knowledge. By Paul Bert. Revised Edition. (Relfe Brothers.) Illustrated.

Ambroise Paré and his Times: 1510-1590. By Stephen Paget. (Putnam's Sons.) Illustrated. 10s. 6d.

Views on Some of the Phenomena of Nature. By James Walker. (Sonnenschein.) 3s. 6d.

John Bright. By C. A. Vince, M.A. (Blackie.) 2s. 6d.

Nature Study in Elementary Schools. By Mrs. Wilson. (Macmillan.) Illustrated. 3s. 6d.

A Trip to Venus. By John Munro. (Jarrold.) 3s. 6d.

Reader's Shakespeare—The Comedies. By David Charles Bell. (Hodder & Stoughton.) 3s. 6d.

What is Life! By Frederick Hovenden. (Chapman & Hall.) Illustrated. 6s.

Notes on Carpentry and Joinery. By Thomas Jay Evans. (Chapman & Hall.) Illustrated. 7s. 6d.

Experimental Work in Chemistry. By E. H. Cook. (Arnold.) Illustrated. 1s. 6d.

The Tutorial Chemistry. Part II., Metals. By G. H. Bailey, D.SC. (Clive.) Illustrated. 3s. 6d.

Geometry for Beginners. By George M. Minchin, M.A. (Clarendon Press.) Illustrated. 1s. 6d.

The Observer's Atlas of the Heavens. By W. Peck, F.R.A.S. (Gall & Inglis.) 21s. net.

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TOTAL SOLAR ECLIPSE, JANUARY 22, 1898.

IT is gratifying to learn that those who journeyed to India to observe the eclipse have enjoyed all the opportunities which favourable meteorological conditions can present for the observation of a total solar eclipse, and there is every encouragement to believe that the results of the several expeditions will form a pleasing contrast to the almost universal failure which attended last year's efforts. The sun was gradually blotted out, and a corona of pale silver and blue appeared. As the eclipse reached its zenith the temperature fell rapidly and the atmosphere became perceptibly chilly. The light during the middle of totality was greater than that from the full moon. The spectacle was magnificent, and excited a feeling of awe and astonishment among the beholders—a scene resembling a landscape under a wintry English sun.

The general shape of the sun's corona was like that seen in the eclipses of 1886 and 1896—that is to say, white, downy blooms winging the dark ball of the moon all round its circumference, but larger on each side of the sun's equator than elsewhere. The streamers, the light of which had a thready aspect, extended into space for an apparent distance of four and a half diameters of the moon. The detailed polar structure arranged itself in lines, as iron filings round the poles of a magnet. The

SPIRAL NEBULA MESSIER 33 TRIANGULI.

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

exposures made with the kinematograph for corona were successful, but no shadow was observed. The spectrum of the chromosphere and prominences was successfully observed with an opera-glass fitted with a direct vision prism in one of the eyepieces, and the spectrum of the "flash" was photographed with a prismatic camera and with a six-inch telescope. Indeed, all instruments, with the exception of the integrating spectroscope, appear to have responded fully to the most sanguine hopes of their respective manipulators, and we have had what may be called a record eclipse.

Native astrologers had prophesied all kinds of calamities, including a tidal wave at Bombay and the downfall of the British raj. Immense crowds bathed in the waters of the Ganges at Benares, Calcutta, and other centres during the eclipse; the bathers at Back Bay tied Durab grass to their clothes, and put some of it into pickles and preserves, to ensure that they should not be affected by the eclipse. Religious Hindus sat down and counted their beads at the moment of contact, at the same time reciting mantras or prayers, and hymns, and there was general fasting. It is the impression of some of the Hindus that when there was no British raj in India the solar eclipses occurred once in twelve years, and that they are now more frequent on account of the increase of sins and misdeeds. Here and there on the foreshore stood Parsees, zend or avasta in hand, and with their faces turned towards the sun; priests, ever ready to receive alms, ceased their solicitations during the eclipse. Beggars, however, swarmed nearly everywhere, crying for alms for the recovery of the sun from the jaws of the dragon Ráhn.

Mr. E. Walter Maunder, whose well-equipped party was favoured with excellent conditions for observing and photographing, will contribute a detailed account of the eclipse to the April Number of Knowledge.

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PHOTOGRAPH OF THE SPIRAL NEBULA MESSIER 33 TRIANGULI.

By Isaac Roberts, D.Sc., F.R.S.

The annexed photograph of the nebula was taken with the twenty-inch reflector on November 14th, 1895, with an exposure of the plate during 2h. 15m., between sidereal time 1h. 18m. and 3h. 33m. A previous photograph of the object was taken with an exposure of three hours, on 27th November, 1891.

Scale of the photograph, one millimètre to twenty-four seconds of arc.

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

Star (.)	D.M.	No. 256	Zone 29°	R.A. 1h. 26m. 8·8s.	Dec. N. 30° 6·5′	Mag.
,, (..)	,,	260	,,	,, 1h. 28m. 1·3s.	,, 29° 53·6′	,, 8·0
,, (·.·)	,,	265	,,	,, 1h. 29m. 38·5s.	,, 30° 9·3	,, 9·2
,, (::)	,,	246	,, 30°	,, 1h. 28m. 49·4s.	,, 30° 47·6′	,, 8·4

The nebula is referred to in the N.G.C. No. 598, G.C. 352, h 131, and is figured in the *Philosophical Transactions*, 1850, Plate XXXVI., Fig. 5, and in 1861, Plate XXXVI., Fig. 10, and in the "Observations of Nebulæ and Clusters of Stars," p. 20, where Lord Rosse describes its spiral character, which he was the first to detect.

This nebula is one of the many that cannot be adequately described by words, or delineated by eye and handwork, because of its very complicated, tortuous, and ill-defined structure as seen with a telescope; but the annexed photograph, and, better still, the original negative, enable us to see the remarkable contortions, and the nebulous and star-like condensations, of which the nebula is formed. We can also see the relationship of its parts and their connection in the formation of the object as a whole, so that much of the mystery concerning it, previously to the revelation by the photograph, is removed.

It will be seen that there are two large, very prominent, spiral arms, with their respective external curvatures facing north and south, and that the curves are approximately symmetrical from their extremities to their point of junction at the centre of revolution, where there is a nebulous star of about tenth magnitude, with dense nebulosity, elongated in north and south directions surrounding it. Involved in this nebulosity are three bright and several faint nebulous stars; the two arms are crowded with well-defined and with faint nebulous stars, having nebulosity between them; and it is to the combined effect of these that the defined forms of the arms are due.

Besides these two arms there are subsidiary arms, less well defined, which are constituted of interrupted streams of faint stars and of nebulosity intermingled together. Many of these stars are nebulous, and many are well defined at their margins, but small. The interspaces between the convolutions of the spiral are more or less filled with faint nebulosity, having curves, rifts, fields, and lanes, without apparent nebulosity in them. They are like the interspaces in clouds of smoke, and cannot be classified.

There are outliers of nebulosity with many small well-defined stars as well as nebulous stars involved in them, and there are also isolated nebulous stars on the extreme boundaries of the nebula; the evidence is strong that they are all related to the nebula.

These descriptions, and more, can be verified by examination of the photograph and the negatives; and they arouse in us the desire to know the kind of cataclysm —for such it appears to have been—that produced the general smash and redistribution of the pre-existing matter. Was it the collision of two suns (with or without attendant satellites) in space, moving from opposite directions, with the high velocities known to exist, and smashing each other so that the material of which they were composed was scattered in a thin discoid form of a mixture of meteorites, meteoric dust, and nebulosity? Was it a collision between two swarms of meteorites, or of two clouds of nebulous matter, or of one of each kind?—for we know with certainty that both forms of matter (meteoric and nebulous) are common in space, and that they extend over areas of sufficient magnitude to include this nebula—or is there another more probable cause?

We may with considerable confidence draw inferences as to the future development of the nebula, for it is evidently aggregating into stars; and those aggregations are assuming the various lines and curves that we can trace in the finished stars which are strewn over the sky.

This nebula is not an isolated example of its class which has been revealed by the aid of photography. There are, for instance, the great nebula in *Andromeda*, Messier 101 *Ursæ Majoris*, and 74 *Piscium* resembling it, though the two last named are further advanced in symmetrical development than M 33; but it is not a tax on the imagination, when the respective photographs are compared with each other, to satisfy our sense of sight that the construction of these four nebulæ has resulted from similar causes, and that their developments into curves and lines of stars are proceeding on identically similar principles.

We have as yet no guide to enable us to form an opinion concerning the rate of their progressive development, for the intervals of from four to eight years that have elapsed since the first and second duplicates of the photographs of these objects were taken, are insufficient to show sensible changes that may have taken place in their structures; but ere long such changes will inevitably be perceptible, and the photographs will with certainty reveal their extent and character.

Who can say that a catastrophe, such as may have produced any one of these nebulæ, will not occur in our time, and that we shall not be both eye-witnesses as well as recorders of the beginning of another new spiral nebula, in addition to the convincing evidence furnished by those already published, showing the evolution of new stellar systems by processes of disintegration and re-aggregation?

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MOON IN ECLIPSE, JANUARY 7, 1898.

On last Friday night I was watching the eclipse of the moon, and was struck with the density of the penumbra, which prevented the outline of the earth's shadow being distinguished. The penumbra also seemed irregular in shape. As the night was fairly clear I took a photograph with a twelve and a-half inch Calver's reflector, with one of Browning's Kellner eyepieces. Time of exposure, one and a-half seconds. L. Paxton.

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THE SPECTRA OF BRIGHT STARS.*

By E. Walter Maunder, F.R.A.S.

There is no branch of spectroscopy without its charm, but the study of the spectra of stars has an attraction all its own. Their likenesses and their differences are so suggestive; they hint at so much of revelation as to the secrets of world life; they have, like an inscription in unfamiliar characters and in an unknown tongue, so plainly a message to tell if we could but interpret them. At such interpretation we have indeed made our first attempts: the riddle is not all unread; we have spelled out a word—it may be even a sentence—here and there, and, like Cleopatra's soothsayer, can say:

> "In Nature's infinite book of secrecy
> A little I can read."

A little as yet; still our knowledge grows, and the fullest putting together of the starry hieroglyphs, the completest alphabet yet formed from them, has just been laid before us.

This work, like so much in the same department of astronomy that has preceded it, comes to us from the Harvard College Observatory, and from that section of it which the munificence of Mrs. Henry Draper has enabled Prof. Pickering to develop.

The great Draper Catalogue was the result of a survey of all stars down to the eighth magnitude, but the dispersion employed was necessarily small, and only the most salient features of the different spectra were brought out. Volume XXVIII., Part I., of the "Annals of the Observatory" continues the photographic study of stellar spectra, giving, however, but six hundred and eighty-one stars as compared with the ten thousand of the Draper Catalogue; but these have been photographed on so much fuller a scale that our advance in the knowledge of stellar constitution will owe far more to it —and one cannot, indeed, help regretting that the more special discussion had not preceded the more general.

The present survey is based upon examination of some four thousand eight hundred photographs, representing the spectra of six hundred and eighty-one of the brightest stars north of −30° declination. The instrument used was a telescope of eleven inches aperture and a focal length of one hundred and fifty-three inches, used in connection with objective prisms in number one to four, each of which had a refracting angle of about 15°. The faintest stars could, of course, be only photographed with one prism; the brighter were therefore photographed not only with the highest dispersion they would bear, but in a number of cases with one or two prisms for the sake of better comparison with the fainter stars. The solar spectrum was photographed for comparison with the same telescope, combined with the Draper fifteen-inch reflector used as a collimator.

The detailed study of these spectra and their classification has been the work of one lady, Miss Antouia Maury, and has occupied her nine years. The most considerable part of this great work is therefore hers alone, though the taking of the photographs, a large part of the determination of the wave-lengths, and of the preparation of the volume for publication, fell to other members of the staff.

A glance at Miss Maury's classification shows how great an advance we owe to her. Secchi's types gave us but a view of the most salient differences existing between the stars. Vogel elaborated these considerably, and introduced the important idea of a connection between the type and the temperature of a star. His idea therefore gave us a connected evolution along a single straight line. Lockyer's classification was more elaborate, and was a further advance—at least in so far that he introduced the idea of rising as well as of falling temperature, and gave us for his line of evolution not a single straight line, but a

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* "Annals of the Astronomical Observatory of Harvard College," Vol. XXVIII. Part I.—Spectra of Bright Stars photographed with the 11-inch Draper Telescope as a part of the Henry Draper Memorial, and discussed by Antonia C. Maury, under the direction of Edward C. Pickering, Director of the Observatory, Cambridge, Mass. (John Wilson & Sons, University Press. 1897.)

curve, with ascending and descending branches. Miss Maury's investigation goes further still. Her classification lies not in one dimension but in two, and she finds it necessary to divide the spectra she has examined, not only into "groups," forming a nearly continuous series, from spectra bearing a close resemblance to those of the bright-line nebulæ, on to the long-period variables at the extreme end of the series, but also into "divisions," in which the leading idea is not the substances producing the lines but the character of the lines themselves.

It is, of course, extremely unlikely that in this new classification we have arrived at finality, any more than in the classifications which preceded it. But this new factor which Miss Maury has brought to light in the course of her most patient study will certainly have to be reckoned with in the future.

The first division in Miss Maury's scheme—Division *a*—is by far the largest, including three hundred and fifty-five stars out of the total six hundred and eighty-one. In these spectra none of the single lines are relatively wide except those of hydrogen and calcium, and all the lines are "clear"—that is, they stand in distinct contrast to the bright portions of the spectrum. Division *b* comprises stars in the spectra of which all the lines are relatively wide and hazy. The fainter lines therefore tend to disappear, and in consequence those observed are relatively few; but their relative intensity remains much the same as in Division *a*, so that there does not appear to be a radical difference of constitution between the two divisions.

Division *c* is in general distinguished by the strongly defined character of its lines, by the presence of certain lines apparently not found in the solar spectrum, by a difference in the relative intensities of the lines as compared with the solar spectrum; and, further, the lines of hydrogen are narrow and well defined but less intense than in the other divisions, whilst the calcium lines are more intense. Stars of this division, therefore, would seem to differ more in constitution from those of Division *a* than do those of Division *b*.

Besides these three great divisions there are a large number of intermediate forms, whilst quite one-sixth of the total number of spectra cannot be assigned with certainty to any of these divisions, either on account of the faintness of the star or of the imperfection of the photograph.

The cross division into "groups" is less novel than the one just noted into "divisions." Miss Maury's scheme makes the "groups" twenty-four in number. Of these, the first five are those in which the Orion lines are specially prominent—a large number of the Orion lines being now, of course, known to be those of helium. The sixth group is intermediate between the Orion type and Secchi's first type. The full members of this Secchi's first type are divided into five groups according to the intensity of the hydrogen lines, which are at their maximum in Group VII. and decrease later, and to that of the solar and calcium lines, which increase from group to group. The twelfth group comprises spectra between the first and second types, and the full members of Secchi's second type are divided into four groups with respect to the increase of the solar and calcium lines. The third type is distributed over the next four groups, bands and flutings replacing lines. As a necessary consequence the divisional differences are no longer noted; indeed, no spectra of Division *b* are noted later than Group XII., or of Division *c* later than Group XIV. The twenty-first and twenty-second groups correspond to Secchi's fourth type and Pickering's fifth type respectively. There remain, then, two classes unnumbered: the "composite" stars, which are probably doubles of different spectra apparently single from their extreme closeness, and bright-line stars of the Orion type.

The annexed little table, the eighth in Miss Maury's Memoir, brings out in a singularly clear fashion the continuity of the series into which she has thus arranged the spectra in her hand. It will be observed that it is no theoretic succession; it is based upon the actual character of the spectra as the photographs present them, and is perfectly independent of any explanation which may be offered as to the cause of the differences thus scheduled. The succession may be one of temperature, of stage of development, or of actual chemical constitution, and it might be supposed to run in either direction without in the slightest degree invalidating the classification here given. On the subject of theory Miss Maury touches lightly, but points out the close resemblance between Group I. and that of Pickering's fifth type stars, Group XXII., and that the latter connect us with the bright-line nebulæ. This consideration, taken in connection with the fact of the obvious connection of the Orion type stars with the nebular regions of Orion and the Pleiades, strongly supports the view that the groups are numbered from I. to XX. in their true evolutionary order.

Group XXI., however, stands apart from this evolution. For Miss Maury finds the difficulty of including the fourth type stars in any regular progression which others have found before her, and which Vogel and Lockyer have tried to meet by such different expedients; the former placing the third and fourth type stars as alternative forms for a late stage in stellar life history, the latter regarding Type III. as indicating an early stage in a star of rising temperature, and Type IV. as a late stage in a star of falling temperature.

TABLE VIII.—RELATIVE INTENSITIES OF LINES.

Group.	Intensity of Hydrogen.	Intensity of Orion Lines.	Intensity of Solar Lines.	Intensity of K Line.
II.	20	148	1	2
III.	35	162	1	1
IV.	45	151	2	3
V.	90	51	3	4
VI.	100	36	43	6
VII.	100	5	99	8
VIII.	95	1	164	13
IX.	95	1	.	28
X.	90	1	...	58
XI.	60	1	.	83
XII.	25	1	432	135
XIII.	20	0	...	160
XIV.	16	0	568	160
XV.	9	0	712	200
XVI.	7	0	...	200 ?
XVII.	7	0	..	200 ?
XVIII.	6	0	860	170 ?

It is sufficiently clear from these very different classifications that no very sure foundation for determining the course of a star's evolution has yet been laid down; but it seems to me that in placing the long-period variables at the end of her series Miss Maury has been guided by a true appreciation of the facts before her, and that her scheme therein is a vital improvement on that of Lockyer. And to leave the carbon stars, the fourth type, unplaced, is probably, in the present state of our knowledge, to exercise a wise discretion, though Mr. McClean's photographs of 152 Schjellerup appear to confirm Vogel's suggestion that both Types III. and IV. succeed Type II., but as alternatives to each other.

The connection between the divisions is a more difficult matter, and except possibly in one point it has to stand without explanation at present. The facts, too, that these divisional differences are practically traceable only amongst the Orion stars and those of Secchi's first type, and that no stars are found of Division *c* in Group XIV., whilst seven are recorded as being intermediate between Divisions *a* and *c*, point to the classification in this direction being neither so perfect, nor so directly the effect of simple causes, as the cross arrangement into groups.

An interesting relationship, which Miss Maury mentions, suggests that in the case of Divisions *a* and *b* the differences between them may possibly be of a mechanical nature rather than one of temperature or constitution. She points out that the two spectroscopic binaries ζ Ursæ Majoris and β Aurigæ, though really of Division *a*, appear as members of Division *b* at that particular point of their orbit when the relative motion in the line of sight of the two members of the system is sufficient to widen the lines of their composite spectrum, but not to separate them into pairs. It is clear, therefore, that the existence of a large number of close binaries might explain the occurrence of Division *b* spectra, provided that these several pairs were composed of stars not very unequal in magnitude, of the same type of spectrum, and with relative motion in the line of sight such that their lines were widened but not separated.

We already know, by direct observation, of binary systems in which the periods vary from five and a half years up to many centuries. The Algol variables and the spectroscopic doubles have similarly revealed to us the existence of systems with periods ranging from a few hours to a few weeks. We may be perfectly assured that there are other systems with periods of an order intermediate between these, not of weeks or of years, but of months. And such, under the special conditions mentioned above, would give us *b* division spectra. In cases where the two components were of different types we should have a "composite" spectrum. It is possible, therefore, that Division *b* and "composite" stars are but different presentments of the same relationship—a binary system of two not unequal stars far too close for optical resolution.

The researches of Darwin on tidal evolution, and of See on that of double stars, lead us to the conclusion, since double stars tend to widen with age, that these very close binaries are yet in an early epoch of their life history. The fact, therefore, that the Algol stars and those of Division *b* are most plentiful in the Orion and first type groups is a confirmation of Miss Maury's conclusion that these are early forms of spectra, and seems better to accord with the facts than Lockyer's view, which places the Sirian stars midway in the evolution.

The test, of course, of the truth of the suggestion will be that a prolonged watch of Division *b* spectra will sooner or later show in some instances a gradual change into Division *a*.

It is worth remembering that there may be a yet earlier stage of double star evolution: where we have a single star in rapid rotation, the separation into two distinct bodies not having as yet taken place. Such rapid rotation would produce a widening and a haziness of the lines—a "Division *b*" spectrum, though differing in character from that of the close binaries. This would not be periodic in its character, and so not demonstrate itself by the test just mentioned.

Division *c* stands on a different footing, and appears to point to a real difference of constitution. The stars, however, of this division are so few in number that the progress of the groups cannot be followed out with anything like the distinctness of Division *a*.

Annexed is a copy of Miss Maury's Table I., which shows at a glance how the stars observed are distributed amongst the various groups and divisions. The numbers in the first column refer to Secchi's types: *O* designating Orion stars, *C* composite spectra, *L* bright-line stars. The last column gives the grouping of the Draper Catalogue. Under the heading "Division" the sub-heads *ac* and *ab* indicate forms intermediate between Divisions *a* and *c* and *a* and *b* respectively; the sub-headings *a*, *b*, and *ab*, *ac* signify spectra which cannot certainly be assigned to either division, owing to the faintness of the star or the imperfections of the photographs. Peculiar spectra are ranged under the sub-head *P*.

Classification of Spectra.

Type.	Group.	Division.								Total.	D.C.
		c.	*ac.*	*a.*	*a, b.*	*ab.*	*b.*	*ab, ac.*	*P.*		
O	I.	.	..		...		7	.	...	7	B
O	II.	.	.	4	5	.	5		2	16	B
O	III.	1	.	5	7		5	...	1	19	B
O	IV.	...	...	11	22	3	14	.		50	B
O	V.	3		9	8	.	5	..	.	25	AB
O-I.	VI.	6	...	4	9	3	9	.		31	AB
I.	VII.	1	.	13	13		17	..	1	45	A
I.	VIII.	1	1	23	6	3	17		7	58	A
I.	IX.		.	?	17	3	9	5		34	AF
I.	X.	.	.	2	12	2	3	.		19	AF
I.	XI.	..	5	?	11	5	...	7	1	29	F
I.-II	XII.	2	3	29	...	1	.			35	FG
II.	XIII.	4	1	22	.	..		...	.	27	G
II.	XIV.	...	7	40	.	..		.	3	50	G
II.	XV.		..	117		..	...	.	1	118	K
II.	XVI.		..	23		..	...	.	..	23	K
III.	XVII.	...	.	19	.	.		...	...	19	Ma
III.	XVIII.	.	...	20	..	...	..			20	Mb
III.	XIX.	...	.	10	..	...	...	..	...	10	Mb
III.	XX.	...		4			...	..	2	6	Md
IV.	XXI.	...	...	.	.	.	...	...	...	4	Na
V.	XXII.	.	.	...	.		...	...		4	O
C.	—		..		.	.	.	..	.	18	—
L.	—	..	...	...	..	..	...	.	.	14	—
Totals		18	17	355	110	20	91	12	18	681	

Beside the two tables given above, very complete tables are supplied of the wave-lengths of the lines found in the different classes of spectra, Fomalhaut being taken as the representative of the first type stars, and the star H.P. 1311 for the fifth type. The solar lines are catalogued from the D lines of sodium to the line ρ of hydrogen far in the ultra-violet, and the lines of Division *c* stars from β to κ of the hydrogen series of lines. The complete catalogue of the 681 stars arranged in order of R.A. is supplemented by tables in which they are arranged in order of spectral group, and copious notes add much important information as to the details of individual spectra, whilst a minute description of the classification, group by group, occupies the longest chapter in the work.

In view of Prof. Ramsay's striking discovery of helium, one naturally looks eagerly to find the place accorded to that spectrum in this classification. The work was, however, too far advanced at the time when the helium spectrum was revealed to us for it to be taken account of in the actual classification. All that could be done was to add a supplementary note. In this we are given a table in which the helium lines are compared with those of the Orion stars, and are told that all the series of both helium and parhelium are represented in them. It appears, further, that nearly all the lines of the first subordinate series of both helium and parhelium are very strong in

Group III., and reach a maximum in Group IV., and fall off far more rapidly toward the later groups than toward the earlier. It is important also that they are more clear and conspicuous in Division *c* than in Division *a*, and far more persistent—the lines 4471·65 and 3819·75 being present in Group VIII., Division *c*.

Complete and thorough as the Memoir is in every other respect, it is impossible to escape the regret that it was not accompanied by a well-chosen series of photographs of typical spectra. We feel sure that if these could have been supplied, they would have added greatly to the value of Miss Maury's careful descriptions and to the information which is to be derived from them.

Great as is the evident value of this Memoir, it may be taken as certain that we shall not be able to realize how heavy a debt we owe to Prof. E. C. Pickering and Miss Maury until it has been made the basis of the many researches which will inevitably be founded upon it. Nine years may seem a long time to have devoted to such an inquiry, but the more the Memoir is studied the more one will feel surprise, not that it has taken so long to prepare, but that so much has been so quickly accomplished.

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ANCIENT RED DEER ANTLERS.

By R. Lydekker, b.a., f.r.s.

Whatever may be the case with regard to its applicability to the human race, there can be no question that the phrase, "There were giants in those days," is perfectly true when the antlers of modern red deer are compared with those of animals living a few centuries ago on the Continent, or with the specimens that are from time to time dug up from the fens of Lincolnshire and Cambridgeshire, or from the bogs of Ireland. Not only are such ancient specimens much larger in respect of length and girth of beam than any to be met with at the present day, but they also greatly exceed the latter in respect to the number of tines or points they carry, as also in the complexity of the so-called cup in which the crown or summit of the beam so frequently terminates. At the time the big antlers of the English fens and Irish bogs crowned the heads of living animals, both Britain and Ireland were either still connected with the Continent, or their separation therefrom was an event of comparatively recent occurrence; and as the greater part of the country was still clothed with forest, the deer were able to wander about as much as they pleased, and there was nothing to prevent them attaining the maximum development of which the species was capable. And on the Continent the conditions of life were, if possible, still more favourable. Contrast this with the mode of life of the deer of the Scottish highlands at the present day. The so-called "deer forests" are nothing but open moorland; and as red deer are naturally forest-dwelling animals, this alone is sufficient to account for their relatively small size and the small development of their antlers. When to this is added the comparatively small size of the area on which they are located, coupled with the effects of more or less continuous in-and-in breeding, it is but small wonder that the antlers of even the finest of Scotch deer are but poor things when compared with those of their predecessors. Some of our readers may perhaps be disposed to say that this is due to the circumstance of the deer being shot down at too early an age, before time has been allowed them to perfect the full growth of their antlers, and that if they were allowed to enjoy life a few years longer their trophies would be fully equal to those of a past age. But, as a matter of fact, this is not the case. After a certain age the antlers of deer begin to retrograde or degenerate, when they develop fewer points than at the prime of the animal, and not unfrequently display various abnormalities. And as Scotch red deer are frequently killed with degenerating antlers, it is manifest that this is not the cause of the comparatively small size of these appendages. Such a degenerating head, showing certain abnormalities, is represented in our first illustration. Like the other specimens figured, this example is in the collection of the Viscount Powerscourt, at Powerscourt, County Wicklow, and belonged to a very aged animal. Its history is somewhat curious. The stag was killed by poachers in Ross-shire during the year 1844, and by them given to Mr. Hay Mackenzie, father of the late Duchess of Sutherland. By her Grace it was presented to Frederick, fourth Marquis of Londonderry, by whom, in turn, it was given to Lord Powerscourt in 1857.

Fig. 1.—Skull and Antlers of Aged Scotch Red Deer.

Fig. 2.—Antlers of Red Deer from an Irish Bog.

English park red deer, from their more congenial surroundings and richer pasture, develop finer antlers than those of their wild Scotch cousins, but even these bear no comparison to those of the stags of former ages. Although larger antlers are still obtained on the Continent, these are—for the most part, at any rate—inferior to those killed years ago. It is true that in the Carpathians and Caucasus magnificent heads are still fairly common. But these belong to a variety known as the Maral or Caspian red deer, in which the face is longer than in the typical race of Western Europe, and the coat more or less distinctly spotted with white in summer, while, as a rule, the crown of the antler is less distinctly cupped and carries fewer points. Still, it is very difficult in many instances to distinguish the antlers of the two races, which, in certain districts of the Austrian Empire, probably pass imperceptibly into one another.

This inferior development of modern red deer antlers being then a well-ascertained fact, it is a matter of congratulation that there exist a few collections where the trophies of the ancient giants have been accumulated and preserved almost from time immemorial, or where judicious purchase has assembled a series which it would be almost, if not quite, impossible to rival at the present day. Of collections of the former kind, by far the finest is the one belonging to His Majesty the King of Saxony, at the old hunting schloss of Moritzburg, near Dresden. Of the latter type, so far as the United Kingdom is concerned, the celebrated collection of Viscount Powerscourt, already mentioned, is far and away ahead of all others. By the kindness of the owner, the present writer has been favoured with photographs of a series of the finest specimens in this collection, from among which a few have been selected to illustrate the present article.

Fig. 3.—Antlers of Ancient German Red Deer, purchased in Berlin in 1863.

From the great individual variation displayed in a large series, the uninitiated often find considerable difficulty in distinguishing the antlers of red deer (including under this term the different races thereof) from those of the allied species. Nevertheless, after some practice, this is a comparatively easy matter; and the subject is one of considerable interest, on account of showing, in spite of great individual variation, the adherence to one distinctive type of structure. The red deer and its allies form a small and well-defined group of the genus *Cervus*, among which are included the wapitis of North America and Central and North-Eastern Asia, the hangul of Kashmir and Yarkand, and the great shou of the district lying to the northward of Bhutan. In all these deer the minimum number of tines to each antler is five, but there may be as many as twelve, or even more. A very general and especial peculiarity of the group is the presence of two tines on each side in close proximity to the forehead. The presence of these two tines is, indeed, as a normal feature, limited to the members of this group, and even among them it is by no means invariably constant. There is, for instance, a Tibetan species, known as Thorold's stag, in which the second is wanting, and the so-called brow-tine alone remains in this part of the antler. The presence of this second tine in the red deer group is clearly, then, what naturalists term a specialized feature of comparatively recent acquisition. And further testimony in favour of this is afforded by the circumstance that even in well-developed heads this tine is frequently much smaller on one side than on the other. This is shown in Fig. 2, where the second tine on the right side is scarcely more than half the length of its fellow on the left. Even more significant is the fact that in heads which are degenerating—or, as sportsmen say, "going back"—this tine is the first to disappear, or to diminish in size. An excellent example of this is afforded by the head represented in Fig. 1, where it is completely wanting on the right side, and is small and rudimentary on the left. Indeed, among Scotch deer the second tine is very frequently wanting even during the prime of life, thus affording further evidence of the decadence of that stock. It is also wanting in the small island race of Corsica and Sardinia, as it is very frequently in the larger race inhabiting the North of Africa and Spain. The red deer being typically a northern species, the degeneracy in the latter instance is probably due to the warmer and therefore less suitable climate.

At some distance above the second is given off a large third tine, which is quite distinct from those above it. In fully developed heads of the red deer of Western Europe, as exemplified by Figs. 2 and 3, the beam of the antler continues undivided for an interval somewhat exceeding the one between the second and third tines, after which it expands to form a more or less distinctly defined cup whose margins are bordered by a variable number of snags or tines of different length. In heads of this type it is scarcely possible to distinguish a separate fourth tine. Nevertheless, in heads where the cupping is less conspicuously developed, the fourth tine exists as a separate portion of the antler, the cupping being then confined to the termination of the beam above. This type of antler is shown by the German head depicted in Fig. 1; and it may be noted that in the Carpathian race of the species it is common to find the fourth tine remaining more or less distinct, as it does in the degenerate modern Scotch deer. The shape of the cupping varies considerably in different individuals, as may be seen by comparing the old German head represented in Fig. 3 with the one from an Irish bog which forms the subject of Fig. 2; the former showing a total of eighteen and the latter of nineteen points. Considerable individual diversity also exists with regard to the angle at which the antlers are set on the forehead. For instance, in Fig. 2 they are directed much upwardly, and this is still more markedly the case with Fig. 3; but as the latter specimen consists of separate antlers affixed to an artificial head, the degree of inclination is not altogether to be depended on. The subject of Fig. 5, which is also an ancient German head, is, however, in its original condition, and here it will be noted that the degree of divergence is very great. This head, too, is

Fig. 4.—Antlers of German Red Deer with Twenty Points.

remarkable for the number of its points, which reach a total of twenty-two; and the almost complete absorption of the fourth tine in the terminal cup-like expansion is also a feature which can scarcely fail to attract attention. Two-and-twenty is, however, by no means the maximum of points, as a pair of antlers from an Irish bog, formerly in the collection of the late Sir Philip Egerton, but now in the British Museum, carry no less than thirty. And it must not be supposed that modern Scotch stags never make an approach to such high numbers, a specimen shot some years ago by Lord Burton exhibiting a total of twenty.

Fig. 5.—Antlers of Ancient German Red Deer with Twenty-two Points.

In spite of the individual variations alluded to, the form of the fourth tine and the terminal cup affords an easy means of distinguishing the red deer antler from that of the wapiti, whether American or Asiatic. In the latter the fourth tine always forms a huge forwardly projecting prong, much larger than either of the three tines below, and situated in the same fore-and-aft plane as the tines above, which are normally quite distinct from one another, and thus do not form a terminal cup. Occasionally, however, such a cup is formed even in wapiti antlers; and it is said that in certain districts of America such cupped antlers are by no means uncommon, being apparently hereditary. Even in such instances, however, an experienced eye will have no difficulty in picking out the wapiti antler, for the great fourth tine always retains more or less of its characteristic form and size, and the whole antler is thus quite unlike that of any red deer.

It has already been said that the red deer of Eastern Europe usually have the terminal cup less developed than in the old giant race of the more westerly districts; and, as we proceed further to the north-east in Asia, the antlers of all the nearest relatives of this species tend to become simpler still. For instance, in the hangul, or Kashmir stag, the number of points on each side rarely exceeds six or seven; while in the still larger shou, of the country to the north of Bhutan, they are limited to five a side, no trace of a terminal cup being formed. Clearly, then, the group attained the culminating complexity of antler development in the countries of Western Europe; and whether this complexity would have gone on increasing to an almost indefinite degree had not man appeared on the scene, and checked the further evolution of these and most other animals, may afford an interesting subject of speculation to the curious. Equal room for speculation exists as to the purpose of the great complexity exhibited by the antlers of the red deer. As fighting weapons, the huge but simpler horns of the shou would seem to be at least equally efficacious; and to human taste it is by no means certain that their severer simplicity of form is not more graceful than the many-branched red deer horn. But it by no means follows that human and cervine æstheticism run on the same lines; and if antler development be due to female preference for the stags with the finest horns, a *vera causa* may exist in this direction.

All the different variations of red deer antlers alluded to above are of a more or less strictly normal type, but there are other variations less commonly met with which come under the designation of abnormalities, or monstrosities. And although such attract much attention from sportsmen and amateurs, the scientific naturalist, as a rule, has no more to do with them than he has with two-headed pigs or three-legged chickens. Nevertheless, there may be exceptions even to this general rule, and a case in point seems to be afforded by a peculiar head of a French red deer in the Powerscourt collection, which forms the subject of Fig. 6. From this figure it will be seen that the left antler is of normal form, exhibiting the first, second, and third tines, and a rather small terminal cup, of which the fourth tine forms a constituent part. The right antler, on the contrary, is double from base to summit, and of a much simpler structure, each portion consisting solely of a long unbranched beam, with a brow-tine at the base, and a simple four-pointed cup-like expansion at the crown. Now at first sight there might seem nothing particularly noteworthy in this, for in all cases of such duplication the divided antler is of a simpler type than the ordinary undivided one. But the curious feature in this instance is that the duplicated antlers are of the same general type as certain peculiar antlers of the Eastern race of the red deer frequently met with in the Crimea and Asia Minor. And although these latter are undoubtedly to a certain extent abnormalities, yet from their comparative frequency in the districts in question they scarcely come under the designation of monstrosities. Whether the undoubted resemblance existing between the duplicated French antler and these abnormal Eastern specimens is anything more than a coincidence, the facts at our disposal are not sufficient to admit of determining. At any rate, the point is of sufficient interest to merit mention. A similar duplication of one antler—and, curiously enough, on the same side—has been recorded in the fallow deer; and Lord Powerscourt also possesses a second French red deer head in which the right antler is bifurcated for half its length. Probably the circumstance that the abnormality in all these three instances is on the right side is a mere coincidence. It would, however, be matter of some little interest if it could be ascertained whether such malformations are due to any injury received by the animal previous to the growth of the horns.

Fig. 6.—Antlers of French Red Deer, with Duplication on the Right Side.

NOTES ON COMETS AND METEORS.

By W. F. Denning, f.r.a.s.

Comets.—Pons-Winnecke's comet was detected by Mr. C. D. Perrine at the Lick Observatory on January 1st, when it was described as very feebly visible. It may well have appeared faint, seeing that its distance from the earth was more than one hundred and sixty million miles. Presumably the comet was picked up with the thirty-six inch refractor; but as the object is rapidly approaching the earth, and gaining in apparent brilliancy, much smaller telescopes will now have the capacity to reveal it. Hillebrand's elements for the comet are:—

Epoch	March 15th, 1898.
M	359° 3′ 52·0′
π	274° 14′ 39·0′
☊	100° 53′ 11·5″
ι	16° 59′ 33·8′
φ	45° 37′ 14·1′
μ	608″·5559

Ephemeris for Berlin, midnight.

	R.A.				Dec.	
	h.	m.	s.			
Feb. 10th	18	8	30	...	12°	29·3′
12th	18	18	35	..	12°	47·8
14th	18	28	48	...	13°	5·1
16th	18	39	6	...	13°	21·0′
18th	18	49	28	...	13°	35·4′
20th	18	59	56	...	13°	48·2

On February 1st the comet's distance will have decreased to about one hundred and thirty-three million miles, and it will be visible before sunrise in the southern region of Ophiuchus. The moon sets on the morning of February 1st at 4.15, and the comet may possibly be picked up about two degrees north of the star 47 Ophiuchi (magnitude 6·3).

Perrine's comet (*b* 1897, discovered October 16th) and D'Arrest's comet have become too faint to be observable in ordinary telescopes. The former was seen on November 18th and 23rd, 1897, with a sixteen-inch refractor, at Northfield, Minn., as a very faint elliptical glow, three minutes long and one minute wide, without any perceptible condensation, and so feeble that the slightest illumination of the micrometer wires overpowered it. Three sets of elements have been published, as follows:—

	Payne and Young.	Perrine.	Möller.
T	1897, Dec. 8·9216 G.M.T.	Dec. 8 8471.	Dec. 8·6899.
ω	66° 10′ 11″	66° 5′ 42″	65° 56′ 34″
☊ ...	32° 4′ 9″	32° 4′ 5″	32° 3′ 27″
ι . .	69° 37 21″	69° 37′ 41″	69° 36′ 36″
log. q.	0·13186	0·13206	0·13242

In *Ast. Nach.*, 3471, Herr Bidschof gives some computations with regard to the ensuing return of the comet (Tempel, 1866, I.) of the November meteors. He supplies a sweeping ephemeris, from which it appears the comet will probably traverse Aries in March and April, Taurus in May and June, Gemini in July and August, and enter Cancer at the middle of September. The great distance of the comet and the uncertainty attaching to its precise position, will, however, prevent its being seen. In the summer and autumn of 1898 the comet and earth will rapidly approach each other, and the former may possibly be rediscovered in the winter following.

Meteors.—*The Leonids of 1897.*—Herr A. A. Nÿland, of Utrecht, reports that on November 13th he watched the sky from 12h. 51m. to 16h. 7m., and saw twelve meteors, of which seven were Leonids and three Taurids. November 14th was cloudy. On November 15th observations were made between 13h. 8m. and 16h. 45h., and forty meteors were recorded, including thirty-two Leonids. There was a well-defined radiant at 152° + 24° and a secondary position at 150° + 29°; no less than ten very bright Leonids were observed, five being estimated to equal first magnitude stars, one equal to Jupiter, and four equal to Venus. Fifteen of the Leonids left bright streaks. The larger meteors exhibited an orange colour in five cases, and a green hue in four cases.

At the Radcliffe Observatory, Oxford, Messrs. Wickham and Robinson maintained a watch on November 13th from 11h. 15m. to 17h. 45m. There were occasional clouds and moonlight was troublesome, so that during the night only about forty meteors were seen. The nights of November 14th and 15th were cloudy.

Prof. A. S. Herschel, at Slough, observed about ten meteors and no certain Leonids on November 13th, during an extended watch of about seven hours between 9h. 30m. and 18h. The sky was overcast on November 14th.

Sir W. J. Herschel and Mr. J. C. W. Herschel, at Littlemore, near Oxford, on the night of November 13th, between 12h. 30m. and 16h. 15m., counted twenty-one meteors, including about seven Leonids.

Herr Franz, at the Observatory at Breslau, on November 13th, saw six meteors (three Leonids); and on November 14th before 16h. recorded twenty-one meteors, including fourteen Leonids, from a radiant at about 145° + 25°.

Herr Rigginbach, at Basel, on November 13th, between 12h. 30m. and 14h. 30m., counted nineteen meteors (ten Leonids). The following nights were cloudy.

The number of bright Leonids observed by Nÿland on the morning of November 16th indicates that, had the sky been favourable before sunrise on November 15th, the shower was, probably, a conspicuous one. Herr Franz's observations on the morning of November 15th terminated at 4h. (= G.M.T. 2h. 52m. a.m.), and before the maximum occurred.

Two of the meteors seen by Sir W. J. Herschel and Mr. J. C. W. Herschel, near Oxford, were also recorded by Messrs. Wickham and Robinson, at the Radcliffe Observatory, Oxford, and by Mr. W. E. Besley at Walthamstow. The meteors were of the first magnitude. One appearing on November 13th, 15h. 28m., was a *Cancrid*, descending from one hundred and twenty-five to seventy-seven miles over the North Sea to Halesworth, in Suffolk. The other was a true Leonid, appearing at 15h. 52m., and falling from one hundred and three to fifty-nine miles over the Strait of Dover to Cranbrook, in Kent.

The Geminids.—Moonlight greatly interfered with observations of this shower. Mr. E. N. Cullum, of Whitby, reports, however, that meteors were both numerous and brilliant on the evening of December 12th. He recorded ten between 8h. and 9h., and many others were seen afterwards. They were nearly all Geminids.

During the past autumn an unusually large number of fireballs have been observed. In the majority of cases, however, the observations were not sufficiently precise and complete to allow real paths to be computed. Three splendid meteors, appearing at convenient times in the evening, were widely observed, and from a large number of descriptions I worked out the following results:—

Real Paths of Three Fireballs, 1897.

Date and hour	(1) October 22nd. 6h. 23m.	(2) Dec. 9th. 9h. 47m.	(3) December 12th. 8h. 6m.
Brightness	> ♀	¼ = ☽	¼ = ☽
Height at beginning	59 miles	76 miles	112 miles
Position over . .	Wooler, Northumberland	Aldeburgh	Lat. 54° N., long. 1° 28 E.
Height at ending	35 miles	21 miles	19 miles
Position over ..	Lat. 55° 10 N., long. 2° E.	Royston	North of Thirsk
Earth point ..	North Sea	Ampthill	Richmond, Yorks.
Real length of path .	171 miles	90 miles	151 miles
Velocity	Very slow	Rather swift	25 miles per second
Radiant point	218° + 10°	113° + 32°	80° + 23°
Inclination of meteor's descent .. .	8°	38°	38°
Parent system... ...	ζ Boötids	Geminids	ζ Taurids

In February no special showers are due, but large meteors are often observed on about the 7th and 10th. At this period there is a well-defined shower from 74° + 43°, near α Aurigæ, which needs further watching.

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THE FACE OF THE SKY FOR FEBRUARY.

By Herbert Sadler, f.r.a.s.

A few, but not many or large, spots are visible on the Sun's disc.

Conveniently observable minima of Algol occur at 10h. 13m. p.m. on the **9th**, at 7h. 2m. p.m. on the **12th**, and at 3h. 7m. a.m. on the **27th**.

Mercury is a morning star, but is badly placed for observation on account of his considerable southern declination. On the **1st** he rises at 6h. 27m. a.m., or about one hour and a quarter before the Sun, with a southern declination of 21° 18′, and an apparent diameter of 6½″. On the **10th** he rises at 6h. 36m. a.m., with a southern declination at noon of 21° 8′, and an apparent diameter of 5½″. On the **20th** he rises at 6h. 40m. a.m., with a southern declination at noon of 18° 25′, and an apparent diameter of 5¼″. After this he is too near the Sun to be conveniently observed. He describes a direct path while visible through a portion of Sagittarius into Capricornus. He is in conjunction with Mars at 6h. p.m. on the **11th**, but of course both planets will have set.

Venus is in superior conjunction with the Sun on the **15th**, and Mars is practically invisible.

Ceres is still fairly well placed for observation, southing on the **1st** at 9h. 5m. p.m., with a northern declination of 29° 29′, and a stellar magnitude of about 7½″. On the **14th** she souths at 8h. 10m. p.m., with a northern declination of 29° 46′. On the **28th** she souths at about 7h. 15m. p.m., with a northern declination of 29° 58′. During the month she describes a short looped path in Auriga.

Jupiter is now very well situated for observation, rising as he does on the **1st** at 10h. p.m., with a southern declination at noon of 2° 42′, and an apparent equatorial diameter of 41″. On the **10th** he rises at 9h. 22m. p.m., with a southern declination of 2° 31′, and an apparent equatorial diameter of 42″. On the **20th** he rises at 8h. 40m. p.m., with a southern declination of 2° 13′, and an apparent equatorial diameter of 43″. On the **28th** he rises at 8h. 2m. p.m., with a southern declination of 1° 55′, and an apparent equatorial diameter of 43½″. During the month he pursues a retrograde path in Virgo, being about 1½° south of γ Virginis towards the middle of the month, the two objects forming a fine naked-eye double star.

Saturn and Uranus do not rise till some time after midnight at the end of February.

Neptune is still favourably situated for observation. He rises on the **1st** at 2h. 29m. p.m., with a northern declination of 21° 42′, and an apparent diameter of 2½″. On the **10th** he rises at 1h. 40m. p.m., with a northern declination of 21° 42′. On the **20th** he rises at 0h. 54m. p.m., with a northern declination of 21° 42′. On the **28th** he rises at 0h. 28m. p.m., with a northern declination of 21° 43′. He is nearly stationary in Taurus during the month, in a region barren of naked-eye stars.

There are no well-marked showers of shooting stars in February.

The Moon is full at 6h. 24m. p.m. on the **6th**; enters her last quarter at 0h. 35m. a.m. on the **14th**; is new at 7h. 41m. p.m. on the **20th**; and enters her last quarter at 11h. 13m. a.m. on the **28th**. No bright star is occulted at any convenient hour for the amateur observer in February.

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Chess Column.

By C. D. Locock, b.a.

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

Solutions of January Puzzles.

No. 1.

1. R to Kt7, dis. ch., K moves. 2. P × B, becoming a Black Knight, dis. ch., Kt to B2, dis. ch., mate.

No. 2.

1. P × R, becoming a Black Rook, Castles! (*a*) 2. R to QB5, B to Ksq, mate.

(*a*) This is a fresh Rook, and evidently, therefore, has not moved. The Black King has not moved (by hypothesis), so that Black is perfectly justified in Castling.

No. 3.

1. P to K8, becoming a Black Knight, ch.

[Both sides being mated simultaneously, the game seems a fair draw. Any other move, such as R to B8, would lose.]

We regret that all the above have proved either unattractive, or, from their novelty, perhaps, too difficult for our solvers.

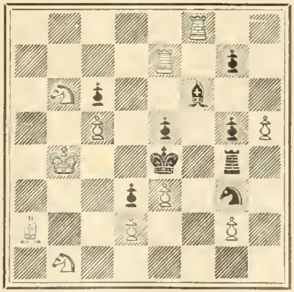
F. W. A. de Tabeck.—The "Chess Intelligence" is intended to be a permanent record of chess events. In a monthly magazine it is obvious that it cannot usually be news. The publication of problems has, during the last nine years, resulted in many hundreds of solutions and inquiries. For some years an annotated game was printed regularly in every number. During all this time there was not one particle of evidence to show that these games were ever played through. We are glad to hear of the exception, and shall endeavour in future to consider the undoubted rights of the minority.

PROBLEMS.

No. 1.

By W. Clugston (Belfast).

Black (9).



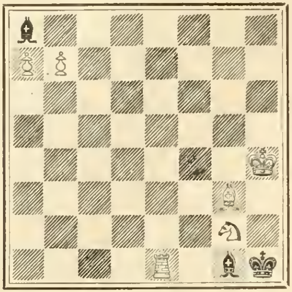
White (11).

White mates in two moves.

No. 2.

By S. Loyd.

Black (3).



White (6).

White mates in three moves.

Game played in the Hastings International Tourney.

Queen's Gambit declined.

White. (H. N. Pillsbury.)	Black. (A. Burn.)
1. P to Q4	1. P to Q4
2. P to QB4	2. P to K3
3. QKt to B3	3. KKt to B3
4. B to Kt5 (*a*)	4. B to K2 (*b*)
5. P to K3	5. Castles
6. KKt to B3	6. P to QKt3
7. R to Bsq	7. B to Kt2
8. P × P (*c*)	8. Kt × P
9. B × B	9. Q × B
10. Kt × Kt	10. B × Kt
11. B to Q3	11. R to Bsq (*d*)
12. P to K4	12. B to Kt2 (*e*)
13. Castles	13. Kt to Q2
14. Q to K2	14. P to QR3 (*f*)
15. R to QB3	15. P to QB3
16. KR to QBsq	16. P to QKt4
17. Q to K3 (*g*)	17. R to B2
18. Q to B4	18. QR to Bsq
19. P to K5	19. P to QB4 (*h*)
20. B × Pch	20. K × B
21. Kt to Kt5ch	21. K to Ktsq
22. R to R3 (*i*)	22. Q to Ksq
23. Q to R4	23. K to Bsq
24. Kt to R7ch	24. K to Ktsq
25. Kt to B6ch	25. K to Bsq
26. Kt × Q	26. K × Kt
27. Q to Kt5	27. P × P
28. R to R8ch	28. Resigns (*j*)

Notes.

(*a*) This and the next four moves constitute Mr. Pillsbury's favourite development. It was probably originated by Mr. Steinitz.

(*b*) Best; though there is a well-known trap by 4. . . . QKt to Q2; 5. P × P, P × P; 6. Kt × P, Kt × Kt; 7. B × Q. B to Kt5ch, etc.

(*c*) The logical reply to the Queen's Fianchetto. If Black retakes with the Pawn, White takes the free diagonal with 8. BQ3, retaining command of the QB file, while the Black QB is blocked. If, as here, he retakes with the Knight, White gains time afterwards by P to K4.

(*d*) Obviously, if 11. . . . B × P, 12. P to QKt3, Q to Kt5ch, 13. Kt to Q2. The move made is forced, as White threatens to win a Pawn by Q to B2, unless, indeed, he can venture on 11. . . . Q to Kt5ch.

(*e*) If now 12. . . . B × P, 13. Q to R4 wins a piece. Or if 12. . . . Q to Kt5ch, 13. K to K2, B × RP, 14. R to B3, Q × Pch; 15. R to B2, Q to R6; 16. Q to Rsq. We cannot, of course, say for certain if this was Mr. Pillsbury's idea.

(*f*) A wasted move. Black is apparently trying to keep his majority of Pawns on the Queen's side, when it would be safer to free his game by P to QB4. Nevertheless, his plan is sufficiently ingenious and characteristic.

(*g*) With a view to the direct attack on the King which follows.

(*h*) Completely overlooking White's intention. He should play Kt to Bsq.

(*i*) Threatening R to R8ch. If now 27. . . . Kt to Bsq, 28. Q to R4, Kt to Kt3; and White mates in three moves.

(*j*) For if 28. . . . Kt to Bsq, R × Ktch, followed by R × R, wins everything. The whole finish was very pretty and forcible.

CHESS INTELLIGENCE.

The first-class amateur tourney at Llandudno resulted in a win for Mr. A. Burn with the fine score of nine out of ten games played. He lost only to Mr. Bellingham, who took the second prize, Mr. Jones being third. Messrs. Owen, Sherrard, and Gunston were among the unsuccessful competitors.

The Hastings Annual Chess Festival is fixed for January 24th-27th. Besides the leading English masters, M. Janowski is expected to be present.

A telephone match, played on December 18th between the City of London Club and the Yorkshire Chess Association, resulted in a victory for the former team by $5\frac{1}{2}$ games to $2\frac{1}{2}$. On the same day Surrey defeated Kent by 13 games to 7.

The Vienna and St. Petersburg Chess Clubs are playing a match of two games by correspondence.

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CONTENTS.

THE TOTAL SOLAR ECLIPSE, JANUARY 22, 1898.

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

There could hardly be a greater difference than between the eclipse of 1896 and 1898. The shadow track in the former case ran through a vast extent of country which offered, however, but few suitable sites. These were clustered together at two or three main points, and in almost every case the intending observers were disappointed of the spectacle which they had come to see. In 1898 the eclipse track lay chiefly in one single country which offered a large number of easily accessible sites, nearly all of which were occupied, and all were favoured with the most perfect weather. Up to the present time it certainly is the record eclipse, either as regards the number of observers, the character of their equipment, or the unchequered favour which they experienced from the weather.

"A victory all along the line," is what we have to record. The full significance of that victory and what results may accrue from it, it will take us many months to learn.

As a sensation the eclipse did not fulfil the popular descriptions. Whether, as has been asserted, the corona was unusually large and bright, or from the special atmospheric conditions prevailing in India at the time, the darkness was much less than is usual in any eclipse of two minutes' duration, and the general effects in colour, light, and the appearance of the landscape were very much those which were brought about more slowly some four and a half hours later some thirty-five or forty minutes after the sun had set. At any rate, the light at mid-totality was certainly greater, considerably greater, than we ordinarily get at night at the full of the moon.

The fall of temperature was, however, considerable, amounting to some twelve degrees; and it was noticed by some of those who had taken part in the Norway expedition of 1896 that, whereas on that occasion the darkness of the eclipse was felt to be a sensible relief from the unceasing sunlight, so now the coolness of the eclipse was a relief from the too powerful heat of the sun.

Consistently with the small amount of darkness of the eclipse the approach of the shadow at the beginning of totality was less marked than usual, and in some places, though watched for, escaped notice. The only record that has yet reached me of its approach having been distinctly observed is from Dr. Robertson, of Nagpur. The shadow-bands were also looked for at some stations without success, though they were caught at both Jeur and Nagpur. At the latter place Miss Henderson, m.d., describes them as having been faint dusky ripples some two inches in breadth, and separated from each other by about the same interval, and in appearance and speed of motion resembling the ripples seen on the ceiling of a cabin in an ocean steamer as they are deflected through the porthole from the water outside.

Of the stars visible during the eclipse one caught every attention, and was, indeed, seen after totality had passed. This was the planet Venus, some six degrees south-west of the sun at the time. Mars, though very small and further from the sun, was also glimpsed, and some two or three other stars were noted.

The shape of the corona recalled at once that of 1896, and with it the two earlier years 1868 and 1886, which it had resembled. To the south-west a long ray nearly in the solar equator was easily traceable for two, if not three, solar diameters from the dark limb of the moon. On the east side a pair of broader and less-extended streamers formed a single connected structure in which the characteristic coronal curves were repeatedly seen.

Bearing in mind that these four years all fell at the time of small but not of minimum sunspot activity, it appears clear that we have here brought out a third coronal type as distinct and definite—perhaps even more so than those which have been already recognized as appropriate to the times of actual maximum and minimum; and it may be hoped that we have now material enough to enable us to trace the course of change which the corona undergoes in its passage from one extreme form to the other.

It may be opportune here to correct a widespread misapprehension, that minimum coronæ are small and faint except for the two great equatorial rays. The reverse would seem to be the case, except in the immediate neighbourhood of the sun's pole. The corona, for instance, of 1878, so far from being small and faint, was unusually large and bright; and the present one, though we have not yet reached the actual minimum, possessed the same characteristics.

The feathery structure round the solar poles, which was so plainly seen in the eclipse of 1878, and which has been recognized more or less clearly at so many eclipses since—

especially at or near the time of minimum—was very apparent on the present occasion.

The photographs of the corona have been unusually numerous, and have been taken on every variety of scale, from a diameter of a single millimètre with a hand camera, up to one a hundred times as great. The latter were obtained at three stations: by the Astronomer Royal at Sahdol, with an aperture of nine inches and an enlarging lens; by Dr. Copeland, at Gogra, near Nagpur; and by Prof. W. W. Campbell at Jeur, with telescopes of about forty feet focal length. Next in order to these giant photographs come the standard instruments of the Joint Eclipse Committee, with their twin cameras giving images of an inch and a-half, and of six-tenths of an inch. These were employed by Prof. Turner at Sahdol, and Captain Hills at Pulgaon. The cameras taking photographs of one inch in diameter and smaller were much too numerous to recount; but special note should be made of Prof. Burckhalter's device for obtaining both the inner and outer corona on the same plate by means of a revolving screen worked by a spindle passing through a hole in the centre of the plate, which diminished the exposure given to the bright central regions of the corona so as to bring it more in accord with the faint light of the outer extensions.

The Sun's Corona, Total Eclipse, January 22nd, 1898.

At the extreme ends of the line of stations a novel experiment in coronal photography was attempted. At Buxar, on the Ganges, and at Viziadrug on the coast, a kinematograph was employed so as to obtain a continuous series of photographs of the progress of the eclipse. The former instrument was supplied by Mr. Nevil Maskelyne, and was worked by the Rev. J. M. Bacon, the astronomer in charge of one of the two parties organized by the British Astronomical Association, and the other was in the hands of Lord Graham.

Of direct visual spectroscopic observations there were few. Mr. Newall and myself endeavoured to trace the distribution of coronium—that is, of the substance which shows its presence in the 1474 K line; but the line was faint, and it could only be ascertained that it showed a general conformity to the shape of the brighter part of the inner corona, without its being possible to ascertain whether it corresponded in minuteness of structural detail. No rifts were detected in it.

The photographs of the spectrum claim the highest interest, and these were of unprecedented number and value. Captain Hills, at Pulgaon, with two great slit spectroscopes, obtained records of the "flash," both at commencement and end of totality, which give a complete history of the spectroscopic changes seen in the various strata of the sun, from its ordinary spectrum up to that of the prominences at Viziadrug on the coast. Mr. Fowler and Dr. Lockyer were equally successful with prismatic cameras of six inches and nine inches aperture, whilst smaller spectrographs of extreme beauty, and ranging from C in the red far into the ultra-violet, were secured by Mr. Evershed at Talni.

The examination and interpretation of these photographs will be the work, not of days and weeks, but of months, and possibly years; but we may confidently look to them for a complete answer to many questions which are engaging the attention of solar physicists at the present time, and particularly for information as to the exact *locale* of the absorbing vapours which give rise to the Fraunhofer lines. Sir Norman Lockyer's theories, in particular of dissociation in solar and stellar atmospheres, will be put to the severest test, and our knowledge of solar mechanism can hardly fail to receive a great advance.

One inquiry which it was hoped the present eclipse would advance has failed to meet with success. Mr. Newall was endeavouring to ascertain if the spectrum of the corona, as obtained from the two opposite limbs of the sun, gave any evidence of relative motion in the line of sight due to rotation. It will be remembered that in 1893 M. Deslandres came to the conclusion that the corona rotated in essentially the same period as the photosphere. Mr. Newall had arranged an exceedingly beautiful instrument for this purpose—a spectroscope, the collimator view telescope of which was parallel to the polar axis. The spectroscope was also provided with a double slit, the one slit tangential to one limb, and the second to the other limb; the one slit stretching from the sun's equator northward, the other from the opposite end of the equator southward. The experiment, which abundantly deserved to succeed, was, however, frustrated by the faintness of the coronal spectrum.

Of other observations it is scarcely possible to speak as yet. It should, however, be added that the polariscope, which has been almost forgotten in eclipse work for the last fourteen or fifteen years, was very successfully used, both at Sahdol and at Pulgaon, and the clearest indications were secured of strong radial polarization.

Such is a very brief outline of the principal results (so far as we yet know them) of this the most completely successful eclipse on record. We hope to be able, at no very distant date, to go much further into detail, when some portion of the photographs obtained have been deciphered and discussed.

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BRITISH BEES.—I.

By Fred. Enock, f.l.s., f.e.s., etc.

The number of species of bees in Great Britain is by no means large—only just over two hundred—and yet to those people who, "having eyes, see not," this small number is far too large for insects which possess stings. Gardeners, too, look upon them as marauding thieves, and this in spite of the fact that fertilization of plants is brought about by the unceasing industry of the bees.

Ungratefulness in man is so common a characteristic that we must not be surprised to find that so little interest is taken in the study of our British bees. It is sufficient for the majority to know that "bees make honey."

For those who *do* desire to be soothed by the humming-bee, or to follow out the habits and economy of our British bees, the choice of books on the subject is by no means a large one. They are: "Bees of Great Britain," by Frederick Smith; Shuckhard's "British Bees"; and the most valuable work, "The British Apidæ," by Edward Saunders. Mr. Saunders is always ready and willing to help young students in naming their captures. It is one of our greatest pleasures to look back upon the many instances of kindness received from the late Frederick Smith, who was in every sense a true lover of bees—one who would inspire enthusiasm in the heart of a young beginner. The collection of British bees at the Natural History Museum, South Kensington, was under his affectionate care years ago at the British Museum.

The first family, the *Andrenidæ*, is divided into two sub-families: the first composed of two genera only, possessing tongues much like the *Vespidæ*, obtuse and rounded; that of *Colletes* being very beautiful when fully expanded (Fig. 1, *Colletes Daviesana*). There used to be a very large colony of this species at Farnborough, where I have seen hundreds of the burrows close together in the sand-banks. In some of the woods near Aldershot there were also a number of colonies, many of which appear now to have become deserted. The exceedingly neat looking species, *C. succincta*, I used to find at Hampstead Heath, but, like other things, it has now disappeared from that neighbourhood. The bees of this genus have exceedingly sharp and powerful stings, and the legs are clothed with most beautiful hairs of varied form.

The members of the other obtuse-tongued genus, *Prosopis*, are all small in size and more or less black. They are exceedingly fond of the flowers of the vetch. The males are most diligent in their pursuit of the females.

The second division, in which are classed those bees possessing tongues more or less acute, is composed of a number of genera. Like those of the first part, the members of these genera are solitary in their habits. The females burrow into the sand for some considerable depth, and line the sides of the burrow with an exceedingly fine membrane, resembling goldbeaters' skin—only considerably thinner.

Fig. 1.—*Colletes Daviesana.*

The bees belonging to the genus *Sphecodes* are small, measuring from three-eighths to half an inch long. They have black heads and bright, shining red bodies. They are fond of settling on the bare patches of sand at Hampstead and in other places where they are tolerably plentiful, the females being more so than the males. The sculpture of the thorax is well worth examination.

The next genus, *Halictus*, is composed of many species, of some which are *very* small, but all are exceedingly neat in their appearance. Both sexes of many species appear in September, when, after impregnation, the females hybernate, and make an early appearance the following spring, when they are busily engaged forming burrows in the sand. Many species are very fond of the flower of the dandelion, and may frequently be found curled up asleep in a half-closed flower. A close watch on these and other flowers during the early hours of the day will often be rewarded by good captures. The tongues of all the *Halicti* are long and lanceolate, and require great care and patience to expand and set out so that all the exquisite structure may be revealed.

We next turn to the genus *Andrena*, which contains the greatest number of species both rare and beautiful. In this genus are the bees which herald the approach of spring. Many of them visit the opening catkins of the willow, and, like the Lepidoptera, soon become intoxicated, and fall an easy prey to the first prowling naturalist. It is, indeed, a glad time when, after weeks of cold and foggy weather, the bright sun breaks out, bringing with its genial warmth these pretty brown bees, each one arrayed in such a perfectly fitting costume of plumed hairs, and their delicate wings glinting in the sunshine—for bees must have bright sunshine to enjoy their lives to the full. I have often heard the remark that it is not much or any use going out in search of bees before nine o'clock in the morning. This was specially impressed upon me when receiving directions as to how, when, and where to look for that most extraordinary parasite *Stylops*, which is found in the abdomen of several of the *Andrenæ*; but having formed some original ideas concerning *Stylops* I am afraid I quite disregarded most of my friend's instructions. Instead of nine o'clock, I was on the ground before eight—waiting for the bees—and as they seemed to be rather behind time I commenced to search for their burrows, which, after a little experience, I was enabled to detect by noting the disturbance of a few grains of sand. By quickly inserting the bent end of my digger (an old half-round file) a short distance away from the burrow, I was able to heave out in nine times out of every ten the *Andrena*, with the moisture clinging to its still yet untried wings. Its astonishment at being so unceremoniously "lifted" appeared to deprive it of the power of sudden flight, and before it could recover it was under close examination, and if stung by *Stylops* it was boxed at once. I placed many of these "stylopized" *Andrenæ* in various parts of Hampstead Heath, hoping to establish the parasite in parts somewhat remote from the area so dear to the holiday makers during Easter (the time when many species of *Andrenæ* are most plentiful), but Hampstead Heath has, within the past twenty years, considerably altered its appearance. Where there used to be rising sandbanks, the head-quarters of endless bees and sand wasps, there is now an unsightly cinder path crossing the very spot which was once the citadel of these beautiful bees, and where, in July, could be seen dozens of the burrows of the sand wasps, *Cerceris arenaria* and *ornata*. Last year I visited this locality several times, but not a single *Cerceris* did I find. The beautiful *Andrena fulva*, with its bright chestnut-coloured abdomen, has not, I am rejoiced to say, yet been exterminated, though how long it will be able to exist time alone will show. Its bright colour is too tempting to the sharp eyes of Easter Monday Cockneys. Fig. 2 shows the head and mouth organs of *Andrena fulva*, which, together with others of the genus, burrow deep down into the sand, throwing up quite large heaps, which frequently are trodden flat to the ground when the industrious female is out collecting pollen and nectar. On her return there is no sign of her home, but she, possessing the bump of locality to a large degree, sets herself to work to find or make an entrance through the hardened sand. This she proceeds to do by removing the sand with her powerful mandibles, which are frequently worn down until they are made stumpy in her efforts to reach her burrow—efforts terminating in success.

Fig. 2.—*Andrena fulva.*

The male of *A. fulva* has its mandibles enormously developed. Some of these bees, on first emerging from their burrow, are exquisitely arranged and exact in every fringe of hairs, on head, abdomen, and legs. One of the neatest is *Andrena fulvicrus*, which is markedly common at Highgate Cemetery—a good locality for many kinds of bees, where they can live and die in peace. The neighbourhood of Highgate Archway, too, used to be a noted spot for uncommon *Andrenæ*, such as *A. longipes;* but now it sounds like mockery to mention such localities as Copenhagen "Fields" and Highgate "Fields."

Leaving the *Andrenæ*, we now come to a bee, *Macropis labiata*, of which, when the late Mr. Fred. Smith wrote his "Bees of Great Britain," in 1855, only three specimens (all males) were known to exist. The first captured in this country found its resting place in the British Museum; the second was taken by Mr. Walton in the New Forest; and Mr. Samuel Stevens captured a third at Weybridge, on July 4th, 1842; and though the surrounding country had been searched year after year, it did not yield another specimen. Not until the year 1878 was this rare bee heard of again, but then the well-known hymenopterist, Mr. Bridgman, appeared at the right time and right place to find both males and females. In 1882 I went to live at Woking, which was then a comparatively small place. At that time I used to wander about without interference, and I could revel in studying insects, especially bees. Previous to taking up my abode at Woking a microscopist asked me what I was going to take when I got there. I immediately replied, "Oh, *Macropis*," adding, "I will write and let you know immediately I capture it." In the following July I observed large quantities of a flower somewhat new to me, upon which I kept constant observation—having a presentiment that I should find *Macropis* upon or about it. On July 27th, 1882, my valued friend, the late Sir Sidney Smith Saunders, paid me a visit, and we both went out "beeing." At noon exactly I noted a bee pass by whose hum I did not know, so I waited until it should return, which it did in a few minutes—little suspecting that it was doomed to be captured, by a rapid stroke from my arm. I quickly removed it from my net and brought my magnifier to bear; I then called to Sir Sidney to come and have a look at something, asking, as I gave it into his fingers, "What's *that?*" when after a few moments' pause Sir Sidney almost shrieked with excitement, "Why, it's *Macropis!*" I boxed it safely, feeling that my presentiment had indeed come true.

Fig. 3.—*Cilissa hæmorrhoidalis.*

After this piece of fortune Sir Sidney and I were much excited, and jumped hither and thither like parched peas; but all in vain that day—no more *Macropis* appeared.

On the 29th I was found on the spot with eyes and ears at full cock; my patience was rewarded by capturing four more male and one female *Macropis.* I quickly discovered the fact that the latter knew how to sting. After my first capture I sent a card to my friend, informing him that "I had got *Macropis.*"

Sir Sidney S. Saunders and I had several rambles together in search of this beautiful bee, and each was rewarded by capturing several males and females. The following year, 1883, I saw dozens of both sexes, which I left to be fruitful and multiply. I searched in vain for their burrows, though I tried all kinds of dodges. Catching some, I gently tied a delicate piece of fine silk to one of the legs, then a small piece of white tissue paper, and started the bee flying. I followed the bees long distances, but all my efforts were futile. Some of the "runs" ended by my catching my foot in a twig and falling headlong into a gorse bush, from which I was glad to retire as soon as possible. Woking has since increased to five times the size, and some of the best parts of the common are utterly ruined.

Another beautiful bee which I used to find occasionally in the neighbourhood of Woking was *Cilissa hæmorrhoidalis*, which affects the flowers of the harebell—another flower that is not so plentiful as in years past, but one absolutely necessary to this bee—one of the most energetic and businesslike insects with which I am acquainted. Quick eyes and hands are needed to capture this prize, for it only appears in the hottest sunshine, when everything must be ready for its reception. It announces itself without a moment's hesitation, and does not tarry long, for it is no sooner in one harebell than it is out again and away—except, indeed, when the net follows up as quickly. Even when it is in the net the capture is not complete, for this bee does not sham death as do others, but bustles about in a most vigorous manner in its endeavours to escape, stinging, too, in the most approved style. I do not think any bee possesses such an exquisitely beautiful tongue as this one. In outward appearance this bee is much like a large honey bee, though much more hairy. Fig. 3 gives an idea of the head and tongue. Whilst searching for *Cilissa* I used occasionally to find a few of that grand bee, *Dasypoda hirtipes*—the hairy bee—without doubt the most beautiful and graceful of all British bees. It has only once been

Fig. 4.—*Dasypoda hirtipes.*

recorded from the London district—July 18th, 1878—when I was fortunate in capturing a fine female specimen as it hovered about the face of a sandbank on Hampstead Heath. *Dasypoda hirtipes* is intensely fond of composite flowers of the dandelion type, among the petals of which it buries itself as it rifles the flower of its nectar and yellow pollen, with which it becomes heavily laden. Its immense bushy hind legs look like bright yellow bottle brushes. The shape of the hairs on the third pair of legs is unique among bees, each tiny little branch being surmounted by a knob or club. This bee is plentiful along the south coast. I found them just emerging from their burrows in the sand at Littlehampton. Fig. 4 shows the peculiar shape of the tongue and maxillæ.

Fig. 5.—*Nomada succincta.*

Panurgus is the next in order. In colour it is a smoky black. It is fond of making its burrows in hard paths, and in such situations I have found them at Woking and Hampstead, besides having swept them up from flowers of the mouse-ear hawkweed, which used to flourish on Hampstead Heath.

The genus *Nomada* consists of a number of species, more like wasps than bees, with bright yellow-banded bodies. All are cuckoo bees, depositing their eggs in the burrows of *Andrenidæ* at the time when the rightful owners are engaged storing up pollen for their progeny, which are starved out by the stronger larvæ of this cuckoo bee. The tongue is a very neat one, more resembling that of the honey bee (*see* Fig. 5).

The prettily marked bee *Epeolus variegatus* is parasitic in the cells of *Colletes Daviesana.* It has a particularly sharp sting. (*To be continued.*)

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THE VINEGAR EEL.

By C. Ainsworth Mitchell, B.A., F.I.C.

In the "Philosophical Essays" of Robert Boyle, published in 1661, there occurs the following paragraph:—"We have made mention to you of a great store of living creatures which we have observed in vinegar; of the truth of which observation we can produce divers and severe witnesses, who were not to be convinced of it until we had satisfied them by ocular demonstration; and yet there are divers parcels of excellent vinegar wherein you may in vain seek for these living creatures, and we are now distilling some of that liquor, wherein we can neither by candle-light nor by daylight discern any of these little creatures, of which we have often seen swarms in other vinegars."

This appears to be the earliest reference in scientific literature to the *Leptodera oxophila*, which, from its shape and fondness for vinegar, has long been known as the "vinegar eel," and which in Schneider's opinion is identical with the "eels" which may often be observed in sour paste.

It is of very frequent occurrence in certain vinegar works, more especially on the Continent, where the vinegar is manufactured at a lower and (for the eels) more favourable temperature than is usual in England. As to its origin, nothing is definitely known, though Czernat is inclined to think that it is introduced in the water used for brewing the vinegar. Occasionally, on allowing vinegar to stand exposed to the air for several days in warm weather, it will soon be swarming with these minute creatures, which have probably developed from germs already present in the liquid. As will be seen from the figure, which shows a single vinegar eel under a high power, it is of very simple construction.

The body is cylindrical and ends in a sharp point, and the skin (which is changed from time to time) is smooth, structureless, and very strong. According to Czernat's average measurements, the length of the male's body is about one twenty-fifth of an inch, that of the female one sixteenth of an inch, the relative proportion generally being as 1 : 1·3. In both sexes minute corpuscles may be observed, which are put in motion by the contraction of the body. In the female the eggs lie in two tubes which unite in one opening.

Vinegar eels are capable of moving either backwards or forwards, and progress by alternately shaping themselves into an S and straightening out again. They appear to be incessantly darting through the vinegar at the top of their speed in all directions, but always with a tendency towards the surface, as they are air-breathing animals. Czernat states that they never rest day or night, and that their rate of progress is about one inch in twelve and a-half seconds.

They are capable of living in very dilute alcohol or acetic acid as well as in vinegar, and can withstand a great variation of temperature, not being killed until the temperature reaches one hundred and forty degrees to one hundred and fifty degrees Fahrenheit in one direction, and about ten degrees below the freezing point of water in the other.

The Vinegar Eel (highly magnified). (*After Pasteur.*)

Pasteur was the first to point out how harmful the vinegar eel is in the manufacture of vinegar. Vinegar is prepared by causing certain micro-organisms (of which there are several species classified under the term of "acetic bacteria") to act upon a liquid containing a small percentage of alcohol, such as beer, fermented malt extract, or cider.

By the action of these bacteria, which are supplied with the requisite amount of atmospheric oxygen, the alcohol is gradually converted into acetic acid, the process being accelerated by maintaining a temperature of about one hundred degrees Fahrenheit within the "acetifier."

When insufficient air is supplied, the bacteria form themselves into a slimy layer on the surface of the liquid, popularly known as "mother of vinegar." Should, now, vinegar eels develop in vinegar in the course of manufacture, they multiply rapidly, and a struggle for the air supplied to the apparatus commences between them and the bacteria. For some time a working balance may be struck between them, and the air shared; but during this struggle, which may last for weeks, the activity of the bacteria is impaired, and though the conversion of alcohol into acetic acid still proceeds, it does so with an increased expenditure of time and a reduced yield. Should the vinegar eels gradually obtain the upper hand, they interfere more and more with the working of the apparatus, and eventually the conversion of alcohol into acetic acid comes to a standstill. If, on the other hand, the bacteria get the mastery, they form the slimy layer, mentioned above, over the surface of the liquid, as the result of their obtaining insufficient oxygen. This skin effectually prevents the eels from breathing when they come to the surface, and so they perish for want of air, and fall to the bottom of the apparatus, where they may accumulate and putrefy. In either case the only remedy is to thoroughly clean and disinfect the apparatus and commence afresh.

It was only with great difficulty that Pasteur could convince certain French vinegar manufacturers as to the advantage of endeavouring to get rid of the vinegar eel, for so general had it become with them that they had begun to look upon it as an essential part of the process instead of a deadly enemy.

Even after vinegar containing eels has been freed from them by filtration the germs remain, and when placed under suitable conditions will develop into eels, which will rapidly multiply and cause the vinegar to become turbid, although it has been recently proved in Germany that they do not affect its strength. As Pasteur was the first to point out the ill effects caused by the vinegar eel in the manufacture of vinegar, so, too, he was the first to devise an effectual means of destroying them, with their germs and all other forms of life in the finished product, by heating it to about one hundred and sixty degrees Fahrenheit, and then rapidly cooling it so as to prevent loss of the acid by evaporation. And this is only one of the many instances in which the studies of Pasteur on micro-organisms have been of practical benefit to mankind.

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BOTANICAL STUDIES.—II.

COLEOCHÆTE.

By A. Vaughan Jennings, f.l.s., f.g.s.

In a preliminary study* we examined a common fresh-water alga which showed in its simplest form the process of oögamous reproduction; the development of a single egg-cell in a simple protective case, fertilized by motile antherozoids formed in an adjoining chamber growing out from the same plant-filament. Apart from structural details of the plant in question, attention was specially called to two points in connection with its reproduction: firstly, that what might be termed the "fruit" was only the fertilized egg-cell surrounded by a thickened wall; and, secondly, that on germination this "fruit" (or oöspore) grew at once into a new plant, in all respects resembling the parent.

Our next illustration may also be taken from the fresh-water algæ, and from a genus by no means uncommon in this country, though not, perhaps, easy to find without some careful observation.

On the stems of water plants such as the water-lily and the common pond-weed, or on the glass sides of aquaria, may be found little green discs ranging in size from almost invisible specks to circles a quarter of an inch or so in diameter.

These belong to the genus *Coleochæte*,* a well-defined and widely distributed genus containing in this country some three species. The plants are, it is true, very frequently sterile, but the nature of the reproductive process is of considerable importance in the line of study we are following.

It will be interesting, however, first to examine the structure of the plant itself. If the species collected is, as it most probably will be, either *C. scutata* or *C. orbicularis*, it will be noted that the whole plant is just a flat plate of cells arranged in radial rows; the cells all in one plane and never superposed one above another. As the cells have all a fairly uniform average size, this must mean that at the growing margin many cells divide in two by radial walls, and numerous instances of this will readily be found. In another species—*C. soluta*—the rows of cells are, in fact, separated for a considerable portion of their length: while in others, such as *C. pulvinata*, the cells are no longer in one plane, but grow up straight or obliquely, forming a sort of cushion.

In other words, we have within the genus† a series of stages connecting the flat cell-plate with the tree-like growth of such types as *Bulbochæte*, one of the most beautiful of our fresh-water algæ. Among the red seaweeds, also, the early stages of some species of the "coralline" *Melobesia* have a similar structure, and the delicate discs of cells may often be found on the surface of the larger weeds. A similar growth-type occurs also on leaves in tropical countries, constituting the genus *Phycopeltis*,‡ but here a yellow colouring matter is present as well; and this fact, together with its reproductive organs, shows it to be allied to the little yellow or red filamentous algæ of the genus *Chroölepus* (or *Trentepohlia*) which occur on rocks and trees all over the world. We have, that is to say, similar or parallel types of growth in plants which are otherwise widely separated. Some writers seem to regard the disc type as derived from the thread-like form; but the early stages in development of such forms as *Phycopeltis* seem, as I have elsewhere suggested,§ to point to an opposite conclusion. Theoretical questions such as this are, however, outside our present purpose.

Coming to the question of the mode of reproduction in *Coleochæte*, we find, as in *Vaucheria*, that there are two distinct methods. In the first case the protoplasm of some of the cells of the thallus becomes contracted and rounded, and finally escapes by an opening in the cell wall. When liberated it appears as a free-swimming *zoögonidium* with a pair of long cilia. This, after a period of activity, loses its cilia, settles down, and subsequently grows into a new plant. The process is therefore physiologically similar to the escape of the more complex *zoögonidium* of *Vaucheria*, and has nothing to do with the formation of a true fruit. It is again a case of "rejuvenescence" of a protoplasmic particle without any combination with other elements.

In the second case the contents of certain cells become enlarged and specialized to form an *oösphere*, while some of the other cells divide in four, and from each new cell

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* *Vaucheria*, Knowledge, January, 1898.

* The name refers to the long bristle-like hairs with a sheathing base which occur on the cells of the disc in most species, but are sometimes altogether absent.

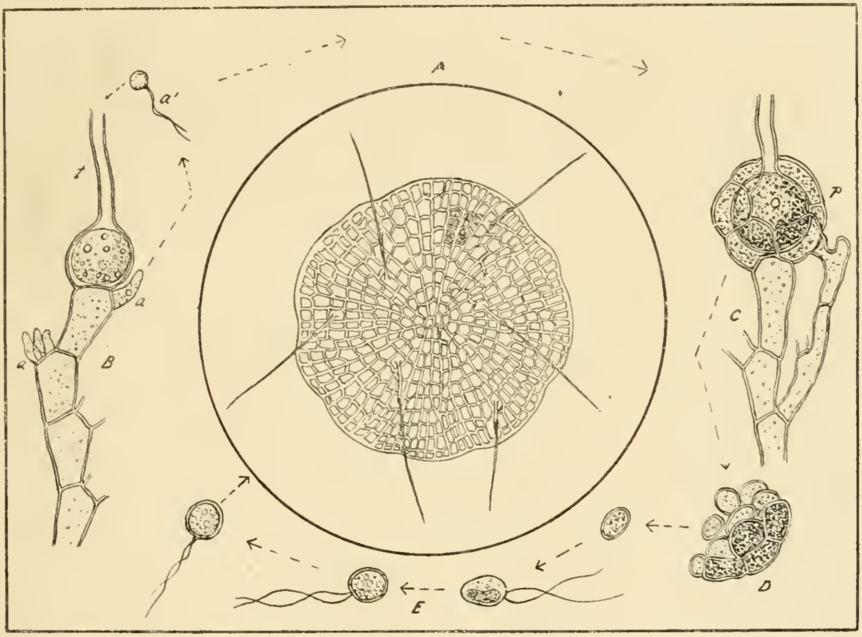
† The closely related genus *Aphanochæte*, which also occurs on fresh-water weeds, shows in the same way an intermediate condition between the discoid and the filamentous growth.

‡ The *Mycoidea parasitica* (Cunningham), which causes disease on the leaves of the coffee and other plants, is nearly related, but may consist of more than one cell-layer, and may penetrate the tissues of the leaf it grows on.

§ *Proceedings of the Royal Irish Academy*, 1895.

thus produced set free an *antherozoid.* This is a free-swimming body with two cilia, similar to the zoögonidia, but smaller, and it reaches and fertilizes the oösphere by different methods in the various species. In the common British species it appears that any cell of the disc may enlarge and become an oögonium; and, similarly, other cells may divide and become antheridia, though often on separate plants. The fertilization of the oöspheres by the antherozoids in these cases apparently takes place by the passage of the latter through an opening in the cell wall of the oögonium.

The process has been studied in detail by Pringsheim in the case of a species which is not found in this country—*Coleochæte pulvinata* (A. Br.)*—and in this case the highest degree of specialization seems to be reached. The species is one of those already referred to as having a half-filamentous, tufted growth, and here the oögonia are terminal on the ends of the threads.



A —Young plant of *Coleochæte scutata* (Brèb), magnified about one hundred times. In the upper part some of the cells are dividing into four previous to the development of antherozoids. B.—A fertile filament of *C. pulvinata* (A. Br.), showing the oösphere enclosed in the oögonium with its trichogyne (*t*). Below are the antheridia (*a*) and above an antherozoid (*a′*). C.—An oögonium in same species after fertilization, showing the surrounding pericarp (*p*). D.—The spermocarp liberating its carpospores. E.—Zoöspores formed from the carpospores. (B to E, after Pringsheim.)

The oögonium is, as before, only an enlarged and specialized cell containing a single oösphere, but its wall is prolonged into a long tubular projection termed a "*trichogyne*." Antheridia are developed from adjacent cells in this species, but in some other cases on separate plants.

There is no doubt that the trichogyne corresponds in function to the *style* of a flower, and is a special structure developed in connection with the process of fertilization. Its presence in this one type of fresh-water weed is specially interesting, because it is a characteristic organ in the case of the red seaweeds, though in these the fertilizing agents are non-motile bodies or *pollinoids.*

This similarity between the reproductive process in *Coleochæte* and in the red seaweeds is still more marked in the subsequent stages. After fertilization not only does the oösphere enlarge and become surrounded by a cellulose wall (constituting an oöspore or oösperm), but some physiological influence extends to the adjacent cells, causing them to divide and grow up round it, enclosing it in a protective cellular layer or *pericarp.*

The structure thus formed—which has been called by different authors a *carpogonium* or *spermocarp*—is therefore a very much higher type of fruit than the simple oöspore of *Vaucheria.*

The fruit remains quiescent during the winter, but in the next spring the oöspore divides and forms several cells or *carpospores*: it does not itself grow into a new *Coleochæte* plant. Further, the carpospores themselves do not grow into new vegetative plants. They liberate free-swimming zoöspores, and these in their turn give rise to new *Coleochæte* plants which may reproduce themselves again by either method.

While, then, an ordinary sterile plant of *Coleochæte* does not show us any particular advance in general structure from many of the lower *Thallophyta*, there are certain well-

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* The species is not uncommon in the lakes of Central Europe. I am indebted to Prof. Oltmanns for calling my attention to it on plants of *Isoëtes* in the Titisee, near Freiburg-in-Baden.

defined features in its life history which mark a great step in the evolution of plant life. Firstly, there is the development of the trichogyne. Secondly, there is the influence of the process of fertilization on cells adjacent to the egg-cell, resulting in the formation of a fruit. Thirdly, there is the all-important phenomenon of the division of the carpospore into a group of cells which do not immediately reproduce the parent plant.

We have here, in fact, a very early indication of that *alternation of generations* which has played so important a part in the story of plant life, and a study of which has given us the clue to the relationship between the lower and higher members of the vegetable kingdom. It is here that we see clearly for the first time, in the upward succession of plant types, the distinction between an *oöphyte* or egg-bearing generation and a *sporophyte* or spore-bearing generation, arising from it and in turn reproducing it again.

Some of the consequences of the increasing differentiation of these alternating stages and the specialization of their accessory tissues will be pointed out in later studies.

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CLOUD BELTS.

By Wm. Shackleton, f.r.a.s.

Anyone who has made a voyage beyond the Equator will, no doubt, retain a good recollection of a day or so of disagreeable, oppressive, damp weather, when moisture seemed to be exuding from all sides, just as if one had come out of a dense Scotch mist, and everything was coated with a thick film of moisture which trickled down in great beads. This journey through the watery-laden atmosphere and almost constant rain, is really a passage through the equatorial cloud belt which girdles the planet on which we happen to be located; and although we may admire Jupiter with his many cloud belts as seen through a telescope, yet we feel thankful for the invention of steamships which enable us to leave behind as quickly as possible the most marked cloud-belt appended to our earth, rather than be becalmed in these "doldrums" where ships have been known to drift listlessly about for whole weeks.

A graphic description of the kind of weather which is usually experienced under the cloud ring of the equatorial calm belt is found in the journal of Commodore Sinclair, kept on board the U.S. frigate *Congress* during a cruise to South America in 1817-18. He crossed it in the month of January, 1818, between the parallel of 4° N. and the Equator. He says :—"This is certainly one of the most unpleasant regions on our globe. A dense, close atmosphere except for a few hours after a thunderstorm, during which time torrents of rain fall, when the air becomes a little refreshed; but a hot glowing sun soon heats it again, and but for your awnings and a little air put in circulation by a continual flapping of the ship's sails it would almost be insufferable. No person who has not crossed the region can form an adequate idea of its unpleasant effects. Except when in actual danger of shipwreck, I never spent twelve more disagreeable days than in these calm latitudes."

The general appearance of the sky in this "rainy sea," as it has been called, is a steamy haze—sometimes growing into uniform gloom, with or without heavy rain, at other times gathering into small ill-defined patches of soft cumulus. After dark there is always a great development of sheet lightning till about two in the morning.

The Plate shows the appearance at the edge of the cloud belt on the confines of the south-east trade wind, and is reproduced by the kind permission of Sir J. Benjamin Stone, M.P., from a photograph taken by him in 1894, on his way to South Africa.

Besides this equatorial cloud belt, however, there are two other rings encircling the earth, where rain falls perhaps more incessantly even than in the equatorial belt itself, though by no means in such large quantities. These latter belts occur near latitude 60° in both hemispheres; and perhaps more of us have passed through these than that of the equatorial belt, especially the one crossing the Shetlands and South Norway about Bergen, where it rains nearly every day throughout the year, and which place tourists speak of as especially relaxing, thus experiencing some of the effects described by Commodore Sinclair.

It is not necessary to go into detail as to the actual cause of these cloud belts—that is a matter for text-books ; sufficient it is to say that in the case of the equatorial belt, the north-east and south-east trade winds flowing into the equatorial regions to supply the up-draught caused by the intense heating of the atmosphere surrounding the Equator, pass over zones of about twenty degrees in width, from which all, or nearly all, the vapour of evaporation is carried into the comparatively narrow zone of the equatorial calm belt before it ascends to higher and therefore colder levels. In these upper reaches condensation takes place, thereby producing a constant canopy of dense cloud which forms a nearly continuous cloud girdle. The equatorial calm belt, therefore, is also a cloud and rain belt.

It has been estimated that the daily amount of evaporation on the ocean within the tropics is about a quarter of an inch per day. If, then, all this amount of vapour over zones, say, one thousand miles in width on each side, is carried into the calm belt, say three hundred miles in width, and is there precipitated as rain, the daily rainfall would be 1·67 inches; and consequently if this belt were to remain stationary, we should have an annual rainfall of about sixty feet for the average of the width. But since the cloud and rain belt oscillates through a range generally more than twice as great as its width, this amount of rain is distributed in the course of the year over a zone more than three times as wide, and hence in general less than one-third of this amount falls in any one place during the year ; *e.g.*, at Maranhão at the mouth of the Amazon, and on the border of the cloud zone, the rainfall is two hundred and seventy inches per year, and is even greater at several places, but this is chiefly due to local influences.

From certain causes the rain and cloud belt, as it exists at any given time, is mostly wider than the belt of calms, but of course neither have very definite limits ; these, however, are much better defined over the great oceans, where the trade winds blow much more steadily than on the continents, where regularity is very much interfered with by the various abnormal disturbances of uneven surfaces and mountain ranges, and likewise by the monsoons of the Indian and other oceans. The rain and cloud belt is, however, clearly traceable across the whole of Africa, wherever observations have been made, as also across the American isthmus ; but it has greater width and its limits are not so well defined. These cloud zones, on which large amounts of rain fall, are traced out naturally for us on the surface of the globe, and it has been truly said that these regions are the "reservoirs of the great rivers"; *e.g.*, those originating from the equatorial cloud belt being the Amazon, Orinoco, Niger, Nile, and Congo, whilst the Yenesei, Obi, Mackenzie, and St. Lawrence largely derive their supplies from the minor belt in the northern hemisphere.

From certain causes which can be explained, the mean

THE EQUATORIAL CLOUD-BELT

Off Africa, March 21, 1894. Latitude near Equator, Longitude 10. From a Photograph kindly lent by Sir Benjamin Stone, M.P.

position of the cloud belt is not coincident with, but lies a few degrees north of, the Equator, and, as has been mentioned before, it oscillates over a zone more than three times its width in a year.

The cause of this annual oscillation of the belt is that during the winter of each hemisphere the earth's surface and atmosphere becomes much colder than it is in the other hemisphere, and consequently the atmospheric volume is considerably less, and there is a pressure gradient above by which the air of the higher strata flows from the warmer hemisphere to the colder, giving rise to a counter flow of air below, from the colder to the warmer hemisphere. The consequence is that the stronger system at this season encroaches somewhat upon the territory of the other, causing the middle of the equatorial calm and rain belt (which is the dividing line between the two systems) to be displaced from its mean position. There is therefore an annual oscillation of the calm and cloud belts, such that the most northerly position is in midsummer and the reverse in midwinter of the northern hemisphere, or, in other words, as the sailors say, "The cloud belt follows the sun."

Wet and dry seasons are thus produced in districts which fall within the range of oscillation of the rain-cloud belt, where it is well defined and not affected by abnormal disturbances, but is somewhat as in the ocean and on level countries. Such is the case with the Orinoco and great Amazonian basin. Humboldt says: "As in the very North the animals become torpid with cold, so here, under the influence of the parching drought, the crocodile and the boa become motionless and fall asleep, deeply buried in the mud. At length, after the drought, the welcome season of rain arrives, and then how suddenly is the scene changed!" In ponds from which, but a week before, the wind blew clouds of sandy dust, the reanimated fish may be seen swimming about, deciduous trees become verdant, and scarcely a week elapses before the plants are covered with the larvæ of butterflies, the forest is murmuring with the hum of insects, and the air is harmonious with the voice of birds.

The rain at these periods excites the astonishment of a European. It descends in almost continuous streams, so close and dense that the level ground, unable to absorb it sufficiently fast, is covered with one uniform sheet of water; and down the sides of declivities it rushes in a volume that wears channels in the surface. In the towns many of the houses are built on raised causeways, so that the roadway is able to act as a river bed during these tropical downpours. Perhaps in some subsequent number of Knowledge we may reproduce a street scene under these conditions, with half-submerged carts, floating barrels, and a rushing stream carrying all before it.

The effects of these alternating seasons can readily be imagined, and to obviate this—or, rather, to have a supply of water for irrigation and other purposes during the dry season—some of the provinces in South America thus affected are constructing large reservoirs; *e.g.*, in the province of Ceará they are damming up the end of a large valley at Quixada, thus forming a large artificial lake in the wet season, which will be distributed gradually over the parched land throughout the *séca*, or dry season.

Space will not here permit me more than to point out that the most conspicuous features of the members of the solar system larger than the earth are their dark belts, whilst in the case of those planets smaller than ours these bands are scarcely traceable. Whether in this respect the earth marks a different condition of things existing on the giant planets to that on the smaller ones (which constitute less than one-hundredth of the planetary mass) is only conjecture; but one would expect that the appearance of the cloud belts on the earth, as seen from some other planet, would, on account of the great reflecting power of clouds and mists, be not in the form of dark but of bands brighter than the general surface.

Seeing, then, that all the large planets are so striated, should we not expect the central and largest body of our system—the sun—to exhibit these characteristics? And, indeed, it does, for are there not two zones of maximum "spotted area" on either side of the equator, along which concentrated portions of cloud belts move across the sun? Hence, if we imagine these gregations of umbræ to be disseminated as penumbræ along the spot zones, we should have presented to us a phenomenon closely resembling that of the "cloud belts" of the larger planets. From these few considerations it may be gathered that "cloud belts" play an important part in the cosmogony of the solar system.

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A NEW THEORY OF THE MILKY WAY.

By C. Easton.

TOWARDS the end of a previous article on "Richard A. Proctor's Theory of the Universe" I suggested that, if we confine ourselves to those facts known to-day with sufficient certainty, we can only affirm, with respect to the structure of the Milky Way, that we there see marked irregularity of details, and some traces of a regularity at least partial in the principal features of the phenomenon. Before venturing to go a little further I must sum up the facts and considerations on which this opinion is founded. Want of space compels me in an article of this kind to direct in some cases the reader to the sources of information.

Now that photographs of the Milky Way are so widespread, there is no need to insist on the great irregularity that we observe (in projection) in the distribution of the stars, so long as we confine ourselves to a relatively small portion of the galactic zone. It follows, moreover, from the evidence of all the results recently obtained in the study of the galactic phenomenon, that the manner of distribution of stars *in space* varies, even between limits that are relatively large: in this part of space the stars are widely scattered, in this other part they are gathered together into veritable stellar agglomerations. But, *à priori*, that does not by any means exclude a fairly marked regularity of the Milky Way, *taken as a whole.* Suppose that the Milky Way has the form of the well-known elliptic nebula in Lyra; unless we admit that its borders are defined by this figure, and a perfect regularity of distribution prevails inside this ellipse, we should see—we being situated near the central portion, relatively void of stars—a "Milky Way" enclosing the heavens in a fashion similar to the one we see in reality.

Besides, this theory of a Milky Way roughly annular or elliptical recommends itself by its simplicity, and appears to be the one most widely spread at the present day.

Nevertheless, if one studies the phenomenon closely, there are, in this theory of a galactic ring, several points that require explanation.

We see, it is true, the Milky Way forming a great circle round the heavens, but, even apart from the irregularity of detail, the galactic light is very unequally distributed on the circumference of this ring. The Aquila part is much more brilliant than the Monoceros part. This is not only seen in the studies made with the naked eye, but also in the star gauges; and it is the case for the southern hemisphere as well as for the northern. As for the general naked-eye aspect, two minutes' study on a fine evening in September is sufficient to establish the great superiority in brightness of the Milky Way between Sagittarius and Cepheus over that between Cepheus and the Twins. As for the counts and stellar gauges, Sir William Herschel found an average of 161·5 stars in his gauges about Aquila as compared with 82·5 about Monoceros. Celoria found likewise for all stars down to the eleventh magnitude in an equatorial zone of about six degrees breadth, 58·883 stars in the region containing the Milky Way about 18h., and 43·822 in the part that the Milky Way crosses about 6h.[*] This is a fact that it is quite easy to establish, but whose consequences have not received the attention that they merit.

Unless we admit that we are situated in the centre of the ring, but that in the body of this irregular ring the stars increase systematically, so to speak, towards a point (which is evidently most improbable), we must conclude, as was said above, that the sun in the interior of this hypothetical ring occupies an excentric position, fairly near the side where is Monoceros, moderately distant from Aquila.

But why, then, does the *breadth* of the galactic zone in Monoceros differ so little from that in Aquila? Evidently the Milky Way in general ought to appear larger to us the nearer we approach the hypothetical ring, for we could not presuppose (and before such an utterly improbable thing has been proved independently) that the irregularities in the breadth of the zone (any more than the irregularities of brightness) increase towards a given point in the circumference. But at first sight the Milky Way appears, on the contrary, larger in the region of the Eagle, because of the two brilliant branches, and that is why Kant has already placed the sun near to that part of the Milky Way where this constellation is found. After studying it, however, more attentively with the naked eye, and including all the branches, it appears rather broader on the majority of charts in Monoceros than in Aquila, but the difference is far less than theory would indicate. Is this circumstance due to the mode of formation of the visual Milky Way itself? (See my preceding paper.) No, for in the paper of Prof. Celoria we find an easy way of measuring the breadth of the zone where the stellar density is greater than the "average" ("*physical Galaxy*" [†]); and it follows from one of his tables—Tavola V—that for the stars as far as the eleventh magnitude (and also for the whole of the fainter stars that W. Herschel saw in his great telescope), the Milky Way is considerably larger in Aquila than in Monoceros, and even (particularly for the relatively brilliant stars 0—11) that the principal branch in the Eagle alone has almost the same breadth as the entire Milky Way in Monoceros, where the galactic light is, moreover, so feeble.

This evidently contradicts the hypothesis of a simple and continuous ring whose parts are all situated at considerable distances from the sun. (Situated in the interior of such a ring, we ought to be able to observe a correlation between the narrow, brilliant, and well-defined portions on one hand, and on the other between the feeble, diffused, and broad portions.) The hypothesis that there is a real duplication of the Milky Way into two branches at the same distance from us, over almost exactly the half of its course, is obviously improbable; but it is also incompatible with the reality, for the classic representation of the "simple" Milky Way[*] in Cygnus, Monoceros, and Crux, as opposed to the double portion in Crux, Aquila, and Cygnus, does not exist.[†] If we hold to an annular Milky Way we are compelled to accept at least *two* rings, which both surround us but at very different distances. The nearest ring easily explains the very remarkable circumstance that the fairly brilliant stars—those found in the "Bonn Durchmusterung" of about 0—9·5 magnitudes—are, contrary to the others, more numerous in Monoceros than in Aquila, a phenomenon that is repeated under another form in the belt of bright stars of Sir John Herschel and of Gould.[‡] Celoria, moreover, does not hesitate to admit "*due anelli distinti, ne mai interrotti nel loro corso.*" The stars in the nearest ring are projected on the sky following the circle: Cassiopeia, Hyades, Orion, Crux, Scorpius, Ophiuchus, Cepheus, those in the more distant ring following Cassiopeia, Auriga, Monoceros, Crux, Sagittarius, Scutum, Sagitta. The Italian astronomer does not venture an opinion as to whether these two rings really interlace or are only in projection.

At the time when Celoria's researches were published (in 1878), this theory of two *distinct* and *uninterrupted* rings, that appeared to explain fairly well the general features of the galactic phenomenon, did not so much clash as it does to-day with the objection that, presented in this form, it is unacceptable because of the structure of the Milky Way revealed by drawings, and, above all, by photographs. For this reason a single ring (the principal ring, for instance, in Sagittarius and Monoceros) cannot be imagined but by straining probability; as for *two* complete rings, they are quite inadmissible. The phenomenon is evidently much more complicated even in its principal features.

But is this a reason for throwing overboard the *whole* of this theory of Celoria's, which rests, moreover, on serious observations and deductions? By no means. It is not admissible in its entirety, but may well be true in part.

Suppose, for example, that these "rings" of Celoria are not "unbroken," nor even complete rings, but annular detached segments roughly disposed in two planes—or, rather, in a "broken plane" (Struve)—the grave objection that we have just raised ceases to exist, and the system is in accord with the results that Celoria and other astronomers have obtained.

But, first, here are some considerations of a different nature.

If we imagine the Milky Way to be an assemblage of stars and of clusters of stars distributed quite by chance, we ought to find in all regions of the galactic zone the same characteristics very nearly: these characteristics depending on the chance of the projection which should manifest itself sensibly in the same manner in all directions. The details of the distribution will differ greatly in one direction from another, but the general character—the type—will depend only on the general conditions of the whole; the limits between which vary the stellar density, the volume and brightness of the stars in different parts of the system, the frequency of nebulosities and of opaque bodies, etc.—this type will be constant.

In reality it is not so in the Milky Way. Those who have studied it best, both in its aspect to the naked eye

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[*] Sir John Herschel, *Outlines*; F. G. W. Struve, *Etudes*; J. T. Encke, *Astron. Nachrichten*, XXVI., 1848, p. 336; Houzeau, *Uranographie*; *Atlas*, Mons, 1878; Easton, *Voie Lactée*, 1893; *Astron. Nachrichten*, 3270; Plassmann, *Jahresberichte der V.A.P.*, Berlin, 1893; Celoria, *Pubbl. del Oss. di Brera*, XIII.

[†] "Le regioni in cui le densità stellari sono più grandi della densità media si possono chiamare regioni lattee." Celoria, *ibid.*, p. 43.

[*] "Thence" (Cygnus to Perseus, etc.) "the stream is single." Proctor, *Monthly Notices*, XXX., p. 50.

[†] Boeddicker, *The Milky Way*; Easton, *La Voie Lactée*, etc.

[‡] Celoria, *ibid.*; Sir John Herschel, *Outlines*; B. A. Gould, *Uranometria Argentina*, I.

and on photographs, will recognize, I believe, that the *character* of the Milky Way is not the same in Sagittarius and Scorpius, where brilliant and irregular masses—which rather appear to be individually connected with parts of the secondary branch (or with its brilliant stars)—alternate with dark or poor regions; in the region of Andromeda, Lacerta, and about ε Cygni, where an even stream runs parallel to the galactic axis; or in Cassiopeia, Perseus, and Monoceros, where the tendency to duplication has been noticed in some cases independently by Boeddicker, Easton, and Pannekoek; or in the region round Aquila to the west of Altair, where there is arranged a series of fairly bright patches.

A remarkable peculiarity of the general distribution of the galactic light between α and ζ Aquilæ and β Cassiopeiæ is that in the principal (following) branch the brightness decreases *gradually* from the interior border to the exterior, whilst the secondary (preceding) branch is much more uniform. There is only one exception, but that is a curious one: between γ Sagittæ and ν Cygni it is the principal branch that appears dull, whilst a great brilliant patch stretches between β and γ Cygni, on the interior border of the secondary (preceding) branch; it encroaches a little on the dark interspace. A small, very brilliant patch, a little distant, between α and 68 A Cygni, is situated exactly on the galactic axis.

I will only recall here the well-known argument of Sir John Herschel on the dark spaces with well-defined contours in the midst of a luminous zone (Coal-Sack): a similar opening, in connection with a dark, large rift, visible to the naked eye, passing between 68 A and ρ Cygni, is found in a dim part of the zone between α Cygni and α Cephei—first drawn, I believe, by Heis. These two are the chief. The probability is, in fact, very great that we have here veritable holes in a "galactic band or stream," fairly shallow, and fairly remote from us.

We may add that the dark regions which often stretch over large spaces, and which sometimes form veritable intervals between two luminous streams, and occasionally bear the character of fissures in a bed of luminous matter (Mr. Ranyard and Mr. Maunder especially have drawn attention to these curious dark lines in this same magazine*), indicate that in several regions the Milky Way is principally formed by a band or layer, relatively shallow (which does not prevent another band or clusters of stars being possibly projected upon this layer), but fairly extensive in longitude and latitude. Sometimes, as between 74, 68 A, and ρ Cygni, a large fissure crosses the greatest part of the Milky Way in all its breadth. All this does not easily fall in with the theory which only sees in the Milky Way agglomerations, wholly chaotic, of stars and clusters.

The very extensive nebulosities, discovered lately by the aid of photography, which sometimes envelop an entire constellation (Orion, Scorpius), and which are certainly related to the stars, furnish also a valuable argument for the theory that certain extensive parts of the Milky Way are in reality associated, and form each a more or less complete whole.

Thus, I believe, we must come back to this consideration. In detail, the real distribution of the stars in the Milky Way is very irregular. In the grouping of the stellar agglomerations there is manifested, however, in a certain degree, a systematic distribution. This organization of the stellar matter does not, however, go so far as to produce a geometrical figure of any regularity whatever—ring, ellipse, or one or more rings, concentric or interlaced.

The undoubted connection between certain stars, nebulosities, and parts of the Milky Way, overthrows the theory that the Milky Way is infinitely more distant from us than the bright stars. Certain regions of the Milky Way may be relatively near us. It follows from the researches of Celoria that in all probability the Milky Way in Orion is much nearer us than the opposite parts of it. But the same conclusion is arrived at for other portions of the Galaxy. I believe that "Holden's ellipses"*—stars ranged in chaplets, etc.—are not, at least in certain cases, the result of optical illusion (see the magnificent photographs published in Knowledge, 1891, October and December—the region between α, ξ, and *f* Cygni), and that the dark fissures sometimes bordered by long ranges of stars, and other phenomena of the same nature, are undoubtedly real. Whatever may be the reason of these strange peculiarities of distribution, it is indeed too difficult to imagine that the regions where they are produced are at incommensurable distances.

Sir John Herschel has already pointed out that the "long lateral offsets which at so many places quit the main stream of the Galaxy, and run out to great distances, are either planes seen edgeways, or the convexities of curved surfaces *viewed tangentially*, rather than cylindrical or columnar excrescences, bristling up obliquely from the general level." ("Outlines," § 792.)

There is nothing, indeed, inadmissible in such trains of stars—veritable branches of the Milky Way—lying across the interior of our stellar system, and, in some cases, coming near our sun. Combining this supposition (which gives a plausible explanation of more than one question) with the theory of "segments of a ring," to which Celoria's theory might be reduced, we find a system of spirals the most simple figure that we can imagine the Milky Way to assume according to this train of thought.

As an analogy from what we see in the heavens, I will take, not the nebula of Lyra, but rather the nebula Mess. 101 Ursæ Maj. (Roberts, "A Selection of Photographs," 1894, p. 32; also Knowledge, February, 1897, p. 54, Fig. 2), or else the celebrated spiral nebula in Canes Venatici, Mess. 51 Can. Venat. (Roberts, *ibid.*, p. 30; and Knowledge, February, 1897, p. 54, Fig. 4).

This analogy also leads us to seek for a central nucleus towards which the spirals may be directed. Now there is one region in the Milky Way which, it indeed appears, may occupy such a position.

In discussing Celoria's theory we have seen that, to explain the more general traits of the galactic problem, we might place the sun excentrically in one great ring (nearer to the Monoceros border), and inside a smaller ring. As the points of intersection of these two hypothetical rings, inclined to each other at about nineteen degrees, are distant from each other in the heavens about one hundred and eighty degrees (Crux—Cassiopeia), it was better to imagine the inner ring as fairly small. On the other hand, the sun ought to be near that part of this small ring which is in the direction of Monoceros, since this region is fairly well resolved into separate stars (see my preceding article). If Celoria had made his counts, not along the equator, but at about thirty-five degrees, he would have found that this secondary "ring," very dim in general, has one brilliant portion in Cygnus; and this portion, opposite to that region to which our sun is nearest, is situated (in the smaller ring) *at the middle of the system.*

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* *See* Knowledge, 1891, October, December; 1892, May; 1893, April; 1894, October; 1895, January, February, August, November; 1896, February.

* Holden, *Publications Washburn Observatory*, II.

Besides, the part of the Milky Way in Cygnus is remarkable from more than one point of view. The luminous spot $\beta-\gamma$ Cygni is the *only* luminous patch situated in the "secondary branch," but near the dark space. It is an exception to the manner of distribution of brightness over the breadth of the Milky Way, between the Eagle and Cassiopeia. It is evidently connected with several other very brilliant regions (the spots α—A, $\rho-\pi$ Cygni, etc., perhaps to the series of spots west of Altair). There are in the Milky Way other more luminous spots, but they are much smaller. Sir William Herschel here found his maximum gauge (588 stars in a telescopic field of 15′·4). Not far from here, Kapteyn placed the centre of the agglomeration of bright stars in the neighbourhood of the sun. Without wishing to dogmatize, it is here that I would place the central condensation of a galactic spiral; the sun is thus found between this central nucleus and the spirals directed towards Monoceros, in a region relatively sparse. As to giving a rather more definite form to such a spiral, it is a research that I have sometimes attempted, but it would be premature to give the result here; moreover, many kinds of spirals are in accord with the theory.

For want of space many considerations could not be presented or only glanced at. In concluding, I wish to insist that this theory does not pretend to give an explanation of all the facts that are grouped about a phenomenon so complicated as the Milky Way, but that it is to be taken above all as a "working hypothesis."

Errata.—In my article in the January Number, 1898, of Knowledge, p. 12, line 24, read: "Sir John Herschel has *not* stated," etc.; p. 13, line 15, read: "these points have *not* been raised," etc.

It would be just to add that the admirable photographs of the Milky Way by Pickering have appeared after my first article was written.

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* Kapteyn, *Verslagen Kon. Akademie v. Wetensch. te Amsterdam* 1892, 1893.

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Letters.

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

VARIABLE STARS.

To the Editors of Knowledge.

Sirs,—Since my note of July 28th, Knowledge, October, 1897, I have seventy-five observations of R Scuti, making in all one hundred and forty-eight up to the close of the season, when the star passed westwards. Each of these observations is the mean of two to five views.

As heretofore stated, neither Chandler or "The Companion" gave data for this star in 1897, but, following their computations of previous years, the computed and observed dates of the extreme phases of the star are as follows:—

		Maxima.			Minima.		
		C.	O.	Mag.	C.	O.	Mag.
1896.	May	6	—	—	—	6	10
	June ...	—	11	5·1	11	29	6·2
	July ...	16	17	5·4	—	31	6 2
	August	—	13	5·8	21		—
	September	25	—	—	—	21	8·5
	October	—	—	—	31	—	—
	November	—	7	5 6	—	17	5·8
	December	5	—	—	—	—	—

From July 31st to September 21st the fall (excepting some small fluctuations) was steady, and was followed by a rise of similar character until November 6th, when it began to fall again, making probably another reversal like those of May 6th and September 21st. The latest observation of the star was November 17th.

From 1896, December 29th—the computed date of maximum of R Leonis that year, as given by "The Companion—another maximum was due in 1897, November 7th; but the same authority, and Chandler, give the date as October 8th, which is apparently a correction of thirty days; but the star, on its last rise, appeared so near daybreak that observations were inconvenient. It fell in with my habits, however, and as soon as it rose above the horizon before day, I gave it attention, and submit the following data, which covers the means of twenty observations, but only the changes are given:—

			Mag.				Mag.
1897.	October	4	6·7	1897.	November	3	7 1
	,,	6	6·4		,,	4	7·2
	,,	12	6 3		,,	6	7·3
	,,	13	6·2		,,	11	7·4
	,,	17	6·1		,,	15	7·5
	,,	21	6·0		,,	23	7·6
	,,	24	6 3		,,	29	8·0
	,,	26	6·6		December	6	8·3
	,,	30	6·9				

A maximum on October 20th is indicated, but some other observers may be able to show that one occurred earlier. It is to be hoped that someone has seen the star in September.

o Ceti (Mira) has been at a stand for some days, nearly on a level with 66 and 70, or at 5·5 magnitude.

I found S S Cygni at a maximum January 17th, at 8·5 magnitude, unchanged on 22nd, and a step or two fainter on 25th. On 26th, the seeing being very poor, the star was hardly visible. The period on this appearance was forty-three days, the previous one being sixty days, and it seems to have remained at maximum longer this time than heretofore.

Cloudiness has been the rule throughout the States at nights for some time; the mornings are more favourable, but are hazy and damp.

David Flanery.

Memphis, Tenn., U.S.A.,
28th January, 1898.

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THE DRAPER CATALOGUE.

To the Editors of Knowledge.

Sirs,—Mr. Maunder has made a mistake in his article in your February Number in describing the Draper Catalogue as a complete catalogue of the spectra of stars down to the eighth magnitude. This is certainly incorrect. But one drawback to this catalogue (as well as to many other catalogues) is that we do not know the point down to which it is complete, and are, consequently, liable to err in applying its results to star distribution generally. The Draper Catalogue is not complete up to the fifth magnitude. For instance, it does not contain the star 3 Aquarii, measured 4·62 in the *Harvard Photometry*, and 4·84 at Oxford. Between the fifth and sixth magnitudes the omissions are pretty numerous; for example, 36 Aquilæ, measured 5·23 in both the Oxford and Harvard Catalogues. The *Harvard Photometry* contains some stars lying farther south than any in the Draper Catalogue, but the latter does not contain thirty or forty of those measured at Oxford as under the sixth magnitude. 56 Pegasi is another instance in which the omitted star is brighter than the fifth magnitude. I am not writing for the purpose of discrediting the catalogue, but in the hope that Prof. Pickering may publish a supplement correcting any errors in it that have since been detected, and making it complete up to, say, magnitude 6·5. According to his present views, moreover, the kinds of spectra enumerated would, I believe, be less numerous, E and H practically disappearing. In his late list of the spectra of bright southern stars in the *Astrophysical Journal* the varieties of spectra are indicated (when not exactly corresponding with a given type) by the two types between which they lie, with a figure indicating the position between them. Thus A 5 F indicates a spectrum just halfway between A and F (the estimate being made in tenths), while A 4 F indicates that it is somewhat nearer to A than to F, and A 1 F is very nearly equivalent to A. This kind of designation will be found more convenient to those who are well acquainted with the Draper Catalogue than the more elaborate classification of Miss Maury.

W. H. S. Monck.

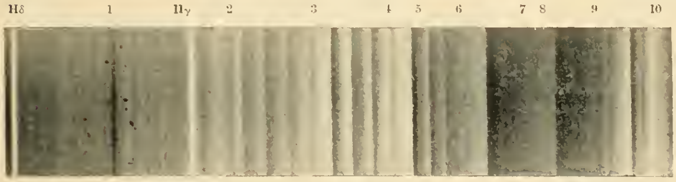
SPECTRUM OF ο CETI.

To the Editors of Knowledge.

Sirs,—The reproduction of the spectrum of ο Ceti is a ninefold enlargement from a negative obtained on November 29th, on an Edwards isochromatic plate, with a small direct compound prism near the focal plane of the fifteen-inch objective. Extra breadth has been given to the enlargement by a cylindrical lens. All the fine lines in the picture have been verified by comparison with the negative, which shows also many details lost in the enlargement. Some of the lines and edges of bands are numbered for reference to the following table of wave lengths :—

1	4227	4	4757	7	5162
2	4421	5	4842	8	5237
3	4580	6	4950	9	5445
				10	5755

The banded spectrum is the same, in general, as that of α Herculis and stars of this class, the minor differences of which are under examination at present.



Photographed Spectrum of ο Ceti.

The characteristic of the spectrum of ο Ceti is its hydrogen radiation. The two brilliant lines H_δ and H_γ have lost nothing during the last seven weeks. The missing lines H_ϵ and H_β would both be well marked on the plate if their radiations arrived. Of the former there is no trace on any of the plates. Of the latter there may be a feeble representative : there is a weak division of the absorption band on the red side of No. 5, at the position of H_β, and this may be a remnant of H_β light unabsorbed by the superposed origin of the dark band.

Smaller photographs of the spectrum, by a half prism and short focus camera lens, show the bright hydrogen lines γ, δ, ζ, and η, with the dark calcium bands at H and K. The hydrogen spectrum is therefore substantially the same now as it appears on a copy of a Harvard College photograph taken some time previous to the spring of 1892, which, by the kindness of the Rev. Espin, is in the possession of the observatory ; but probably the lines δ and γ are much brighter now, while β cannot be compared, this region not being included in the copy of the Harvard photograph.

There appears to have been a progressive change during the last seven weeks in the relative intensities of parts of the continuous spectrum. The maximum brightness in the accompanying photograph is between the numbers three and four. On December 11th the brightest parts are the two columns near No. 9, and on December 19th this change is still more pronounced.

Walter Sidgreaves, s.j.

Stonyhurst College Observatory,
8th January, 1898.

ERRATA IN TIMES OF ECLIPSES OF THE MOON.

To the Editors of Knowledge.

Sirs,—I expected you would have noticed in February Number the erroneous times given for the moon's eclipse in January Number, but I do not observe any correction.

Any great mistake in the *Nautical Almanac* is so unusual that it is not wonderful it should appear in other publications; but as all the eclipses of the moon for this year are wrong in the *Nautical Almanac* for 1898, it is of importance that it should be known. The errata are given in *Nautical Almanac* for 1899, and the true values are given in *Whitaker's Almanack*, the nearest second ; but so many almanacks have been more or less caught that you will pardon me for sending you a line.

Lewis Hensley.

Hitchin Vicarage,
February 22nd, 1898.

"LIQUID FLUORINE."

To the Editors of Knowledge.

Sirs,—In the article on "Fluorine" there is an expression made use of which, I think, requires some explanation. It is—"absolute zero, where, if our present knowledge is of any worth, the life of the universe itself would be extinguished."

What is the life here meant? Of course a much less minus temperature than $-210°$ would extinguish all animal life on any planet; the "life of the universe" must be something else.

S. H. Wright.

3, Cator Road,
Sydenham, S.E.,
2nd February, 1898.

[In writing of a particle of matter, its energy of motion—that is to say, its heat—may be considered as the vitality of the particle. When we speak of "live steam," for instance, we mean steam at a high temperature and pressure. Now, a gas expands by $\frac{1}{273}$rd of its volume (at 0° C. and 760 min. bar. pressure) for every degree Centigrade through which the temperature is raised, and if the temperature be lowered by one degree it contracts by that amount ; so that "absolute zero" is the point where the gas has contracted theoretically to nothing, namely, $-273°$ C. At this point a gas has no volume and no pressure, and may be considered as dead. This is what I meant when I said that at absolute zero the life of the universe itself would be extinguished.—C. F. Townsend.]

THE MASSES AND DISTANCES OF BINARY STARS.

By J. E. Gore, F.R.A.S.

In a valuable and interesting volume recently published by Doctor See, of the Lowell Observatory, Mexico, he gives a recomputation of the orbits of forty of the best known binary systems. Some of his results —all of which are based on a careful consideration of the best recorded measures—do not differ widely from those of other computors. In other cases, however, his orbits differ considerably from those previously published; and as he has included very recent measures in his discussions, his results are probably more accurate than any hitherto published. In the following table I give the period (P) and the semi-axis major (*a*) of the orbits found by Dr. See. From these I have computed the hypothetical parallax, $p=\frac{a}{P^{\frac{2}{3}}}$, or the parallax of the star on the assumption that the mass of the system is equal to the sun's mass. To these I have added the magnitudes of the stars which have been photometrically determined at Harvard, and the character of the star's spectrum, I. being the Sirian and II. the solar type.

Star.	Period. Years.	Semi-Axis Major.	Hypothetical Parallax.	Mag.	Spectrum.	Remarks.
		Secs.	Secs.			
Struve 3062 . .	104·61	1·3712	0·061		II.	
η Cassiopeiæ	195·76	8·2128	0·243	3·64	II.	
γ Andromedæ	54·0	0·3705	0·026	(5)	.	Magnitude estimated.
Sirius... ...	52·20	8·0316	0·575	+1·43	I.	
9 Argûs ...	22·00	0·6549	0·083	5·49	.	
ζ Cancri ...	60·0	0·8579	0·056	4·72	II.	
Struve 3121 ...	34·00	0·6692	0·063	.	II.	
ω Leonis ...	116·20	0·88241	0·037	5·55	II.	
ϕ Ursæ Maj.	97·0	0·3440	0·016	4·43	I.	
ξ Ursæ Maj.	60·00	2·508	0·163	3·80	II.	
O Σ 234 ...	77·0	0·3467	0·019	...	II.	
O Σ 235 ...	80·0	0·8690	0·047	5·56	II.	
γ Centauri ...	88·0	1·0232	0·051	2·36	I.	
γ Virginis ...	194·0	3·989	0·119	2·84	II.	
42 Comæ ..	25·556	0·6416	0·074	4·38	II.	
O Σ 269 ..	48·8	0·3248	0·024	.	.	
25 Can. Venat.	184·0	1·1307	0·635	5·00	I.	
α Centauri .	81·10	17·70	0·944	0·20	II.	
O Σ 285 ..	76·67	0·3975	0·022		..	
ξ Boötis .	128·0	5·5578	0·218	4·60	II.	
η Cor. Bor. ..	41·60	0·9165	0·076	4·98	II.	
μ^2 Boötis .	219·42	1·2679	0·034	(6·5)	I.	Magnitude estimated.
O Σ 298 ..	52·0	0·7989	0·057		II.	
γ Cor. Bor. ...	73 0	0·7357	0·042	4·18	I.	
ξ Scorpii ...	104·0	1·3612	0·061	4·10	II.	
σ Cor. Bor. .	370·0	3·8187	0·074	5·29	II.	
ζ Herculis .	35·00	1·4321	0·134	3·09	II.	
β 416 . .	33·0	1·2212	0·118	5 85		
Σ 2173 . .	46·0	1·1428	0·089		II.	
μ^1 Herculis	45·0	1·390	0·110	(9·4)		Estimated Magnitude.
τ Ophiuchi .	230·0	1·2495	0·033	4·93	II.	
70 Ophiuchi .	88·3954	4·548	0·229	4·11	II.	Computed mass of system equals 6·368 times sun's mass.
99 Herculis ...	54·5	1·014	0·070	5·36	II.	Mass of system equals sun's mass.
ζ Sagittarii ...	18·85	0·686	0·097	2·89	I.	Star 1·75 magnitude brighter than sun.
γ Cor. Aust.	152·7	2·453	0·085	4·28	II.	
β Delphini ...	27·66	0·6724	0·073	3·74	I.	
4 Aquarii ...	129·0	0·732	0·028		II.	
δ Equulii ..	11·45	0·452	0·089	4·60	II.	
κ Pegasi ...	11·42	0·4216	0·083	4·21	II.	
85 Pegasi ...	24·0	0·8904	0·107	5·83	II.	
β 883	5·5	0·621	0·1993	(7·8)		Estimated magnitude.

Now, if we take the sun's stellar magnitude as —27: that is, twenty-seven magnitudes below the zero magnitude (see my paper in Knowledge for June, 1895): and compute what its magnitude would be if removed to the distance indicated by the "hypothetical parallax," we find that in most cases the binary star is brighter than the sun would be if placed at this distance. It follows that to make the sun of equal brightness with the star it should be placed at a less distance than that indicated by the "hypothetical parallax"—that is, the parallax of the binary star should be increased. This would have the effect of diminishing the mass of the system, as I showed in a former paper. (Knowledge, December, 1894.) Now if B represents the number of times which the star exceeds the sun in brightness when both are placed at the distance indicated by the "hypothetical parallax," and *s* represents the increased parallax, we have $s = p\sqrt{B} = \frac{a\sqrt{B}}{P^{\frac{2}{3}}}$ Again, if m and m_1 represent the masses of the components of the binary system, and $m + m_1 = nM$, where M is the mass of the sun, we have, taking $M = 1$, $n=\frac{a^3}{p^3P^2}$, and for the parallax, s, $n = \frac{a^3}{s^3P^2}$, or, substituting the value of s found above, and reducing, we have $n = \frac{1}{B^{\frac{3}{2}}}$. To find B we have (sun's mag. — star's mag.) × 0·4 = log. B.

Let us now consider some of the most remarkable cases in the above list which have spectra of the solar type. I omit those in which the difference of magnitude between the sun and star does not exceed one and a half magnitude, or about four times.

ξ Boötis. In this case the sun would be reduced to a star of 2·88 magnitude, which gives a difference of 1·72 magnitude in favour of the *sun*. This would make the sun 4·875 times brighter than the star at equal distances. The parallax must therefore be diminished, and hence the mass of the system would be $B^{\frac{3}{2}}=10{\cdot}77$ times the mass of the sun.

ξ Scorpii. Here the sun would be reduced to magnitude 5·64, giving a difference of 1·54 magnitude in favour of the *star*. Hence the mass of the system would be $\frac{1}{8{\cdot}395}$ of the sun's mass. The spectrum is a doubtful one of the second type (F ?).

τ Ophiuchi. In this case the sun would be reduced to magnitude 6·98, if placed at the distance indicated by the "hypothetical parallax," and, the star's photometrical magnitude being 4·93, there is a difference of 2 05 magnitudes in favour of the star. Hence B = 6·607, and $n = \frac{1}{17}$, or the mass of the system would be one-seventeenth of the sun's mass, and the star's parallax about 0·085″. The spectrum is of the solar type.

In the case of 99 Herculis the sun would be reduced to magnitude 5·34, or almost exactly equal to the star in brightness, and, the spectrum being of the solar type, the mass of the system is probably equal to the mass of the sun. The companion is very faint and of a purple colour, and may possibly be approaching the planetary stage of its history.

α Centauri is a very interesting case. Here the sun would be reduced to a star of magnitude —0·31, or 0·31 magnitude brighter than a star of zero magnitude; and as the star's photometric magnitude is 0·20, we have a difference of 0·51 magnitude in favour of the sun, or $B=\frac{1}{1{\cdot}6}$. Hence the parallax would be reduced to $\frac{0{\cdot}944}{\sqrt{1{\cdot}6}}$ $=0{\cdot}746''$, and the mass of the system would be 2·023 times the sun's mass. As Dr. Gill found a parallax of 0·75″, and Dr. See computes from his orbit a mass of 2 00, the mass of the sun, it would seem that the orbit, parallax, and photometric magnitude of this remarkable star have been correctly determined.

With reference to the binary stars having the Sirian type of spectrum, let us consider the case of Sirius itself. If the spectrum of Sirius were of the solar type and strictly comparable with the sun, I find that its parallax would be about 1·58″, and its mass about one twenty-first part of the sun's mass. But Dr. Gill found a parallax of 0·38″, and Dr. See computes from his own orbit and this parallax that the mass of the system is 3·473 times the mass of the sun.* Now I find that if the sun were placed at the distance indicated by Dr. Gill's parallax it would be reduced to a star of 1·67 magnitude, or 3·10 magnitudes fainter than Sirius. This implies that Sirius is 17·38 times brighter than the sun would be at the same distance. But if Sirius were of the same density and intrinsic brightness as the sun, its mass would imply that it should be only 1·773 $(2·36)^{\frac{2}{3}}$* brighter than the sun. Hence we see that Sirius is nearly ten times brighter than it would be had it the same density and brightness of surface as the sun has. Hence, as Dr. See says, "there is some reason to suppose that *Sirius* is very much expanded, more nearly resembling a nebula than the sun."

ϕ Ursæ Majoris is a very brilliant star. Here we have the sun reduced to a star of 8·55 magnitude, or a difference of 4·12 magnitudes in favour of the star. Hence $B=44·47$ and $n=\frac{1}{296}$. The spectrum is of the Sirian type. For γ Cor. Bor., I find $B = 8·091$ and $n = \frac{1}{23}$. γ Centauri is another brilliant star. Here $B = 29·38$ and $n=\frac{1}{159}$.

There are two remarkable cases in which the sun, if placed at the distance indicated by the "hypothetical parallax," would be considerably *brighter* than the binary star. One of these, μ^1 Herculis, is referred to in a former paper (Knowledge, December, 1894). Here, the sun would be reduced to 4·36 magnitude, and, taking the star's magnitude as 9·4, we have a difference of about five magnitudes in favour of the *sun*. This would *reduce* the star's parallax to 0·011″, and would make its mass no less than one thousand times the mass of the sun! The star being so faint its spectrum has not been determined, but it forms a distant companion to μ^2 Herculis, the magnitude of which was measured 3·49 at Harvard, or nearly one magnitude brighter than the sun would be if placed at the "hypothetical" distance. If we increase its distance ten times, as indicated by the above calculation, we must conclude that μ^2 Herculis is no less than two hundred and twenty-three times the brightness of the sun! According to the Draper Catalogue the brighter star has a doubtful spectrum of the solar type (Class II.?). As both stars have a common proper motion, they probably lie at practically the same distance from the earth, and the only explanation of the above startling results seems to be that the binary star has—like the companion to Sirius—cooled down, and is, therefore, not comparable in its physical constitution with the sun.

Another remarkable case is that of β 883—a binary of very short period, whose rapidity of motion has recently been discovered by Dr. See. Here the difference of brightness is about four magnitudes in favour of the sun, which would make the mass of the system about two hundred and fifty-one times the sun's mass! But here again we do not know the character of its spectrum, so cannot say whether the star is really comparable with the sun in brightness.

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We understand that Mr. Thomas H. Blakesley, m.a., c.e., the well-known instructor in physics and mathematics at the Royal Naval College, Greenwich, has resigned his seat at the Council Board of the Physical Society of London. Mr. Blakesley is, therefore, no longer Honorary Secretary of that learned body.

Science Notes.

H.R.H. the Prince of Wales has graciously consented to open the International Photographic Exhibition at the Crystal Palace. Intending exhibitors are asked to note that the date of opening of the Exhibition by His Royal Highness has been fixed by him for Monday, April 25th, and not Wednesday, April 27th, as originally announced. The latest date for the reception of exhibits in each section will therefore be two days earlier than that first stated on the prospectus.

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The number of applications for patents during the year 1897 was thirty thousand nine hundred and thirty-six, as compared with thirty thousand one hundred and ninety-four in 1896 and twenty-five thousand and sixty-five in 1895. Although the number of patents applied for illustrates the progress of inventive activity, it does not afford any reliable criterion as to the number which arrive at maturity. Out of the thirty thousand one hundred and ninety-four in 1896, for example, only thirteen thousand three hundred and sixty were completed, the rest being allowed to lapse after the nine months' protection. Not a few of the applicants for patents are women, of whom there were about seven hundred in 1896; some hundred and fifty of these inventions relating to dress.

◆

A new bibliography of great value to scientists is now being prepared of all the technical works in that unique and most easily accessible collection, the Patent Office Library, and will be completed in two volumes. In the first volume the books and pamphlets, etc., will be indexed under the names of authors, and the second volume will be a subject-matter index. A proof, including the letters A, B, C, D, consisting of two hundred and forty pages of the first volume, has been placed in the Library for the use of the public.

Notices of Books.

The New Psychology. By Dr. E. W. Scripture. Illustrated. (Walter Scott.) 6s. By such a book as this, belonging to the Contemporary Science Series, psychology is lifted out of the arena of abstract philosophy and established upon the sound basis of experimental science. The development of the new or experimental psychology within the last few years has produced a large amount of remarkable material which has remained almost unknown except to specialists. Most of this work has been done in Germany and the United States, and Dr. Scripture is one of the foremost of the workers. What a vast amount of material has been accumulated may be seen by reference to the "Psychological Index," or those two excellent journals the *Psychological Review* and the *Journal of Psychology*—the like of which do not exist in this country. Perhaps, now that a psychological department has been established at University College, we may also be able to give similar hostages to fortune. The fact is that many men of science in this country are disinclined to give psychology a *locus standi*: the chemist and physicist look upon it as akin to metaphysics, and the physiologist regards it as a presumptuous sub-department of his branch of natural knowledge. It is not clear why physiologists generally do not look with eyes of favour upon this younger science, for surely it is immaterial what designation is given to any department of scientific work so long as facts are being accumulated. Moreover, the barriers between the various sciences are being broken down daily. The methods and

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* The mass of the bright star is 2·36 times the mass of the sun. The mass of the companion, which is very faint (and does not affect the brightness of the primary), is, according to Dr. See, 1·113 times the sun's mass.

results of physical science (using the term in its widest sense) are being used to assist the progress of the natural sciences; and the new psychology is a valuable product of this combination.

Dr. Scripture's volume contains a clear statement of the chief work that has been done on what may be termed the connection between thought and action. It is not concerned with the academic distinctions between sensation and perception, and similar discussions of ideas, but treats of mental life in relation to time, energy, and space, and shows how physical instruments may be used to measure these relationships. The book is in itself a justification of the claims of psychology to a place among experimental sciences.

Natural Causes and Supernatural Seemings. By Henry Maudsley, M.D. Third Edition. (Kegan Paul.) Dr. Maudsley's book is neatly, if not completely, epitomized in its title. Presentiments, imprecations, magic incantations, predictions of witchcraft, omens, hallucinations, and all phenomena usually ascribed to the supernatural, are here sternly confronted with the unsympathetic conclusions drawn by cool reason from cause and effect. The multitude will always take its opinions from custom and tradition, and on the authority of others; but there are not a few who agree with Voltaire when he said that "magic words are capable of destroying a whole flock of sheep — if the incantation be accompanied with a sufficient dose of arsenic." The author looks upon life as an intensely real thing, and apparently regards the whole of our existence as a sort of complex mosaic, the intrinsic beauty of which is masked by the creations of unbridled imagination. It is plausible but quite false presumption that mankind in general act on rational principles: the masses, being mainly foolish, have always held to the wrong opinion until dragged out of it by the labours of the few who differed; and there is probably much truth in Dr. Maudsley's assertion that "the extinction of a few hundred persons in a generation, who keep the torch of knowledge burning in Christendom, would bring progress to a standstill, and might throw the world back into intellectual barbarism in the course of two or three generations; all the more easily because, besides the passive resistance of a dead weight of ignorance, there is a vast and powerful organization of hostile superstition watching and working to stop intellectual progress." In short, the volume affords us a glimpse into the mighty edifice of error built on the basis of defective observation; and, abandoning the preposterous plane of speculative intuitions, we have presented before us images in the unassuming habiliments of sense and reason. Still, as the senses are only so many narrow chinks of experience between two unknown infinities—the infinitely great and the infinitely small—there is a danger of oscillating from the warm equatorial regions of imagination to the extreme polar climes of frigid logical deduction.

By Roadside and River. By H. Mead Briggs. (Elliot Stock.) 3s. 6d. Richard Jefferies has had of late many imitators. For some years past the public has been liberally supplied with a class of book of which "By Roadside and River" is an example. The authors, without laying claim to scientific accuracy, display, as a rule, some powers of observation, and Mr. Mead Briggs is no exception. The one thing necessary to make such a book readable, however, is a fair command of literary English, and the power of recording the author's observations and meditations (if we must have these meditations) in language which is intelligible. But it is in those very points that Mr. Mead Briggs comes lamentably to grief. It is scarcely an exaggeration to say that in every page of "By Roadside and River" the reader is irritated and perplexed by some atrocious solecism, some wanton dislocation of a trite expression, even if he escape the puerile essays in metre with which the book is plentifully studded. Passing by with a shudder such combinations as "child and blandlike" (applied to a bird which "ventures to speak in a shrilly voice"), we are pulled up short by the following reflection: "But accident and misfortune appearing suddenly upon our best bright days, comes [*sic*] as a thief in the night to take our happiness, and leaves our senses numbed." The swallow is depicted as "reflecting her dainty form in the mirrored stream." When Mr. Briggs descends from reminiscence and moralization to a record of facts, he has much that is interesting, if little that is new, to tell us. His observations of nature are, in the main, just, though we believe naturalists are agreed that the cuckoo's method of depositing her egg in the nests of other birds is by the beak, and not by the claw; and also that the eyes of the mole are practically useless, and that this creature cannot "see with ease in the dark caverns of the earth."

Wild Traits in Tame Animals, being some Familiar Studies in Evolution. By Louis Robinson, M.D. (Blackwood.) Illustrated. 10s. 6d. net. This is a very readable book for several reasons. It is well written; it deals with simple everyday matters. The theories and suggestions it contains are plausible, and, above all, it teaches the reader to think. The plan of the book is to discuss familiar traits in tame animals such as dogs, horses, cats, etc., to compare these traits with those of wild animals, and to seek to trace their origin and explain their significance. The author succeeds fairly well, but, as would be expected, he occasionally pushes an analogy or a theory too far, and there is a paucity of facts throughout. Some of the suggestions and hints for study and research are valuable. If there is not much that is actually new in the book, there are many things which are put in a new and generally attractive light. Altogether, it is a book which should be read by every naturalist, and parts of it could, with profit, be read more than once. It will prove very valuable to the young student, providing he reads it slowly, and, thinking for himself, sifts the evidence, takes nothing for granted, and, above all, compares it with the greatest book of all—the book of nature.

Montaigne and Shakspere. By John M. Robertson. (The University Press, Limited.) 5s. net. The debt of genius to its forbears must always be considerable, for human experience is so "cabin'd, cribb'd, confin'd," that even Shakspere could only write upon what he had himself observed, heard, or read. That he was familiar with Florio's rendering of Montaigne has long been unquestioned, but the precise degree in which he was influenced by the great essayist will always form material for interesting if not altogether profitable inquiry. In this handsomely printed and elegantly mounted volume, Mr. John M. Robertson has brought his critical acumen to bear upon the problem, which he discusses throughout with a refreshing freedom from that venomous antipathy which so often disfigures these analytical examinations of the work of the immortals. "We are embarked," he says, "not on a quest for plagiarisms, but on a study of the growth of a wonderful mind. And in the idea that much of the growth is traceable to the fertilizing contact of a foreign intelligence, there can be nothing but interest and attraction for those who have mastered the primary sociological truth that such contacts of cultures are the very life of civilization."

In this eminently fair introduction to the study of the comparisons will be found the key to Mr. Robertson's work; and if he has claimed more for his thesis than the occasional identity of thought and similarity of expression will fairly carry, still he has not for an instant wavered in his allegiance to the study on which he set out. But he appears to contradict himself upon the important question as to whether Shakspere had seen parts of Florio's translation earlier than 1603—the year of its publication—"or even that he might have read Montaigne in the original" (page 12); for later on in the essay (page 50) Mr. Robertson says: "That Shakspere read Montaigne in the original once seemed probable to me, as to others; but on closer study I consider it unlikely, were it only because the Montaigne influence begins in Hamlet." In that case, of course, at least one of Mr. Robertson's parallelisms falls to the ground.

That Montaigne lighted a lamp in Shakspere which shone through all his after work is clear, but the quaint old French philosopher's searching criticisms of life were given an immortal setting by the poetic genius of the English dramatist. "The influence," says Mr. Robertson, "is from the very start of that high sort in which he that takes becomes co-thinker with him that gives, Shakspere's absorption of Montaigne being as vital as Montaigne's own assimilation of the thoughts of his classics. The process is one not of surface reflection, but of kindling by contact; and we seem to see even the vibration of the style passing from one intelligence to the other, the nervous and copious speech of Montaigne awakening Shakspere to a new sense of power over rhythm and poignant phrase, at the same time that the stimulus of the thought gives him a new confidence in the validity of his own reflections."

The subject is a fascinating one indeed, and not alone to the student of Shakspere, for Mr. Robertson's critical method is so unemotional and impassive, and yet so scrupulously just and many sided, as to afford in itself an interesting and instructive study, quite apart from the special interest of its subject.

The Elements of Astronomy. By Chas. A. Young, Ph.D. (Ginn & Co.) Illustrated. This edition of Prof. Young's book has been revised and brought up to date. The author is well known by his larger work—"General Astronomy"; but it is asserted that the volume under notice is not a mere compilation from the more pretentious work. Its purpose is to teach astronomical science to scholars in middle-class schools, and more especially those who have not much mathematical knowledge beyond the limits of simple algebraic and trigonometrical functions. Indeed, the science of astronomy may be made interesting without any knowledge at all of formulæ. The book, we think, fills the requirements of the class of students specified. All the latest researches are mentioned, including the eclipse of the sun in August, 1896, and genuine additions to our knowledge are incorporated. Clear descriptions are given of the planets, stars, nebulæ, etc.—and by *clear*, we mean that the author here exhibits the happy knack of conveying information, even on intricate subjects, in language shorn of all pedantry: an acquisition, or a gift—it is difficult to say which—not by any means common among scientific men of the first rank. A little pamphlet, called a uranography, is tacked on, which was at first intended to be issued separately; it is meant as an open-air guide to a study of the principal stars, and is accompanied by charts representing the chief constellations. A good feature of the whole book consists in the free distribution of a large number of first-rate diagrams, which add not a little to the general attractiveness of the volume—a great desideratum in text-books. A synopsis and questions are added for the benefit of those who read the book for examination purposes.

SHORT NOTICES.

The Machinery of the Universe. "Romance of Science" Series. By A. E. Dolbear. (Society for Promoting Christian Knowledge.) Illustrated. An ambitious title, truly! and also misleading. "The machinery of the universe" turns out to be that mysterious ether which, if occasion requires, can perform either the functions of a fluid or a solid, or do duty for *both* at one and the same time. Writing of the number of molecules in the visible universe, the author says (page 29): "The point is that there is a definite, computable number." A definite number there may be, but *computable*, never. As well might one say that all the thoughts which have ever entered the myriads of human heads are computable. Although the author displays much erudition, he has not yet learnt to take off his shoes, and to cover himself with sackcloth and ashes, when entering the inner court of the great unknown.

Chemistry for Photographers. By C. F. Townsend. (Dawbarn & Ward.) Illustrated. 1s. net. There is much in this book of use to the practical amateur photographer who wishes to understand the nature of the various chemicals he has to use. There are brief but ample explanations of such mysteries as the salts of silver and development; also useful chapters on the different printing processes, impurities in acids and alkalis, and a number of hints on miscellaneous subjects connected with the art of photography.

Pictorial Instruction Object Lessons. By G. Colomb. Adapted into English by Seymour J. Gubb, B.A. (Relfe Bros.) Illustrated. 1s. 6d. Akin to that popular French scientific book of Paul Bert's, the idea of M. Colomb is to combine in his book pictorial illustration with instruction in a manner suitable to be put into the hands of the younger generation. It is, in fact, a kind of child's picture book, but of a more edifying sort: pictures of everyday life, including manufactures, domestic operations, natural history, chemistry, physics, mineralogy, and so on. A short—very short—description is placed underneath each figure. On the whole the book has a very lively appearance about it and deserves to be widely known.

Revolving Planisphere. (George Philip & Son.) 2s. An oval opening in the disc of this apparatus represents the horizon for which the planisphere is constructed, and the part of the heavens visible at any stated time may be found by adjusting the movable disc till the day of the month marked upon its edge corresponds with the time of day or night figured upon a superposed disc. An auxiliary disc, adjustable once a week, serves the purpose of a perpetual calendar. The apparatus is ingenious in construction and extremely attractive in appearance.

We have received from Mr. L. Casella a catalogue of automatic recording instruments of various types, described as well as figured, among which is a pyrometer, recording results up to 4500° F., the automatic rain gauge, barograph, thermograph, electrograph, anemograph, and many others; also the actinometer for measuring the heat and light of the sun. A new photo-theodolite here figured is of considerable value for determining the dimensions of objects accurately by means of photographs which give true perspective pictures, and obviate the use of a large number of note-books in surveying operations.

BOOKS RECEIVED.

Andrée and his Balloon. By Henri Lachambre and Alexis Machuron. (Constable.) Illustrated. 6s.

Glass Blowing and Glass Working. By Thomas Bolas. (Dawbarn & Ward.) Illustrated. 2s. net.

On Laboratory Arts. By Richard Threlfall, M.A. (Macmillan.) Illustrated. 6s.

The Arrangement of Atoms in Space. By J. H. Van't Hoff. Translated by Arnold Eiloart. (Longmans.) 6s. 6d.

The Moon. By Richard A. Proctor. Fourth Edition. (Longmans.) Illustrated. 3s. 6d.

The War of the Worlds. By H. G. Wells. (Heinemann.) 6s.

Elementary Physics. By John G. Kerr, M.A. (Blackie.) Illustrated. 1s. 6d.

The Story of the British Coinage. By Gertrude B. Rawlings. (Newnes.) Illustrated. 1s.

Calendar, History, and General Summary of Regulations, Science and Art Department. (Eyre & Spottiswoode.) 1s. 7d.

The Science of the Ideal. By F. J. Linford-Wilson. (Reeves.) Illustrated. 2s. 6d.

Storm and Sunshine in the Dales. By P. H. Lockwood. (Elliot Stock.) Illustrated.

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

Elementary Botany. By Percy Groom, M.A. (Bell.) Illustrated. 3s. 6d.

Charles Dickens. By George Gissing. (Blackie.) 2s. 6d.

Terje Viken. From the Norse of Henrik Ibsen. By Alfred Lishman. (The Author: Fockerby, Goole.)

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

Mistle Thrush swallowing Droppings of Young.—Last spring I was much interested in watching a pair of Mistle Thrushes which had their nest on a branch of a tree some twenty feet from the house. From an upper window one could get an uninterrupted view down into the nest. When the young were hatched I watched the nest very carefully, and with a pair of field glasses, which revealed every detail of the birds and the nest, I made the following observations. As soon as one of the parent birds appeared in the tree the four young ones stretched up their necks and opened their gaping yellow mouths. The old bird cautiously made its way to the edge of the nest, and put a piece of a worm first into one mouth, then into another (generally only two at a feeding), seeming by its actions to discriminate which young ones to feed. Immediately it had emptied its mouth the parent put its head down to the nest, and one of the young turned round and voided its white droppings into the open beak of the parent bird, which then swallowed the droppings and flew away. In two minutes the other parent appeared, and went through exactly the same process. For a fortnight I watched this extraordinary method of sanitation many times a day. On no occasion did either parent leave the nest after feeding the young without swallowing the droppings of one young bird and only one. Moreover, on several occasions the old bird, after having waited a few seconds without result, gave a gentle peck to one of the young, which immediately turned round and voided its droppings into the parent's mouth. At about every fourth visit to the nest one of the parents covered the young for a quarter of an hour after having fed them and swallowed the droppings, and on several occasions I kept my eyes upon the parent during the whole time, but never saw it attempt to disgorge. During the last week in which the young ones were in the nest the droppings were, apparently, sometimes too large to swallow, and consequently they were often carried away in the beak; but every now and then they were swallowed.

I have set these facts out in detail because, although it is well known that birds carry away the droppings of the young, the fact that they are usually swallowed by certain birds seems to have been overlooked. In the second volume of Macgillivray's "British Birds," that excellent naturalist, the late J. Jenner Weir, in communications to the author concerning the habits of the Blackbird, Song Thrush, and Mistle Thrush (the nests of which he had watched most carefully), mentions the fact that in each of these species he observed that the old birds "swallowed nearly all the droppings of their brood" during the day; moreover, he shot one of the birds and found the droppings in its stomach. In the fourth edition of Yarrell's "British Birds" we are merely told that Song Thrushes "have been observed to swallow the fæces of their offspring."

In no other book can I find the fact mentioned. It seems to me that either the habit has been overlooked or else it requires confirmation, and I have therefore ventured to publish this note.

It is evident that the droppings go into the stomach, and it is also evident that they are sometimes retained for at least a quarter of an hour. It is questionable if the bird would be able to disgorge them after they had been in the stomach for fifteen minutes. It is conceivable that the droppings are taken by the parent bird as food, for it would be able to digest what the young bird had, perhaps, been unable to assimilate, and would thus save a great deal of time in procuring nourishment for itself.

It seems to me that for those well situated for observing birds it would be most profitable to ascertain during the coming spring what species do swallow the droppings of the young, if they do this regularly, and if there is sufficient nutriment in them to induce the birds to swallow them for the sake of nourishment. If the droppings are swallowed for this purpose it may be that they are only swallowed when food is scarce. I shall be very glad of any further information on this interesting subject.—Harry F. Witherby.

Quail in Sussex.—We have had brought us to-day for preservation a Quail (*C. communis*), caught in the lark nets near here yesterday. We suppose that the mildness of the winter is the cause of its remaining in this country. —Edwin A. Pratt, Brighton, January 28th, 1898.

Curious Jackdaw's Nest.—Last season but one, while looking over the grounds at Bretton Hall, near Barnsley, I saw sticks protruding from the top of the old chimney formerly belonging to the greenhouses. I suspected it to be a nest. On making inquiries from the gardener he told me it was the nest of a pair of Jackdaws, which had filled the chimney with sticks and made their nest on the top. On looking in at a doorway at the bottom of the chimney I saw it was quite filled from the base, and the man told me he had cleared it out several times, but they always filled it again.—S. L. Mosley, Educational Museum, Huddersfield.

Early Nesting of the Starling, the Long-tailed Tit, and the House Sparrow.—The Rev. Francis C. R. Jourdain writes from Asburne, Derbyshire, that a Starling's nest, with nearly fledged young, was found at Bradley at the end of January. Mr. W. Dunn, of Exmouth, writes that on February 7th he watched a pair of Long-tailed Tits collecting moss, evidently for a nest. A brood of House Sparrows is also reported from Blackheath, Kent, as having been hatched on February 15th.

Crane in County Tipperary (*Irish Naturalist*, February, 1898, p. 51).—A specimen of *Grus communis* is reported by Mr. W. Johnston, of Thurles, to have been shot at Seskin in September, 1896.

Little Bittern in County Cork (*Irish Naturalist*, February, 1898, p. 51).—Mr. John J. Wolfe records that a bird of this species was shot on November 8th, 1897, by Mr. W. Sweetman, of Schull, and sent to him.

Little Bustard in Norfolk (*The Field*, February 19th, 1898, p. 285).—Lieut.-Col. E. A. Butler records that a specimen of the Little Bustard (*Otis tetrax*) was shot on January 25th by Mr. Godwin at Feltwell, near Downham Market, Norfolk.

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.*

Note.—The first issue of Knowledge containing British Ornithological Notes was that for October, 1897.

Obituary.

We regret to record the death of Prof. T. Jeffrey Parker, f.r.s., whose decease occurred on the 7th November last. He was the eldest son of the well-known osteologist, William Kitchen Parker, and was born in London in the year 1850. Obtaining the associateship of the Royal School of Mines in 1871, he, after a short appointment as science master in Yorkshire, returned to London and became demonstrator under Prof. Huxley, at the latter's invitation, at the Royal School of Mines. In 1880 he left England for New Zealand, to take up the duties of Professor of Biology in the University of Otago, which post he retained till his death. Prof. Parker was the author of a great number of original scientific memoirs, some of which are of far-reaching importance. He also wrote some valuable text-books on natural science, one of which, to wit, "Lessons in Elementary Biology," has been translated into German. In conjunction with Prof. Haswell, of Sydney University, he attempted the laborious task of writing a large text-book of zoology, which he was not destined to see in circulation. Prof. Parker was entrusted with the task of forming a museum of biology at the Royal School of Mines, on the type system. He advocated the study of the lower organisms first in preference to the vertebrates, as inculcated by Huxley, and in due course secured a triumph over his great teacher on this point. As a worker, Prof. Parker was of the first rank, and also a luminous teacher. He was a kind, considerate, and lovable man, and the biological world is the poorer by his untimely death.

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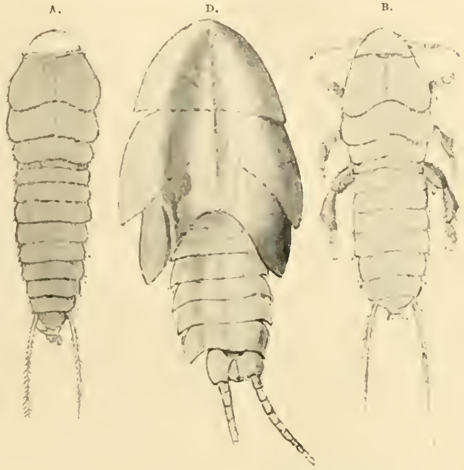
THE KARKINOKOSM, OR WORLD OF CRUSTACEA.—II.

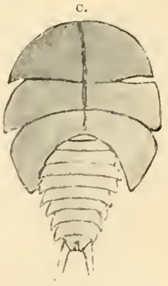
By the Rev. Thomas R. R. Stebbing, m.a., f.r.s., f.l.s.

In the previous chapter examples were given to show the extreme divergence of form and structure to be found in the Crustacea at large. The differences are scarcely less striking that may be seen within the limits of the Malacostraca. Yet that group, by the close interweaving of affinities, is as inseparably compacted together as any in the animal kingdom. Especially notable is one character which may be traced through all its divisions. The somites, or segments of the body, are in a numerical bondage; they are never allowed to exceed twenty-one. That might not seem wonderful were it not that, in the segmented appendages of these same animals, there is frequently shown the most contemptuous indifference to arithmetical restraints.

As to the mystic number twenty-one, though it is never transgressed, the chance spectator will never find it fully developed for straightforward counting and ocular demonstration. It is only discoverable by inferences and comparisons. Always some of the segments are in more or less complete coalescence. This fusion might lead to confusion, did not the following rule provide a guiding light. Wherever a segment can be definitely proved to be single, it never bears more than a single pair of appendages; elsewhere, then, the presence of two or more pairs of appendages in apparent attachment to a single segment may safely be taken to imply that such a segment is in reality composite. Moreover, composite segments which have lost their appendages present no great difficulty, because they can be compared with corresponding segments which in other genera and species have retained their appendages. Often, in a male crab, the pleon or tail-part has such an unfurnished compounded segment, which plainly tallies with separate appendage-bearing segments in the other sex. When, therefore, we read of a genus in which the male pleon has five segments and the female seven, it does not mean that nature has been more stingy to one sex than to the other, but only that in the masculine tail three segments have been soldered into one. With regard to the last segment, or telson, there is this difficulty: it never has distinct appendages. Consequently its character has been aspersed, as though it were not a segment at all, but only a caudal excrescence—like the child which fancied itself a first-class carriage, while its playmates regarded it as nothing but a truck. The first segment, like the last, has had its claim disputed. It is rarely free and independent. It carries the eyes, which some naturalists do not consider to be true appendages. Often, indeed, the eyes are "sessile"—that is, seated under the skin of the head, with nothing limb-like about them. On the other hand, the "ocular segment" is sometimes movably articulated, and often the eyes are placed on jointed stalks, freely movable, and sometimes of great length. Between the two debatable points there lie nineteen undisputed segments, verified by nineteen pairs of undoubted appendages. These begin with two pairs of antennæ and a pair of mandibles. It is a matter of convenience that throughout the Malacostraca every segment should have its constant number, from the first to the twenty-first. Consequently, although in the sessile-eyed division the first is always either wanting or undecipherable, that need not interfere with our reckoning the mandibular segment uniformly as the fourth.



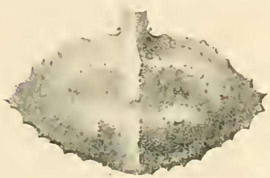
A. *Hemimerus talpoides* ♂. D. *Dipeltis carri* (from Schuchert).
B. *Hemimerus talpoides* ♀.



C. *Dipeltis diplodiscus.*

Here it should not be entirely overlooked that, though insects have no stalked eyes and have only one pair of antennæ, there are some among them, as H. J. Hansen[*] has shown, in which nineteen segments may be inferred exactly comparable to the last nineteen of the Crustacea Malacostraca. With the living forms of the male and female *Hemimerus talpoides* (Walker) (A and B), regarded by Hansen as a wingless orthopterous insect, it can scarcely be uninteresting to compare the species *Dipeltis diplodiscus* (Packard) (C) and *Dipeltis carri* (Schuchert) (D),[†] fossils derived from the lower Carboniferous system, and placed by those authors among the entomostracan Apodidæ. The entomologists now, with some reason, claim these fossils for their own, so that the common ancestors of insects and Crustacea remain as heretofore the phantoms of an undiscovered past.

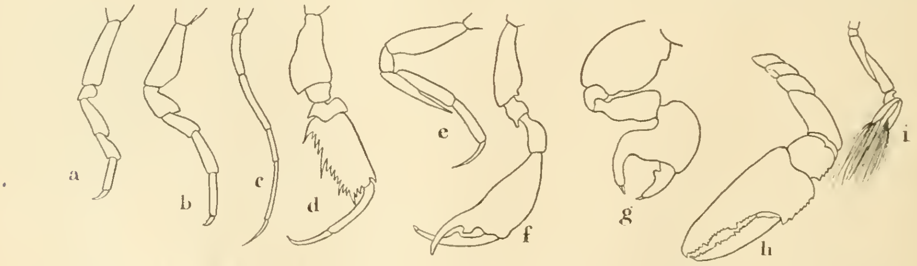
Reverting to our more immediate subject, a remark must be made on the mandibular segment. Owing apparently to that predominance which the jaw so often asserts in the affairs of life, this segment, not content with its nineteenth or other fractional share of the back, has spread itself in an obtrusive and in what might be called an overbearing manner. It assumes the title of carapace, or cephalothoracic buckler. It is no doubt a valuable shield, but, like other saviours of society whose natural motto is "*L'état, c'est moi*," the carapace of the crab sometimes takes leave to pose as if it were the whole animal. Of this an extreme example is afforded by the Californian *Cryptolithodes typicus*, of which a portrait by Stimpson is here presented. As will be perceived, the great shield, in dorsal view, completely hides all the working members of the organism except the little twinkling eyes.



Cryptolithodes typicus. (Dorsal view.)

The ten pairs of appendages which follow the mandibles are objects of study of almost inexhaustible interest, not only because of the variety of form and function they exhibit in any one specimen, but because of the surprising variety of that variety as we pass from group to group. Among the functions more or less generally allotted to them may be reckoned those of tasting and pasting, biting and fighting, grasping and clasping, walking and a kind of inarticulate talking, swimming, burrowing, house building, besides the automatic services which they render to the eggs in the brood pouch and to the animal's own respiration. It will be easily understood that this diversity of function is matched by some diversity of form, and the use of distinctive names, such as maxillæ, maxillipeds, and trunk-legs, becomes indispensable. Some, in fact, are a kind of jaws—organs of the mouth—while others are a kind of arms or legs—organs of the trunk; but the curious thing is that the middle pairs may be either one thing or the other, according to the group which owns them. The term "maxillipeds," or jaw-legs, enshrines the idea that these appendages, though used as jaws, are nothing but modified legs; and the corresponding term "gnathopods," with the same meaning, hints at legs which are longing to be jaws. The hypothesis we have to consider is that all the appendages, including, with those already mentioned, the six pairs belonging to the pleon, are modifications of one original pattern. Between the primitive simplicity to be expected of such a pattern and the complicated structure observable in a crab's maxillæ, it might at first sight seem hopeless to find the requisite connecting links. But extended comparison of features difficult to interpret with those that are common and commonplace has long ago brought out a sort of ground-plan of a crustacean appendage. According to this it principally consists of a stem and two branches. Three joints are perhaps the normal number for the stem, but it often displays only two, and occasionally only one. The joints of the branches are indefinitely variable in number. But, limiting ourselves for the present to the Malacostraca, it may be said that, in the organs of the mouth and in the limbs of the trunk, the inner or main branch of an appendage shows a preference for not exceeding five in the number of its joints. Add these to two in the stem, and entrust the seven to the plasticity of nature, and then see what will follow. A man has only to look at the noses and chins of his friends and neighbours to know what may be expected from modifications of shape and size.

Imagine, then, a primitive limb of seven approximately uniform joints. In all but the last of these room must be found for the retractor and extensor muscles. For firmness of attachment to the trunk it may generally be convenient that the first joint should be short. The last, which does not require muscles, may be thinner than the rest. Being in frequent contact with external surfaces, it may acquire a hardened apex and become claw-like, or, for purposes of navigation, it may assume a broad, flat, blade-like appearance. The other joints will certainly not for ever maintain uniformity of length, and those which are longer will at least sometimes have a proportionate increase in breadth. By the course thus indicated we arrive at the ordinary leg of an ordinary amphipod, such as a sandhopper (*see* Fig. *a*), or that of an ordinary isopod, such as a woodlouse (*see* Fig. *b*), or that of a



a. Talitrus. b. Porcellio. c. Crangon. d. Primno. e. Aora. f. Phronima. g. Sphyrapus. h. Potamobius. i. Atya.

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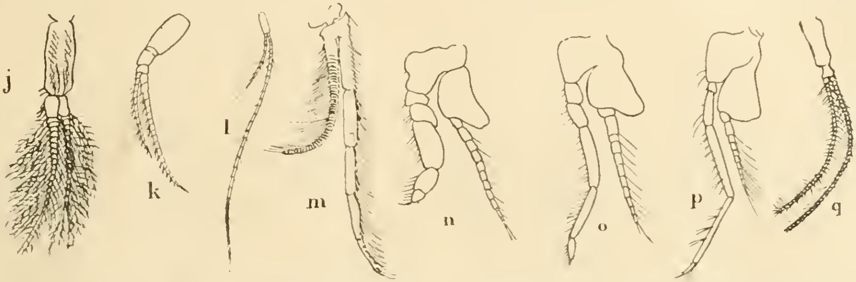
[*] "Contributions to the Knowledge of the Insect Fauna of Camerun." *Entomol. Tidsker.*, Pl. II., Figs. 1, 2, 1894.

[†] *Proceedings U.S. National Museum*, Vol. XIX., Pl. LVIII., Figs. 4, 6, 1897.

Crangon, an ordinary shrimp (*see* Fig. *c*). But besides being lengthened and widened, the joints may be variously sculptured, as in the fifth joint of the next specimen, which represents the uncommon leg of an uncommon amphipod (*see* Fig. *d*); or one joint may be outdrawn at its apex to overlap the next, thus producing various forms of what is known as a chela or claw. In Fig. *e* the fourth joint is prolonged; in Fig. *f* the fifth joint. These are two peculiar forms among the Amphipoda. The next example shows the quaintly shaped leg of a deep-sea isopod, where the so-called "thumb" is on the sixth joint, though, owing to coalescence, it looks like the fifth. The following figure shows the same thing in the more familiar leg of the river crayfish. Sometimes the joints are attached to one another, not end to end, but at various angles, as in the leg of a tropical prawn (*see* Fig. *i*), which has thumb and finger furnished each with a brush of long hairs, in nature as useful as they are beautiful. Of the limbs here shown none have the outer branch developed: some have over the first joint an expansion called a side-plate; some have gills or breathing organs attached to them; most have some sort of garniture of hairs and spines; but these details are omitted as foreign to our present purpose. Most of the figures are considerably magnified portraits; that from the crayfish is much reduced.



j. Swimming Foot of *Amphipod.* *k.* First Antenna, *Liljeborgio.* *l.* Tail-Foot, *Apseudes.* *m.* Maxallipeds, 3, 4, *Penæus.* *n. o. p.* Maxillipeds, 2, 3, and following limb, *Sorialla.* *q.* Leg of *Lepas.*

Crayfishes, lobsters, prawns, and shrimps, all belong to the *Decapoda macrura*, the ten-footed long-tailed tribe. In these the muscular pleon or tail part, through its strong development, possesses a commercial value and cannot escape observation. The crabs, on the other hand, which have no meat to boast of in the flexed and flattened pleon, are often erroneously supposed to be devoid of tails. That they are not open to this reproach is obvious, since they form the ten-footed short-tailed tribe, *Decapoda brachyura*. But be the tail short or be the tail long, all these stalk-eyed creatures agree in having, after the mandibles, two pairs of maxillæ and three pairs of maxillipeds and five pairs of peds, pods, feet or legs. In this respect one of the sessile-eyed groups—the highly curious Cumacea—agrees with them. But the sessile-eyed isopods and amphipods have, instead of three pairs of maxillipeds and five of legs, one pair of maxillipeds and seven pairs of legs. Upon comparison, then, it becomes perfectly clear that the appendages of the eighth and ninth segments are strictly homologous throughout the Malacostraca. We may call them maxillipeds or gnathopods or trunk-legs, according to their differences of form and function, but they are none the less essentially equivalent structures. In some of the Amphipoda and Isopoda the maxillipeds are more leg-like than the legs which come next to them, and the same may be said of the third maxillipeds in the Decapoda. But whether the appendage be adapted for eating, grasping, digging, or walking, its form can easily be referred to a simple linear original, and this applies also to the maxillæ and the mandibles, although in them the leg-like or linear pattern has become strangely disguised.

The typical appendage was spoken of as consisting principally of a stem and two branches. Other appurtenances of the stem must be left for future notice, but the second or outer branch claims more immediate attention. As we have seen, it may remain entirely undeveloped. At other times it invites observation, as in the shrimp-like Schizopoda, which bear this name of "cleft-legs" because their trunk-limbs display both branches. But really there are very few crustaceans which do not, in one appendage or another, display them both. Throughout the Amphipoda the first three pairs of appendages of the pleon have a very uniform character. They almost invariably consist of a two-jointed stem and two subequal lash-like branches. The lashes are constituted of a great many small similar joints, each furnished with a couple of long hairs, and they are generally effective swimming organs (*see* Fig. *j*). In these pleopods, or legs of the pleon, one may imagine that one sees a pattern of crustacean appendage more primitive than the leg-like one before suggested. Both pairs of antennæ usually end in lashes. The first pair often has two (*see* Fig. *k*). Occasionally, as in the isopod *Apseudes*, there are two such lashes at the opposite extremity of the animal, in the last pair of tail-feet (*see* Fig. *l*). Repeatedly in the triple maxillipeds of the Decapoda, while one branch is pediform, the other has a terminal lash (see Fig. *m*). In the Schizopoda this structure is to be found not only in the two pairs of limbs which are equivalent to the second and third maxillipeds (*see* Figs. *n*, *o*, *p*), but in all the five pairs which follow (*see* Fig. *q*), these being succeeded by five pairs of pleopods, each with two lash-like branches. One abnormal case is often quoted, in which the eye-stalk of a crayfish developed into an antenna-like lash. This has recently been matched by an equally abnormal case in which a "trunk-leg" has been developed on the pleon of a crab.

From a wide-reaching subject enough has perhaps been culled to lead the industrious beginner into an engaging path of inquiry—the comparative anatomy of Crustacea. It will be strange if he can avoid drawing the conclusion that at least all the Malacostraca are of a common origin. It will be strange, too, if the cirri, or legs of the barnacle, with their stem and two lash-like branches (*see* Fig. *q*), do not awake in him at least a suspicion that the crustacean family is not only not confined to a few articles of domestic consumption, but may have ramifications even beyond the bounds of the Malacostraca.

◆

NOTES ON COMETS AND METEORS.

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

Comets.—Pons-Winnecke's comet at the beginning of March will enter the head of Capricornus and pass between the bright stars α and β of that constellation ; but as these objects will be only forty degrees west of the sun, and rise about two hours before him, there will be but a slender prospect of observing the comet. The distance of this object from the earth is now increasing, and it is not likely to be seen again in ordinary telescopes until the early part of 1904.

Comet II. 1892 (Denning).—In *Ast. Nach.* 3472, Dr. Steiner, of O'Gyalla, Hungary, gives a definite orbit which he has derived for this object from a discussion of one hundred and eighty-six observations. Though a very small, faint comet, it was visible for a long period, and its positions were secured during the ten months from 1892, March 19th, to 1893, January 12th. Dr. Steiner concludes that the orbit is hyberbolic, for, with the excentricity at 1·000345, the sum of the squares of the residuals is 103·2″ for an hyperbola, and 279·5″ for the parabola. The observations near the middle of the series, in the summer of 1892, exhibit rather large residuals, and Dr. Scheiner regards this as unsatisfactory. But the comet was difficult to observe at that time owing to the twilight, and to its faintness, due to great distance from the earth ; for at the middle of June the comet was separated from us by an interval of two hundred and seventy millions of miles. The path of the comet was nearly vertical to the ecliptic, the inclination being eighty-nine and three-quarter degrees. Dr. Scheiner's definitive elements are :—

T	... ...	1892, May 11·261935 M.T. Berlin.
π	... ...	22° 45′ 42·40″
☊	... ...	253° 25′ 50·92″
ι	... ...	89° 41′ 54·10″
log. q.	...	0·2946197
e	... ...	1·000345

Meteors.—Though the shower of Leonids in 1897 was not very brilliant, and completely obscured by clouds at the majority of stations on the mornings of November 15th and 16th, it returned with fair activity on those dates. There is little doubt, however, that the earth did not encounter the really dense portion of the stream, but it is difficult to specify what strength is fairly representative of the main swarm, and a certain standard (or rate of apparition) will have to be adopted to express it. The richest part of the current is probably not a sudden development, but due to gradually increasing abundance along a considerable stretch of the orbit. It is important to ascertain the time when the earth encounters that section of the stream in which the meteors begin to be thickly congregated. In 1833 there were one thousand meteors per minute, while at about the period of maximum frequency on November 13th, 1866, there were one hundred per minute for one observer. What, therefore, will be the rate of appearance assumed for the fore region of the main swarm? Perhaps ten meteors per minute might satisfactorily represent it, for this would give six hundred per hour, it being understood that the figures are for one observer watching a clear, moonless sky with the radiant at a fair altitude. It is certain from the conditions of the case that the relative intensity of the stream at different parts can only be ascertained after many cyclical returns of the swarm, for the earth is only involved in it for a short time once a year, and in the interim of successive encounters a vast range of the current passes the node without recognition.

Now that the effort is being made to photograph the group of Leonid meteors in space, it might be as well to endeavour to get an impression of the parent comet. On March 16th the comet will be certainly less than two hundred millions of miles distant, and possibly less than one hundred and fifty millions, whereas the meteoric swarm will be about five hundred and sixty-eight millions distant on the same date. In view of the fact that the comet is more highly condensed and probably far more luminous than its accompanying meteoric stream, the prospect of detecting it is much more favourable. Towards the close of the present year, however, the comet will approach much nearer to the earth than it is at present, and no doubt some special efforts will then be made to redetect it.

Fireball of 1898, January 21st.—In the twilight of Friday evening, January 21st, at 5h. 32m., one of those large fireballs which occasionally burst out and illuminate sky and landscape with startling brilliancy, was observed at a great many places in the South of England, and in some parts of Ireland and Wales. A considerable number of descriptions of the object were published in the newspapers, and if, as usual, the writers failed to record the exact position of the meteor's path and its duration of flight, they one and all testified to the astonishing brilliancy of the phenomenon. Not many stars were visible at the moment of the meteor's descent, so it was difficult to fix its apparent course with the necessary precision. But several of the observers were fortunate enough to obtain a good view of it, and recorded the path as accurately as circumstances permitted. From thirty-three accounts which I have compared together, it appears certain that the fireball traversed a very long path from east to west over the south coast of England. Observers in London and that district say that the object first appeared at a great altitude in south-east or south, and disappeared in south-west ; while spectators in the western counties describe the motion as from east or east by south to south-west, or south-west by south. The flaming nucleus was not so large as the moon, but was, according to several reports, about twelve or fifteen minutes of arc in diameter, but its brightness exceeded that of the full moon. The colour appears to have varied, and observers are by no means agreed in their estimations, but the head seems to have been yellowish and the train bright green and purple. The meteor burst before vanishing ; and it travelled, not with that very slow, sailing flight which is often characteristic of the largest fireballs, but with moderate velocity, and its entire visible course probably occupied seven seconds. One person, however, says it lasted thirty seconds ; another estimated the duration as nearly five minutes ! The best estimates vary from three to seven seconds, but most of the observers only caught the meteor after it had already traversed a part of its course, and when it was descending at a low altitude in the south-west.

The fireball when first seen appears to have been eighty-two miles above a point five miles south of Croydon in Surrey. Moving to the south-west by west it passed over Petersfield, Lymington, and St. Alban's Head, and disappeared at a height of twenty-five miles over the English Channel some thirty-five miles south of Eddystone Lighthouse. Its length of path was two hundred and thirty-five miles, and velocity about thirty-four miles per second. The radiant point was in the north-east region of Cancer at 130° + 30°, in azimuth about 31° north of east, and altitude 14° at the time of apparition. The fireball was probably a member of a meteoric shower seen at Bristol in 1887·9, January 25th to February 1st, at 131° + 32°. A fireball seen in 1877, January 19th, may also have been derived from the same system, for its real path, computed by Prof. Herschel, presents a striking resemblance to that of the recent meteor, as follows :—

	Height at first. Miles.	Height at end. Miles.	Path. Miles.	Velocity. Miles.	Radiant.	Position of Path.
Jan. 21, 1898	82	25	235	34	130° + 30°	South of England.
Jan. 19, 1877	75	45	230	35	135° + 27°	Wales and South of Ireland.

Two large and brilliant meteors were observed on the night of Sunday, February 20th, 1898, at 8h. 54m., and 10h. 20m., and particulars of these will be given next month.

◆

THE FACE OF THE SKY FOR MARCH.

By Herbert Sadler, f.r.a.s.

Sunspots may occasionally be observed on the solar disc.

Conveniently observable minima of Algol occur at midnight on the **1st**, at 8h. 50m. p.m. on the **4th**, and at 10h. 32m. p.m. on the **24th**.

Mercury is too near the Sun to be observed this month, being in superior conjunction with the Sun on the **16th**.

Venus is too near the Sun for the observer's purposes, and Mars is also practically invisible.

Jupiter is an evening star, and is excellently situated for observation, being in opposition to the Sun on the **25th**. On the **1st** he rises at about 8h. p.m., with a southern declination at noon of 1° 52′, and an apparent equatorial diameter of 43½″. On the **12th** he rises at 7h. 9m. p.m., with a southern declination of 1° 22′, and an apparent diameter of 44″. On the **22nd** he rises at 6h. 24m. p.m., with a southern declination of 0° 51′, and an apparent diameter of 44¼″. On the **31st** he rises at 5h. 44m. p.m., with a southern declination of 0° 24′, and an apparent diameter of 44¼″. During the month he describes a retrograde path in Virgo.

Saturn does not rise till just before midnight on the **1st**, so we defer an ephemeris of him till April, and an ephemeris of Uranus is omitted for similar reasons.

Neptune is an evening star, being in quadrature with the Sun on the **10th**. On the **1st** he souths at 6h. 37m., with a northern declination of 21° 43′, and an apparent diameter of 2½″. On the **31st** he souths at 4h. 40m. p.m., with a northern declination of 21° 45′. He is almost stationary in Taurus during the month.

There are no very well marked showers of shooting stars in March.

The Moon is full at 9h. 29m. a.m. on the **8th**; enters her last quarter at 7h. 48m. p.m. on the **15th**; is new at 8h. 37m. a.m. on the **22nd**; and enters her first quarter at 7h. 40m. a.m. on the **30th**. Some of the small stars in the Pleiades will be occulted on the evening of the **26th**.

◆

Chess Column.

By C. D. Locock, b.a.

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

Solutions of February Problems.

No. 1.

(W. Clugston.)

1. Kt to B4, and mates next move.

No. 2.

(S. Loyd.)

1. P × B (becoming a Knight), K × Kt.
2. Kt to QKt6, anything.
3. P to R8, mate.

White gets a Knight in order to be able to place it between his RP and the Black Bishop on his next move. No correct solutions have been sent, but the problem was well worth solving, as all Mr. Loyd's are.

Correct Solutions of No. 1 received from G. G. Beazley, H. Worsley Wood, W. de P. Crousaz, J. M'Robert, A. E. Whitehouse, H. W. Elcum, Mrs. C. F. Giddings.

Capt. Forde.—If 1. Kt to B8, K to B4, dis. ch.

F. A. Curtis.—1. B to K6 is met by Kt to K7. In No. 2, after 1. Kt to B4, B × P; 2. Kt to K2, the King moves and escapes mate.

H. W. Elcum.—Your solution of No. 2 fails as above.

J. B. (York).—See above. In No. 2, if 1. P to Kt8 (Queens), B to Kt2, and the Queen cannot play to Kt6. But the Bishop may also safely play to Q4 or K5, though not elsewhere. A note appended to the January puzzles gave warning that a "liberal interpretation" of the laws of the game was required for their solution. As a matter of fact, the law says nothing as to the colour of the piece to be chosen. If, therefore, White selects a Black Rook, Black has a perfect right to use it for Castling purposes. We are glad to hear that you appreciate the February Number.

H. Worsley Wood and *A. E. Whitehouse.*—In answer to 1. P to Kt8 (becoming a Queen), Black moves his Bishop to Kt2 or Q4 or K5, and there is no forced mate in two more moves. If he move elsewhere there is.

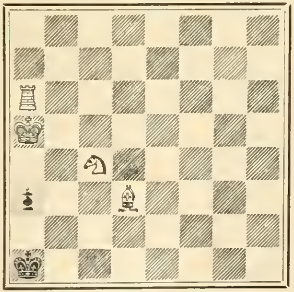
F. W. A. de Tabeck (Rome).—Many thanks for your appreciative card.

D. R. Fotheringham.—The massacre suggested is too terrible to think of. Could you not be contented with 3. PQR3, and less bloodshed?

PROBLEM.

From the *Standard*.

Black (2).



White (4).

White mates in three moves.

We propose this month and next to try the effect on our readers of some very full analysis. For this purpose we have selected a short game of nineteen moves, played on Board No. 1 in the Kent *v.* Sussex correspondence match last year. Our analysis is compiled from notes made at the time.

Part I.—The Opening.

White.	Black.
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. P to Q4	4. P×P
5. P to K5	5. Kt to K5
6. Castles	6. P to QR3 (*a*)
7. B to R4 (*b*)	7. Kt to B4
8. B×Kt	8. QP×B
9. Kt×P	9. Kt to K3 (*c*)
10. Kt×Kt (*d*)	10. B×Kt
11. Q to K2	11. Q to R5 (*e*)
12. Q to K3 (*f*)	12. Castles (*g*)
13. Q to R7 (*h*)	

Notes.

(*a*) Not to be found at this particular stage in any book on the openings. The time-honoured move is 6 . . . B to K2.

(*b*) This loses a move. 7. BQ3, or B to B4, would be answered by 7. . . . P to Q4. But the best course seems to be 7. B×Kt, QP×B; 8. Kt×P (or A, B), B to K2; 9. B to K3, Q to Q4!

(A) 8. *Q to K2*, QB to B4 (or (i.)) [not 8. . . . Q to Q4, on account of P to QB4, now or later]; 9. B to K3, Q to Q2 (9. Kt×P, Q×Kt!); 10. Kt×P, Castles (QR); 11. P to KB3, etc.

(i.) 8. . . . Kt to B4; 9. R to Qsq, B to Kt5; 10. B to K3, Kt to K3 (or 10. . . . Q to Q4); 11. P to B3, Q to Q4, or KB to B4, etc.

(B) 8. *R to Ksq*, Kt to B4; 9. Q×P (or 9. Kt×P, Kt to K3), Q×Q; 10. Kt×Q, Kt to K3, etc.

(*c*) By a transposition of moves the position in a match game, Morphy *v.* Lowenthal, has been reached. Lowenthal played this move, which is much better than 9. . . . B to K2, as recommended by Morphy, Salvioli, and Steinitz. The two latter authorities give 9. . . . B to K2; 10. QKt to B3, Castles; 11. B to K3, P to KB3; apparently overlooking the powerful reply, 12. Q to K2, threatening Kt×P.

(*d*) This and his next move were played by Morphy against Lowenthal. If, instead, 10. B to K3, Kt×Kt; 11. B×Kt, QB to B4; 12. P to QB3, Q to R5, with a good game. But, on account of Black's 11th move in the actual game, we are inclined to prefer 10. KKt to B3, Q×Q; 11. R×Q, BK2; though Black can develop afterwards by Kt to KBsq, and B to KB4.

(*e*) Much stronger than either 11. . . . B to QB4, as played by Lowenthal, or 11. . . . B to K2, as recommended by him. The Black Queen is never dislodged from this powerful position. Black now threatens B to B5.

(*f*) Evidently intended to prevent Castling (QR), and in a minor degree, perhaps, to support the entry of a Knight at QB5. But in other respects it loses time.

(*g*) A bold course, but 12. . . . B to K2, followed by Castles (KR), and QR to Qsq, would leave the Queen's side pawns unprotected. 12. . . . Q to QB5; 13. Kt to R3 (best), B×Kt; 14. Q×B, leads to a draw, as Black cannot take the BP on account of B to Kt5. Another plan would be 12. . . . R to Qsq; 13. Q to R7 (?), B to Bsq; 14. Q to Kt8, Q to K2.

(*h*) This subjects him to a strong attack. Another course would be—13. Kt to Q2, B to Q4; 14. Q to R7 (or A), P to QB4; 15. Kt to B3 (if 15. R to Qsq, Q to Q5!), B×Kt; 16. P×B, Q to R4!

(A) 14. P to QB4, B×P; 15. P to KKt3, Q to Kt5; 16. Kt×B, Q×Kt; 17. Q to R7, B to B4; 18. Q to R8ch, K to Q2; 19. Q×KtP, Q to Kt4 [or, perhaps, 19. . . . B to Kt3; 20. R to Qsqch, K to K3; 21. R×R, R×R; 22. B to K3, B×B; 23. P×B, Q to K5; with some advantage].

We reserve the rapid and interesting finish for next month.

CHESS INTELLIGENCE.

The following team has been chosen to represent the British Isles in the Cable Match *v.* the United States, on March 18th and 19th:—Messrs. Atkins, Bellingham, Blackburne, Burn, Caro, Jackson, Jacobs, Locock, Mills, and Trenchard. Reserves: Messrs. Cole and Wainwright. Messrs. Caro and Trenchard are new to the match, while Messrs. Blake, Cole, and Lawrence, who were in last year's winning team, are not playing on the present occasion.

The order of the team is not yet decided on, but it is fairly safe to predict that the first three letters of the alphabet will be well to the fore.

The Hastings Chess Festival last month met with its usual success. Messrs. Blackburne, Bird, Gunsberg, and Janowski gave simultaneous exhibitions, and took part in consultation games against each other with amateur partners.

Messrs. Pillsbury and Showalter have begun their second match for the championship of the United States. It will be remembered that their former encounter last year resulted in a hard-earned victory for Mr. Pillsbury by 10 games to 8.

On January 24th the British Chess Club defeated the St. George's Chess Club rather decisively by 8 games to 2, the latter score being made up of 4 drawn games.

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CONTENTS.

ECONOMIC BOTANY.

By John R. Jackson, A.L.S., etc., *Keeper of the Museums, Royal Gardens, Kew.*

In our introductory remarks on this subject (Knowledge, February, 1898) we drew attention to the fact that the Kew Museums from their foundation were unique in their character, and at the present time are far and away the most important institutions of the kind throughout the world. It will be best, therefore, to take these collections as the basis of our remarks in succeeding papers, following the arrangement of the natural orders as there adopted, which is based on the system of the *Genera Plantarum* of Bentham and Hooker. By this means we shall be able to prove what we said in our introductory remarks on the distinct economic character of certain natural orders and their importance over others in supplying the wants of man. In treating our subject in a scientific rather than a commercial manner, the advantages will be that those of our readers to whom the Kew Museums are available will have object lessons before them which they will find no difficulty in applying to their own individual requirements, and occurring in the same sequence as here set down. Other advantages will be that the habits of the plants constituting each natural order will be briefly stated, as well as their geographical distribution. Of necessity these descriptions must be brief, and only the principal products can receive treatment; more attention, of course, being given to those of greater than those of lesser commercial value.

Ranunculaceæ.—The type of this order is the buttercup. The plants which form the group are herbaceous. Very few have woody stems. They have a wide geographical range, but are more abundant in cool climates. Their general properties are acrid and poisonous, which is well exemplified in the common aconite or monkshood (*Aconitum napellus L.*). The order is chiefly valued for its medicinal products, the principal of which is the aconite just referred to. It is a perennial plant found in sub-Alpine pastures, and damp, shady places in hilly districts, particularly in the Alpine chains of Europe, as well as in the Himalayan range, where it extends from ten thousand feet elevation up to the limit of vegetation. Though it occurs in some counties of England and Wales, it is scarcely considered a native.

The aconite is valued economically both for the rhizome, or rootstock, and for the leaves, both of which contain the alkaloid *aconitine*, though the rhizomes are said to be six times stronger than the leaves. The rootstock is most active in the winter and early spring, and for medicinal purposes should be collected at those periods. The fresh rhizome varies in size from three to six inches long, broad at one end, and tapering to a fine point. It descends perpendicularly into the ground, and gives off numerous rootlets. It has an earthy odour, and a taste which is slightly bitter at first, but which is succeeded in a few minutes by a burning sensation, and a tingling or numbness in the lips, cheeks, or tongue. The market is mostly supplied with aconite root from the wild plants, but some of the dried root is imported from Germany. Though aconitine is one of the most virulent poisons known, it is an extremely valuable medicine. Tincture of aconite is much used for outward application to allay pain in rheumatic and similar affections. The accidents that sometimes occur from mistaking aconite root for horseradish can only happen at the time when the plants are leafless, as the foliage of the two plants is very distinct; and even then the tapering and dark-coloured root of the aconite is quite different in appearance to the long, cylindrical light-coloured root of the horseradish. Several other plants belonging to this order, natives chiefly of America and India, furnish useful medicines. The small black seeds known as fennel-flower seeds are also the produce of a ranunculaceous plant—*Nigella sativa*, an annual of the South of Europe, Levant, Egypt, etc. The common name is derived from the fennel-like odour the seeds have when fresh. In the East they are used as a carminative medicine and for flavouring curries, as well as to keep insects from woollen cloths. In France they are used as a spice.

Magnoliaceæ.—Trees or shrubs, many of them with handsome and fragrant flowers, found in North America, India, China, and Japan. They possess bitter tonic and aromatic properties. The woods are of a light colour, even grained and easily cut. The two most important economic plants of the order are the star anise and the American tulip tree or white wood. The first, *Illicium verum*, is a tree about twenty feet high, the fruits of which are composed of several carpels, and when fully ripe and dry they open and expand in the form of a star; hence the common name. The whole fruit has a most agreeable aromatic odour and yields an equally aromatic oil. They are imported in considerable quantities from China into Europe, America, and India for flavouring liqueurs and spirits. The tree grows to a height of about twenty feet. The tulip tree or white wood, *Liriodendron tulipifera*, grows in its native country of America to a height of over one hundred feet. It grows well in England, and is a favourite tree in consequence of its peculiar-shaped foliage and tulip-like flowers. The wood is fine and even grained, very white, and free from knots, so that it is in very great demand both in America and in England for cabinet work, door panels, etc. In some trunks, however, the wood is of an even yellowish tint, and is known as canary wood.

Most of the species of *Magnolia* yield white and even-grained wood, which is much used for various purposes in the countries where the trees grow.

Anonaceæ.—This is an important natural order of tropical trees and shrubs, noted for the aromatic and even pungent properties of some of its species. They are chiefly natives of tropical countries, and are perhaps best known for their edible fruits, such, for instance, as the sour-sop, *Anona muricata*, a West Indian tree producing a fruit sometimes weighing upwards of two pounds. It is somewhat oval in shape, of a greenish colour externally, and covered with prickles; internally the pulp is white and has an agreeable slightly acid flavour. The sweet-sop, *A. squamosa*, is a native of the Malay Islands, but is cultivated both in the East and West Indies. The fruit is nearly globular, somewhat larger than a cricket ball, and is covered with projecting scales, or mammillæ, over which is a thick rind. The central portion is filled with whitish pulp, in which are embedded the numerous black shining seeds. The custard apple, or bullock's heart, *Anona reticulata*, is smaller than the preceding, and is somewhat irregularly heart shaped. It is a native of the West Indies, but is cultivated also in the East. The yellowish pulp is not generally so much liked as that of the preceding. The cherimoyer (*Anona cherimolia*) is said to be the most delicious fruit of the order. It is a native of Peru, but is cultivated in the West Indies and other countries exclusively for the sake of its fruit. Like those of the other species the fruit is somewhat heart shaped, the outside covered with scales and the inside pulp of a yellowish pink colour. The aromatic character of the order is well illustrated in the seeds of many of the species, as in *Monodora myristica*, the numerous seeds of which are borne in large globular fruits. These seeds are remarkable for their distinct rumination, which, indeed, is a character of the order generally. What is known as negro or Ethiopian pepper is the fruit of *Xylopia Æthiopica*, a large tree of the West Coast of Africa. When ripe and dry, as they appear in the West African markets, the fruits are black and quill-like, arranged in bunches or clusters around a central axis. They are aromatic and strongly pungent, and are used by the natives for seasoning their food. Attempts have been made to introduce them into English commerce, but as they have no advantage over pepper or other condiments they have not succeeded.

Menispermaceæ.—This is a group of climbing tropical shrubby plants, abundant in woods of Asia and America. In cross section the stems and roots show a very large development of the medullary rays, and the structure is so open or porous that the more slender stems are often so pliable as to be used for ropes. Another distinct character is the bright yellow, or greenish yellow, colour shown when the wood is freshly cut. Their properties are bitter and narcotic, and, in some cases, poisonous. The order is essentially a medicinal one, several of the species yielding valuable remedies, such as the *pareira brava* (*Chondrodendron tomentosum*), a woody climber of Brazil and Peru, having a bitter taste but no smell, and it is used as a mild tonic and diuretic. Calumba root is another bitter tonic. It is the product of *Jateorrhiza calumba*, a perennial climber of the forests of Mozambique and Quillimane. It appears in commerce in this country usually in dried, yellow-coloured, transverse slices, which have been cut when fresh, and are consequently shrivelled. Under the name of *Cocculus Indicus* the berry-like fruits of *Anamirta paniculata* are sent in very large quantities to this country from India. They are poisonous, and the only use to which they are known to be put is in the preparation of ointments, chiefly for killing pediculi; but it is said that they are also used in giving a bitter flavour to beer. The plant is a large woody climber, and the fruits are about the size of a large pea.

Other medicinal plants in this order that may be mentioned as more or less useful are the spurious *pareira brava* (*Cissampelos pareira*), a slender woody climber found in tropical regions of both hemispheres, which has bitter and tonic properties; and false calumba (*Coscinium fenestratum*), also a climber of Ceylon, Southern India, and Malacca, the wood of which is of a greenish yellow colour. It is a bitter tonic.

Berberidaceæ.—This order consists of shrubs and herbaceous plants, mostly natives of temperate climates. The common barberry (*Berberis vulgaris*) is the only British species of the order, the properties of which are acid and astringent; a yellow colouring matter is also found in the woods. The most important economic plant is *Podophyllum peltatum*, a perennial of the United States and Canada, the rootstocks of which contain an active principle known as *podophyllin*, and much valued in medicine.

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THE STRUCTURE OF IRELAND.

By Grenville A. J. Cole, m.r.i.a., f.g.s., *Professor of Geology in the Royal College of Science for Ireland.*

OWING to the isolation of Ireland, as compared with Scotland, its geological features have remained comparatively unknown, except to the officers of Government Surveys and the authors of certain careful and conscientious text-books. Readers of the latter are still apt, however, to skip the pages dealing with so remote an island, and to devote their earnest attention to the minuter details of purely English stratigraphy.

Even now, when the finest line of channel steamers on our coasts runs between Holyhead and Kingstown, the visitors who throng these boats at certain seasons aim at little more than Killarney or the Giant's Causeway. The associations of the former place in summer are scarcely suited for philosophic speculation; while the speculation at the latter place is mainly confined to the syndicate which has recently enclosed it, and which, after the manner of the enterprising Swiss, charges an entrance-fee for the inspection of its natural beauties.

But no one who approaches Ireland can fail to be struck by certain of its physical features, notably the picturesque and even mountainous character of its coast. Off Dublin, the cliffs and the rugged little moor of Howth may remind us of Holyhead or Cornwall; but on the south side of the bay the eye is caught by the still bolder promontory of Bray Head, the graceful cones of the Little and Great Sugarloaves, and the long range of the Dublin and Wicklow mountains, stretching sixty miles into the south, and rising two to three thousand feet above the sea.

Or at Greenore we may enter on a sunny morning, to see the mists clearing from the granite peaks of Mourne, and the saw-edge of the Carlingford range already black against the sky. And we look farther up the sea-lough towards Newry, where the ground rises inland to form the plateau of Armagh, bearing on its back the volcano of Slieve Gullion and other giants of the moorland.

To reach Belfast, again, we pass up the lough between the hills of Down and the far bolder and terraced masses of the Antrim coast, and rest at last against the quay, where the smoke of a busy commercial centre cannot blot out the great black crags that rise almost sheer above the town.

Or, again, near Cork, where the foreground is lower, and something in the pleasant Falmouth style, glimpses are seen of those fine red-sandstone ranges that run from Waterford to Kerry, and form a backbone to all the southern coast; while an approach from the Atlantic side, to Bantry, Galway, or Donegal, would impress still more firmly on the traveller the mountainous nature of the country.

Yet, start this traveller by rail from Galway to Dublin, or from Cork to the sea again at Drogheda, and he will report that Ireland is a flat country, with occasional bands of mountains on its margins. In the former case he will cross the Shannon in a broad prairie at Athlone, and will hail even the little gravel-ridges as welcome features in the plain. In the latter case he will pass the lordly range of the Galtees, and will have visions of the long chain of the Leinster granite between him and the eastern sea; but his course will lie through a pleasant cultivated lowland, with white farms and foursquare mansions, and anon stretches of brown bogland, margined by wind-swept belts of firs. The structure of Ireland seems, then, fairly simple—a shallow basin, bordered for the most part by a rim of higher ground.

The details of its structure have been put before geological readers in two well-known works;[*] and, in a more popular setting, by von Lasaulx,[†] who visited the country in 1876. One of the most charming accounts of Ireland, and the most fully illustrated, is to be found in the work of another foreign author, M. Martel;[‡] and the geological matter in this book is unfamiliar to most of us, dealing as it does with the underground waterways of the Carboniferous Limestone area. In this and succeeding papers, I propose to regard Ireland from a broad standpoint, as a part of Europe, as a mass set upon the continental edge—that is, upon one of the most interesting structural lines of Europe at the present day.

Bertrand and Suess, the authors of our more recent generalisations respecting European structure, have not overlooked Ireland as the visible western termination of their systems of earth-folding; and the latter writer may be said to show an intimate acquaintance with the geology of the island. M. Bertrand[§] has recited to us the four principal epochs of mountain-making, and has somewhat daringly pictured the folds as successively extending southward, banked one against the other, from the Polar Circle to the Mediterranean. Certainly, the bared Archæan masses of the north, and the growing limb of the Italian region in the south,[||] go far to support his generalisation.

Ireland, as an epitome, retains traces of these four great epochs. In the mountain-rim of the north and west, the oldest system of folds, the *Huronian* chain of Bertrand, comes to light. Complex as the older rocks of Donegal may be, few will deny that their fundamental series is of equal antiquity to the Hebridean gneiss of Scotland; while an interesting inland exposure in the east of the county of Tyrone shows that ribs of the pre-Cambrian chain are not far distant beneath any part of the north of Ireland. The handsome gneisses of this latter area, north of Pomeroy, form a broken moorland, to which echoes of the outer world travel slowly even in our own time—a region in which the old language, and the brightness of the old costumes, linger almost within sound of the clanging shipyards of Belfast. Flanking this core of antique rocks, come interpenetrating masses of igneous origin, and an extensive series of schists that form mountain-ridges of their own.

In the counties of Mayo and Galway, again, the stratified but metamorphosed series that underlies the first fossiliferous horizons is now known to be at least of Cambrian age;[*] and its general relationships would carry it down even further. The quartzite masses of the Twelve Bens of Connemara may even represent the Torridon series of Sutherland; and somewhere beneath them must lie the gnarled and twisted gneiss, forming part of the continent of "Huronian" times. South of this point the old rocks are cut off by the Atlantic, and play no further part in the structure of our modern Ireland.

The *Caledonian* epoch of mountain-building set in at the close of the Silurian period, and gave us the Grampian folds, and the great thrust-planes that have wrought such havoc with the true order of things in north-west Sutherland.[†] It gave strength and compactness to a great part of Wales; and its first throes are seen in the break that occurs between the Ordovician and the Silurian beds in Shropshire. On the Welsh border, in fact, the Caledonian movements made a start a whole geological period in advance of the main upheaval of the chains.

Evidence of something of the kind is now reported from the west of Ireland; but the principal folding in that country certainly included Silurian beds as well as Ordovician. Along the east coast, from the neighbourhood of Belfast to the south of the county of Waterford, the Caledonian pressures have thrust up these two systems of beds on end, and have contorted or even inverted them. From the mountains and plateaux then raised, pebbles were copiously rolled down, to form the first deposits in Devonian lakes, or, later, in Carboniferous seas. In fact, a continent then arose across all the northern European area, on which room was found for the fresh-water basins of the Old Red Sandstone, and on the mobile edge of which the volcanoes of the Cheviots fumed.

The surface of this continent is, then, exposed to us by denudation whenever the Devonian conglomerates are removed; and certain portions of it must have stood up as barriers between the lake-basins, and were never submerged until the great subsidence, which readmitted the sea in early Carboniferous times.

The great thickness of the Old Red Sandstone implies that the floors of the lakes in which it was deposited, or of the estuaries that may have served in certain cases as the gathering-ground, were steadily sinking as

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[*] G. H. Kinahan, "Manual of the Geology of Ireland," 1878; and Prof. E. Hull, "Physical Geology and Geography of Ireland," Second Edition, 1891.

[†] "Aus Irland: Reiseskizzen und Studien," Bonn, 1878.

[‡] "Irlande et Cavernes anglaises," Paris, 1897.

[§] "Sur la Distribution géographiques des Roches éruptives en Europe." *Bull. Soc. géol. de France*, Troisième Série, Tome XVI. (1887-8), p. 576.

[||] *See* Knowledge, Vol. XX. (1897), p. 285.

[*] This, at least, may be safely concluded from the most recent results of the Geological Survey in that district. (*Ann. Report Geol. Survey of United Kingdom*, 1897, pp. 50 and 51.)

[†] See the sections in the Survey Report published in *Quart. Journ. Geol. Soc., London*, Vol. XLIV. (1888), p. 378.

layer after layer was laid down. Between the parallel ranges of the "Caledonian" chain, long valleys of subsidence may have existed like that in which the East African lakes have arisen at the present day. By an opposite movement, along the planes of gradual faulting, the intervening ridges may have prolonged their existence, and may have maintained the level of the continent. By our own times, a succession of later earth-movements has complicated the relations between the Devonian sandstones and the land-surface that gave them birth; but we may still see in the great chain of Leinster one of the real highlands of "Caledonian" times.

Fig. 1.—Sketch-map of Ireland, showing the direction of the principal axes of folding. The lines represent the trend of both anticlinal and synclinal axes. Lines with dots represent the "Caledonian" folding; thick lines, the "Hercynian" folding.

The marine Carboniferous beds abut directly on a great part of this chain, with no exposure of Old Red Sandstone round their margins; hence the ridge stood out as a long island even in the Carboniferous sea. To this day it forms the most continuous portion of the mountain-rim of Ireland, though shorn of its former schistose peaks by whole eras of denudation, and though the round back of the granite-core is now laid bare to view.

The "Caledonian" uplift was characterised by a feature common in true mountain-chains—the intrusion of granite along the more important lines of elevation. As the long arch formed, the igneous mass rose with it, melting off its lower layers, sending off veins into higher ones, and inducing crystallisation and foliation in the argillaceous beds along the contact-zone. Hence the backbone of Leinster became strengthened from below; and its double structure is seen clearly in any traverse of the range.

Round Newry, again, granite forms a hard ridge intimately connected with the "Caledonian" folds; and at Castlewellan, a little further north, the igneous invader has been caught, as it were, in the act, and is seen to be stuck full of fragments of Ordovician or Silurian strata, which present every stage of alteration, from mere baking to almost complete absorption. It is very reasonable to suppose that the characters that distinguish the Newry granite from that of Leinster are induced by the amount of foreign material absorbed by it in the portion now exposed.

Further evidence of the support given to the "Caledonian" folds by the intrusion of granite is seen in the exposures in the county of Cavan. At and near Crossdoney, a granite of very various grain and character comes to the surface among the Ordovician shales. It is a miniature picture of the structure of the Leinster chain, and suggests the vast extent of similar features hidden throughout Ireland beneath the blanket of Carboniferous rocks.

When we go north or west, we are confronted with the schistose ranges, which may be of any age between the date of the "Huronian" uplift and the Devonian period. Unconformities show that there were movements, unclassified in the broad scheme of Bertrand, before Ordovician times; but the great folding of the country, like that of the Scotch Highlands, clearly occurred about the close of the Silurian period. To this we owe the green and romantic range of the Sperrins, a highland scarcely visited, even by the dwellers on its flanks; also the whole present structure of wilder Donegal, with its ridges and valleys running north-east and south-west, still preserving the general trend of the Caledonian folds; and, again, the superb coast-scenery of Slieve Liaga and Achil Island, where cliffs of two thousand feet remind us of the mass of "Caledonian" land that has become lost in the Atlantic. The uplift of Mweelrea, with its fossiliferous Wenlock zones, and of the Wenlock and Ludlow beds of the Dingle promontory, dates from the same period of unrest. In the latter spot one of the fractures reached the surface, and our unique volcano of Wenlock age threw its bombs briskly in the air, as a sign that the Silurian gulfs were about to pass into dry land.

A great part, then, of the mountain-rim of Ireland is of extreme antiquity; and in other places the pre-Devonian surface has been, as it were, restored to us after many strange vicissitudes. The Carboniferous subsidence converted the region of the British Isles into an archipelago; and in Ireland the separate islands can sometimes be traced out by the conglomerates formed in the Carboniferous beds upon their flanks. This invasion of the sea left its mark upon the whole centre of the present Ireland, through the uniform deposition of the blue-grey Carboniferous Limestone. The denudation, and the actual solution, of this rock have given us the landscapes of the great plain; these become often impressive in their very breadth, and are never monotonous to those who love to watch the cloud-shadows move across the bogland or the lake, in a picture that takes half its life and colour from the changing temper of the sky.

The great limestone-sea was thrust out, very gradually at first, by what is known in Europe as the *Hercynian* uplift, named after the forest-ranges of Central Germany. The sandy beaches that were formed as the sea shallowed give us ledges of hard rock at the present day, such as that on the crest of Cuilcagh, where the Shannon first forms into a stream. The trend of the Hercynian folds was no doubt diverted locally by the surviving knots of the Caledonian chains; but in many places the pre-Devonian land gave way. It was thus worked up again, and was brought into new prominence, and into a new scheme of arrangement, in the cores of the Hercynian folds.*

From the west of Kerry to Waterford, away on across Pembrokeshire and the South Welsh coalfield, under Oxfordshire and London, and through Belgium and Central

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* Compare W. J. Sollas, "Geology of Dublin and its Neighbourhood," *Proc. Geol. Assoc.*, Vol. XIII. (1893), p. 113.

Carrion Crows capturing a Lark.—A labourer told me he recently saw two Carrion Crows capture a Lark by seizing it on the wing. It was not a wounded bird, but in strong flight down some stubbles with many others. The Crows acted very cunningly, working together, one keeping above and the other below, with the Lark between them, and the upper repeatedly making swoops and at last seizing the Lark in its beak, when both Crows descended and commenced (not without a quarrel between themselves) to tear their quarry to pieces.—John Cordeaux, Great Cotes House, R.S.O., Lincoln.

Glaucous Gull (*Larus glaucus*).—Mr. Geo. Adams, of Douglas, taxidermist, has shown me a Gull of this species recently received by him for preservation, and obtained on the island. It is an immature bird, in the whitish and pale brown plumage well described in Mr. Macpherson's manual. This is, so far as I am aware, the second record of this Gull in the Isle of Man, though it has doubtless occurred much oftener.—P. Ralfe, Castletown, Isle of Man.

Variation in the Song of the Mistle Thrush.—It seems to me that the Mistle Thrushes near Eltham sing longer strains than are heard from those of Gloucestershire, and that the latter birds more frequently utter a few high broken notes after the strain, in the manner of a Blackbird. It would be interesting to learn whether anyone has heard the Mistle Thrush sing a long strain such as one hears from the Blackbird. This point appears to me important in connection with the fact that the young Blackbird, when commencing his full-toned song, utters short strains like a Mistle Thrush.—Charles A. Witchell.

Song of the Redwing.—On the 6th of March I heard the song of a wild Redwing. The morning was very fine, and the bird sang earnestly. The strains were continuous, composed of a very rapid repetition of metallic but not loud notes, and lasted throughout the space of half a minute. Each strain contained a few short full-whistled notes. The whole song reminded one much of the twittering of a young Thrush in September, or the high sharp notes emitted by fighting Thrushes. I listened to the bird for some minutes.—Charles A. Witchell.

Grey Phalarope near Kilkenny, Ireland (Irish Naturalist, March, 1898, p. 88).—Mr. G. E. H. Barrett-Hamilton reports that a specimen of this bird was shot by Mr. John O'Connell, jun., near Kilkenny, in October, 1897.

Parus salicarius (Brehm).—"A Hitherto Overlooked British Bird," by Ernst Hartert (*Zoologist*, March, 1898, p. 116).—Under this title Mr. Hartert claims to add a new resident species to the British list. The bird in question is a Marsh Tit, called "*Parus salicarius,*" which is allied to the northern form, *P. borealis*. Mr. Hartert says that *P. salicarius* has been recently "re-discovered" and brought to his notice by two Continental ornithologists — Kleinschmidt and Prazak. He himself has since then procured three specimens from Finchley. With no intention of slighting the authority of so well-known an ornithologist as Mr. Hartert, we feel disposed to await further evidence as regards the habits, the habitats, and the specific distinctness of this bird, before we venture to add it as a new species to the British list.

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.*

Note.—The first issue of Knowledge containing British Ornithological Notes was that for October, 1897.

The British Museum has, we understand, acquired by purchase the valuable collection of fossil insects formed by the late Rev. P. B. Brodie, of Rowington Vicarage. The collection is the result of the labour of fifty years, and contains many historical and valuable specimens, including several types figured in various monographs and memoirs.

Letters.

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

VARIABLE STARS.

To the Editors of Knowledge.

Sirs,—A maximum of ο Ceti (Mira), following previous computed maxima, was due October 1st, 1897. The star rose in September at such late hours and under such unfavourable conditions of position, moonlight, and atmosphere, that, although it was looked for diligently, no satisfactory observations were obtained until the first week in October. Since then my observations are as follows :—

			Mag.				Mag.
1897.	October	8	5·8	1897.	November	25	3·4
	,,	15	5·6		,,	27	3·3
	,,	17	5·4		,,	30	3·2
	..	18	5·2		December	4	3·4
	,,	19	5·0		..	5	3·3
	,,	23	4·9		..	12	3·5
	,,	24	4·7		,,	22	3·8
	,,	27	4·6		..	26	3·9
	November	2	4·2		,,	27	3·8
	,,	3	4·1		,,	28	4·1
	,,	4	4·0		,,	31	4·5
	,,	5	3·7	1898.	January	1	4·1
	,,	6	3·5		,,	6	4·4
	,,	7	3·4		,,	7	4·6
	..	11	3·5		,,	16	5·1
	,,	12	3·7		,,	22	5·3
	,,	14	3·6		,,	26	5·4
	,,	17	3·5		,,	27	5·5
	,,	18	3·4		..	28	5·6
	,,	21	3·3		..	29	6·0
	,,	24	3·5		,,	31	5·7

There were many observations between these dates, but as no change of as much as a step 0·1 was seen, they are omitted.

In the first week of October the star rose rapidly, and I am not unwilling to believe in a rise of a full magnitude on a single night.

The maximum was reached on November 30th, which, after reviewing previous computed maxima, shows the star, ο Ceti, to have been sixty days late in 1897.

Comparison stars used were as formerly: 71, 6·55; 75, 5·75; 70, 5·62; 66, 5·65; ν, 5·2; ξ^1, 4·75; ξ^2, 4·50; δ, 4·2; α Piscium, 3·90; γ Ceti, 3·5 magnitudes.

The star was less than the sixth magnitude last night, changing slowly.

Memphis, Tenn., U.S.A., David Flanery.
12th February, 1898.

To the Editors of Knowledge.

Sirs,—At the last apparition this variable star has been brighter than at the two immediately preceding. There does not seem to have been much change in its magnitude between November 13th and December 3rd. From the observations given below I conclude that the maximum occurred between November 15th and 23rd.

			Mag.				Mag.
1897.	October	20th ...	5·2	1897.	November	19th ...	3·3
	,,	21st ...	5·2		December	3rd . .	3·4
	,,	29th ...	4·6		,,	12th ...	3·7
	November	5th .	3·8		,,	24th ...	3·9
	,,	13th ...	3·4		,,	28th .	4·1
	,,	15th ...	3·3				

Mira has not been seen since the last-mentioned date, owing to the almost continuous obscuration of the sky.

Westminster, W. E. Besley.
February 14th, 1898.

We regret that the Photograph of the Spectrum of Mira Ceti, appearing in the March Number, was printed without the guide lines, and with the reference numbers out of position. We propose to reproduce the photograph in our next issue.—Eds.

BRITISH BEES.—II.

By Fred. Enock, f.l.s., f.e.s., etc.

It is a well-known fact that many people are remembered by their "impressive manner"; so also are certain kinds of bees by their most impressive sting. The name *Cœlioxys* is quite sufficient to recall to my mind the capture of my first specimen, which I saw flying very quietly past a prickly bramble, and then, being met somewhat unceremoniously by my net, it commenced to act on the defensive in a most vigorous way. Laying back its antennæ and opening its mandibles, it twisted about its very sharply shaped abdomen in such an active manner that I found it an impossibility to avoid its long and powerful sting; but I preferred the sting to injuring the delicate pubescence, which, if roughly handled, robs this bee of its beauty. Like the bloodthirsty "clegg" or grey gad-fly, this bee is almost silent in its flight. It is parasitic, and may frequently be caught hovering near the burrows of *Megachile* and *Saropoda*. The males have a peculiar bifurcate appendage on the apical segment. I have often swept these bees up from meadows, and in days gone by it was possible to obtain specimens of *C. simplex* at Hampstead; but those days, like the sandbanks there, have passed away.

Of the next genus, *Stelis*, I have had no personal experience, though frequently directed to its quarters by the late Fred. Smith, who advised me to collect all the pierced bramble stems I came across.

The genus *Melecta* contains but two species, both most beautifully marked, the abdomen of *M. luctuosa* being adorned on each side with tufts of silvery white hairs on a shining black ground. The flight of this bee is slow and gentle, and so far as my experience goes, it seldom wanders far from the burrows of *Anthophora*, in whose cells it is parasitic. Last year I was delighted to find that a small colony had not been quite turned out from Hampstead Heath, though more than half the bank had been cut through for "improvements." *M. luctuosa* was then enjoying a sluggish flight in the bright sunshine, and, quietly alighting on the sandy ground close to an *Anthophora's* burrow, sat pluming itself, patiently waiting for its mate. It is very easy to capture when so basking, but painful and powerful and far-reaching is its sting.

Fig. 1.—Rose Leaves cut by *Megachile.*

The bees forming the genus *Osmia* exhibit an immense amount of intelligence in the selection of situations for their burrows. Some of these are made in sandy banks or in the decaying trunk of an old willow tree, and in such situations the boring of a deep hole is comparatively an easy matter to these busy insects, which are such patterns of industry. A short time ago a brother entomologist showed to me a number of cells which some bee had made in the space between two section boxes in a hive. These I quickly recognized as those of an *Osmia.* Many times have I watched *Osmia rufa* going in and out at a small bolt-hole in one of the tombs at Highgate Cemetery. No doubt this had become the family mansion of these beautiful bees, which have a great love of locality.

Fig. 2.—The Leaf-cutter Bee.

We now pass on to the genus *Megachile*, the leaf-cutting bees, which are without doubt the most intelligent insects. All the species (some nine in number) cut pieces from various kinds of leaves, with which they build their cells in burrows formed in sandbanks, old decaying trees, as well as in the crumbling mortar of old walls, and under old tiles. Several species are quite common in London gardens during June and July. There is a considerable amount of businesslike bustle about them, which is most attractive to the naturalist, who is quite willing to allow them to cut up the leaves of his rose bushes so that he may have the opportunity of studying their habits. Though certain species prefer the green leaves of the rose (Fig. 1), they do not hesitate to cut circles and oblongs from almost any good sound leaf. I have watched them attack those of laburnum, rhododendron, laurel, sweet pea, nasturtium, geranium, laurustinus, etc., etc. Two years ago I saw *M. centuncularis* cut dozens of pieces from the soft leaves of an edible pea in a London garden which did not possess a

Fig. 3.—Under Side and Side View of Abdomen. showing Pollen-collecting Hairs.

Fig. 4.—Head of Leaf-cutter Bee; Mandibles ready for cutting.

Fig. 5.—Head of Leaf-cutter Bee, showing Clypeus.

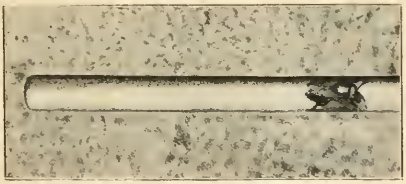

Fig. 6.—Tunnel of the Leaf-cutter Bee, driven into a Sandbank.

rose bush. These bees are remarkable for their strength of flight and muscular mandibles, legs, and stings, while in general build they are much heavier than the honey bee. (Fig. 2.) The pollen-gathering hairs are spiral in shape, arranged in rows on the under side of the abdomen (Fig. 3), and are of a chestnut colour. The males of *M. Willughbiella* are very beautifully clothed with hairs of wonderful form. This is especially noticeable in the tarsal joints of the anterior legs, which have long fringes of curled hairs. These hairs are spread wide open and the legs kept forward when the bee is on the wing following in the wake of the female. Upon her he waits in the most attentive manner, flying after her wherever she goes, though sometimes his attentions do not appear to be altogether appreciated. As soon as the courting and nuptials are over, the female goes in search of a suitable sandbank in which to drive her tunnel. This she makes about half an inch in diameter, and excavates to a depth of eight or nine inches in a horizontal direction (Fig. 6). The sand is at first removed with her powerful jaws (Figs. 4 and 5), but as she goes deeper and deeper the legs are used for cleaning it away by scratching and shooting it out at the entrance. When the required depth has been reached, and the burrow cleared and swept of all loose sand, the bee carefully lines it with a delicate membrane laid on in a fluid state from its mouth. When this operation is finished, the burrow is ready for the reception of the building materials forming the cells. In the case of *Willughbiella* these are made entirely of pieces of green rose leaves, taken preferably from a Maréchal Niel. The building up of these cells, were they constructed by human hands, would no doubt be looked upon as a wonderful performance; but where could be found a workman clever enough to attempt such a task, even supposing he were allowed to make the habitation on a much larger scale? Let us examine the structure in detail. We find a hole ten inches deep and half an inch in diameter, containing from nine to a dozen cylindrical cells fitting one on top of each other somewhat like a pile of thimbles. They are all of one size, and are composed of pieces of leaves, cut to certain shapes, each piece being accurately fitted and placed in order in its right position.

Fig. 7.—Third Pair of Legs, *open*.

It is only after years and years of the most careful observations, aided by a number of small contrivances for watching these creatures at work, that we are able to give every detail as we have seen it. But such observations are not to be completed in one season. The links composing the life-history of any common insect often remain hidden, and evade the most untiring search for years, or the greater part of one's life. Some writers state that this bee, after cutting ten or twelve pieces of leaves, "enters the tunnel, and begins to twist and fold the leaves, making them fit together into a sort of funnel-shaped cone, something like a thimble." A human being does occasionally do things in a rough, jumbling fashion, but a leaf-cutter bee, never! I speak positively on this subject, as I have watched the bee make its burrow and then commence its cell, besides having frequently unearthed burrows containing cells in all stages.

Fig. 8.—Third Pair of Legs, *shut*.

Now let us go back to plain facts, leaving theories for "the armchair naturalist." The tools with which this wonderful leaf-cutter bee cuts out most accurate circular pieces of leaves are her two powerful jaws (Figs. 4 and 5). These are beautifully chiselled out, so that the exceedingly hard edges of the teeth are perfectly sharp, working one over the other like a pair of gardener's shears. Another valuable and indispensable set of tools is to be found in the six legs, each one containing several brushes and combs of the finest quality and each one adapted for a certain purpose, while the whole set of legs form a perfect vice (Figs. 7 and 8), in which the leaf to be cut is held in a firm grasp, and in such a position that the jaws and head can work round freely—so freely, indeed, that in less than twenty seconds the bee has cut out an exactly circular piece of leaf, just the size for her purpose.

Fig. 9.—Leaf-cutter Bee cutting circular piece from leaf.

To watch these bees at work on a bright sunshiny morning (and they get up and to work very early) is to me one of the most fascinating sights. Two years ago I spent several days in succession watching *M. centuncularis* cut dozens of pieces from a soft-leaved sweet pea growing up my summer arbour, which backed against a wall eleven feet high (not too countrified). My busy visitor arrived on June 14th, pitched down upon a leaf, and before I could take out my pencil and note-book it had flown over the wall, carrying with it a piece of the leaf. I quickly obtained my field-glasses, and returned to find that during my absence the bee had again visited the pea, and departed with another piece of leaf. I had not long to wait for its return, and now, being armed with note-book, I settled down to steady work. The bee pitched upon the top edge of a leaf, with its head towards the base (Fig. 9), and, placing three legs on one side and three on the other, it took hold of the edge with its jaws. Then the jaws began opening and closing rapidly, and the head was moved down and round. So quickly were these operations performed that in just fifteen seconds the bee had cut a circular piece from out of the leaf (Fig. 10). The insect then dropped down slightly, but recovered itself, and flew up towards the wall. I watched it with my glasses, and saw it fly over the wall to an old outhouse covered with tiles, under one of which it quickly disappeared. In less than a minute it reappeared, and flew straight for my boundary wall and down on to the pea. Taking hold of the lower edge of the leaf from which it had cut the circular piece, it commenced operations this time by making a much larger arc (Fig. 11), which was finished off just before the midrib of the leaf was reached. The bee then continued to cut almost parallel to the midrib for a distance of over half an inch, and then, turning, it completed its task in the form of a segment of a circle. Once more it dropped towards the ground, and, recovering as before, flew off over the wall to the tiled outhouse. It laboured thus for between three and four hours, during which time I noted down the following particulars. Fifteen seconds were occupied in cutting out a circular and twenty-seven seconds an oblong piece of leaf. The journey to and from the tiles, including arranging the piece of leaf, was performed in less than one minute. When the leaf was almost cut through the bee poised itself by gently vibrating its wings, and so prevented the weight of its body from tearing the leaf. Day after day the industrious bee visited my garden, until there was scarcely a perfect leaf left on the clump of sweet peas. From 1870 to 1874, each June, I observed numbers of *Megachile centuncularis* visiting a clump of everlasting peas, the flowers of which they are exceedingly fond of, but I did not observe that they cut the leaves. They are particularly fond of the leaves of the garden fuchsia.

Fig. 10.—Leaf-cutter Bee flying away with circular piece.

Fig. 11.—Leaf-cutter Bee, cutting an oblong piece from leaf.

(*To be continued.*)

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IN THE MOON'S NORTHERN REGIONS.

By Arthur Mee, F.R.A.S.

Although the northern regions of the moon cannot compare for one moment with the glorious and bewildering complexity of the southern, still they contain a number of interesting objects that never fail to delight the observer. Take, for instance, the fine picture which illustrates these notes. It

THE LUNAR ALPS AND THEIR NEIGHBOURHOOD.

is a reproduction of plate No. 6 in the Observatory Atlas of the Moon in course of publication by the Mount Hamilton Observatory, the original negative of which was secured April 9th, 1897; moon's age, eight days.

The reader will hardly need to be reminded, ere we proceed with our brief description, that the Lick and Paris Observatories are each publishing atlases in which the original photographs taken at the respective institutions are moderately enlarged. A third publication is that of Prof. Dr. Weinek, in which the magnification is pushed a good deal farther in the able hands of this most skilful selenographer. Last comes the atlas of Herr Krieger, who has deftly inserted details at the telescope, using existing photographs as a guide. A comparison of these various methods and results is deeply interesting and instructive, and these atlases between them must immensely advance our knowledge of the moon.

The scale of the accompanying photograph is not large enough to bring out those minutiæ which have such interest for selenographers, and which at times give rise to lively and even acrimonious discussion. But though detail be wanting, the picture shows—very nearly as well as though the reader were actually peering through the eyepiece—the broad lines of lunar landscape, which are perhaps as important in the framing of hypotheses as the minute objects amongst which the wielder of high powers is always so happy to revel.

Our key-chart will render easy the identification of the various objects in the photograph. The sun is just rising on the western ramparts of Plato, and is throwing the Alps, Caucasus, and Apennines into splendid relief, all the more marked because of the sombre plain from which they rear their crests. Let us look for an instant at the great craters which the photograph includes.

The largest is Aristoteles, and somewhat to the south the smaller but still immense Eudoxus. Aristoteles is no less than sixty miles in diameter, and its walls rise to a maximum height of eleven thousand feet above the floor. It is, however, but imperfectly seen in the illustration, for the camera cannot be prevailed on to show objects exactly as they appear to the eye, introducing a glare here and a blackness there which detract somewhat from its inestimable value.

The splendid ring of Archimedes is described by Elger as "next to Plato the finest object on the Mare Imbrium." It is fifty miles in diameter, but the walls are less lofty than those of Aristoteles. Still, the shadows show out splendidly as sunrise progresses, whilst about the lunar noon a curious system of craterlets and light streaks is revealed, reminding one of the interior of Plato.

To the north-west of Archimedes lie Autolycus and Aristillus — stately names all three! Both the latter are the centres of minor ray systems, and Aristillus is "flanked on all sides" (as Webb tells us) "by radiating banks resembling lava streams, or currents of ejected blocks or scoriæ," of which there is just a faint trace in the illustration. On its eastern side Aristillus is eleven thousand feet deep.

To the north, between the Alps and Caucasus, is the interesting crater plain Cassini, which will afford the lunar draughtsman many hours of pleasant work; and he may afterwards compare advantageously his drawings with the photographs in Knowledge and elsewhere.

Towards the north pole of the moon we have quite a crowd of craters, confused by foreshortening, but forming a very poor second to the tremendous display near the southern extremity of the axis.

Most of these objects have but feeble terrestrial analogies, but when we turn to the lunar mountain ranges we seem on more familiar ground. And what a glorious spectacle would stretch before the observer could he but stand on one of these lofty peaks—on Mont Blanc (twelve thousand feet), Mount Wolf (eighteen thousand feet), or Caucasus (nineteen thousand feet)! What a bewildering panorama would it not be—a "nightmare vision," as one writer calls it, only to be imagined in our dreams!

Perhaps the great mountain ranges are the most satisfactorily depicted of any objects on the photograph before us. They will bear long looking at, but must of course be seen in the telescope to appreciate their full magnificence.

The eye will not be long before it rests on that very remarkable object, the great valley of the Alps. This mighty gash, as though the work of some gigantic axe, is above eighty miles long, and to be distinctly seen in all but the feeblest telescopes. Only from four to six miles broad, its walls tower up for well-nigh twelve thousand feet. At its southern end it opens out into a noble amphitheatre. Webb, Elger, and others have studied and drawn this wonderful valley, and two of Mr. Elger's drawings enrich the *Journal of the Liverpool Astronomical Society*. The lunar members of the British Astronomical and other Associations might well turn to the great Alpine valley as a change from the bewildering spots, craterlets, and streaks of more frequently delineated objects.

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Notices of Books.

A Treatise on Chemistry. By Sir Henry Roscoe and C. Schorlemmer, F.R.S. Vol. II.—"The Metals." (Macmillan.) Illustrated. 31s. 6d. Nineteen years have now elapsed since the publication of the first edition of this treatise, and in consequence of the many innovations in the chemistry of the metals during that period, the present edition (the third) may be regarded as a new work. Drs. Colman and Harden have taken part in the sweeping changes which have been necessary to bring the work into harmony with the present condition of chemical science, the systematic description of the metallic elements and their derivatives having been re-arranged in accordance with Mendeléeff's—the Russian chemist—natural classification, which resolves the elements into eight groups, the members of each group showing in most cases a close connection with each other. By thus taking advantage of the hint afforded by the natural gamut of the elements, so to speak, the study of chemistry becomes, in a way, comparable to the study of botany or zoology, the eight groups of elements being the equivalents of the chief representatives of the great groups of plants and animals, while the individual members of each group may be likened to the different species—all bearing certain characters in common, but with specific differences. Such a relation between the organic and inorganic is not inconsistent with the unity which science has shown to exist in the universe, and the sooner this method of conveying a knowledge of the chemical elements becomes general the better it will be for all concerned. Chemistry, however, has in recent years grown to such gigantic proportions in both its main branches, organic and inorganic, as well as in its theoretical and practical aspects, that a book, in order to be of maximum value to a student, must be consistent throughout. If it is a book purporting to deal with the principles of the science it must steer clear of the technical or industrial applications, otherwise there is sure to be a too apparent deficiency somewhere. Special treatises are required, and exist, nowadays, for such purposes as soap and alkali making, the metallurgy of iron, copper, etc., and the extraction of gold and silver from their ores. In the article on gold mining, for example, in this work much space is occupied on such subjects as the capital and labour required in the working of auriferous deposits, which are certainly outside the domain of theory, and yet not full enough to be of practical value to the actual miner. The same remarks would apply in the case of the section on iron smelting and the Bessemer steel process, as well as several other chapters, such as the manufacture of glass, bleaching powder, and so on. A proper division of labour in matters literary as well as industrial has its advantages. In the case under consideration, had the authors confined themselves to the pure principles of chemistry, and reserved the technical portions for books professedly practical, the book need not have swollen to its present dimensions, and might then, at a lower figure, have been accessible to students in general; whereas it is now almost entirely confined to libraries, where it can only be casually consulted, and its many excellencies are thus buried as far as the great majority of chemical students are concerned.

Notes on Carpentry and Joinery. By Thomas Jay Evans. Elementary Course. (Chapman & Hall.) Illustrated. 7s. 6d. Students preparing for the technical examinations of the City and Guilds of London Institute, the Technical Education Board of the London County Council, and other examining bodies, will find here a reliable guide. The subjects included are practical geometry, graphic arithmetic and statics, elementary carpentry and joinery, and mensuration—a course of instruction well adapted for apprentices who desire to acquire a thorough knowledge of the principles underlying their craft. The text is lucid, the diagrams large and well drawn, and, where necessary, in the geometrical portion of the book, practical methods of solving problems are given such as the workman would be required to use in the shop. The section dealing with graphic statics and mechanical contrivances is particularly good. Drawing, of course, takes the place of calculation in this section, and Mr. Evans has, we think, succeeded in presenting an intelligible exposition of the principles involved in this useful method of computing strains and stresses. Isometric projection, in both its theoretical and practical aspects, comes in here for a fuller and more luminous treatment than we have ever seen before in a book of this kind; and, considering its value in practice, we are of opinion that the author has acted wisely in making this departure, although it has been somewhat at the expense of other important sections—the resolution of forces for example, the treatment of which is rather meagre, and yet the subject is one difficult to comprehend, especially by students whose groundwork in mathematics is circumscribed—a condition of things which nearly always obtains among the artizan classes. On the whole, however, we have nothing but praise for Mr. Evans's work. He has so subordinated and dovetailed the subjects forming the groundwork of an artizan's education that we venture to think there is no better book available for such a purpose.

Glimpses into Plant Life. By Mrs. Brightwen, F.E.S. (Fisher Unwin.) Illustrated. Mrs. Brightwen is well known for her writings for young people, and this book is executed in her usual clear and pleasant style. It is written with the intention of preparing the "minds of young people for the study of botany by explaining in the simplest language some of the elementary phenomena of plant life." For this purpose we are sure it will be successful. Some of the many subjects dealt with are roots, tree stems, leaves, flowers, fertilization, fruit, and habit of growth in plants. The illustrations are good and adequate, and a useful glossary of scientific terms is provided. We have no hesitation in heartily recommending the book to young botanists, or, indeed, would-be botanists of any age.

The Elements of Hypnotism. By Ralph Harry Vincent. Second Edition. (Kegan Paul.) 5s. If the amount of literature published on a subject is a measure of its worth, then hypnotism is insinuating itself more and more into popular favour in spite of the ignominy heaped upon it by the practices of the professional entertainer, the charlatan, the juggler, and the trickster, who have laid their hands on the much-suffering science, for the number of books on the subject is now not only large but also rapidly increasing. The public, which in the main is entirely ignorant of the nature of hypnotism, has always regarded the subject as something akin to the supernatural, and quacks have made their fortunes by availing themselves of this weakness and mesmerising human beings in the presence of large assemblies; hence, mesmerism has long been a sort of byword for all that is low and contemptible. Hypnotism has also antiquity to recommend it—if age be a virtue in matters intellectual—for it dates back as far as the year 1552 B.C., when it was practised in Egypt. The early kings of France were credited with curing people by the "royal touch"; and even in Queen Anne's time faith in this mode of cure was still in vogue. As to the ultimate value of hypnotic science it is difficult, at this stage, to form any clear notion; but Mr. Vincent has certainly made the subject attractive, and, by numerous footnotes of reference to literature of this kind, has invested his work with a fund of information which will be specially acceptable to those who wish to pursue their studies further than is possible by the aid of a single volume. A chapter on the use of hypnotism in detecting crime, and the medical treatment of patients by mesmerism, concludes the book—a chapter, by the way, which we think might with advantage be amplified in a subsequent edition. Some noteworthy remarks are advanced on the way in which hypnotism has been abused and misrepresented in modern fiction, and it is certainly remarkable that all such writers should have failed to convey "any true idea of the hypnotic state or the dangers which may attend its use."

Andrée and his Balloon. By Henri Lachambre and Alexis Machuron. (Constable.) Illustrated. 6s. There is little of importance in this book that was not generally known before its publication. In the introduction a very brief history of the life of Andrée is followed by a detailed account of the construction of the famous balloon. The rest of the book deals at great length, and in a highly emotional style, with the two expeditions to Spitzbergen, and the work done there in connection with the inflation of the balloon, to which is added an account of its final departure with the three explorers on July 11th, 1897. As everyone knows, the first of these expeditions was a failure. Owing to the prevalence of northerly winds the balloon was unable to start, and the whole expedition had to return. M. Lachambre accompanied this expedition to superintend the inflation and general preparation of the balloon. M. Machuron accompanied the second and successful expedition in the same capacity as his collaborator. The whole story would have formed a fitting subject for a couple of magazine articles, but there is nothing in it to warrant its publication in book form.

The Naturalist's Directory, 1898. (Upcott Gill.) 1s. The idea of this book is good, and if it were conscientiously and exhaustively carried out the work would have considerable value. As it is, the inconsistent omission of the names of a number of well-known naturalists makes the book utterly worthless. This is now the fourth year of its publication, and we almost cease to hope that it will ever have any value. Perhaps the editor, whose name is not disclosed, will some day be aroused by his critics and wake up to his responsibilities.

The Journals of Walter White. With a Preface by his Brother, William White. (Chapman & Hall.) 6s. Walter White was for thirty years the assistant secretary of the Royal Society, having been appointed to that office after serving ten years as sub-librarian. In his later capacity he came into intimate contact with many of the men whose names are now famous throughout the world. The diary, which he seems to have very carefully kept, contains all sorts of interesting facts—many of them trivial, it is true—about notables, as well as quaint expressions of his views of things in general. Some of his reflections on the characters of various men of science might, we think, have been rather more carefully edited. Men of science, like other mortals, are not without their faults and eccentricities, but no good purpose is served by exhibiting them to the public. We did not anticipate finding that Prof. Dewar, when he was younger than he is now, remarked to the diarist that "he was shocked when in London by the self-seeking of scientific men; no man caring to work for love of the work." Much water has, however, passed under the bridges since then. If any of our readers find themselves with an hour which they can spare, they will be able to pleasantly occupy it with these journals of Walter White.

The Encyclopædia of Sport. Edited by the Earl of Suffolk and Berkshire, Hedley Peek, and F. G. Aflalo. Vol. I. (Laurence & Bullen.) Illustrated. This work, which is to be completed in two volumes (the first of which is now under review), is being issued in parts. There is no doubt that such a work is needed, since it will take the place of "Blaine's Encyclopædia of Rural Sports," which is now quite out of date. The scope of the present volume is very wide and embraces every sort of sport, from amateur athletics to leopard spearing, besides describing a great many beasts, birds, and fishes, and dealing with such a subject even as "first aid." The articles are for the most part written by authorities on the several subjects treated of, and the matter is therefore generally accurate and up to date. A bibliography is provided at the end of each important subject, and this forms a very valuable adjunct. Mr. Millais' statement, on page 118, that blackgame are practically extinct in the New Forest is not warranted by the fact. There are still a fair number of blackgame in the New Forest, as, indeed, the Marquis of Granby correctly states on page 487, in the article on grouse. In dealing with the use of brass cases for wildfowl guns (page 499), some mention should have been made of the pegamoid waterproof cases. The book is provided with a large number of illustrations, many of them very fine. Amongst these are a number of drawings by Mr. Thorburn, whose only weak point seems to be a lack of accurate proportion. We would draw attention to the picture of the capercailzie, facing page 178. The male and female birds are there made about the same size, notwithstanding the very marked difference in size of the two sexes. If the second volume proves equal in accuracy and completeness to the first, this encyclopædia will form an indispensable book of reference to sportsmen of every order.

Applied Mechanics. By John Perry, M.E., D SC., F.R.S. (Cassell & Co.) 9s. It is not too much to say that the publication of this book was awaited with the greatest interest by all teachers of applied mechanics in those technical schools and science classes where the subject is taught under the regulations of the Science and Art Department. Prof. Perry was quite recently appointed the examiner in applied mechanics for the central authority at South Kensington; consequently, there are upwards of eight thousand students, in nearly three hundred classes, interested in learning how he thinks this subject should be taught and learnt. At the outset we venture to say that, under the conditions which obtain in the ordinary evening classes, applied mechanics cannot be taught in the way Prof. Perry lays down as the only proper method. The first chapter opens with the statement: "The student of applied mechanics is supposed to have some acquaintance already with the principles of mechanics; to be able to multiply and divide numbers, and to use logarithms; to have done a little practical geometry; to know a little algebra, and the definitions of sine, cosine, and tangent of an angle; and to have used squared paper. He is supposed to be working many numerical and graphical exercises; to be spending four hours a week at least in a mechanical laboratory; to be learning about materials and tools in an iron and wood workshop; and to be getting acquainted with gearing and engineering appliances in a drawing office and elsewhere." This reads well enough, but we wonder how many of the students who present themselves for instruction at the first meeting of an elementary class in applied mechanics in connection with the Department of Science and Art are able to do half the things enumerated in the paragraph we have quoted? The book will have been a disappointment to the teacher who has to be examined by its author, for it is evidently addressed to a different class of student altogether. Of the volume as a treatise on applied mechanics it is unnecessary to say anything. Prof. Perry's name is evidence enough that the book is accurate, modern, clear, and practical. It is written in a style which immediately arrests the reader, but soon makes him angry with the frequency of the outbursts against "academic" methods, and the free use of the first person singular. Certainly every teacher of the subject should read the book from cover to cover, and then, if possible, re-read it.

Some Unrecognized Laws of Nature. By Ignatius Singer and Lewis H. Berins. Illustrated. (John Murray.) 18s. There are a few pages in this book worth reading; the remainder produces vexation of spirit. To criticize the book in detail would take up far more space than we can spare, and though it is the duty of a scientific periodical to prick the bubbles of paradoxers, life is too short to explain fully why their destruction is desirable. The best way to deal with a work of this kind is perhaps to leave it alone, when it will die of inanition. We will, however, state briefly some of the reasons why this book is unworthy of the attention of students engaged in the realities of science, selecting our instances from many marked in the course of reading the book. "The current assumption is of two kinds of electricities; but though the two-fluid theory has its rival in what is called the single-fluid theory, it is still the dominant conception." This statement is not correct; the two-fluid theory of electricity is as dead as Queen Anne, so far as scientific men are concerned, yet the authors spend page upon page in killing it. They do not seem to be at all familiar with modern conceptions of electrical phenomena. Bodies weigh less at the Equator than in Polar regions, the reason being that they are further from the centre of mass, and that there is a greater tendency for them to be thrown off, on account of the earth's rotational velocity. The authors endeavour to show that the argument derived from considerations of the earth's mass is not admissible, but they entirely neglect to consider the levity given to bodies at the Equator in consequence of the earth's rotation. They make erroneous statements as to the periods of vibrations of pendulums, and their theory of the cause of the earth's axial motion is ludicrous. They hold that "no contradiction is involved in assuming the axis of the earth to be at right angles to its circumsolar path; and that the obliquity of the ecliptic can be explained by the 'up and down' motions of the earth on its axis." Sunspots are believed to be "planets but a comparatively short distance from the sun, and revolving round it," which absurd theory is enough to put any observer of solar phenomena completely out of patience. We need not give any further instances of the kind of mistaken ideas with which the volume bristles. No volume that has come before us during the last two or three years more fully justifies the expression that "what is new in it is not true, and what is true is not new."

Elements of the Comparative Anatomy of Vertebrates. Adapted from the German of Dr. Robert Wiedersheim by Dr. W. N. Parker. (Macmillan.) This second edition of Prof. Parker's work is based upon the third edition of Dr. Wiedersheim's standard treatise. Faithful translation of a German scientific work is always difficult and generally undesirable. A much better method is to use the original freely, and to aim at presenting ideas accurately, rather than slavishly following the text. This is the principle which Prof. Parker, with Dr. Wiedersheim's permission, has adopted. As a result we have a book in readable English, and admirably adapted for English students of comparative anatomy. Considerable condensation of the third German edition has taken place in some sections, but new material has been added to others. Prof. Parker's object has been to prepare a short text-book, which, while retaining the original descriptions and arrangement as far as possible, should deal with the more essential and well-ascertained facts of comparative anatomy. He has carried out his plan most successfully, and the only criticism we have to offer is that the treatment is a little unequal, the skeleton being dealt with much more fully than some of the other organ-systems. Probably Prof. Parker has his reasons for this, though it will not find favour with all students of morphology. The organ-systems described in order in the book are as follows: (1) the outer covering of the body, or integument; (2) the skeleton; (3) the muscles, together with electric organs; (4) the nervous system and sense organs; (5) the organs of nutrition, respiration, circulation, excretion, and reproduction. By dealing with the facts in this way the student is led to see clearly that there has been an evolution of organs as well as of animals, and this is the right aim of the study of comparative anatomy. The remarkably fine illustrations—there are three hundred and thirty-three in all—assist the text in showing the various phases of development of the organs of vertebrates. A valuable bibliography concludes this excellent work, which will be of great service to medical students as well as to students of comparative anatomy.

SHORT NOTICES.

A First Year's Course of Experimental Work in Chemistry. By Ernest H. Cook, D.SC. (Arnold.) Illustrated. 1s. 6d. Dr. Cook's book contains the usual instructions for conducting an elementary class in practical chemistry. The experiments are well chosen for emphasizing fundamental principles, but the illustrations are rather sparsely distributed. "Very brief accounts are given in the text," in order to judge the better of the student's honesty and care in observation. Indeed, brevity is here carried to such an extreme, one may safely predict that the student will do little work by following the text unless the teacher is always at his elbow.

Organic Chemical Manipulation. By J. T. Hewitt, D.SC. (Whittaker.) Illustrated. 7s. 6d. Books on practical organic chemistry are comparatively rare, and there is room for a good, handy, and cheap treatise on the subject. Dr. Hewitt has, in a measure, met this deficiency, but he has spoiled his chance by a prohibitive price—a price out of all proportion with the dimensions of the book and the cost of first production. Accurately and concisely written, the work is of more than ordinary value to students of organic chemistry. A large section is devoted to quantitative analysis, which the author correctly states in the preface has not heretofore been treated as fully as it ought to be. A goodly number of preparations is given, including the fatty and aromatic series, together with a number of rare compounds, and the synthesis of organic substances—a new feature in books of this class. Besides the mere preparation of the compounds suitable explanations are advanced of the theory of the reactions which take place; and, where necessary, diagrams are shown of the apparatus employed, as well as full directions as to quantities of materials to be used in each experiment.

Observational Astronomy. By Arthur Mee, F.R.A.S. Second Edition. (*Western Mail*, Limited.) Illustrated. 2s. 9d. A new edition of this admirable work was, of course, to be expected. It has been greatly enlarged, and most of the illustrations are new. Numerous representations of the planets, etc., are shown, as well as thumbnail sketches of eminent astronomers; features which impart to the book an interest which is peculiar to itself. In the plate forming the frontispiece is given a drawing of Saturn, by Antoniadi, as it appeared on July 16th, 1897. A photograph of the great nebula in Orion, by Dr. Roberts, also enhances the value of the work. We have not seen a popular book on astronomy for many a day which possesses so many and diverse attractions as this one; and we hope that its circulation may increase in a ratio commensurate with its improved condition.

The First Book of Scientific Knowledge. By Paul Bert. (Relfe Bros.) Illustrated. 2s. 6d. We are pleased to observe that a new and improved edition of this admirable introduction to the sciences has just been issued. It is sufficient to say of so successful a work, both in France and in our own country, that the publishers have done all that seemed needful to make the volume a solid foundation for more advanced study.

BOOKS RECEIVED.

Poultry for the Table and Market versus *Fancy Fowls.* By W. B. Tegetmeier, F.Z.S. (Cox.) Illustrated. 2s. 6d.

A New Astronomy. By David P. Todd, PH.D. (American Book Company.) Illustrated. $1·30.

The Story of Life in the Seas. By Sidney J. Hickson, F.R.S. (Newnes.) Illustrated. 1s.

The British Colonies : 1883-1897. By Rev. Wm. Parr Creswell, M.A. (Blackie.) 2s. 6d.

Audubon and his Journals. Two Vols. By Maria R. Audubon. (John C. Nimmo.) Portraits and Illustrations.

Ethnological Studies among the North-West-Central Queensland Aborigines. By Walter E. Roth. (Queensland Agent-General's Office.) Illustrated.

The Year-Book of British Columbia (1897). (Victoria, B.C.)

The Natural History of the British Isles : Vertebrates. By F. G. Aflalo, F R G.S., F.Z.S. (Blackwood.) Illustrated. 6s. net.

The Miner's Arithmetic and Mensuration. By Henry Davies. (Chapman & Hall.) 4s. net.

Who's Who (1898). (A. & C. Black.) 3s. 6d. net.

General Elementary Science. By William Briggs, M.A. (Clive.) 3s.6d.

The Smithsonian Institution : 1846-1896. (Washington.)

Sixteenth Annual Report of the Bureau of American Ethnology. (Washington.)

Das Weltgebäude. Von Dr. M. Wilhelm Meyer. (Leipzig.)

A Treatise on Magnetism and Electricity. By Andrew Gray, LL.D., F.R.S. Vol. I. (Macmillan.) 14s.

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STARS HAVING LARGE PROPER MOTION.

A recent announcement has been made by Prof. Kapteyn that the star Cordoba Z. C. 5h 243 has an annual proper motion of 7·5″, which is larger than that so far found for any other star (*Astronomische Nachrichten*, Vol. CXLV., p. 159).

The effect of this motion is shown in the accompanying illustration, which is enlarged nine times from two photographs taken with the eight-inch Bache telescope, at the Arequipa Station of the Harvard College Observatory.

Proper Motion of Cordoba Z. C. 5h 243.

The scale of the original photographs is 180″=0·1 cm. The plates were superposed so that the images of the stars on one should be a short distance below those on the other. The motion of Z. C. 5h 243, which is indicated by an arrow, is at once apparent from the displacement of the line connecting the two photographic images of this object. The southern of each pair of images, and the right-hand image of 5h 243, are reproduced from a photograph taken October 8th, 1889, with an exposure of fourteen minutes. The northern images are reproduced from a photograph taken November 10th, 1896, with an exposure of twelve minutes.

E. C. Pickering.

THE LEVEL OF SUNSPOTS.

By the Rev. Arthur East.

That sunspots are holes in the sun most people admit; that they are black is manifest to everyone who has observed them, even with a field-glass; but whether they are raised above or sunk below the general level—if there even be a general level—and why anything in the sun should be black, are questions not so easily answered. That the blackness of the "umbra" is probably brighter than the electric light is immaterial. Compared to the far brighter photosphere the inner portions of a spot are black or nearly black. To the superficial observer the answer might appear obvious, viz., this: "The deeper a hole is, the blacker are the shadows." But it must be borne in mind that we are not dealing with shadows; there can be no such thing on a self-luminous body as a shadow, and the reason why one part of the sun is darker than another, and even relatively black, is due to an entirely different cause, namely, absorption of the light. The edge of the sun is darker than the central parts because the light from the edge reaches us after passing through a vast thickness of solar atmosphere, and this is very manifest in photographs of the sun; for the same reason the middle part of a spot appears black because the light from below has to traverse the depth of the spot, which is known to be filled with comparatively cool and light-absorbing vapour. If the writer has been fortunate enough to induce anyone to experiment in the way of making artificial sunspots,* it will have been observed that the spots may be broadly classified under four types:—

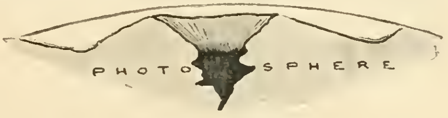

Fig. 1.—Symmetrical Spot, elevated Penumbra. Black Umbra surrounded by Penumbra; margins of "Spot" depressed below general level.

Fig. 2.—Symmetrical Spot. Penumbra with dark margin next to Photosphere.

1. Spots more or less elevated above the general level, with deep central part and gaping orifice, as Fig. 1.
2. Spots with a cup-shaped orifice, where the ascending fluid scours out the sides of the cone of granules, as Fig. 2.
3. Spots where the hot fluid rushes up obliquely, making the sides much steeper in one part than another, as Fig. 3.
4. And, lastly, spots which are not cone- or crater-like in form at all, as the others are, but where the sides recede from the orifice, leaving only a black and gaping hole as Fig. 4.

It is not meant that each spot is restricted to any one type; it may belong to two or three, or even all four, in different parts of the same spot: *e.g.*, the sides of the penumbra may be nearly flat in one place and concave in another, and almost vertical in a third; whilst the older a

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* *See* article on "Artificial Sunspots" in Knowledge, December, 1897.

spot is the larger grows the vent, and the more the crater form tends to disappear. And these forms may be modified at any stage of development—with this exception, that the form in Fig. 4 always comes last.

Now, if these pulp spots were self-luminous, and seen from above and not in section as the diagrams are drawn, and if the usual terms used to describe sunspots may be used, it is evident that they would, when filled with light-absorbing vapours, appear as follows :—

Fig. 1 would show as a black umbra surrounded by a lighter border, this latter being due to the light of the photosphere having to travel through a comparatively shallow stratum of absorbing vapour ; the black vent or nucleus at the bottom of the crater-like spot might or might not appear, according to its position in the bottom and the clearness of the " seeing."

Fig. 2 would show as a black umbra surrounded by a lighter penumbra, with an overhanging "thatch" at its outer edge.

Fig. 3.—Unsymmetrical Spot: Penumbra wanting on one side.

Fig. 3 would appear as an unsymmetrical spot, *i.e.*, with the penumbra wider on one side of the umbra than the other.

Fig. 4 would appear as a spot consisting of an umbra alone, not surrounded by any penumbra.

It is easy to see how the Figs. 1, 2, and 3 come to be as they are: in the lowest part or vent, the hot vapours are confined by the weight of the photospheric matter; as they approach the surface the weight is less, and they are able to thrust the granules aside into the crater-like form. When the surface is reached they expand more suddenly, sometimes making a salver-shaped orifice as Fig. 1, and sometimes scouring out the sides into the cup-shaped form of Fig. 2. This latter is often beautifully shown in the artificial spots, the stray granules playing within the hollow in a most realistic manner.

An objection to these diagrams as truly representing actual sunspots will no doubt be made that the umbra is often seen when the spot is close to the limb, and that therefore a spot must be nearly always relatively *shallow*, otherwise the umbra would be hidden ; and herein, as in the general discussion of the appearance of spots seen obliquely, I venture to suggest that there occurs occasionally a very great fallacy. The text-books say : " Imagine a saucer with a blackened middle slowly turned edgeways to the observer, and see the black part gradually disappear." This is quite true of an *empty* saucer, but a *full* saucer will behave differently, and the black middle in the *full* saucer will apparently keep on rising long after it should have been hidden. It is, of course, as everyone knows, refracted upwards, owing to the difference in density between the water in the saucer and the air through which the observer views it; and a spot is not an *empty* saucer but a *full* saucer, filled with dense vapour, and doubtless the bottom of the spot is refracted upwards more and more as the spot approaches the limb, and making it visible long after it apparently should have disappeared. Not only will the umbra be affected in this way, but the whole of the farther side of the spot, causing the curious optical effect of the edge of the spot appearing to rise up, and tend to face the observer, when, in reality, it of course lies flat on the solar surface.

Fig. 4.—Spot without Penumbra, and level with Photosphere.

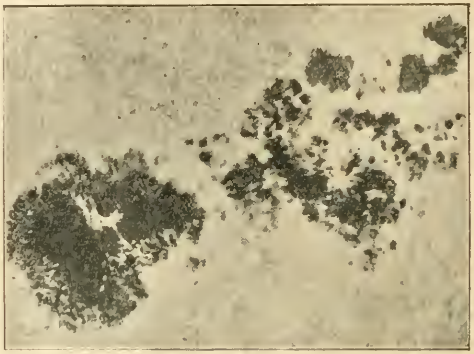

Fig. 5.—Sunspots. (From Sir R. Ball's "Story of the Sun," by kind permission of Messrs. Cassell & Co.)

To show that these analogies between the form of artificial " spots " and the real solar spots are true ones—at least, if not wholly, yet in part—I would refer to the very beautiful photograph of a sunspot taken by M. Janssen, and reproduced by kind permission of the publishers of Sir Robert Ball's " Story of the Sun " (Fig. 5); and I would ask the reader to compare one feature in this photograph with Fig. 3 of the plate in Knowledge of December, 1897.

Fig. 6.—Empty Vessel, with black bottom just in view.

There appears in this photograph of M. Janssen's the black umbra with a few wandering granules within ; the lighter penumbra with sides vertical apparently in one part, steeply inclined inwards elsewhere ; the brilliant bridge extending across the chasm, and the granulated surface of the photosphere beyond: but the brightest part of the whole plate, except the bridge, is *the portion next to the penumbra*. Looking at it, it is almost impossible to doubt that we are looking down upon a vast *mound* or *tumulus* with a yawning opening and steeply shelving sides within, and that the reason for this excessive brightness is that the edge of the spot is really protruded to a vast height above the general level, and that the brilliance of that part is to this extent unimpaired by absorption. Now the Fig. 3, already referred to, gives exactly this appearance of an elevated mound with a gaping hollow, which, as a matter of fact, it was.

Fig. 7.—The same viewed from identically the same point, but filled with water.

The appearance of a spot having a penumbra with its *outer* margin the darkest part must be familiar to all observers of sunspots; the photosphere at some points seems to overhang the spot—as it probably does.

But there is one effect caused by this darker part of the penumbra coming next the bright photosphere, and the brightest part of the penumbra coming next the black umbra, namely, that the centre of the spot appears to be protruded outwards, in a convex manner—an appearance due, in my opinion, to the deceptive shading, as it were, in spots of this character, the penumbra being in reality wholly concave within.

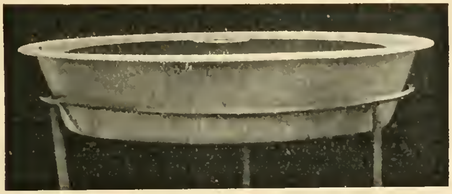

Fig. 8.—The same viewed very obliquely, the bottom apparently risen to the top.

There is just one other point shown in the diagrams, Figs. 1, 2, and 3, which may interest some observers of sunspots. The weight of the protruded penumbra, resting as it does on the photosphere (artificial), depresses the surface not a little, so that the *mound* is resting in a depression of its own making; and if this condition of the penumbra really exists on the sun, it ought to be observable on the limb, as a writer in the *British Astronomical Journal* for August, Mr. F. K. McDowall, states that he does see it.

The Figs. 6, 7, and 8 may serve to make clear the above contention as to the probable refraction of the umbra. It will be seen that, when viewed even very obliquely, the black bottom (umbra) is very visible, and suffers but little, comparatively, from being viewed in profile.

It is *not* contended that spots are very deep relatively to the sun's diameter, which is improbable, but only that they are very much deeper than they appear to be; and also that to attempt to arrive at the depth of the photosphere by micrometric measurement of the farther side of the penumbra is not only impossible, but that the results arrived at would be entirely misleading.

As the *mean* density of the sun is only about 1·4 compared with the density of water, it is evident that the vapours on the solar surface cannot be of anything like the density of the water in the basin; their density, nevertheless, must be very great, the attraction of the sun being more than twenty-seven times that of the earth.

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THE EVOLUTION OF THE VENOM-FANG.

By Lionel Jervis.

It would be difficult to name a creature more feared and loathed than the deadly serpent; yet, deprived of its fangs, how helpless it becomes! It is true that the great size and enormous muscular power of the giant constrictors render them formidable antagonists to all but the very largest animals, but these monsters are comparatively rare, and are confined to a limited number of species. The anaconda (*Eunectes murinus*) from South America, two species of python (*P. molurus and P. reticulatus*) from the East Indies, and one (*P. sebæ*) from Africa, about exhaust the list of unvenomed snakes dangerous to man, though the common boa constrictor sometimes attains considerable proportions. Generally speaking, however, the non-venomous serpent, or the venomous serpent that has been rendered innocuous by the removal of its fangs, is quite defenceless against its enemies—and they are numerous.

The mongoose, the hog, and many other animals—not to mention man—kill them on sight. It is, indeed, wonderful that the harmless species succeed in holding their own in the struggle for existence, considering that even the most venomous serpents frequently fall victims. The hog, for instance, is said to have extirpated in certain districts the rattlesnake, which is far from harmless, although a very overrated creature, its sluggishness rendering it a comparatively easy prey. The inhabitants of the Lesser Antilles—at least, so the tale was told to me—seem to have been unacquainted with this fact, or to have overlooked it, and, arguing no doubt that if a hog would kill a rattlesnake it would kill a *fer-de-lance (Lachesis lanceolatus)*, they imported swine to keep down the pest; but that was a very different story. Then they tried the mongoose; but the mongoose does not appear to have found the business good enough, and turned its attention to the fowl-houses—a move which the inhabitants neither anticipated nor approved. It would seem from these incidents that to interview the *fer-de-lance* is a risky commission, though I believe that the secretary bird was domesticated in Martinique with a fair amount of success. Thus we see that, although no doubt the object of the fang is primarily to render the capture of the prey easy, it is also very valuable as a means of defence.

The first trace of this terrible weapon is found in the ophistoglyphs, and to explain its gradual development in this family and in the vipers, as well as in the elapine and sea-snakes, it will be necessary to say something about the normal dentition of serpents. Generally speaking a snake has six rows of teeth, one on each side of the upper jaw, one on each side of the lower jaw, and one on each side of the palate: certain species have teeth on the pre-maxillary bone, but (for the purposes of this article) this feature is unimportant. Now, some snakes appear to have decided that the capture of lizards, birds, and "such small deer" as formed their prey would be greatly facilitated if the struggles of their victims could be rendered less violent. They seem to have been disinclined to exercise or develop their muscular power to crush or smother them like the constrictors; the only alternative was to paralyze them. Nature accordingly set to work to modify a portion of the salivary gland, and to impregnate the saliva with venom, or to develop the poisonous properties already existent therein. Here, then, the serpent had a store of the composition necessary for its purpose ready to hand. At the same time a groove began to be formed in two or three of the teeth at the back of the upper jawbone (that is to say, those below the salivary gland), and gradually became deeper, thereby forming a channel by which the poison might be transmitted into the system of the victim. The snake thus became furnished with its poison and the means of injecting it. As a last measure—to make quite sure that the animal, when seized, should not escape—the poison-fangs became somewhat longer than the original solid teeth, and the whole machinery of death was complete (*see* Figs. 1 and 2). The prey is entangled in the front teeth and forced back under the fangs. These are then driven home and the venom is injected; the struggles of the victim almost at once become feeble and soon cease, when it is devoured at leisure.

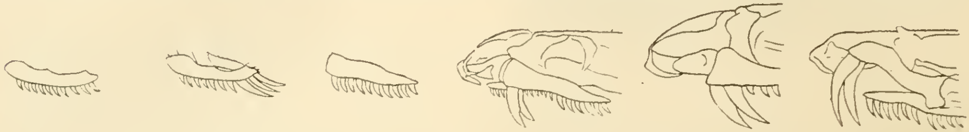

Fig. 1.—Maxillary bone of innocuous colubrine, showing solid teeth. Fig. 2.—Maxillary of ophistoglyph, showing development of back fangs. Fig. 3.—Maxillary of innocuous colubrine, showing solid teeth. Fig. 4.—Maxillary of elapine snake, showing solid teeth remaining behind poison-fangs. Fig. 5.—Maxillary of cobra *(Naja)*, showing almost total absence of solid teeth. Fig. 6.—Maxillary of mamba *(Dendraspis)*, solid teeth altogether discarded.

This apparatus, though effectual, is rather clumsy, and we find a great improvement in the proteroglyphs. It is obviously better to have the fangs in the front of the mouth than at the back, as the serpent can then seize its prey and inject the poison at one and the same time, instead of having to work it under the back fangs before it could commence to paralyze it. Before I go any further I should like to have it quite clearly understood that the development of the fangs of the vipers, which are descended from the ophistoglyphs (as I shall endeavour to show later on), is in no way connected with the development of the fangs of the other proteroglyphs, viz.: the elapines and the sea-snakes. In fact, two distinct families of serpents appear to have become venomous at about the same time, quite independently of each other.

Accordingly, in the elapines and sea-snakes* two of the front teeth on either side of the upper jaw became grooved and enlarged, and a channel was gradually formed from the gland behind the eye to the base of the fangs. The distance, however, between the gland and the poison-fang is never great, and the modification of their relative positions is more apparent than real. As a matter of fact the fangs are always either nearly under the eye or close in front of it.

For many years it was believed that the duct from the gland to the poison-fang was continued into the fang itself, but research has shown that this view is entirely incorrect. The functional fang is frequently either broken off or shed, in which case the end of the duct would either be carried away or left to dangle unprotected in the front of the mouth until it could find shelter in the reserve fang which is advanced to take the place of the broken or discarded one; in either of these contingencies it would in all probability be irretrievably damaged. In reality the duct terminates in the centre of the gum, just between the fangs. It frequently happens that a portion of the venom goes astray between the opening of the duct and the base of the fangs, although they are very close together, and the fleshy sheath that covers the fangs when at rest, but is raised and crinkled up across the gum when the serpent strikes, is said to be instrumental in preventing the poison being ejected right in front, and in directing it down the channel and into the wound. To prevent the venom escaping when the snake is using its jaws without the intent of poisoning, a strong binding muscle is placed close up to the front of the duct. The groove is much deepened and the edges have come closer together, forming a more perfect channel for the passage of the poison; in fact, in the genus *Elaps* (the coral snakes) the fang has come to have the appearance of being perforated. The poison-gland itself is much enlarged—in one case (*Doliophis*) eccentrically so, for it is extended about a third of the way down the body, thereby further upsetting the already disordered internal arrangements of the serpent—and round it is twisted the anterior temporal muscle, so that it can be violently compressed and the poison squirted deep into the wound. It can be readily seen that this machinery, even in its undeveloped stages, is a great improvement on the back-fanged arrangement.

Fig. 7.—Fang (much enlarged) of elapine snake, showing groove.

In the earlier forms numerous solid teeth continued to exist behind the poison-fangs, as can be well seen in the sea-snakes, and in the less specialized elapines (Figs. 3 and 4)—examples, *Glyphodon* and *Pseudelaps* from New Guinea and the neighbouring countries. The serpents, however, with their new and formidable dental armature, began to discover that the envenomed wound caused by their bite paralyzed their prey so quickly that it became less and less necessary for them to retain their hold in proportion as the poison apparatus became more and more developed, and consequently the solid teeth on the maxillary bone became useless and gradually disappeared; so that in the cobra (*Naja*), in which the fangs are highly specialized, we only find two or three left (Fig. 5), while in the Ring Hals snake (*Sepedon*), the coral snake (*Elaps*), and in the mamba (*Dendraspis*) (Fig. 6), they are altogether wanting.

In some cases the fangs have grown so large that it has become imperative to provide for a certain amount of motion in the maxillary bone, so as to allow them to point slightly backwards when the mouth is shut, and to avoid

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* One species of sea-snake *(Distira semperi)* is confined to a freshwater lake in Luzon.

wounding the lower jaw. Of course, when the snake is about to strike, the fang has to be raised again; and with this object certain modifications have been made in the bones of the palate, and certain muscles have been requisitioned to govern the necessary motions, to explain which in detail would require another article as long as this one. By means of this complicated machinery the fang of the cobra (Fig. 5) can be erected and depressed to a limited degree, though not to anything like the same extent as in the case of the vipers. In the mamba, however, the difficulty has been overcome in another way: the maxillary bone is lifted in front and curved backwards (it is shaped something like a sickle with about six inches of the point broken off, held edge downwards), so that the base of the fang is considerably above the roof of the mouth (Fig. 6).

Now, these long, sharp, delicate weapons are extremely likely to be broken off, and it is very necessary that there should be a reserve of fangs to take their place in case of accidents. Consequently, behind the functional fangs are others in every stage of development: the minute germ, the more markedly grooved tooth, and so on to the perfectly developed functional fang, with the edges of the groove nearly joining in front (Fig. 7). This being so, the necessity for taking any particular care of the front fangs of course ceases to exist; indeed, it appears that they are not unfrequently shed voluntarily.

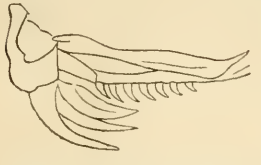

Fig. 8.—Portion of skull of viper (rattlesnake), showing the vertical position of the maxillary.

While the sea-snakes and elapines were thus being armed, the back-fanged snakes (ophistoglyphs) were slowly becoming front-fanged snakes (proteroglyphs) also. As regards the poison-gland (with the exception of the exaggerated development of the *Doliophis*), the duct, and the fang-sheath, the same principles are in evidence; but the maxillary bone has been modified and turned up in front, the solid teeth in front of the grooved fangs have been discarded (Fig. 8), and the fangs themselves have come into position in the front of the mouth—or, rather, to be more accurate, the front of the mouth has come back to the fangs. At the same time the edges of the groove have gradually closed up, until at length they are fused, and have the appearance of being tubular (Fig. 9)—an appearance which has deceived many into the belief that the fang is actually hollow or perforated. If the fang be bisected, however, the error at once becomes evident, for the section will show the semicircle of pulp completely surrounded by dentine (Fig. 10). Thus came the vipers. It is true that for many years it was considered that the fang machinery of the viper was merely a specialization of the elapine, and it is to Mr. Boulenger's researches that we owe the true solution of the question. In the less specialized forms of viper, such as the Cape viper (*Causus rhombeatus*), "the fangs," to quote his words, "are situated on the posterior extremity of the maxillary, close to its articulation with the ecto-pterygoid—a condition which is identical with that of the ophistoglyphous colubrids." In the more highly specialized vipers, such as the crotalines and the atractaspis, the maxillary bone has fallen away altogether in front of the fangs. It is hardly necessary to say that in this family the solid teeth which were originally in front of the back fangs have altogether disappeared.

Having, as I have said, the fangs already grooved and elongated before their position was altered from the back to the front of the mouth, it became doubly necessary for the vipers to have the maxillary bone movable. There was not much difficulty in this, as that bone had already so changed as to lie almost vertically to the jaw instead of parallel with it (Fig. 8), there being only just sufficient space left on its tooth-bearing face to admit of a single pair of fangs. It was a comparatively easy process, then, that this face should become normally directed towards the throat, with the fangs shut back, as it were, like the blade of a clasp knife, on the roof of the mouth; and that by a modification of the structure of some of the bones in the front of the skull, and by an exaggeration of the action of the motor machinery already referred to, it should be possible for the snake to erect its fangs vertically to the upper jaw when it was striking. It is almost superfluous to say that the fangs, having in their new recumbent position much more room to grow in than when they were at the back of the mouth, have availed themselves of the space at their disposal to the fullest extent, some of them reaching almost to the back of the palate. It is natural, then, that the mobile erectile fangs of the viper should be longer than the practically immovable fangs of the elapine. I trust that no one will be misled by this sentence into the erroneous idea that the fang itself is movable: the fang is always and quite immovable; it is the maxillary bone, to which the fang is attached, that moves.

Fig. 9.—Fang (much enlarged) of viper; *a*, orifice by which venom enters fang; *b*, orifice through which venom is injected into wound (much enlarged).

The viper of vipers, the most highly specialized of the group, is the atractaspis from Tropical Africa. The solid teeth on the lower jaw and palate have almost altogether disappeared—there are only about eight or ten all told—and the poison-fangs are so enormously developed that Mr. Wood, in his popular but not over reliable natural history, suggests that the atractaspis cannot open its mouth sufficiently wide to erect its fangs, and that the poison is injected while the prey is being swallowed. If this view were correct, it would be a case in which ultra-development had defeated its own end, for the serpent would find itself in the same position as regards injecting its poison as when it was in its back-fanged position—or, rather, in a worse one, for it would have no solid teeth to secure its prey with. But of course Mr. Wood's supposition is incorrect. The gape of the viper is enormous: it can easily open its jaws to an angle of one hundred and eighty degrees; so that it is quite clear that, however long the fangs may be, there is plenty of space in which to erect them—unless, indeed, they were to grow right down the throat.

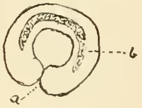

Fig. 10.—Section of fang of viper; *a*, dentine; *b*, pulp (much enlarged).

Specimens of these different families are usually to be found in the reptile house at the Zoological Gardens, except the sea-snakes, which die almost at once in captivity, however large the tank. The ophistoglyphs are usually represented by the Cape bucephalus *(Dispholidus typus)* and some species of sand-snake *(Psammophis)*; the elapines by the cobras, and what they are pleased to call death-adders (as a rule the *Pseudechis porphyriacus)*: and the vipers by one or two pit-vipers. They have a cotton-mouth *(Ancistrodon piscivorus)* there now and a *fer-de-*

lance. The other species of viper do not as a rule thrive in captivity, though the cerastes seem to be doing well enough, and there is usually a puff-adder *(Bitis arietans)* on view; but, as I believe they lost thirteen of these last year, this is probably due to a large number being generally available. At the present moment they have a mamba there, and a true death-adder *(Acanthopis antarcticus)*, both elapine snakes, which I understand to be the only serpents of these species ever exhibited in this country.

It may be interesting to those who are inclined to be sceptical to know that the theory as to the derivation of the vipers from the ophistoglyphs has been recently confirmed by researches on the venom-glands of snakes. To attempt to give even an outline of these conclusions would, however, exceed the scope and limits of this article, and it will be sufficient to refer intending students to the paper of M. Phisalix on this subject.

◆

NOTES ON COMETS AND METEORS.

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

Cometary Discoveries.—The total number of comets observed sufficiently well during the last thirty years (1868–1897) for their orbits to be calculated amounts to one hundred and thirty-five, but of these thirty-seven were returns of periodical comets which had been previously seen. The average rate of apparition of new comets has, therefore, been 3·27 annually, and of new and periodical comets 4·5 annually. In 1873, 1881, 1892, and 1896, seven comets were discovered; in 1872 not one was observed; and in 1875 the only two comets which appeared were known ones. The best months for the discovery of these objects appear to be July and August. Of three hundred and twenty-eight comets discovered between the years 1782 and 1897 inclusive, the following are the numbers found in the various months:—

January	...	22	July ...	...	37
February	...	21	August	...	43
March	...	24	September	...	25
April ...	...	27	October	...	26
May ...	...	20	November	...	34
June ...	...	22	December	...	27

These figures include every description of these bodies. During the sixty years from 1782 to 1841 there were eighty-seven comets, averaging 1·45 per year; but during the fifty-six years from 1842 to 1897 there were two hundred and forty-one comets, averaging 4·30 per year.

Pons-Winnecke's Comet.—This comet is now too faint for observation, and is, moreover, unfavourably placed in the morning twilight. Its position during the next few months is indicated by Hillebrand in *Ast. Nach.*, 3480, as follows for Berlin noon:—

		R.A.			Declination.	
1898.		h.	m.	s.	°	′
April 8	...	22	51	55	−11	5·1
,, 24	...	0	5	21	−7	32·5
May 14	...	1	11	59	−3	21·2
June 3	...	2	6	32	+0	1·4
,, 23	...	2	49	35	+2	10·9

Perrine's Comet, 1896, VII.—In *Ast. Nach.*, 3478, Hans Osten, of Bremen, gives definitive elements for this comet. It was observed from 1896, 8th December, to 1897, 1st March, and was visible, therefore, for twelve weeks. He finds the period 2352·5 days, or 6·441 years, with a probable error of 6·8 days. This result agrees exactly, as regards periodic time, with that given by Ristenpart in *Ast. Nach.*, 3402, based on observations in 1896, December, and 1897, January. At the time of the comet's next return in 1903, April-May, there is little prospect that it will be observed, as it will pass through its perihelion when the earth is on the other side of the sun. In 1909, October, however, the conditions will be extremely favourable.

Fireballs of 1898, February 20th.—On this night two large meteors were seen, their times of apparition being 8h. 54½m. and 10h. 20m. The former was observed by many persons, and some of the details were as follows:—

Chiddingfold, Surrey.—Brilliant meteor passed close under Procyon and pursued a straight course through the middle star of Orion's belt to about ten degrees beyond, when it was lost sight of behind the roof of a house. The colour was that of the arc electric light. Nucleus pear-shaped, leaving a trail. When about midway between Procyon and Orion it blazed up, emitting sparks; then became much fainter until past Orion, when it blazed again, and then again faded. The meteor seemed to be moving very slowly to the west, and remained in sight about three seconds, during which time it travelled through about fifty degrees of arc.—Rear-Admiral Maclear.

Ealing, Middlesex.—Meteor of exceptional size and brilliancy appeared in due south at altitude of about twenty to twenty-five degrees, and travelled to west, at first slightly ascending and then descending. Light greenish, and it left behind a long, broad, livid streak. At middle of flight it threw off numerous small pieces of slightly redder tint. Duration of flight, four seconds.—O. J. Preston.

Freemantle, Southampton.—Splendid meteor; emitted a brilliant blue light which lit up everything around. Quite stationary for several seconds before it sped away due south, leaving a trail of thousands of sparks behind it.

Harrogate, Yorks.—Very brilliant meteor low down in south sky. Apparent motion slow, and it was observable for about four seconds. It left a long trail.—J. G. C.

Edgbaston, Birmingham.—Brilliant meteor seen low down in the south (about the height of the middle of the small stars under Sirius).—W. Arthur Smith.

Wednesbury.—Magnificent meteor, of an intense orange colour, and leaving a long train of sparks; travelled a long distance from east to west, and finally disappeared apparently just under Sirius.—T. F. Bissell.

Clifton, Bristol.—Brilliant meteor appeared rather low in the south-eastern sky, and travelled slowly in a westerly direction along a nearly horizontal path. Visible for several seconds, and disappeared nearly in the south.—R. F. Sturge.

Wimbledon.—Walking along a road facing south the meteor came into view in front of me, a little to the right of my course, and about two-thirds up towards the zenith. It travelled quite slowly towards the west. Interior blue with an outer edge of red. It appeared to me a little less than half as large as the full moon.—E. J. R. Radcliffe.

Westminster.—Meteor brighter than Venus, bluish white, swift. Path, 111° + 5° to 97° − 17°.—W. E. Besley.

Newbury.—A large and brilliant luminous body travelled across the heavens in a nearly straight line from east to west. Visible for several seconds. It illuminated the entire district.

Chichester.—Shot athwart the zenith, crossing the clear open space directly overhead, and leaving a trail of sparks. It moved with slow apparent velocity, and passed north of Pleiades before it disappeared behind clouds.—A. Rusbridge.

Without attempting to reconcile these and other accounts it seems that the meteor appeared over the English Channel, and fell from a height of sixty-one to twenty-seven miles. When first seen it was above a point thirty-three miles south of Beachy Head, and moving almost due west; it disappeared thirteen miles south-east of St. Alban's Head. The earth point is indicated near Teignmouth, and the length of observed path was ninety-five miles. Taking the duration as four seconds, the velocity will be twenty-four miles per second. The radiant point was at about 176° + 12° near β Leonis, and it agrees with the position of a long-enduring meteor shower.

The fireball which appeared at 10h. 20m. on the same evening as the one described above, was not observed with sufficient fulness to enable its path to be determined.

Fireball of March 12th, 7h. 5m.—A very brilliant object of this class was observed at Slough and St. John's Wood, London. The nucleus was globular, and traversed its path with moderate velocity, leaving a long train behind it.

The April Lyrids.—This shower will be due on April 19th-20th, and, the moon being absent, the conditions will be highly favourable for witnessing any display that may occur. The periodical maxima of this stream probably recur at long intervals, for its parent comet has a computed time of revolution of four hundred and fifteen years. There was, however, a brilliant display of Lyrids on the morning of April 20th, 1803. This shower is usually by no means rich, but it requires further observation. Its radiant point is at 270° + 32°, and it probably travels eastwards during the very few nights of the shower's visible activity.

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THE FACE OF THE SKY FOR APRIL.

By Herbert Sadler, f.r.a.s.

Some spots still occasionally diversify the solar disc.

Conveniently observable minima of Algol occur at 0h. 15m. a.m. on the **13th**, and 9h. 4m. p.m. on the **16th**.

Mercury is an evening star, and is very favourably situated for observation during the first three weeks of the month, but afterwards he approaches the Sun too closely to be visible. He is at his greatest eastern elongation, 19⅓°, on the **11th**. On the **1st** he sets at 8h. 5m. p.m., with a northern declination at noon of 11° 38′, and an apparent diameter of 6″. On the **11th** he sets at 8h. 50m. p.m., with a northern declination of 17° 45′, and an apparent diameter of 8″. On the **23rd** he sets at 8h. 26m. p.m., or about one hour and a quarter after the Sun, with a northern declination of 18° 39′, and an apparent diameter of 10½″. While visible he describes a direct path in Aries, without approaching any conspicuous star.

Venus is too near the Sun to be conveniently observed this month.

Mars is technically a morning star, but his diameter is so small that it would be useless for the amateur to expect to see any indications of markings on his surface.

The minor planet Vesta is in opposition to the Sun on the **6th** of May, with a stellar magnitude of 6·0. However, she is conveniently situated for the amateur observer during the last half of April, so we give a short ephemeris of her. On the **15th** she rises at 8h. 18m. p.m., with a southern declination at transit of 6° 52′. On the **25th** she rises at 7h. 29m. p.m., with a southern declination at transit of 6° 18′. During the month she pursues a retrograde path in Libra.

Jupiter is an evening star, rising on the **1st** at 5h. 26m. p.m., with a southern declination of 0° 20′ at noon, and an apparent equatorial diameter of 44¼″. On the **9th** he rises at 4h. 39m. p.m., with a northern declination of 0° 2½′, and an apparent diameter of 44″. On the **16th** he rises at 4h. 27m. p.m., with a northern declination of 0° 21′, and an apparent diameter of 44″. On the **23rd** he rises at 3h. 55m. p.m., with a northern declination of 0° 37′, and an apparent diameter of 43½″. On the **30th** he rises at 3h. 24m. p.m., with a northern declination of 0° 51′, and an apparent equatorial diameter of 43″. During the month he describes a retrograde path in Virgo.

As Saturn does not rise till 9h. 50m. p.m. on the **1st**, with a great southern declination, and Uranus is as badly situated, ephemerides would be useless.

Neptune has left us for the season.

There are no very well marked showers of shooting stars in April.

The Moon is full at 9h. 20m. p.m. on the **6th**; enters her last quarter at 2h. 28m. p.m. on the **13th**; is new at 10h. 21m. p.m. on the **20th**; and enters her first quarter at 2h. 5m. a.m. on the **29th**.

◆

Chess Column.

By C. D. Locock, b.a.

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

Solutions of March Problem.

Key-move.—1. B to R7.

If 1. . . . P to R7, 2. R to KKt6, etc.
1. . . . K to R7, 2. K to Kt4, etc.

Correct Solutions received from Alpha, J. T. Blakemore G. J. Newbegin, Capt. Forde.

H. S. Brandreth (Algiers).—Solutions of February Problems correct.

Alpha.—The laws of the British Chess Association, approved by Mr. Steinitz in his "Modern Chess Instructor," allow a Pawn to decline promotion. By common consent this "dummy Pawn" is no longer allowed in problems.

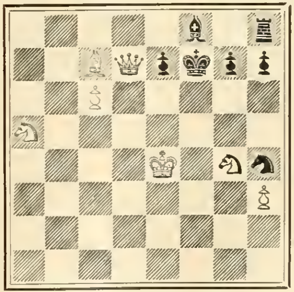
P. G. L. F.—Many thanks; they shall appear next month.

J. T. Blakemore.—It sounds good; have had no time to examine as yet. Your other suggestion comes just a day too late to be adopted. The game, however, is so short that we thought one diagram rather liberal in the way of illustration.

PROBLEM.

By A. C. Umlauff.

Black (7).



White (7).

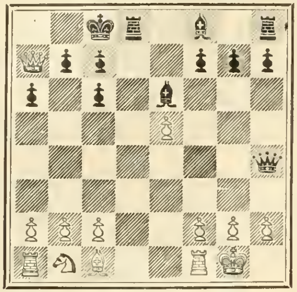
White mates in three moves.

CORRESPONDENCE GAME.

(*Concluded.*)

Position after White's Thirteenth Move.

Black (13).



White (13).

White.	Black.
	13. R to Q4 (*i*)
14. Q to R8ch (*j*)	14. K to Q2
15. Q × KtP	15. R × P (*k*)
16. Kt to Q2 (*l*)	16. R to KKt4 !
17. P to KKt3 (*m*)	17. KB to B4 (*n*)
18. Kt to K4 (*o*)	18. Q × Kt
19. R to Qsqch	19. B to Q4
Resigns.	

Notes.

(*i*) The most attacking continuation. 13. . . . Q to Q5 would be perfectly safe, as Black must exchange Queens with a slightly inferior development.

(*j*) He should certainly keep the check in reserve. Other continuations are most interesting, *e.g.* :—

i. 14. *Kt to B3* (?), R × P; 15. R to Qsq, B to Q3 (if 15. P to KKt3, Q to R6, threatening Q × Rch ! as well as R to KR4); 16. Q to R8ch (?), K to Q2; 17. Q × R, and Black mates in four moves.

ii. 14. *Kt to Q2*, B to KKt5; 15. Kt to B3 (if 15. Kt to B4, B to QB4; and if then White checks and wins the R, Black mates in two moves), 15. . . . B × Kt; 16. P × B, R × P (or . . . P to KKt4 !); 17. R to Qsq, R to Q4; 18. B to K3, Q to R6 (threatening B to Q3); 19. R × R, P × R; 20. P to KB4, P to KKt4, etc.

iii. 14. *B to K3 !* R × P; 15. R to Qsq (if 15. Kt to Q2, B to Q4), 15. . . . B to Q4 (or A); 16. Kt to B3 ! (if 16. P to QB4, Q to KKt5, or Q × BP).

(A) 15. . . . B to Q3; 16. Q to R8ch, K to Q2; 17. Q × R, R × B; 18. P to KKt3, Q to Kt5; 19. Kt to B3, R moves, etc., with a good game.

iv. 14. *P to KKt3* (?), Q to R6 (or Q to Q5); 15. B to B4, B to QB4; 16. Q to R8ch, K to Q2; 17. Q × R, B to KKt5 ! (17. . . . R × P, or 17. . . . R to Q7, is very tempting, but is met by 18. Kt to B3, the only move in each case); 18. P to K6ch, K to K2; 19. R to Ksq (best) (if 19. P × P, Black mates in three moves), 19. . . . B × Pch probably wins.

(*k*) 15. . . . B to QB4 would threaten Q × Pch, but is much inferior to the Rook's move.

(*l*) Natural enough, but he overlooks the bolt from the blue. In any case he has a bad game now.

(*m*) There is no good defence to the numerous mates latent in the position, *e.g.* :—

i. 17. *Kt to B3* (or anywhere except to K4), R × Pch and wins.

ii. 17. *R to Ksq*, Q to R6 ! 18. P to KKt3, B to Q4; 19. Kt to K4, R to R4; 20. B to B4, Black mates in three moves.

iii. 17. *P to KB4*, B to B4ch; 18. K to Rsq, R × P and wins.

iv. 17. *R to Qsq*, R × Pch; 18. K × R, Q to Kt5ch wins.

v. 17. *Q × RP*, Q to R6 (B to Q4 is even stronger); 18. P to KKt3, B to Q4; 19. P to KB3, R × Pch.

vi. 17. *Kt to K4*, R × Pch (or A; but if 17. . . . R to QKt4, 18; Q × RP, Q × Kt; 19. R to Qsqch prolongs the game); 18. K × R, B to R6ch ! 19. K to B3 (best), Q to Kt5ch; 20. K to K3, B × R and wins, for if 21. Q to Kt3, P to KB4.

(A) 17. . . . B to Q3 (?); 18. P to KKt3 (?) (or i.), Q × Kt; 19. B × R, B to Q4 ! 20. P to KB3, B to B4ch; 21. K to Kt2 (if 21. K to Rsq. mate in two), 21. . . . Q to K7ch; 22. K to R3, B to K3ch; 23. P to Kt4, B to Q3 ! and wins.

(i.) 18. Kt to Kt3 ! R to KR4; 19. P to KR3, B × P; 20. R to Qsq ! (not 20. Kt × R, on account of the winning reply, Q to Kt5).

(*n*) Much stronger than the more showy move, 17. . . . B to Q4 (threatening Q × RPch), for White could then reply 18. Kt to B3 (forced), B × Kt; 19. B × R, Q × B (best); 20. Q × RP, B to Q3; 21. KR to Ksq, etc. The waiting move made leaves White absolutely without resource.

(*o*) Any reader who may have persevered so far will be able to work out for himself the forced (and in some cases beautiful) mates resulting from any other move. We give only one variation: 18. R to Qsq, R × Pch; 19. K to Rsq (A), B to Q4ch; 20. Kt to B3 (or 20. P to B3, Q to Kt5 !), 20. . . . R to Kt8ch; 21. R × R, Q × BP !

(A) If 19. K to Bsq, R to Kt8ch; otherwise Q × Pch, B to Q4ch, and Q to B6ch.

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CONTENTS.

BRITISH BEES.—III.

By FRED. ENOCK, F.L.S., F.E.S., etc.

IT is only when we come to examine the burrows of leaf-cutter bees and dissect the newly formed cells, that we begin to realize the marvellous ingenuity displayed in their construction. We find that generally the foundation is formed of a circular piece of leaf, which the bee has so rammed down that it fits into the rounded end of the burrow (Fig. 12). The bee, having satisfied itself with its work so far, next proceeds to exhibit such high intelligence that we are bewildered with the thought, "Where does so-called instinct end and reasoning power begin?" The bee does not hesitate in its work, but as soon as the circular piece of leaf is fixed it seems to recognize in a moment that it would not do to attempt to form the sides of the cells of circular pieces; accordingly, without compasses or two-foot rule, or any other means of measurement than her unerring eye and powerful mandibles, in a few seconds she has cut an oblong wedge-shaped piece of leaf (Fig. 13), which she carries to her burrow, and, taking it down thin end first, carefully places that end in the saucer-shaped foundation (Fig. 14). Another oblong wedge-shaped piece of leaf is cut and carried home and down the burrow, and once more our "superior intellect" is humbled when we find that the bee shows still greater common sense in depositing the second piece than the first, for she so fits it that one edge just overlaps that of the first (Fig. 15). Another visit to the bush outside furnishes an exact counterpart of the first and second oblongs, fixed in the same methodical manner (Fig. 16); but still the circle is incomplete, and for the fourth time the untiring architect leaves the nest for the stores, from which it again cuts an oblong, and as quickly returns to its burrow, and so carefully and correctly has it measured the circumference that this fourth piece fits in, just overlapping both the third and first pieces (Fig. 17). Owing to the wedge shape of these four pieces the cell is not by any means fit to receive the nectar and pollen for which it is intended. The bee still works on, cutting another oblong from a leaf, which she places exactly midway over the joint of the first and second (Fig. 18), and so on until she has completely closed every

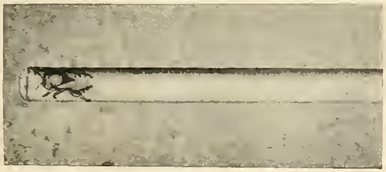

FIG. 12.—Foundation of First Cell.

FIG. 13.—First Side-piece cut and carried.

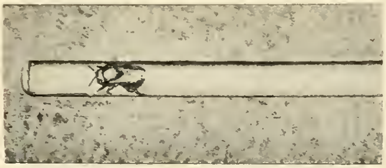

FIG. 14.—First Side-piece fixed in Position.

opening at the sides. Sometimes she places an additional thickness both at the bottom and at the sides. The cell now is ready for the "pudding," and the bee goes out to gather the ingredients from the flowers—notably those of the campanula. Having filled her reservoir with nectar and covered her body with pollen, she flies off to her burrow, and quickly divests herself of her load. Carefully brushing the pollen from her abdomen, and ejecting the nectar from her honey stomach, she proceeds to mix the two into a "pudding," to the best of her ability, so that it will not disagree with the stomachs of her progeny. Many journeys are made before a sufficient supply is collected, and the cell filled to within a certain distance of the top. When this point is reached, the bee lays a single egg on the top of the pudding (Fig. 19). Having taken so much trouble to build up this wonderful cell, it is not surprising to find that she next proceeds to protect her property. She makes another journey to the bush, and cuts out a circular piece of leaf, which she fits into the cell so carefully that it does not press upon the delicate egg; and, to make assurance doubly sure, she not unfrequently places as many as a dozen of these circular covers superposed on each other, a short space being left from the last cover to the top edge. As soon as this first cell is finished and sealed up, she proceeds to build the second, the end of which fits into the first (Figs. 20 and 21).

Fig. 15.—Second Side-piece fixed.

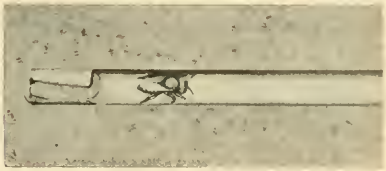

Fig. 16.—Third Side-piece fixed.

Fig. 17.—Fourth Side-piece fixed.

In this way the industrious bee continues her work as long as the sun continues to shine, until she has placed from nine to a dozen cells in her burrow, the entrance to which is then carefully closed with sand; a few broken bits of dead leaves and heather bells are scattered about, and no trace is left. Should the weather continue bright, the bee sinks another burrow, which she fills with cells, and sometimes she will make others before her energies are exhausted.

Other marvellous work lies hidden under the sand, but nature is carrying on her transformations. The eggs hatch into legless maggots, that find their food ready to their mouths (Fig. 22); a few weeks of such sweet food brings them to full growth, and they are ready for their next change—the chrysalis. Before that stage is reached, however, they spin themselves a silken shroud, and fastening the silk to the sides and ends they turn themselves round and rest upon their backs, with their heads pointing to the entrance of the burrow (Fig. 23). In this position they assume the chrysalis stage, in which they remain for at least a month. During this time the changes of colour and gradual formation of the bee may be watched. At first there is but little difference in the form, but in a week the limbs are all plainly visible. The eyes and mandibles then begin to assume distinct shape and colour, and the various parts of the delicate tongue can be traced out under the membrane which encloses the whole of the body. In a fortnight the joints appear and then the hairs on various parts, and in a month's time the bee appears quite ready to burst through its delicate shroud. This generally happens in early morning, and is a sight to be remembered. After brushing each organ, and pluming each wonderful hair, the bee is ready for its virgin flight. Occasionally the bees are matured some time before they emerge in June.

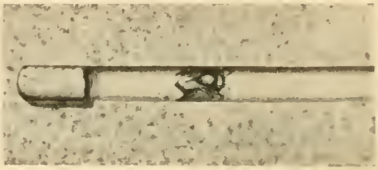

Fig. 18.—First Gap filled up.

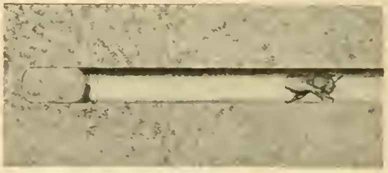

Fig. 19.—Section of First Cell, showing Pudding and Egg.

Fig. 20.—Three Cells.

It is a remarkable fact that the eggs laid first in the lower cells produce females, which take some days longer to reach maturity than do the males, which are always produced from the eggs laid last in the cells nearest to the entrance of the burrow. This egg laid last is matured first, and the bee (a male), excavating its way into the open air, leaves its cell empty, so that the bee below it can then eat its way through the cap of leaves and pass out through the empty cell (Fig 21). The third bee does the same, and so on until the last bee (the egg of which was laid first) is enabled to pass through the whole of the other cells until she reaches the open air.

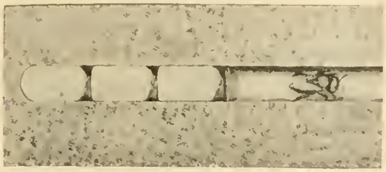

Fig. 21.—Section of Cells and Puddings.

The peculiar bee the sole representative in this country of the genus *Anthidium* is fond of taking to any old hole in a post or tree. It has the habit of collecting the woolly tomentum from the stems of the hollyhock. The bee runs up the stem and quickly divests it of its covering, which it heaps up into a ball and holds between the legs and mandibles. This material is used in the formation of its cells. I used to take this bee plentifully in my garden near Finsbury Park some twenty years ago, when houses and smoke were not quite so plentiful as now. The male is very much larger than the female, and has its abdomen terminated by an armature of strong spikes.

Two small bees constitute the genus *Chelostoma*—the larger one, *C. florisomne*, being particularly fond of the flowers of mignonette, wild and cultivated; while the smaller, *C. campanularum*, is plentiful in the delicate harebell.

The bees forming the genera *Heriades* and *Ceratina* are both strangers to me. The records of the capture of *Heriades* are somewhat doubtful. Naturalists cannot be too exact in such matters.

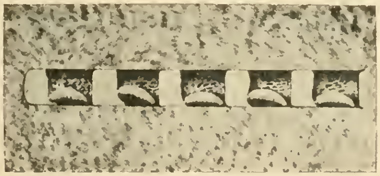

Fig. 22.—Larvæ feeding.

Eucera longicornis is the only one of the genus and is a very beautiful bee. The male has immensely long antennæ that reach right over and beyond the tail when the bee is flying. A large colony used to exist in the bank bounding the horse exercise ground near the Vale of Health at Hampstead. It has long ago disappeared—even before I commenced to work this locality. At Woking it was tolerably plentiful years ago. In company with this bee I generally found its striking parasite—*Nomada sexfasciata.*

Our next bee generally makes itself heard before being seen, for of all notes (and all bees have their special ones) this is the shrillest. They love the hottest and most brillian sunshine, and they whiz past with lightning-like rapidity from flower to flower. The opal eyes of the male render it a most beautiful insect. The bank from which I used to dig these bees at Woking is, I am pleased to note, still in existence.

We now come to two bees which are also musicians, viz., *Anthophora retusa* and *acervorum*—the so-called "mason bees" of certain localities. On February 19th of this year I noticed one of the first-named species basking in the sunshine on a wall at Haslemere, while the ground was almost an inch deep with snow. This is one of my earliest records of this merry bee. At Hampstead there still exists a small colony of *A. acervorum*, and few prettier sights can be seen in April than that of the males sitting with outstretched legs at the entrance of their burrows, The intermediate legs have very long fringes of black hairs arranged in the most exact manner. In various parts of Lincolnshire and the south coast these bees absolutely swarm in the mud or mortar between the stones of walls and old buildings. The young natives catch the "white-nosed" ones, and put them into their handkerchiefs for company during school hours; but even they are wise enough not to catch the "black-nosed" ones (the females), though they are quite ignorant as to the sex, and why one possesses a sting. I once was fortunate in finding a fine specimen of the strange beetle, *Sitaris*, which is a parasite of this bee. These bees do not loiter about when on the wing, but fly with immense rapidity, coming upon one so suddenly that a nervous person is often startled by their loud hum.

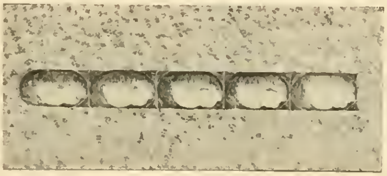

Fig. 23.—Pupæ.

Our very old friends the humble bees and their parasites (*Psithyrus*) are next in order, and so much has been written of these "bumblers" that we can only confirm the praise bestowed upon the beautiful creatures whose hum is so comforting to the tired entomologist. How eagerly do we watch for the reappearance of the hybernated females to the yellow catkins of the sallow. To these bees the farmers of New Zealand owe the fertilization of the clover.

To the bees comprising the genus *Apis* every human being is more or less indebted, for what should we do without honey or beeswax? Perhaps better than our ancient ancestors, who had not the knowledge which we now possess for manufacturing all kinds of things, pure and impure.

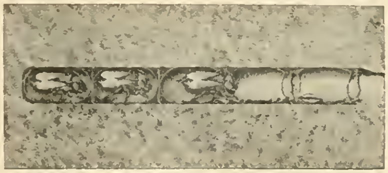

Fig. 24.—Five Cells; two vacated.

Bees have ever been set forth as the emblems of industry, and the more we study the habits of the solitary species so much more does our wonder and admiration increase. When we subject each species to a microscopical examination, we find such an endless wealth of beauty of form, and marvellous adaptation of every part, that we feel utterly at a loss for words wherewith to describe their perfection.

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A VALLEY ON SÃO NICOLAU, CAPE VERDE ISLANDS.

By Boyd Alexander, M.B.O.U.

On dropping anchor in Porto Preguiza, the little harbour of São Nicolau, one seeks in vain for cool verdure whereon to look and rest one's eyes. Brown, lofty hills, with acute-angled summits, chiselled by the rough hand of Vulcan, rise up with weary persistency. There are places, however, on their lower portions washed over with the filmy green of grass, a growth which is quickly eaten over by goats and the thousands of locusts that infest the plains. The little clouds now and again take pity on these pastures of stone; they come creeping to their relief, but it is often only to expire in the attempt about half way down the steep slopes. Here and there on the small plains grow scattered acacia trees (*Acacia albida*). Some are stunted as though they had devoted all their lives in trying to obtain a firm foothold in the rocky soil, while there are others with backs bent double by the strong north wind.

For the past three years rain has hardly fallen on the island, with the result that a famine is pinching the inhabitants.

The maize, the peasants' chief support, will not grow, and now they have only to rely upon the tardy arrivals of schooners filled with grain from the States.

From Preguiza a road leads up to the village of Stancha, situated in the only fertile valley that the island possesses. It is a broad, finely paved road, constructed with great skill, and with a careful eye to gradients; too good by far, and, in fact, incongruous, for such an island, where there is only donkey and foot traffic. But the Portuguese excel in road making. Furthermore, this road is the means of employing many of the native women, who would otherwise starve during frequent dearths of rain on the island.

On November 5th we travelled along this road on donkeys, and met numbers of women struggling with heavy stones upon their heads and sweating from every pore. Their work, which lasts from sunrise to dusk, is hard, and they earn scarcely enough to keep body and soul together —fourpence a day.

After a good half-hour's ride along the foot of a lofty hill range, that increased in height as we journeyed northwards, we commenced to descend a steep and capacious valley; and at the bottom of this great dried-up watercourse, just where it bends eastward to gain the sea, lay the village of Stancha, nestling amongst an abundance of tropical growth. Owing to the limited space the houses of this little town are closely packed together, the majority being nothing better than huts, with walls of rough stone pieced and stuck together with mud, and thatched with the dried blades of the maize and sugar cane. In colour the huts are a predominant brown, only a shade or two darker than the steep sides of the valley.

There are, however, besides a church, a few houses that stand out distinct, by reason of their size, white-plastered walls, and red-tiled roofs. One of these, a well-built chateau, is on an eminence overlooking Stancha, and belongs to Mr. St. Aubyn, an Englishman—and the only one on the island.

Both he and Senhor Antonio Reis, one of the principal Portuguese citizens of the place, showed us much kindness, supplying us, amongst other necessaries, with bread that was almost at famine prices.

The day after our arrival we arose early and started out to investigate the bird life of this large valley. On that particular morning an entrancing beauty seemed to hold it.

Coffee bushes clothe many portions of its sides, while on the higher ground maize surrounded the scattered huts of peasants. Here and there the coffee growth gives way to orange trees flourishing in the midst of sugar cane plantations, bordered in places near a stream's bank with strips of fish cane; while beyond, and overtopping them, are tall cocoanut trees.

All this mass of foliage forms a fine study in shades of green—the deep green of the orange leaf, and that of the cocoanut palm a few tones lighter; then the tender verdure of the sugar cane blade; and, lastly, the delicate bluish green of the fish cane.

The innumerable banana plants, with some of their large leaves in shreds, as if deftly torn by many fingers, made avenues of the streams, with banks adorned by maidenhair ferns hanging in tresses from the rocks.

Almost the first birds to draw our attention were two species of sparrows—the Santiago sparrow (*Passer jagoensis*) and the Spanish sparrow (*Passer salicicola*). We had met with them on the other islands of the archipelago, but had come to São Nicolau just at the right season to find them breeding.

Since Gould described *Passer jagoensis* as being peculiar to Santiago it has now become well distributed throughout the whole group, but it is most numerous on Santiago and Maio, where, in the latter island, its numbers are truly remarkable.

This bright-plumaged sparrow is not at all particular as to where it builds its nest. Where trees are absent, hollows underneath boulders or crevices in rocks are chosen as nesting sites. In a tree the nest is domed, but when in a hollow of the ground it is an open, compact structure, and often lined with feathers.

The eggs are four in number, and, like those of our tree sparrow, in each clutch they are fairly uniform in colour, with the exception of one, which is invariably lighter than the rest.

As to the Spanish sparrow, it breeds in the tops of the cocoanut trees, and for this reason it has received the name of the "cocoanut bird" from the natives.

While on the island of Maio we came across this species in vast numbers.

Small clumps of acacia trees in a valley close to the sea presented extraordinary spectacles. The upper branches were simply crammed with bulky domed nests, hardly a foot intervening between each, while musical chirpings issuing from a thousand throats tended to enhance the remarkable aspect of this sparrow colony.

Blackcap warblers filled the valley with their singing, while now and again a far more mellow song would come from a reed warbler (*Calamocichla brevipennis*) hidden in the depths of some coffee grove. The blackcap (*Sylvia atracapilla*) is a resident in the island, and breeds in November. We found a considerable number of nests—all built in the upper boughs of the coffee trees. The eggs of only one out of the six perfect clutches we obtained approach in any way the common type of our blackcap's; all the others are very light in ground colour, being blotched, spotted, and streaked with dark and reddish brown and underlying purplish markings—all forming a thick zone round the larger ends.

Of course we devoted much attention to *Calamocichla brevipennis*, and secured a fine series of this rare warbler, together with a couple of nests containing eggs. This species exhibits all the habits of a true reed warbler.

Though concealed from view, in yonder group of coffee bushes there is a pair. Ever and anon the male bird tempts his mate with song. First of all the male bird begins by uttering a soft, melodious "chou" several times in a deliberate and slow manner, and this call is responded to in a similar way by the female; and then the male, as if assured of her attention, pours out his string of exquisite notes. The first three notes are uttered with marked feeling and a pause follows, after which the remaining notes are given out in quick succession and in a higher key—a pretty, mellow trill being given to the last one.

This song is not unlike that of our reed warbler (*Acrocephalus streperus*), but it is of far finer quality, though not so rich in notes. English reed beds are not conducive to fine singing. A chilly atmosphere pervades them, while the reeds themselves tremble and commence to jostle one another at the mere mention of the wind's coming. And amid such disturbing influences the reed warbler utters his song, which at times becomes discordant and shrill as though he were shouting to the reeds to keep quiet.

But the other reed warbler (*C. brevipennis*) pours out his song under peaceful and lethargic influences. The leaves hardly as much as stir; a tropical heat pervades the passages of the coffee groves, and imparts to the bird just that amount of languor which makes him utter his song with soft deliberate feeling, coaxing forth the notes, as it were, till they become round and mellow—a song, truly, that haunts the memory.

The nest, figured here, is of a deep cup-shaped form, and bound to two or more of the upper stems of a coffee bush or of a young orange tree, and about eight or nine feet from the ground.

Nest of *Calamocichla brevipennis* in a Coffee Tree.

Fine strips from the dried-up blades of the maize plant, dead grass, and the fibrous rind from the trunk of the banana tree compose the body of the nest, while fine grass and bents form the lining.

The eggs, generally three in number, are bluish white, spotted and blotched all over (but more thickly at the larger ends) with pale brown and purplish brown, with underlying blotches of violet grey.

Their dimensions correspond with those of the round form of our reed warbler.

Round about this valley a species of owl (*Strix insularis*) is met with. It is a very beautiful bird, and is closely allied to our common barn owl (*Strix flammea*). A deep fawn colour takes the place of the white in the latter, while its upper parts are suffused and marked with a rich French grey. It is by no means common, and we found it a matter of great difficulty to induce the natives to search the tops of cocoanut trees, in which these birds generally live. They look upon this owl with superstitious fear, believing that a wound from its claws never heals.

On returning home, as we entered the outskirts of Stancha, a company of Egyptian vultures arrested our attention. They gave us a lazy glance, and then stared in the opposite direction.

In spite of their repulsive habits, one cannot help possessing a sneaking regard for these birds with their wrinkled faces of the colour of yellowed parchment, for one somehow feels that they are old and venerable, and have outlived many a human life.

The birds find plenty of food about Stancha. Every morning, as regular as clockwork, they troop towards the slaughter-house and then return the same way—only a little slower this time—to an old place of *rendezvous* outside the town, where they indulge in *siestas*, now and again to awake, to ponder, perhaps, upon what the nature of the next "kill" would be in yonder house.

During the breeding season, which is generally in December, they cease to haunt the villages, and betake themselves in couples to lofty hill ranges; and then they appear again in the vicinity of dwellings with their young as February comes round.

The Cape Verde Islands are the westernmost range of this species.

Above the heads of the vultures, enjoying a pure atmosphere, resided a number of ravens (*Corvus umbrinus*) that cawed lustily from time to time.

It is very interesting to have discovered this raven, with the brown head and neck, on São Nicolau, as the species was considered by ornithologists to have its westernmost range in Egypt.

With another hour gone by the light of a brief twilight commenced to creep over the plains and then down into the valley, while the distant hills were suffused with a hue like the purple bloom on a grape. And then, as twilight glided into dusk, the stillness was broken by the locusts, who vamped incessant accompaniments to the soft music of night.

DESERTS AND THEIR INHABITANTS.

By R. Lydekker, b.a., f.r.s.

If popular errors connected with matters scientific are hard to kill, still more is this the case when the erroneous opinions have been held by scientists themselves. The idea that flints and other stones grow is, I have good reason to believe, still far from extinct among the non-scientific; and it is not improbable that there are persons possessing a more or less intimate acquaintanceship with science who still cherish the belief that deserts are uninterrupted plains of smooth sand, originally deposited at the bottom of the sea, from which they have been raised at a comparatively recent epoch. At any rate, there are several valuable books, published not very many years ago, in which it is stated in so many words that the Sahara represents the bed of an ancient sea, which formerly separated Northern Africa from the regions to the southward of the tropic.

As a matter of fact, these opinions with regard to the origin and nature of deserts are scarcely, if at all, less erroneous than the deeply ingrained popular superstition as to the growth of flints and pudding-stones. And a little reflection will show that the idea of the loose sands of the desert being a marine deposit must necessarily be erroneous. Apart from the difficulty of accounting for the accumulation of such vast tracts of sand on the marine hypothesis, it will be noticed, in the first place, that desert sands are not stratified in the manner characteristic of aqueous formations; and, secondly, even supposing they had been so deposited, they would almost certainly have been washed away as the land rose from beneath the sea. Then, again, we do not meet with marine shells in the desert sands, of which at least some traces ought to have been left had they been marine deposits of comparatively modern age.

Whether or no the subjacent strata have ever been beneath the ocean, it is absolutely certain that the sands of all the great deserts of the world have been formed *in situ* by the disintegration of the solid rocks on which they rest, and have been blown about and rearranged by the action of wind alone. All deserts are situated in districts where the winds blowing from the ocean's surface have to pass over mountains or extensive tracts of land, which drain them more or less completely of their load of moisture. Hence, in the desert itself, when of the typical kind, little or no rain falls, and there is consequently no flow of water to wash away the *débris* resulting from the action of the atmosphere on the rocks below.

In other words, as has been well said, desert sands correspond in all respects, so far as their mode of origin is concerned, to the dust and sand which accumulate on our high roads during a dry summer. On our highways, indeed, the summer's dust and sand are removed by the rains of autumn and winter, only to be renewed the following season; but in a desert no such removal takes place, and the amount of sand increases year by year, owing to the disintegration of the solid rock exposed here and there.

Only one degree less incorrect than the idea of their submarine origin is the notion that deserts consist of unbroken tracts of sand. It is true that such tracts in certain districts may extend on every side as far as the eye can reach, and even much farther; but, sooner or later, ridges and bands of pebbles, or of solid rock, will be met with cropping up among the sand, while frequently, as in the Lybian desert, there are mountain ranges rising to a height of several thousand feet above the level of the plain. And it is these exposed rocks which form the source whence the sand was, and still is, derived. Such mountains naturally attract what moisture may remain in the air, and in their valleys are found a more or less luxuriant vegetation. Oases, too, where the soil is more or less clayey, occur in most deserts; and it is in such spots that animal and vegetable life attains the maximum development possible in the heart of the desert.

In the most arid and typical part of the Lybian desert the sand is blown into large dunes, which are frequently flat-topped, and show horizontal bands of partly consolidated rock; and between these are open valleys, partly covered with sand, and partly strewn with blocks of rock polished and scored by the sand-blast. In such sand wastes the traveller may journey for days without seeing signs of vegetation, or hearing the call of a bird or the hum of an insect's wing. But even in many of such districts it is a mistake to suppose that vegetable and animal life is entirely absent throughout the year; in the western Sahara, for instance, showers generally moisten the ground two or three times a year, and after each of these a short-lived vegetation springs suddenly up, and if no other form of animal life is observable, at least a few passing birds may be noticed.

Among the most important and extensive deserts of the world we have first the great Sahara, with an approximate area of sixteen thousand square miles, nearly connected with which is the great desert tract extending through Arabia, Syria, Mesopotamia, and Persia. By means of the more or less desert tracts of Baluchistan, Sind, and Kuch, this area leads on to the great Rajputana desert of India. More important is the vast Gobi desert of Mongolia, and other parts of Central Asia. In Southern Africa there is the great Kalahari desert, of which more anon. In North America there is a large desert tract lying east of the Rocky Mountains, and including a great part of Sonora; while in the southern half of the New World there is the desert of Atacama, on the borders of Peru and Chili. Lastly, the whole of the interior of Australia is desert of the most arid and typical description.

But among these, there are deserts and deserts. Tracts of the typical barren sandy type are, as already said, extensively developed in the Sahara, as they are in the Gobi and the Australian deserts. Between such and the plains of the African veld there is an almost complete transition, so that it is sometimes hard to say whether a given tract rightly comes under the designation of a desert at all. A case in point is afforded by the South African Kalahari. Although there are endless rolling dunes of trackless sand, and rivers are unknown, yet in many places there is extensive forest, and after a rain large tracts could scarcely be called a desert at all. Mr. H. A. Bryden, for instance, when describing the Kalahari, writes as follows:—" And yet, during the brief weeks of rainfall, no land can assume a fairer or more tempting aspect. The long grasses shoot up green, succulent, and elbow-deep; flowers spangle the veld in every direction; the giraffe acacia forests, robed in a fresh dark green, remind one of nothing so much as an English deer park; the bushes blossom and flourish; the air is full of fragrance, and pans of water lie upon every side. Another month, and all is drought; the pans are dry again, and travel is full of difficulty." During the grassy season herds of springbok used to migrate in the old days to the Kalahari, in the northern part of which giraffes live the whole year, although they must exist without tasting water for months.

While such a district can scarcely be termed a desert in the proper sense of the word, yet its sands have precisely the same origin as those of deserts of the typical description.

For sand to accumulate to the depths in which it occurs in many parts of the Sahara and the Gobi by the slow disintegration of the solid rocks under the action of atmospheric agencies, must require an enormous amount of time, to be reckoned certainly by thousands, and, for all we know, possibly by millions of years. And we accordingly arrive at the conclusion that the larger desert tracts must not only have existed as land for an incalculable period, but also as desert. Hence we can readily understand why the animals of Algeria and the rest of Northern Africa differ for the most part from those of that portion of the continent lying to the south of the northern tropic, the Sahara having for ages acted as an impassable barrier to most if not all.

But if other evidence were requisite, there is another reason which would alone suffice to compel us to regard deserts as areas of great antiquity. The habitable parts of all deserts—and it is difficult for the inexperienced to realize what barren tracts will suffice for the maintenance of animal life—are the dwelling places of many animals whose colour has become specially modified to the needs of their environment. And it will be quite obvious that such modifications of colour, especially when they occur in animals belonging to many widely sundered groups, cannot have taken place suddenly, but must have been due to very gradual changes as the particular species adapted itself more and more completely to a desert existence.

To obtain an idea of the type of coloration characteristic of the smaller desert animals, the reader cannot do better than pay a visit to the Natural History Museum, where, in the Central Hall, he will find the lower part of a case devoted to the display of a group from the Egyptian desert, mounted, so far as possible, according to their natural surroundings. He may also turn with advantage to the coloured plate of desert finches and larks facing page 380 of the third volume of the "Royal Natural History."

Among such animals may be mentioned the beautiful little rodents respectively known as jerboas and gerbils, together with various birds, such as sand grouse, the cream-coloured courser, the desert lark, desert finches, and desert chat, and also various small snakes and lizards, among the latter being the common skink. Although some of the birds retain the black wing-quills of their allies, in all these creatures the general tone of coloration is extremely pale: browns, fawns, russets, olives, greys, with more or less of black and pink, being the predominant tones; and how admirably these harmonize with the inanimate surroundings one glance at the case in the Museum is sufficient to demonstrate. Very significant among these are the desert finches (*Erythrospiza*), which belong to the brightly coloured group of rose-finches; one of these specially modified species ranging from the Canaries through the Sahara and Egypt to the Punjab, while the second is an inhabitant of the Mongolian desert.

Among larger animals a considerable number of the gazelles are desert dwellers, these including the palest-coloured members of the group; and lions are likewise to a great extent inhabitants of deserts—as, indeed, is true of tawny and pale-coloured animals in general.

All the animals above mentioned belong, however, to widely spread groups, which are common to the desert tracts of both Africa and Asia, and they do not, therefore, serve to prove the antiquity of any particular desert, as they or their ancestors might have migrated, and probably did migrate, from one desert to another. Birds of such groups are, of course, even more untrustworthy than mammals, owing to their power of flight. And among those referred to, some, such as the sand grouse, can scarcely claim to be regarded as exclusively desert birds, since they are partial to any open sandy plains, like those of the Punjab, or even Norfolk.

The case is, however, very different with certain of the larger mammals, a notable instance being afforded by the antelopes allied to the South African gemsbok (*Oryx*). All the members of this group are inhabitants of more or less sandy open districts, and none range eastwards of Arabia, or possibly Bushire. The gemsbok itself, together with the beisa of Eastern and North-Eastern Africa, are inhabitants of districts which do not, for the most part, come under the designation of typical deserts. And we accordingly find that they are by no means very pale coloured animals, while both are remarkable for the bold bands of sable ornamenting their faces and limbs. On the borders of the Sahara there occurs, however, a very different member of the group—the white oryx (*O. leucoryx*)—differing from all the others by its curving horns, and likewise by the extreme pallor of its coloration, which is mostly dirty white, with pale chestnut on the neck and under-parts. Obviously, this species has been specially modified as regards coloration for the exigencies of a purely desert existence, and as it is also structurally very different from all its existing kindred, it must clearly be looked upon as a very ancient type, which commenced its adaptation to the surroundings of the Sahara ages and ages ago. The Arabian desert is the home of another species of oryx (*O. beatrix*), which, although more nearly allied to the East African beisa, is a much smaller and a much paler coloured creature. In this case also there would seem little doubt that the period when this animal first took to a purely desert existence must have been extremely remote.

But an even more striking instance is afforded by another antelope remotely connected with the gemsbok, which is an inhabitant of the Sahara and the Arabian desert, and is commonly known as the addax. It is an isolated creature, with no near relation in the wide world, easily to be recognized by its dirty white colour, shaggy mane, and long twisted horns. It must have branched off at a very remote epoch from the gemsbok stock, and affords almost conclusive evidence of the antiquity of the deserts it inhabits, since we have no evidence of the occurrence of allied extinct species in other countries.

Some degree of caution is, however, necessary in drawing conclusions that all isolated desert animals have been evolved in the precise districts they now inhabit. A case in point is afforded by the saiga, a pale-coloured antelope without any very near kindred, inhabiting the steppes of Eastern Russia and certain parts of Siberia, where it is accompanied by the hopping Kirghiz jerboa (*Alactaga*). Now, since fossilized remains of both these very peculiar animals have been discovered in the superficial deposits of the south-eastern counties of England, it is a fair inference that physical conditions similar to those of the steppes (which, by the way, are by no means true deserts) obtained in that part of our own country at an earlier epoch of its history. From their comparatively isolated position in the zoological system, as well as from their occurrence in the strata referred to, both these desert animals evidently indicate very ancient types; and they accordingly serve to show not only that the semi-desert steppe area formerly had a much greater western extension than at present, but probably also that the existing portion of that area dates from a very remote epoch. Hence they confirm the idea of the early origin of the present deserts of the Old World and their inhabitants.

It will be gathered from the foregoing that the deserts and steppes of Africa and Asia possess a large number of animals belonging either to species which have no very near living relatives, or to altogether peculiar genera. In the Arizona desert of the Sonoran area of North America it seems, however, to be the case that its fauna is largely composed of animals much more nearly related to those inhabiting the prairie or forest lands of the adjacent districts, of which, in many cases at any rate, they constitute mere local races distinguished by their paler and more sandy type of coloration. This is well exemplified by the mule deer, which in the Rocky Mountains is a comparatively dark and richly coloured animal, but becomes markedly paler on the confines of the Arizona desert, assuming again a more rich coloration when it reaches the humid extremity of the Californian peninsula. Most of the North American mammals, indeed, acquire similar pale tints as they reach the Arizona desert tract; and a practised naturalist can pick out with comparative ease the specimens coming from this area from those of the moister districts.

It is not easy to obtain information as to the physical features of the Arizona desert as compared with the Sahara, and especially as to the amount of sand it contains area for area; but, judging from the comparatively slight modifications which its mammals appear to have undergone as compared with those of the more humid regions adjacent, it seems not unlikely that these deserts are of more modern origin than the Sahara and the Gobi.

Whether or no it be true in this particular case, it may be laid down as a general rule that the greater the amount of sand to be found in a desert, and the greater the difference between the animals inhabiting that desert from those dwelling in the adjacent districts, the greater will be the antiquity of the desert itself. In the case of a desert forming a complete barrier across a continent, like the Sahara, if the animals on one side are quite different from those on the other, its antiquity will be conclusively demonstrated. If, on the other hand, they are more alike, the age of the desert will be proportionately less.

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THE KARKINOKOSM, OR WORLD OF CRUSTACEA.—III.

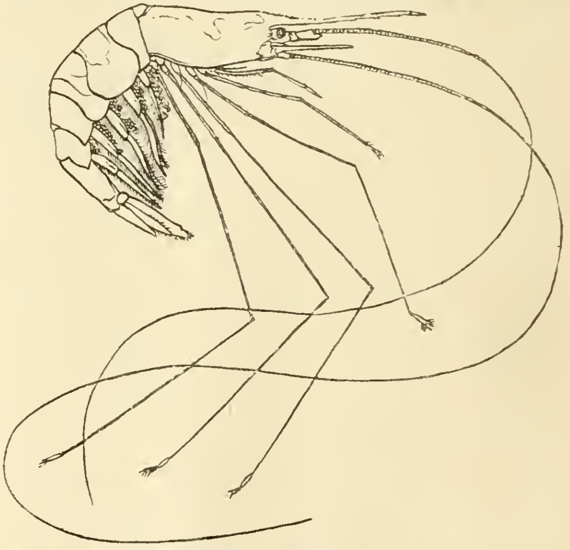
By the Rev. Thomas R. R. Stebbing, M.A., F.R.S., F.L.S.

The poet says, "Tell me where is fancy bred." The philosopher asks, "Where shall wisdom be found?" To the carcinologist it is no less important to inquire where he should search for Crustacea. To him a comprehensive answer may be given that, with one exception, there is no sort of place on the garment of the globe where they may not be encountered. Like adventures to the adventurous, they will meet the expectant observer as well in his daily rambles as in his most audacious wanderings from Pole to Pole.

Only in arid deserts the pursuit is at a monstrous disadvantage. For almost every crustacean specimen might claim a share in the sweet singer's epitaph: "Here lies one whose name is writ in water." Whether Mammalia have had marine ancestry may be disputed by the disputatious, but few will care to deny that crabfishes and the whole crustacean tribe must have begun the business of life in the sea. Out of water, and out of salt water, the most part cannot sustain life at all. Almost all of them are dependent for health and activity on an abundant and constant supply of moisture. The comparatively small number of terrestrial species, by their close affinity to the aquatic hordes, show that they themselves must have had water-breathing progenitors. Some of them, as is well known, make periodical pilgrimages to lay their eggs in the ancestral sea. In lakes which are evidently upraised and isolated fragments of the ocean, crustaceans are found the counterparts of others which are still marine.

From the general facts of the distribution one may believe that the Crustacea began in moderately shallow water, and that they have thence spread themselves on the one hand to the shores, up the rivers, over plains, valleys, and mountains, and on the other hand into all depths and all quarters of the widespread sea. Thus, to deal with them efficiently as a whole you need a dredge and a trawl, a boat and a ship. You need a navy. That such an expression is not hyperbolical can easily be proved. For though the names of the *Racehorse*, the *Discovery*, the *Vincennes*, the *Samarang*, the *Astrolabe*, and others may be little remembered in connection with the progress of carcinology, yet the *Lightning*, the *Porcupine*, and the *Challenger*, the *Talisman* and the *Travailleur*, the *Blake* and the *Albatross*, have been made familiar to the present generation by popular narratives as well as by volumes of profound research. Without entering into rivalry with Homer in his famous "Catalogue of the Ships," which is after all only a sum in addition, one may make honourable mention of the *Novara*, the *Joséphine*, the *Vettor Pisani*, the *Dijmphna*, the *Willem Barents*, the *Alert*, the *Hauch*, the *Buccaneer*, the *Hirondelle*, the *Princesse Alice*, the *Hassler*, the *Caudan*, the *Investigator*, and still leave the list uncompleted. Some of the vessels, no doubt, have been less important for their size than for their services. A full enumeration of them, nevertheless, would show a notable international fleet. The immediate object of each expedition may have been geographical discovery, the sounding of depths, the laying of cables, astronomical observations, magnetic surveys, or other such trivialities; but overruling destiny employed them all—more or less—in catching crustaceans.

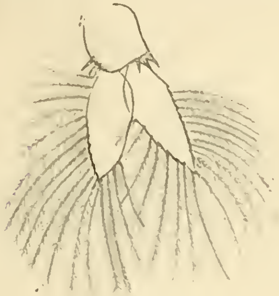
The ocean floor is difficult of access. The ocean surface is more easily skimmed from a boat than from a man-of-war. But, whether from boat or pier or ledge of rock, the sweeping of that surface with a hand-net is productive of treasure. It is rich in larval forms of various groups. It is thronged with innumerable Entomostraca. For some captures the night is the most favourable period. At some times and places the abundance of individuals is overwhelming. Square miles of ocean may be coloured by the blood-red *Calani* known as "whale-food." To a cetacean, with one or two thousand pounds worth of plates of whalebone depending from its cavernous skull, the extravagant



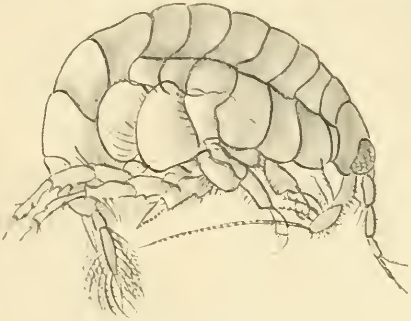
Nematocarcinus Agassizii (Faxon). Deep-sea Shrimp, taken by the *Albatross*. Life size. Upper antenna imperfect.

quantity of these Copepoda is not unwelcome. To the naturalist the superfluity of this or any other single species is distracting. He does not wish the novel or the rare to be concealed or entangled amidst the multitudinous. At times, however, numbers help to enhance the charm as well as the wonder of the scene presented. Especially is this the case with the genus of Copepoda called *Sapphirina*, concerning which Dana says that nothing can exceed the beauty of some of the species, conspicuous in single specimens, but still more when they are congregated in abundance. "On account of their extreme brilliancy and rich reflected tints they may be seen at great depths on a sunny day, and as each becomes visible only when the position is right for the observer's eye, the water seems to flash with moving gems; they even rival the richest opal and sapphire, and the most brilliant combination of metallic hues." So they endear themselves to the observer, and he distinguishes the fascinating species as "the belle," "the rainbow," "the gem," "the radiant," "the resplendent."

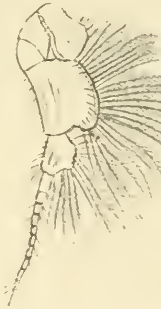
There was a time when collectors deplored that on board a swift ocean steamer they could not ply their favourite occupation. That tantalizing era is at an end. As explained in recent papers by Giesbrecht* and Herdman,† small invertebrates from a few feet below the surface can now be easily obtained while the ship is in full career, by day or by night, in tempest or in calm. The water which is continually being drawn into the vessel to supply tanks and baths is simply filtered through nets, which detain the desired organisms. Dr. John Murray, Captain Hendorff, and Dr. Krämer are credited with having been the pioneers in this method of retrieving—so facile, so fruitful, so inexpensive. Thus far it appears that a large proportion of the game which is bagged in this ingenious manner consists of Copepoda. How great a hold these and other Entomostraca have obtained on all the waters of the globe, both fresh and saline, will be considered hereafter in connection with notes on their classification. For the Copepoda in particular Mr. I. C. Thompson has recently called attention to the grand economic service rendered by their immense profusion at the mouths of rivers and outside harbours. Transmuting the importunate refuse of populous towns into their own minute forms of life, they in turn become the food of larger marine animals, variously adapted to gratify the palate of Lucullus, to illumine his banquet, or adorn his person.



Last uropod of the *Urothoe*, highly magnified.



Urothoe brevicornis (Bate). From North Wales.



Second antenna of *Haustorius arenarius* (Slabber).

The sea-shore is generally rich in crustaceans. It is almost always far richer than might be supposed from a casual survey. The common shore crab, by way of exception, is an impudent, defiant creature; but even the fighting shore crab is coloured for concealment, lies low by preference, and, upon occasion offered, adopts the policy of scuttle. As a rule the crustaceans of the shore don't want to fight—at least not with human antagonists. They do not court the eye; they make themselves small. They burrow; they hide under stones, in crevices of rock, in folds of seaweed, in neat but unobtrusive tubes, built by themselves or borrowed. They mimic surrounding objects. They prowl about in the shells of untempting molluscs. In captivity some of them change colour; some of them flounder about as if indignant. The prawns and shrimps and hoppers make astounding and unexpected leaps and bounds—not into the arms of the intellectual observer, but in the other direction, in an unappreciative sort of way. There are Tanaids and Cumacea so tiny that to look for them in the sand which they inhabit is like looking for a needle in a pottle of hay. These can be obtained by stirring about a spadeful of the shore in a bucket of water, and then pouring the water through a fine net before the small animals have had time to bury themselves once more in the subsiding sand. The amphipod, *Haustorius arenarius*, can be obtained in the same manner, but also by simple digging, as it is a monster half an inch long. It will "scriggle" in the hand, but is warranted harmless. Often, however, when taken, it morosely or modestly folds itself up, unwilling to display the beauties which, were it an exotic species, would make it a prize. It appears to be little known, though widely distributed on the sandy shores of our islands; and much the same may be said of the species of *Urothoe* and *Bathyporeia*.

It should be remembered that the population of the sand is in general quite different from that of the seaweed-covered rocks and stones, and this is illustrated in a rather remarkable manner by the distinction between the sand-hoppers and the shore-hoppers, although the two groups are closely related. Of the rock pools it must suffice to say that, in sheltered and unfrequented spots, they are often Liliputian gardens of marine zoology, from which many interesting crustaceans may be gathered, either by examining tufts of weed or by fishing with a fine net. Different forms are to be expected, according as the climate of the district explored is cold, temperate, or tropical; but some species have an extremely extended and others a very

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* *Abdruck aus den Zoologischen Jahrbüchern*, Neunter Band, 1896.

† From *Trans. Liverpool Biol. Soc.*, Vol. XII., 1897.

limited distribution. The mangrove swamps of the tropics are distinguished by a highly remarkable crustacean fauna. The weed of the Sargasso Sea may be regarded as a kind of floating shore. It has its own crabs and shrimps. Turtles and hairy crabs play the part of floating islands to a considerable population, and an anchored buoy is often rich in amphipods among its fringing weeds.

Platyarthrus Hoffmannseggii (Brandt). From ants' nest, South of England.

To the general policy of concealment above described there are some exceptions. On the open shore the sessile cirripedes called Balani make no pretence of hiding. Being cemented to the rock, they cannot run away if they would, and they have little reason to wish for the power. The hermit crab may say, like an Englishman, "My house is my castle"; but the Balanus is a castle in itself. Six rigid interlocking valves make a stout wall round about it, and the movable valves above, through which from time to time the delicate cirri protrude, can be firmly closed down at the top. Great stretches of coast-margining rocks are coated with colonies of these Balani. But there are many other situations in which cirripedes occur. Like the spider, which impartially fastens its web to the rafter of a cottage or the ceiling of an imperial palace, the cirripede plants itself on the body of a whale or the carapace of a crab, on the iron sides of a merchantman or on a piece of pumice. It will cluster in dense masses round an old floating bottle, and some of the small species crowd the mouth-organs of crab or crawfish, with easy security, where they might seem to be running into the jaws of death. The sausage-like *Pachybdella carcini* is parasitic on the tail part of *Carcinus mænas*, the above-mentioned shore crab, and within reach of the claws of its host. Now, if there is one thing more than another about which the shore crab is touchy, it is about having its tail part drawn away from its breast, except by the intervening mass of its own numerous eggs. No doubt the heartless *Pachybdella*, brainless impostor though it be, is all the while making believe to be the eggs of the deluded shore crab. But the afflicting behaviour of parasites is too extensive a subject for the end of a chapter.

Of inland Crustacea there is much to be told, of which only a hint or two can here be given. Several of the groups are but poorly represented in our own islands. Apart from Entomostraca, our fresh waters can boast of a crayfish and here and there a prawn, of the isopod *Asellus communis*, and of a few Amphipoda in rivulets, lakes, and wells. We have nineteen species of terrestrial Isopoda, these woodlice including the small *Platyarthrus Hoffmannseggii*, found only in ants' nests—blind, slow moving, white; and the delicate *Trichoniscus roseus*—nimble, rose-coloured, and rare. Exotic species of sessile-eyed crustaceans may chance to be found in our botanic gardens as they have been in France. But no land crabs are likely to disturb our picnics, requiring as in Panama the flourish of a cudgel to repress their effrontery. No river crabs ascend the summit of Helvellyn to match those found at similar heights in Himalayan ricefields. No little mole of a crayfish burrows under our flower beds, as in Tasmania. We have no prawns like those of America, which rival the size of large lobsters; or like those of the Ganges, concerning which the Asiatic complacently observed to the fastidious Englishman, "Prawn eat nigger—nigger eat prawn." No hermit crabs on our hills confront the geologist as they do in the West Indies, marching about among the bush in large and heavy shells transported from the beach a thousand feet below. No *Birgus latro*, strange hermit without a shell, is here seen competing for cocoanuts as in the islands of the Pacific. But notwithstanding some deficiencies, our position is extraordinarily favourable for the study of Crustacea. The extensive seaboard with its many sheltered bays and inlets and harbours; the variety of climate from north to south and from summer to winter; the differing depths of water round our coasts; the ebb and flow of tides; the mud, the sand, the weeds, the rocks, the stones of the shores; the frequent occurrence of wooden piles for piers or breakwaters, of buoys and other floating objects; the abundance of fish and of empty shells, severally enable us to accommodate a multitude of crustacean species out of proportion to the space our islands cover on a map of the world. To become familiar with the names and with the nature, with the habitat and with the habits, of all these species, will be found a task the more inexhaustible the more absorbing the industry brought to bear upon it.

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NEBULÆ AND REGION ROUND γ CASSIOPEIÆ.

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

THE photograph covers the region between R.A. 0h. 45m. and R.A. 0h. 55m. 57s.; declination between 59° 21′ and 61° 2′ north. Scale—one millimètre to twenty-four seconds of arc.

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

Star (.)	D.M.	No.	124	Zone	+60°	R.A.	0h. 47m. 7·5s.	Dec. N.	60° 33·9	Mag.	5·0
,, (..)	,,		146	,,	59°	,,	0h. 50m. 45·6s.	,,	59° 49·3′	,,	6·3
,, (.:)	,,		137	,,	60°	,,	0h. 51m 16·1s.	,,	60° 53·1′	,,	7·0
,, (::)	,,		161	,,	59°	,,	0h. 53m. 57·5s.	,,	59° 58·3	,,	7·2

The photograph was taken with the twenty-inch reflector on 1895, October 25th, between sidereal time 0h. 16m. and 1h. 46m., with an exposure of the plate during ninety minutes.

On the *north following* side of γ are two nebulæ having the outlines of cones or fans, with faint nebulosity between them, which on the negative can be traced nearly the whole distance between one nebula and the other; the apexes of the nebulæ are bright, and the brightness diminishes gradually into invisibility as it expands outwards from the conical ends. The nebula farthest from the north is brighter than the other, and both have a cloud-like structure, with many stars of between the ninth and seventeenth magnitudes involved, apparently, in them.

The following are the measured position angles and distances of the nebulæ.

Position angle from γ of the faint star touching the apex of the conical end of the northernmost nebula, 14° 26′ 12″; distance from γ 22′ 46″. Position angle of the faint star touching the apex of the other nebula, 57° 34′ 51″; distance from γ 19′ 19″.

A photograph of the region here referred to was taken on 1890, January 17th, upon which the two nebulæ were faintly, but distinctly, shown; and I have compared the

NEBULÆ NEAR γ CASSIOPEIÆ.

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

original negative of that photograph with the one here depicted, with the result that no obvious change could be detected to have taken place, either in the nebulæ themselves, or in the relative position angles, or distances between them and γ, or of the surrounding stars.

An interval of five and three-quarter years is therefore too short to show sensible changes to have taken place in these objects. From this it follows that their distances from the earth are great; and we have yet no unquestionable evidence to prove that the nebulæ are physically connected with the star γ, but their apparent distances from the star are not too great for us to entertain the possibility of such a physical connection.

The diffused patch of light surrounding γ must not be mistaken for nebulosity; for it is caused by the strong light of the star illuminating a part of the earth's atmosphere affecting the photographic plate during the exposure. This atmospheric glare is of the same character as that observed in forming halos round the sun, moon, and bright stars; but the possibility of the star having an extended coronal light around it should not be omitted from consideration, for, though it might exist, its structure would be masked on the photograph, by the atmospheric glare, as effectually as that of the solar corona is masked.

There are many stars visible on the negative involved in the patch of glare, but they cannot be reproduced on the photo copies, for the reason that if the glare is printed out so also are all the stars that differ but little from it in density.

A dense photo image of the star can be obtained with the twenty-inch reflector in a small fraction of a second of time; but an exposure during an hour, or more, is required to show the fainter parts of the nebulæ, and the faint stars, with clearness.

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THE RECENT ECLIPSE.

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

The methods of investigation employed during the late eclipse were so numerous, and their general success so great, that it seems impossible to give any adequate account of the entire campaign in a single paper. I have therefore thought it would be better if I confined myself to the work on which my wife and I were immediately engaged, and I have no doubt that the editors will easily be able to arrange for a succession of similar papers, contributed by observers engaged in other departments.

My wife and I, when we contemplated going to India to take part in the eclipse observations, found ourselves confronted by an extremely difficult problem. Our instrumental means were of the very smallest. They consisted of a small binocular, one eyepiece of which was fitted with a little direct-vision prism, and of a photographic camera, the lens of which, though of high quality, had but an aperture of one and a half inches, and a focal length of nine inches. We could not but compare, with something like a feeling of dismay, this almost microscopic equipment with the magnificent instruments with which the members of the official parties were furnished, or which the directors of large observatories had at their disposal. We were standing up in line, armed with our little flint-headed arrows, whilst our comrades in the battle were rejoicing in the possession of Maxims and Lee-Metfords.

Still, after looking the problem round, we concluded that it was not one to lose heart over. We saw our way to at least trying three lines of work. With the opera-glass and prism I intended to ascertain the distribution of coronium in the corona, and especially to see if it showed the rifts and rays which form so striking a feature of coronal structure as it appears to the eye. With the camera, we thought that we might try, first, by giving a very long exposure to obtain an image of the long coronal streamers, and secondly to photograph the corona, if possible, after the end of totality.

All three enterprises appeared very hazardous. It was exceedingly doubtful under the first head whether, with so small a dispersion, the 1474 K light would be sufficiently strong to declare itself over the continuous spectrum which the corona also gives. The attempt to secure the long extensions was less likely still. Only a week or two before we left England Miss Clerke, whose admirable judgment and exact insight in astronomical matters have deservedly won such wide and general confidence, had written :—" . . . the camera, owing to special difficulties, has not yet been able to pursue them [the coronal extensions] so far as four solar diameters." (" Concise Knowledge Library," Astronomy, p. 268.) And Mr. Albert Taylor, in a paper read before the Royal Dublin Society in 1894—a paper evidently most carefully thought out and in the conclusions of which our own experience led us to place great confidence—had laid down that the maximum effective exposure for F/15 in coronal photography was thirty seconds—that is to say, for our camera five seconds. Such exposures had on former eclipses failed to give any great extensions; indeed, had generally proved less effective than shorter exposures, from the cause Mr. Taylor so clearly points out—the great brilliance of the sky background. Whilst the last item on our programme seemed, *à fortiori*, to be more doubtful still.

It will be seen that our prospects did not appear too brilliant. Nevertheless, we felt strongly that if new fields of eclipse work were to be opened up it necessarily involved the risk of failure in the first experiments, and those first experiments might be made as effectively on a very restricted scale as on a large one. Their success would be no less indubitable, their failure far cheaper.

And we felt that we were justified in undertaking this risk. We received absolutely no financial help from Government or any other public body,[*] either for our equipment or for our personal expenses in our expedition, and we were therefore hampered by no restrictions whatsoever.

We had, moreover, grounds for hope. We had made a few experiments in the use of the " Sandell " double and triple coated plates, and had been convinced that they at least offered us a chance over and above that which ordinary dry plates afforded. It seemed to us that, by their use in conjunction with a slow and prolonged development, it might be possible to bring up the faint extensions of the corona before the sky glare blotted them out; whilst in view of Prof. Wadsworth's recent papers, the very smallness of the scale of our instrument formed an encouragement.

One difficulty, however, remained. The second item in our programme demanded an equatorial and driving clock. These we were without, but the Council of the Royal Astronomical Society very generously placed at our disposal the pretty little equatorial and camera bequeathed to it by the late Mr. Sidney Waters, f.r.a.s., and met the expense of putting it into full working order.

The camera attached to this equatorial was not suitable

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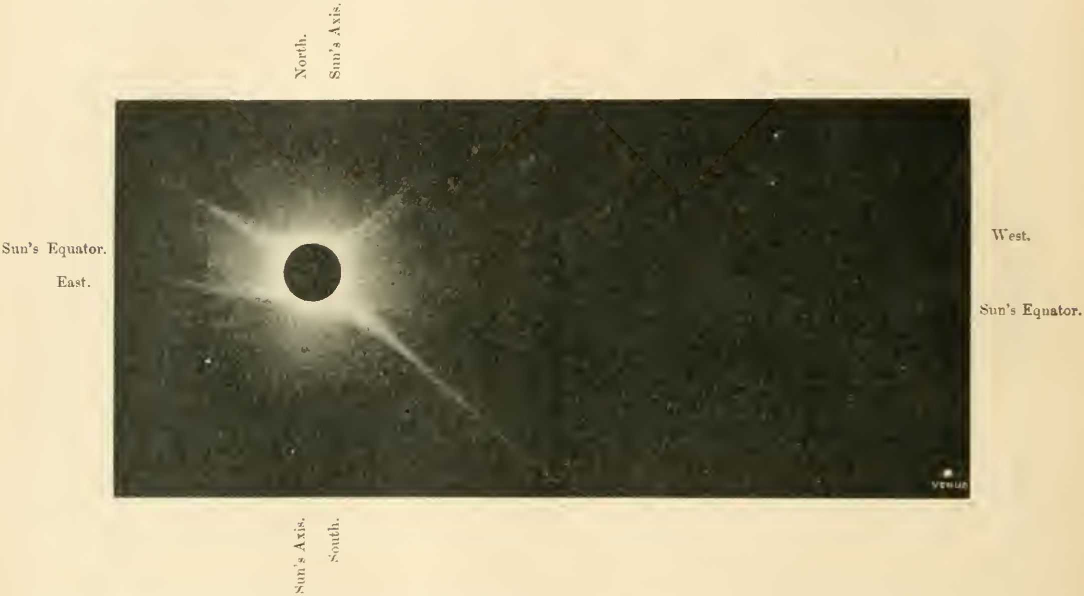
[*] The generosity of two members of the British Astronomical Association enabled the Eclipse Committee of that body to undertake the expense of insuring the instruments taken out by the members of its two expeditions, and we have to thank them for our share in this benefit.

for the special work which we had in contemplation, but it seemed to us that we might make good use of it. It was fitted with one of Dallmeyer's telephotographic lenses, and had a full aperture of nearly two and a half inches and an equivalent focal length of almost eight feet. The magnifying power employed was therefore very nearly twelve diameters. This appeared to us much too high, but the definition which we actually obtained justified Mr. Waters in his choice of so great a scale, and forms the highest possible testimonial to the quality of Mr. Dallmeyer's optical work. Our idea was that with the two cameras we might obtain a series of photographs, the equivalent exposures of which might be arranged so as to form a geometrical series ranging from the shortest up to Taylor's limit. The common ratio in this case was about four and a half, and, taking Taylor's limit as unity, ranged from one four-hundredth up to one. We thought this additional item would not be devoid of interest, as it seemed to us that not a few coronal photographs on former occasions had failed to be so successful as they might have been through over exposure.



So much as to our programme; now as to our results.

With the prismatic opera-glass, my first sensation, after watching the indescribably beautiful changes which the spectrum underwent as totality came on, was one of profound disappointment. The continuous spectrum entirely swamped nearly all the bright rings except those of hydrogen and helium; and the 1474 K ring, either because it was fainter on the eastern side than on the western, or because my eyes took some time to become attuned to the light, was not seen till after the middle of totality. It was then detected over an arc of about one hundred and forty degrees—that is to say, only in the semicircle round the point of third contact, and not over the whole of that, as the continuous spectrum was necessarily so bright at its two edges as to swamp the bright line spectrum there. Still, over this one hundred and forty degrees the "coronium" ring was perfectly continuous, it was interrupted by no rifts, it spread out into no rays. It was traceable to a height of between five and six minutes from the moon's limb, and corresponded therefore very closely to what to the eye appeared to be the brightest inner corona. So far, then, "coronium" appears to be pretty evenly distributed round the sun, and not to follow the striking and characteristic forms which attract such notice in the corona as seen directly.

Our second field of work, the attempt to photograph the long coronal streamers, met with a most wonderful success. Our two long-exposure plates—four times Taylor's limit—equivalent to one hundred and twenty seconds with F/15—showed the four principal coronal streamers to a much greater distance than ever before. They can be clearly and unmistakably followed to distances from the moon's centre of three, four, four and a half, and six diameters respectively. In the case of the great south-west ray we believe that we have traced it, though very feebly, under suitable illumination, to a much greater distance still, and we may have further remarks to make upon its details on some future occasion. As it is, however, it is beyond challenge that this south-west ray is shown clearly and distinctly upon two photographs much further than has been the case in any photograph of the corona that has ever been taken before.

Indeed on three photographs. For beside these two long-exposure photographs taken on "Sandell" plates (kindly developed by Mr. J. T. Sandell himself), a third photograph taken with one quarter the exposure—practically Taylor's limit—an "Ilford extra rapid" plate which we developed ourselves, might have claimed, had it not been for the two "Sandell" plates, to have given the record coronal extension.

The orientation of these three plates is given with great precision by the presence upon them of Venus, which burned like a lamp some six degrees away from the sun. The plates were amply large enough to take in the planet, since they were sixteen centimètres square; and the focal length of the lens being nine inches, six and one-third degrees correspond to an inch, and the solar diameter is almost exactly one-twelfth of an inch.

We learn at once by this means that the great south-west ray, so far from coinciding with the sun's equator, lay in thirty-five degrees south latitude. The two rays which composed the "fishtail" on the eastern side of the sun, lay some twenty-four degrees north and south of the equator respectively, the equator itself therefore being void of any great streamer.

It will be seen that, in disregarding Taylor's limit, we have been abundantly vindicated by the result. Nevertheless, the considerations Mr. Taylor urged in the paper alluded to substantially held good. In developing these plates, even the one with only five seconds exposure, the general sky glare came up deep and black at an early stage. Here we owe our success to the fact that we exposed two plates for each given exposure. The companion plate to the Ilford five seconds was in itself a comparative failure, but its development gave us the experience and courage necessary to push the development of its more fortunate comrade to a successful conclusion.

Our last photograph was the most important. Totality was over by nearly two minutes when we exposed a plate with our little camera for a second and a half. This on development yielded us not only the brilliant arc of sunlight, but showed an unmistakable coronal ring, for the entire dark disc of the moon is seen upon it.

This success, we may well hope, will have far-reaching effects. It is a very long way from realizing that ambition of so many astronomers, the photographing the corona in *full* sunlight. But the corona has never before been photographed unmistakably and beyond challenge in *so much* sunlight. And even should it never lead on to the desired goal, something has at least been done to lift large partial eclipses from the category of being astronomical mere waste material. It will be a distinct advance if in future we can fix the positions of the roots of the great coronal rays on such more frequent occasions: a most necessary advance if we are to learn the true nature of coronal change and motion.

Our experiments, therefore, were successful beyond our hopes, and their success seems to justify us in having made them. Yet had they failed we feel that we should have been not one whit less justified.

But our photographs are on an almost microscopic scale, and although sufficient to prove the practicability of our methods it is much to be desired that they should be repeated on the next occasion with ampler means. We feel it incumbent on us, if any way possible, to take part in the observation of the next eclipse, that of May 28th, 1900. We want to photograph the sun during the entire period of the partial phases, to give a considerable range of exposures, and to try the effect of various developments. We want, in short, to follow the corona to the utmost extent which the sunlight permits. We want also to obtain the greatest possible extension of it. We want also to give two exposures during totality of much greater length than the longest we gave in India. These experiments we are prepared to carry out with the little camera which has just done us such yeoman service, but we earnestly hope that we may also be entrusted with instruments that may enable us to duplicate this programme, but on a much larger scale.

The accompanying pictures are reproduced from drawings which Mr. W. H. Wesley has most kindly made from the original long-exposed photographs. Amongst other details of interest Mr. Wesley especially remarks on the corroboration which these negatives afford of certain well-known drawings of the corona. Hitherto there has been a wide difference between the corona as presented us on the sensitive plate and in drawings even of the most trustworthy observers, and this fact has thrown a good deal of doubt upon the value of such drawings. A comparison of the corona as here shown with the well-known drawing, by Captain Bullock, of the eclipse of 1868, shows a most remarkable resemblance between the two. If the two were representations of the same eclipse one could not ask a more complete correspondence.

Notices of Books.

A New Astronomy for Beginners. By David P. Todd, M.A., PH.D. (The American Book Company, New York. 1898.) This book deserves an appreciative welcome. It is moderate in compass, precise in plan, succinct in treatment. There is a freshness about it, too, that pleasantly reminds one of its origin in a "new" continent. *Loci communes* are few: the topics introduced are mostly discussed from an original point of view; students are made to feel the *inwardness* of them. A "pedagogic purpose" is throughout kept in view. The fundamental idea of the volume is to teach astronomy as a science of observation—to inculcate principles and indicate modes of working them out in practice, no matter how roughly, were the available equipment "but a yard stick, a pinhole, and the rule of three." One recalls—be it said without prejudice—the system in vogue at Dotheboys Hall of learning botany by planting cabbages. For, apart from the rigorous *sic vos non vobis* code there enforced, that system possesses high excellences and manifold resources, which Prof. Todd's sixteen years' experience as a teacher enables him to develop to the full. With resourceful ingenuity, he makes the "appeal to observation which can alone," as Huxley wrote, "give scientific conceptions firmness and reality." In the pages before us, precepts are given for pursuing a "laboratory course" in the study of the heavenly bodies; the construction of home-made apparatus, needing only "moderate mechanical deftness," is described preferably to the latest refinements of modern instrumental methods; nor can we doubt that its use, while flattering the instinctive egotism of beginners, tends at the same time to develop in them both mental alacrity and manual aptitude. The present author, while rightly dwelling upon "the importance of thinking rather than memorizing," lets them off with perhaps undue ease from the stern necessity of confronting mathematical difficulties. Yet we cannot find it in our hearts to quarrel with the capital illustration at page 398, where an instantaneous photograph of a "foul ball" at cricket replaces a formal demonstration that "a projectile's path is a parabola." The book is to a most praiseworthy extent "up to date." The newest results in every department are included in it—included, perhaps, with too slight an allowance of grains of salt, desirable *caveats* being here and there conspicuously absent. We note, however, with satisfaction that the author has boldly adopted Schiaparelli's long periods of rotation for Mercury and Venus, while withholding an unqualified assent from the hypothesis of "irrigation works" on Mars. A few slips and errors might be pointed out, but they are in general not very material. The most misleading is an attempt to explain stellar variability by the *direct* analogy of sunspots, the actually subsisting relation being of the inverse kind. Most of the illustrations are new and excellent. Only the coloured frontispiece savours of claptrap.

A History of Fowling. By Rev. H. A. Macpherson, M.A., M.B.O.U. (Edinburgh: David Douglas.) Illustrated. We have in this volume a detailed and exhaustive account of the many curious devices by which wild birds are or have been captured in different parts of the world. The energy, the pains, and the time which the author has expended in the compilation of his work may be gathered from the fact that his plan has been, as he tells us in the introduction, "to read through every ornithological work that I could find, in the five or six languages which are all that I can personally translate"; besides which he has elicited much information by correspondence with persons in Japan, China, Borneo, India, Australia, New Zealand, as well as in many different parts of Europe, Africa, and America.

The result is that we have a book which will long remain as a classic upon the subject of past and present fowling (exclusive of the use of gunpowder) in every part of the world. Comment upon such a book is needless, since it is evident at the outset that the author has made himself a thorough master of his subject. The book is profusely illustrated; many of the cuts being taken from rare and quaint prints and drawings specially prepared from specimens of traps and devices which the author has procured from many parts of the world. The book is printed and bound in the sumptuous style generally adopted by Mr. David Douglas—a style very well suited for a book of this character, but the use of which cannot be too strongly condemned for books which should be within reach of the purse of every naturalist.

It is neither our intention nor indeed within our province to dictate to anyone as to what he should do or what he should not do, but we cannot refrain from expressing our regret that so good an ornithologist as the author should have employed so much energy and time in a work of this character, which does little to advance the science in which he is so prominent and devoted a labourer.

What is Life? or, Where are we? What are we? Whence did we come? and Whither do we go? By Frederick Hovenden. (Chapman & Hall.) 6s. As the majority of people are rightly impressed with the complexity of the experiences and functions which are collectively referred to as "life," Mr. Hovenden's well-meaning efforts to reduce this complex expression to its simplest terms may, by those who judge books by their titles, be considered deserving of encouragement. An examination of the prolix argument, and perusal of the large amount of irrelevant matter contained in this volume, will, however, soon convince the reader that there are many things both in life and in Mr. Hovenden's explanations of it quite beyond comprehension.

The book, which comprises two hundred and eighty-four pages, is divided into three parts. The first of these consists of a statement of the case in two pages; the second is concerned with what the author calls the evidence proving the case; the third includes the deductions which Mr. Hovenden derives from the issue. The "statement of the case" is a bewildering succession of definitions of elementary truths and assertions which challenge contradiction. We have no space to multiply instances, but the following examples are typical of the uneven value of these statements:—"4. Time is the measurement of terrestrial motion." "9. All 'regeneration' arises from the influence of the prime factor, the ether, through which the inherent properties of the atom or molecule are made active. Hence, no ether, no regeneration."

In Part II. Mr. Hovenden succeeds in being interesting only when he confines himself to a description of well-recognized facts, and forgets his special mission. When he is possessed by the prophetic spirit he becomes impolite. Thus, on page 50: "The mathematician is so confident that his powers are absolute, and he is so dogmatic in his tone, that he is unapproachable. He stands alone, a monument of his own creation, in his own egotistical greatness." Or, page 53: "The public should study and grasp these ideas, which transcend the mind of the physicist, for the physicist has got into a fossilized condition; he will not move until that rising power, general intelligence, forces him." We trust that when this happens it will not mean the publication of more books after the nature of the present one.

We must refer the curious reader to the book for the contents of Part III. Mr. Hovenden becomes even more pronounced in his language when he speaks of the orthodox religious teachers of the time. On page 221, in dealing with the story of the fall of man, our author says: "What must we say, then, of priests who attempt to fossilize the mind within the limits of this grand *lie!—a lie which is damned.*" The italics are Mr. Hovenden's.

But we must leave this book, which Mr. Hovenden describes as his "contribution to the altruism which is to commemorate the jubilee of our beloved Queen Victoria," and as "the result of original experiments, earnest thought, of extensive reading, and of help from contemporary workers and thinkers. It is practically the work of a lifetime." We can only regret that the work of a lifetime should not have been better directed and more worthily employed.

The Sun's Place in Nature. By Sir Norman Lockyer, K.C.B., F.R.S. (Macmillan & Co. London, 1897.) 12s. The present work is, in the main, a republication of a series of "lectures to working men," given in 1894, at the School of Mines, by Sir Norman Lockyer, and which were published in *Nature* at that time.

We must at the outset enter our protest against the attacks upon one of the most eminent astronomers of the age which disfigure so much of the present book. They lower science and scientific men in the eyes of the public, and they tend to hide from the reader the real value of Sir Norman Lockyer's own work.

For if we could cut out from the present volume these unworthy attacks on Sir William Huggins, and the author's reiteration of his own infallibility—a good third of the book—we should have left a very large amount of most valuable scientific material, most of which has been the work of Sir Norman Lockyer himself or has been gathered under his superintendence. Prof. Lockyer's industry in the collection of facts and opinions is great, and this book, like the "Chemistry of the Sun" and the "Meteoritic Hypothesis," will be very useful as a work of reference.

The chief points dealt with in the work are, in the first book, the romantic story of the discovery of terrestrial helium; in the second, the demonstration that nebulæ and stars are but stages in one and the same evolution; the third book is an attempt to reinforce the meteoritic hypothesis from the observations of new stars; the fourth and final book is a strong argument that we have, amongst the stars, cases not only of diminishing but also of rising temperature, and incidentally that our sun should be included in the former class. Had the work been confined to the setting forth of these four subjects it would have demanded a very considerable meed of praise, though Sir Norman Lockyer is always too much theory-ridden to be quite a safe guide to the student. A further and serious drawback to the book is that several of the most important diagrams are completely spoiled in the printing.

The Concise Knowledge Astronomy. By Agnes M. Clerke, A. Fowler, and J. Ellard Gore. (Hutchinson & Co. London, 1898.) 5s. A handbook of astronomy from three such writers might well be expected to be one of most unusual excellence, and, as a matter of fact, there can be no question but that they have produced a very useful and interesting volume. And yet, those to whom the deservedly high reputations of Miss Clerke and Mr. Gore are known, will scarcely avoid a feeling of disappointment. This is chiefly due to the untoward conditions under which these two gifted writers have had to work. To Miss Clerke are assigned two sections of the book—a history of astronomy and the section on the solar system. The former has been limited to thirty-six pages and has been marvellously well done within this contracted compass. It is true that it begins only with Hipparchus, omitting absolutely all reference to the astronomies of Chaldea and early Egypt, and the enforced rapidity of its glance gives no opportunity to the author fairly to exercise her research or her grace of style. In the third section, on the solar system, also entrusted to her, Miss Clerke has an ampler space, which she therefore uses to much better effect, but which is yet too confined for her subject. And we notice in not a few instances that an unfaltering verdict is given on subjects which are still before the court. No doubt, did space permit, the evidence for and against would have been fairly presented. We may mention as illustrations the rotation of Venus and the nature of the zodiacal light.

Mr. Gore in the fourth section, on the sidereal heavens, has brought together a vast amount of important information; but it is simply a reference book, carefully collated, well arranged—not a treatise.

Mr. Fowler, in section two, on geometrical astronomy and astronomical instruments, deserves unqualified praise, and has handled his subject in a clear, straightforward, businesslike manner. We may mention the conditions, number, and recurrence of eclipses, the "hunter's" and "harvest" moons, amongst many others as subjects which he has treated with special lucidity. We would only take some exception to the title "Geometrical Astronomy" as applied to his section, as the term so used is a little apart from its ordinary acceptance.

In conclusion the book is admirably illustrated by five fine plates and a number of clear diagrams. Its faults, which are few, are almost inseparable from the plan of such a handbook; and as carried out by its three authors the book is most thorough, trustworthy, and complete.

SHORT NOTICES.

Physiography for Advanced Students. By A. T. Simmons, B.SC. (Macmillan.) Illustrated. 4s. 6d. Intended for students preparing for the examinations of the Science and Art Department, this book is one of the best which we have seen for that purpose. There are many others in the field written on similar lines, but in this one a large section is devoted to geology—a subject which, in the new syllabus, has been considerably modified—and in many other respects the author has contrived to adapt his subject-matter to the latest requirements of that unstable syllabus of physiography which, ever since its first inception, has been undergoing a kind of metamorphosis that renders all books on the subject of an ephemeral character. Hence the never-ending procession of them, which, like Banquo's line of kings stretching out to the crack of doom, quickly follow on the heels of each other.

Elementary Physics, Practical and Theoretical. First Year's Course. By John G. Kerr, M.A. (Blackie.) Illustrated. 1s. 6d. Intended for organized science schools, this book deals with both practical and theoretical physics, and includes mechanics and hydrostatics for first year students. The treatment of the subjects is conventional, yet sound. The book will, no doubt, serve as a useful lever for the purpose of lifting students over the stile in those formidable examinations of the Science and Art Department.

We have received from Messrs. George Philip & Son a little book entitled "A Popular Introduction to the Study of the Sun," by George Mackenzie Knight, a very young man, who displays a wonderful insight into that complex subject—cosmography. Mr. Knight is already known as the author of a short history of astronomy. The work under notice is written in an eminently popular style, and, as the production of a young man only twenty years of age, it augurs well for the author's future as a man of letters. The book is inscribed to the late Mr. Ranyard, who took a friendly interest in the youthful astronomer's earlier work.

Remarkable Comets. By William Thynne Lynn, B.A., F.R.S. Sixth Edition. (Stanford.) 6d. The present edition of this little brochure is brought up to date. All the most remarkable comets from the earliest times up to the present day are here described. A list of comets which are expected to return during the next hundred years is inserted at the end of the book.

The Story of the British Coinage. By Gertrude Burford Rawlings. (Newnes.) Illustrated. 1s. Our author has presented the history of our coinage from the earliest times. Each coin is exactly described, and many of them are figured on both the obverse and reverse sides. Colonial coins also are included, and photographic reproductions given, the whole forming a very complete and handy guide to what may be called British numismatics.

BOOKS RECEIVED.

William Moon, LL.D., and his Work for the Blind. By John Rutherford, M.A. (Hodder & Stoughton.) Illustrated. 5s.

Cantor Lectures on Gutta-Percha. By Dr. Eugene F. A. Obach, F.I.C. (Society of Arts.)

A Student's Text-Book of Zoology. By Adam Sedgwick, M.A., F.R.S. (Sonnenschein.) Illustrated. 18s.

With Peary near the Pole. By Eivind Astrup. Translated by H. J. Bull. (C. A. Pearson, Ltd.) Illustrated. 10s. 6d.

The Free-Trade Movement. By G. Armitage-Smith, M.A. (Blackie & Son.) 2s. 6d.

Musical Statics. By John Curwin. New Edition. Revised by T. F. Harris, B.SC. (Curwin & Sons.) Illustrated. 3s. 6d.

A Simple Photographic Guide to the Choice of a Photographic Lens. By T. R. Dallmeyer. (Dallmeyer, Ltd.) Illustrated.

Elementary Chemistry. First Year's Course. By T. A. Cheetham. (Blackie.) Illustrated. 1s. 6d.

Practical Radiography. By A. W. Isenthal and H. Snowden Ward. Revised Edition. (Dawbarn & Ward.) Illustrated. 2s. 6d. net.

Notes on Observations. By Sydney Lupton, M.A. (Macmillan.) 3s. 6d.

Essays on Museums. By Sir William Flower, K.C.B. (Macmillan.) Illustrated. 12s net.

Radiography and the X Rays. By S. R. Bottone. (Whittaker.) Illustrated. 3s.

Meteorological and Magnetic Observations. (Stonyhurst College Observatory. 1897.)

The Barometrical Determination of Heights. By F. J. Cordeiro. (Spon.) 4s. 6d.

The Process of Creation Discovered. By James Dunbar. (Watts & Co.) 7s. 6d.

A Text-Book of Botany. By Drs. Strasburger, Noll, Schenck, and Schimper. Translated from the German by H. C. Porter, PH.D. (Macmillan.) Illustrated. 18s. net.

What is Science? By the Duke of Argyll. (David Douglas.)

Bibliography of the Metals of the Platinum Group. By Jas. Lewis Howe. (Smithsonian Miscellaneous Collections.)

The Mammals, Reptiles, and Fishes of Essex. By Henry Laver. (Simpkin, Marshall, & Co.) Illustrated.

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

Notes from Dublin Bay.

Ruff.—On the 28th of August I obtained a pair of Ruffs in immature plumage, and also saw another one.

Curlew Sandpiper.—On the same day I saw large flocks of Curlew Sandpipers; one flock certainly could not have been less than five hundred strong. It passed quite close to me, the white upper tail coverts of the birds being very conspicuous, thus easily distinguishing them from the Dunlin when flying.

Avocet.—In the beginning of October I saw an Avocet, which stayed about the marshes till the last week in the month, but I failed to add him to my collection.

Albino Varieties of Mistle Thrush, Common Snipe, Woodcock, and Curlew.—The following is a list of the varieties which came under my notice last season.

Mistle Thrush.—October 5th; bluish white all over, showing the markings of the breast and throat. This seems a very persistent variety, as a winter seldom passes without two or three specimens coming under my notice. This, like all the other ones I have seen, was greatly frayed along the edges of the wings and tail. The owner informed me that it had been mobbed by other Mistle Thrushes for at least a month during which it was under his observation.

Common Snipe.—October 10th; perfectly white all over, eyes dark, bill and feet light yellowish brown. Obtained in Co. Meath. November 27th; whole plumage rich buff, the usual Snipe markings showing through. One of the commonest varieties of this species; usually get three or four in a season. Obtained in Co. Kerry.

Woodcock.—December 6th; whole plumage a beautiful buff, with a bluish sheen on wings and tail, bars and markings a bright brick red. Beak and legs reddish brown. From Co. Tipperary.

Curlew.—January 4th; whole plumage white, with usual markings showing against the white background; a most striking variety; bill and feet tan colour. Shot by Mr. Young, Brockley Park, Queen's County.—E. Williams, 2, Dame Street, Dublin.

Water Pipit (Anthus spipoletta) in Carnarvonshire.—At a meeting of the British Ornithologists' Club, held on January 19th, Mr. Howard Saunders exhibited an immature example of the Water Pipit which had been procured by Mr. G. H. Caton Haigh on December 3rd, 1897, in Carnarvonshire.

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.*

Note.—The first issue of Knowledge containing British Ornithological Notes was that for October, 1897.

Science Notes.

At a recent meeting of the Members of the Institution of Electrical Engineers, Mr. Robert Hammond explained in detail a method by which electrical energy on a large scale will, at an early date, be generated and at the service of consumers. The cost, it is stated, will be such as to bring the electric light within the sphere of all light-users, as the distribution can be effected at the rate of about three farthings per unit.

Neptune's diameter, according to a recent determination by Prof. Barnard, is 32,900 miles.

Sections A to K of the British Association at the Bristol meeting in September next will be respectively presided over by Prof. W. E. Ayrton, f.r.s.; Prof. Francis R. Japp, f.r.s.; W. H. Huddleston, f.r.s.; Prof. W. F. R. Weldon, f.r.s.; Dr. J. Bonar; Sir John Wolfe-Barry, f.r.s.; H. E. W. Brabrook, c.b.; and Prof. F. O. Bower, f.r.s. Sir William Crookes, f.r.s., is the President elect, and he will deliver his address on Wednesday evening, 7th September. Prof. W. J. Sollas, m.a., f.r.s., and Mr. Herbert Jackson, will deliver the two evening discourses.

The third annual Congress of the South-Eastern Union of Scientific Societies, whose President is the Rev. T. R. R. Stebbing, will be held at Croydon, on June the 2nd, 3rd, and 4th. A number of interesting papers are to be read and discussed, among the contributors being Mr. J. W. Tutt, Mr. C. Dawson, Prof. J. Logan Lobley, Mr. Fred. Enoch (on the "Life History of the Tiger Beetle"), and Prof. G. S. Boulger, who will deliver the annual address, as President elect, on June 2nd. The hon. secretary is G. Abbott, m.r.c.s., 33, Upper Grosvenor Road, Tunbridge Wells.

As an indication of the interest centred in technical education, the vast sum of money raised for the Northampton Institute, Clerkenwell, is convincing. On the 18th March the Lord Mayor inspected and formally opened the buildings, which, together with the equipment, have cost upwards of £80,000. In addition, the land, generously given by the late Marquis of Northampton, is estimated to be worth not less than £25,000. Dr. Mullineaux Walmsley, the Principal, is a man of great experience in applied science, and a casual inspection of the programme of studies to be carried out under his direction augurs well for the artizan classes. Examinations (to youths and men of this class) are a bugbear, and it is gratifying to note that this institute provides courses of lectures and demonstrations for nearly all trade subjects at twopence per lecture, without any stipulation as to examination for the purpose of grant earning.

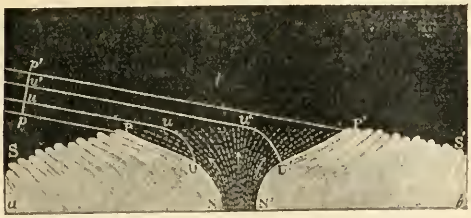
Letters.

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

THE LEVEL OF SUNSPOTS.

To the Editors of Knowledge.

Sirs,—The instructive article on "The Level of Sunspots," by the Rev. Arthur East, in your last issue, part of which dealt with the probable refraction of the umbra by the vapours on the solar surface within the spot cavity (an opinion which he has already expressed in a recent paper to the British Astronomical Association), is interesting from the fact that the late R. A. Proctor had arrived at the same idea many years ago. In Proctor's "Old and New Astronomy," on page 381, the figure (257) is sufficiently explanatory as embodying this idea; and on page 382 the footnote reads :—“ In Fig. 257 I indicate a way in which the width of the penumbra on the side furthest from the sun’s edge (occasionally equal to the width of the side nearest to the edge) may be explained by the refractive action of the vapours within the spot cavity. The lines Pp, Uuu, U'u'u', and P'p', are supposed to be lines of sight from the earth when the spot is viewed aslant.”



Ideal Vertical Section of a Sunspot in the earliest stage of its development.

We must, however, thank the Rev. A. East for the beautiful experimental illustrations of this point.

From the satisfactory way this theory simplifies many of the difficulties connected with spot phenomena, it is somewhat surprising that it has not found its way into more general favour and recent text-books.

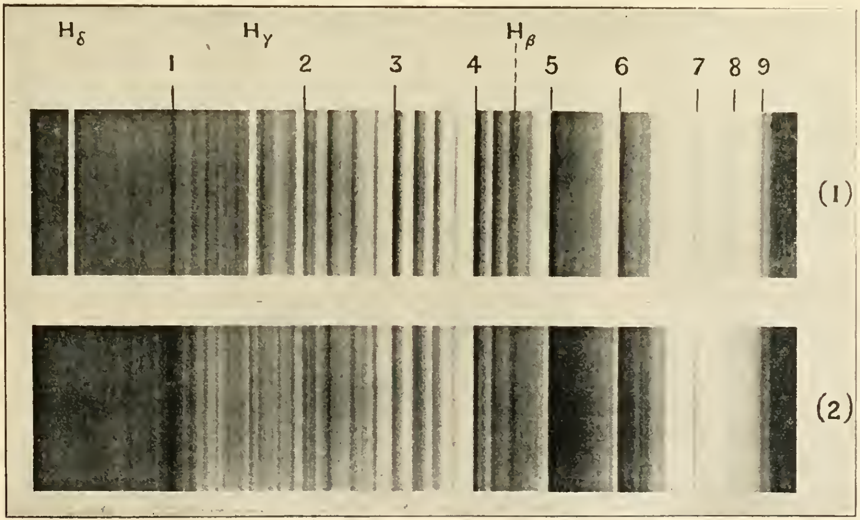
Wm. Shackleton.

Royal College of Science, London,
April 11th, 1898.

PHOTOGRAPHED SPECTRA OF o CETI AND α HERCULIS.

By the kindness of the Rev. W. Sidgreaves we are enabled to give the accompanying reproduction of two beautiful photographs of these most interesting stellar spectra, obtained at the Stonyhurst College Observatory in December and February last. The spectra are on the same scale as that of o Ceti given in the number of Knowledge for March (page 61), but are prolonged a little in both directions, extending, in the orange, below the D lines; and the reference numbers to the great absorption bands, accidentally displaced in the earlier reproduction, are here given in their proper places.

The juxtaposition of the two spectra brings out clearly their very significant likenesses and differences. Under the former head comes the series of great fluted absorption bands which forms the distinguishing feature of this stellar type. Under the latter may be noticed the greater structural detail in the bands of α Herculis, the presence of numerous fine lines, and the appearance, whether actual or a mere contrast effect, as of a very bright line to the blue of the sharp edge of the dark bands, especially of bands four, five, and six. The spectrum of o Ceti, on the other hand, is especially distinguished by its two bright lines of hydrogen, γ and δ. The comparison of the two spectra at the places of the three hydrogen lines renders more distinct the relationship of these to the rest of the spectrum, and emphasizes the remarkable fact of the absence of the third line, Hβ; the line which we should have rather expected to show its presence with the greatest plainness.—E.W.M.



Photographed Spectra of o Ceti (1), 1897, December, and α Herculis (2), 1898, February.

λ
1 = 4227.
2 = 4420.
3 = 4581.

λ
4 = 4757.
5 = 4951.
6 = 5162.

λ
7 = 5447.
8 = 5597.
9 = 5756.

Stonyhurst College Observatory.

A BRILLIANT METEOR.

To the Editors of Knowledge.

Sirs,—Last night at 10.20 I saw an extremely brilliant meteor, which appeared a little south and east of Procyon, and disappeared quite at the zenith. In spite of the bright moonlight it was a very conspicuous object of bluish white colour; its course appeared (perhaps from my point of view) to be quite straight, and occupied about five or six seconds of time. It seemed simply to "go out" at last, without explosion, sparks, or anything else.

April 6th, 1898. G. Northover Stretton.

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MERCURY.

To the Editors of Knowledge.

Sirs,—I think it may possibly interest some of your readers to know that I observed Mercury to-night, unassisted, except by a mental knowledge of its R.A. and Dec., at the short interval of seven minutes only after sunset, from my window at King's Cross. Is not this a record for a London view? It was conveniently observable until 7.50 p.m., except at infrequent intervals, when it was obscured by stray clouds. C. B. Holmes.

April 12th, 1898.

P.S.—It was between three and four minutes to seven when it first revealed itself.

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NATURE'S FINER FORCES.

SOME NOTES ON OLD WORK AND NEW DEVELOPMENTS.

By H. Snowden Ward, f.r.p.s., *Editor of "The Photogram."*

It is rather difficult to find a title for an entirely new subject which is still in its early days of investigation, and to which its pioneer has given no name. It is all the more difficult when three or four unauthorized persons have undertaken to christen the subject, when its scientific basis is uncertain, and when there is a suspicion that it may be closely allied to an older class of results which have a recognized title. The subject of the Bakerian Lecture before the Royal Society this year is extremely interesting, because it opens up a field of investigation in which the results are surprising and curious, while the methods are so simple and the requisites are so cheap that it is possible for anyone to take up the work and to carry the results a few stages further.

Dr. W. J. Russell gave his lecture the non-committal title of "Experiments on the Action exerted by Certain Metals and Other Bodies on a Photographic Plate"; and journalists who have recorded his results have given the subject such titles as Scotography (apparently because this is the name of a method of teaching the blind to write), Vapography (because the phenomena *may* be the result of vapour given off from the metals, etc.), and other equally appropriate titles.

Before dealing with Dr. Russell's observations it may be well to recall one or two older phenomena which do not seem to have been referred to in the discussion on Dr. Russell's lecture, but which may have a distinct connection with his work.

A common phenomenon, familiar to students, and even to many schoolboys, is the formation of "breath figures" upon a mirror, a piece of plate glass, or, better still, a polished metallic reflector. On the polished surface, which should be cold, lay any small object such as a coin. While this is in position breathe on the polished surface. Afterwards, for days and sometimes even for weeks or months, the image of the object may be restored by again breathing upon the polished surface; and this may be done repeatedly, even though the surface be well cleaned and polished.

A possibly kindred effect may be seen on windows to the inside of which a printed placard has been affixed. Though the printing ink does not touch the glass, it will be found, after the placard has been exposed for some time, that the window has acquired the property of condensing moisture on the parts near the printing ink of the placard differently from its condensation on other parts. And this property will remain for weeks or months, through repeated cleanings of the window.

In the early forties, M. Moser, of Konigsberg, and Robert Hunt, the British investigator on light, reported some extremely interesting experiments on the effects of contact between various substances and polished metallic plates; and after long, patient research Hunt attributed the results to difference of temperature, and called the process Thermography. He even went so far as to anticipate that the process might prove more valuable than photography when fully developed.

Hunt, working in the days of the Daguerreotype, when the photographic image was developed upon a metallic plate by means of vapours, applied the same method to the development of his thermographic images, with the result that he got strong and permanent representations of the objects laid upon his metallic plates. He found that dissimilarity in the objects and the polished plates was necessary; for instance, gold and silver coins gave good images on a copper plate, while copper coins did not act on copper. He noted further that the mass of the receiving plate affected the result, and that better images were made upon a large than upon a small sheet of copper, Using various pieces of glass, mica, tracing paper, etc., it was found that while some of the glasses and the tracing paper gave strong images, other glasses made little or no impression, and the mica left no trace. It was found that some objects of which no trace could be developed with mercury vapour gave good images with the vapour of iodine.

The later experiments bring us nearer to the results shown on dry plates by Dr. Russell, for Hunt found that objects separated from the metallic plate by air space of half an inch, or more, were capable of strongly impressing it after one night's exposure, and that a deal box acted very strongly. Further, that printed paper acted on the plate to such an extent that very good copies of any printed matter could be made, and it was in this direction that Hunt suggested the first practical application of Thermography.

Another set of observations, received with scorn by most of the scientific men of their day, but confirmed in 1883 by a committee of the Psychical Research Society, were those of Reichenbach, on what he called "odic force," a property which he found to emanate from almost all substances. Most of Reichenbach's observations were made by means of sensitive patients, who stated that they could see luminous emanations from various metals, etc.; and it is unfortunate that he did not carry out to a considerable extent his experiments with photographic plates — on which he did find results after the very few experiments made. I mention Reichenbach's work because his patience in research and verification was enormous, and his book ("Researches on the Dynamics of Magnetism") is full of reports of very suggestive experiments—researches which might now be repeated with lenses and photographic dry plates, with, perhaps, good results in the light of the recent work of Dr. Russell.

Scattered through the pages of the photographic journals are many reports of single observations, and short series of experiments on similar lines to those of Dr. Russell, and the results have been variously ascribed to heat, to X rays, to magnetism, to "dark light," etc.; but it seems to have been left to Dr. Russell to carry out a comprehensive series of experiments, and to—in some measure—raise the veil which has hitherto shrouded these phenomena in obscurity.

Dr. Russell found, incidentally, and in the course of experiments for another purpose, that zinc, if placed in contact with a photographic dry plate, had some action upon it which would enable it to be developed as if it had been exposed to light; and, further, that a similar action was exerted by many other metals, by wood, by strawboard, by many printed papers (which would leave a clear impression of their printed matter), etc., etc. All these results he detailed in a paper before the Royal Society about a year ago; and in the meanwhile he has been repeating, verifying, and extending his observations, with the results which were brought forward in the recent Bakerian Lecture. At first the zinc and other materials were placed in contact with the photographic plates, and it was found that after a week's contact an image could be developed which would plainly show such minute marks as scratches on the zinc; that the structure, rings of growth, etc., in a section of a pine tree, and even the grain of mahogany which had formed part of a piece of furniture, and had been practically in darkness for a couple of centuries or more, were also plainly visible; and that not only the printing, but also the water-marks and accidental defects on certain papers, could be developed on the plates. When the objects were placed at a little distance from the dry plate (gradually increased to an inch or more) the effect was still produced, but, of course, without any detail being visible. Not only would the action thus pass through an inch or more of air, but it also passed easily through gelatine, celluloid, collodion, and gutta-percha tissue. Glass was found to be quite impervious, though, curiously enough, glass was pervious to the emanation from some of the uranium salts which were tested, and which acted very strongly, whether in the dry state or in solution. This point is important, since it shows that there are at least two classes of emanation; and other experiments point to the possibility of there being several more.

Amongst the most active metals are zinc, magnesium, aluminium, nickel, lead, and bismuth. Cobalt, tin, and antimony are less active, while copper and iron are practically inert. Strawboard and fresh charcoal act very strongly upon the plate, as does copal varnish, even when quite dry and hard. In the earlier experiments mercury seemed to be one of the most energetic agents, but it had since been shown that pure mercury was inactive, and that the effects observed were due to zinc and lead contained as impurities.

With zinc, which is one of the most satisfactory subjects for experiment, it is found that the action is strongest when the face has recently been brightened (as by cleaning with emery paper), and that old zinc, which is considerably oxidized, has practically no effect upon the plate.

The possibility of the action being due to what may be called latent light was suggested, but Dr. Russell finds that the action is the same whether the active substance has been recently insulated or has long been kept in complete darkness.

The action of temperature is very important, and while the necessary exposure for a good impression is usually about a week (at a temperature of fifteen degrees Centigrade), an increase of temperature to fifty-five degrees will reduce the exposure to a few hours.

As to the cause of these results Dr. Russell does not speak with certainty, but he has made many experiments which confirm his idea that the effects are due to vapours given off by the objects. On this point a great deal of additional work is needed, especially in view of the significant facts that the most volatile metals are not the most active; that some oils and gums (such as turpentine and copal) will act strongly, while volatile substances like alcohol and ether have no effect; that the uranium salts act strongly through glass; and that a book printed so long ago as 1641 still gives a faint impression, while one dated 1805 gives a strong impression on the plate. If the results are due to a vapour it will be interesting to know the conditions under which it can continue to be given off through two hundred and fifty years.

Altogether the field of research is most attractive and promising, and the publication of Dr. Russell's results should lead very many investigators to take it up. If they do, I trust we may have more careful observation and less hasty publication than was revealed by many of the announcements made soon after the publication of the work of Prof. Röntgen.

BOTANICAL STUDIES.—III.

JUNGERMANNIA.

By A. Vaughan Jennings, F.L.S., F.G.S.

OUR last study* dealt with a type of fruit formation which is about the most highly developed among the lower cellular plants. In *Coleochæte*, while the vegetative part of the plant consisted of a simple cell-plate, it was noted that the reproductive process was far more specialized than that in the first type, *Vaucheria*.† It was observed that the egg-cell (or *oösphere*) after fertilization became surrounded by a layer of cells developed from adjacent tissues, and also that it subsequently divided into a number of separate bodies (*carpospores*), each of which could give rise to a new plant like the parent.

It is evident that both these modifications of the method of reproduction are of great advantage to the chances of survival of the plant. Not only is the egg-cell more protected in its resting stage, but by dividing into several independently living portions the probabilities of preservation of the type become vastly increased. Those genera in which the liberated carpospores have the greatest activity and the best power of resistance are those which will survive and multiply.

In the algæ, and certain fungi which are probably their degenerate descendants, this seems to be the highest stage reached in the evolution of "fruits" and the phenomenon of "*alteration of generations*." When we look for the next step there is a great break in the series, and one which we shall probably never be able to bridge over satisfactorily. There seems every reason to suppose that the early stages in the evolution of the higher plants resulted from the spreading of simple aquatic forms on to the land, their attempt to gain a footing there, and to adapt themselves to terrestrial conditions.

What the intermediate stages were there is no evidence to show. Delicate cellular plants have practically no chance of preservation in the rocks of the earth's crust, and geological science can give no help. The only available method of investigation is the study and comparison of living forms: their life history, and early stages of development.

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* Knowledge, March, 1898. † Knowledge, January, 1898.

There would seem to have been three alternatives open to the water plants which invaded the land. In the first place they might perhaps accommodate themselves to living under terrestrial conditions without undergoing much structural change. So long as moisture is abundant enough at times, a plant can, as it were, learn to do without it at others. It can live through times of dryness, and complete its life history when proper conditions are prevalent. Thus the simpler forms of the green and the blue-green algæ can be found in salt water, in fresh water, and on damp earth, trees, or brick walls; and even such highly developed forms as *Chroölepus* and *Phycopeltis* are distinctively land plants, though retaining all their algal characters. One is liable to forget that a very thin layer of moisture is sufficient in proportion to the actual size of these living cells: a consideration of much importance in connection with the reproduction of terrestrial cryptogams.

Other algal forms seem to have accommodated themselves to earthly life, even under conditions of extreme dryness, by entering into a mutual contract with certain fungi, and establishing the type of plants we know as lichens. This story is a biological romance in itself, but for the present outside our line of study.

The third alternative was the gradual change of the structure of the plant, so as to render it more capable of existence and propagation under altered circumstances.

In this process of accommodation of the plant to new conditions it became advantageous to develop parts which could penetrate the soil and absorb moisture and partial nutriment from it, as well as to raise some parts above the original level, to be sure of their reaching the sunlight. Thus in time resulted the well-defined distinction of root, stem, and leaf, with which we are naturally familiar.

The simplest of terrestrial plants—using the term for those distinctly modified for living on ground, as distinct from algæ—are the *Hepaticæ* or *Liverworts*. They can be found everywhere, on damp banks or rocks or tree-trunks, and they present a beauty and variety of structure that makes them a fascinating study to the microscopist.

There are the wide-spreading lobes of the flat thallus of *Marchantia* and its kin, to be found on moist banks everywhere; and in mossy places in the springtime the slender leafy branches of the *Jungermannias* grow and fruit with a fresh luxuriance which renders them, in the opinion of many, more attractive than their drier and hardier cousins, the mosses. It is unfortunate that names of such Teutonic clumsiness as Liverwort and Jungermannia should be applied to so graceful a group; but the necessities of scientific nomenclature oblige us to retain them.

So far as the vegetative part of the plant is concerned, the different genera do to some extent bridge over the space between the mosses above and the algæ below. Though in *Marchantia* the thallus has a structure so specialized as to show at once how widely it is separated from a simple seaweed, there are other forms, like *Riccia* and *Anthoceros*, in which the thin, green, plate-like thallus seems but little different from *Coleochæte*.

Yet all the forms included in the *Hepaticæ* differ from lower plants and agree with all higher crptyogams in the fact that the most essential part of the reproductive system is an "*archegonium*." So constant is this organ that the liverworts, mosses, ferns, and fern allies are now often grouped together under the name "*Archegoniatæ*."

An *archegonium* is a flask-shaped structure containing the oösphere. Its lower part is an oval chamber in which the egg-cell lies, and is prolonged upward into a neck composed usually of four columns of cells round a central axis. As the egg-cell becomes mature the cells of the central axis degenerate, so that a canal is formed full of a mucilaginous material, which projects also at the top of the neck.

The *antheridia* are little round or oval bodies occurring at the bases of the leaves of the same or a separate shoot. Their interior cells divide up into numerous minute *antherozoids* (or *spermatozoids*) which are capable of swimming by means of a pair of delicate cilia. They are, of course, so minute that even a raindrop is amply sufficient to enable them to reach the archegonia. When this occurs some of them enter the mucilaginous cap at the end of the neck, and, making their way down the canal, effect the fertilization of the oösphere.

Hepatics, then, differ from even the highest of thallophytes in the fact that the egg-cell is, even before fertilization, contained in a special structure intended not only for protection, but also modified to assist in the process of fertilization.

It might be expected that this advance in the preliminary stages would be followed by a corresponding elaboration of the fruit structure, but such is not the case. In aquatic types, such as *Coleochæte*, the resting stage seems to be a necessity to the oöspore in view of the future free-swimming life of the unprotected carpospores.

In a land plant, on the other hand, the swimming powers of the carpospores would be of little use in comparison with the far wider distribution attainable by the help of the wind. If the spores developed protective coats of their own they would be capable of considerable resistance to adverse conditions, and this appears correlated with a decreasing necessity for a resting stage of the oöspore.

Accordingly, what takes place after fertilization is an almost immediate enlargement of the fertilized egg-cell, and its commencing internal division into spores. At the same time the cells below it grow down into close connection with the tissues of the parent plant, forming a structure known as the *foot*. So that the spore-bearing generation or *Sporophyte* adopts the method of remaining in connection with its parent plant till it is ready to liberate its spores; instead of, as in the algæ, preparing itself to keep alive for a time after the parent plant has died down. In this way it differentiates itself into a *foot* which remains in connection with the parent tissues, a *seta* or stalk which grows upward, and a globular *sporangium* or *capsule* carried at its apex. The whole is thus not a fruit, but almost a second or alternative plant dependent on the first. It has no roots, leaves, or green colour (*chlorophyll*), and therefore cannot exist as an independent plant, but is nevertheless on the road to become one.*

The further stages in the life history differ, of course, in different genera, but the main features are remarkably uniform throughout the group.

The neck of the archegonium withers after fertilization of the egg-cell. Its wall enlarges for a time with the growth of the oöspore, but finally splits at the top, leaving a sheath, termed the *vaginula*, round the base of the up-growing sporophyte.

The tissues of the *sporangium* itself become differentiated into an outer two-layered wall and an inner cell-mass or *archesporium*. It is in the further development of the latter that we meet with the most striking difference from the corresponding organ in algæ, and the most evident modification for terrestrial conditions. The cells divide up into a large number of smaller ones, and while some of these develop into *spores*, the remainder change into long sterile threads termed *elaters*. The latter are long filaments

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* In one very interesting group of the *Jungermanniaceæ*, the archegonia are carried in a sac-like structure hanging down from the stem, and in some cases this may bury itself in the soil and even attempt to root itself.

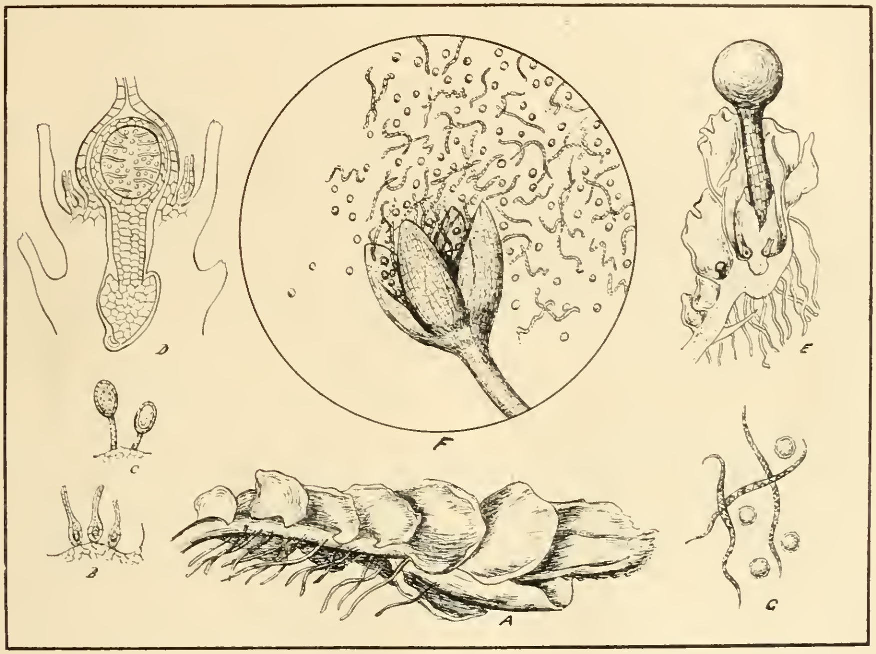
pointed at the ends, and possess a single or double spiral thickening-band. Their elasticity and response to changing conditions of moisture and dryness assist very much in the dispersal of the ripe spores.

Both spores and elaters are formed while the capsule is still surrounded by its "perianth," and the upgrowth of the seta commences later and takes place with great rapidity. Finally, when atmospheric conditions are suitable the capsule bursts, and in the *Jungermanniaceæ* always divides into four valves. Spores and elaters are thrown out and dispersed together. In some genera a number of elaters remain attached at one end to the tips of the segments of the capsule, but in the genus which forms the subject of our illustration they are all free. It is very interesting to note that, while the mosses and ferns dispense with this assistance to the liberation of the spores, it should occur in such different groups as the liverworts and the horsetails. Further, that a similar phenomenon is seen in those strange fungi, the Myxomycetes; and that a somewhat similar mechanism is employed in dispersing the seeds of some flowering plants.

The spores themselves are small spherical bodies with a single or double wall. Under suitable conditions the inner wall, when there are two coats, breaks through the outer, and the contained protoplasm grows out into a cell-plate or a cell-thread (*protonema*), which then buds out into a new plant and develops its own archegonia.

This protonema stage seems to be a "reminiscence" of the algal ancestor, but it is curious that it is far less evident here than in the true mosses, as will be seen later.

Meanwhile the parent egg-bearing plant or oöphyte may still continue to exist, and throw out fresh shoots to bear a new generation of archegonia and antheridia.



A.—The end portion of a shoot of *Nardia crenulata*, a simple type of the leafy Hepatics. The terminal leaves differ from the rest, and form a *Perianth*, at the base of which the reproductive organs are developed. B.—Archegonia of one of the leafy Hepatics (*Calobryum*). C.—Antheridia of the same. D.—Microscopic section through the apex of a shoot of a similar type (*Jungermannia*). Two unfertilized Archegonia are shown; one on each side. In the centre is the young "*Sporophyte*," resulting from the fertilization of a third Archegonium. The archegonial wall still remains as the *Calyptra*, with the lower part of the neck, but has enlarged with the growth of the Oöspore. The latter is already undergoing internal division to form Spores and Elaters. E.—The apical portion of a shoot of *Nardia*, showing an Antheridium and two unfertilized Archegonia. In the centre is the *Sporophyte*, consisting of a globular *Sporangium* carried up on a Stalk or *Seta*, and sheathed at the base by the remains of the Archegonium. F.—A ripe Sporangium or Capsule of *Radula complanata* at the moment of dehiscence, showing the splitting of the wall into four valves, and the ejection of the numerous Spores mixed with Elaters. G.—Spores and Elaters magnified. (A and E, after Engler; D, after Hofmeister; B and C, after Göbel.)

If, then, we summarize the results of our study of the liverwort, regarding especially the mode of reproduction and the interrelationship of the two stages of its life, we arrive at some such conclusion as this:—

When the water algæ tried to live on land some of them were able to do so with little change of structure and still retain their primitive character. Others gradually advanced by a specialization of the reproductive process and the evolution of archegonia, whether or not accompanied by increasing complexity of the thallus. This advantage in the life struggle was followed up by the persistence of the connection between the fertilized egg-cell, with its resulting growths, and the parent plant; just as the evolution of mammals has gone side by side with the progressive dependence of the young on the mother.

At the same time, the formation of spores with a strong protective coat became a necessity under the new conditions, and the accessory assistance of the elaters became of much value in securing the wide dispersal of the spores.

In the liverworts we have, in fact, an indication of a tendency on the part of the spore-bearing generation to assert itself as an independent plant. It will be our business in our future studies to try to discover what has been the result of this tendency, and along what lines it has acted.

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NOTES ON COMETS AND METEORS.

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

New Comet.—A bright comet was discovered by Mr. C. D. Perrine, of the Lick Observatory, Mount Hamilton, on the night of March 19th. The position of the comet was at R.A. 319° 39′, Dec. 16° 43′ N., and it was moving rather quickly to the north-east. Its brightness was estimated as of the seventh magnitude, the diameter of the coma was two minutes, and it had a tail about one degree in length. Elements were computed by Ristenpart and by Hussey and Perrine, from which it appeared that the comet had just passed its perihelion, and was receding from the sun and earth. From observations between March 19th and 31st, Kreutz, of Kiel, gives the following elements :—

Perihelion passage	1898, March, 17·37558		
	°	′	″
Longitude of perihelion ...	310	8	11·7
Longitude of ascending node	262	33	59·6
Inclination	72	27	48·1
Perihelion distance ...	1·0986		

The perihelion place of the comet occurred, therefore, at a distance of about nine millions of miles outside the orbit of the earth. The position of the comet will be as follows :—

Ephemeris by F. Möller, for Berlin, Mean Midnight.

		R.A.			Declination.		Distance in millions of miles.	Brightness.
		h.	m.	s.	°	′		
May	4	0	53	16	+51	57·4	177	0·47
,,	8	1	15	0	+53	14·7	182	0·42
,,	12	1	36	25	+54	16·3	188	0·38
,,	16	1	57	18	+55	2·5	193	0·33
,,	20	2	17	30	+55	36·6	198	0·30
,,	24	2	36	52	+55	59·9	204	0·27
,,	28	2	55	20	+56	14·1	209	0·24
June	1	3	12	49	+56	20·5	214	0·22
,,	5	3	29	19	+56	20·7	219	0·20
,,	9	3	44	51	+56	15·8	224	0·18
,,	13	3	59	25	+56	7·0	229	0·16

On April 30th the comet will be placed three degrees south of the star ζ Cassiopeiæ (magnitude 3·7). On May 6th it will be two degrees south of θ Cassiopeiæ (magnitude 4·4), and for a few nights, about May 18th, will be very near the great star cluster in Perseus.

Encke's Comet.—This well-known periodical comet will pass its perihelion on May 24th, but will not be visible at that time, as it is near ζ Tauri, and only about twenty degrees east of the sun. In June the comet will move rapidly southwards, and will approach the earth to within about twenty-three millions of miles on July 3rd, so that it will be a fairly conspicuous object to observers in the southern hemisphere.

Cometary Discovery.—At the last meeting of the British Astronomical Association, on March 30th, Mr. Crommellin, of the Greenwich Observatory, made some remarks rather derogatory to English observers in regard to discoveries of comets. His strictures appear to be quite justified by the facts, for there is no reason why nearly all the prizes in this field should be carried off by Americans. In view of the large number of capable observers, it is certainly a very remarkable circumstance that so few comets are discovered in this country. The climate cannot be blamed for it. Either observers do not thoroughly pursue the work of sweeping or there must be something wrong with their instruments or methods. The work itself is easy and requires no great skill, the chief things essential to success being patience and perseverance. But a man's individual observational capacity comes in as an important factor, for small, faint, and difficult comets would again and again elude detection by a poor observer. It is hoped that some English amateurs will give their earnest attention to this department. They would find it equally interesting, and in the end more profitable, than observing the moon, planets, and double stars.

Recent Fireballs.—On March 29th, 8h. 51m., a fine slow-moving meteor, not quite as bright as Jupiter, was observed by Mr. A. King, at Leicester. It had the appearance of a bright green star, followed by a red tail three and a half degrees in length. Its path was from 124¼° +1½° to 97½°−12°, and duration of flight about equal to four and a half seconds.

On April 4th, 10h. 35m., a very brilliant meteor was seen by Mr. J. H. Preston, of Fishponds, near Bristol. It fell in a very oblique path from east to west. The nucleus appeared to be of the size of a fairly large orange, and at the end of its flight it apparently exploded into a large number of fragments.

On April 5th, 10h. 15m., a large meteor, brighter than Venus, and with a remarkably slow movement, was observed by the Rev. T. E. R. Phillips, at Yeovil. He says : "It was of a beautiful golden yellow or orange colour, and left a train of sparks behind. One can hardly conceive of what its splendour would have been had there been no moon. It travelled through a hundred degrees of longitude so far as I traced it, and I probably missed the beginning and certainly missed the ending, as the meteor dropped behind some houses. Owing to the brilliant moonlight it was difficult to determine its position with accuracy. I first caught it near η Leonis, and followed it as far as a point a little below δ Herculis. The duration of flight was twelve to fifteen seconds, and position of the path from 154°+17° to 260°+22°." The same object was seen by Mr. Vaughan Cornish at Bournemouth. He gives the time as 10h. 17m., and says the meteor was quite as bright as Venus at her maximum. The nucleus had a sensible diameter and a deep yellow colour. It threw off a short train. The observed part of the path was very nearly vertical, and extended over about twelve degrees, ending three degrees to the right of Vega, and about half a degree lower than that star. "The finish up of the meteor was like that of a burning body being extinguished ; it did not end with a burst." Mr. P. M. Ryves, of Stone, Staffordshire, also witnessed the appearance of the meteor, and gives the time as 10h. 10m. He describes it as travelling from south-west to south-east in a very nearly horizontal flight, and with extreme slowness. There was no train, but a fragment behind and in front. The duration was from twenty to thirty seconds, but may have been much more as he did not see the beginning. The exact path was from 151°−9° to 199°−19°.

From a careful comparison of these observations it appears that, when first seen, the meteor was situated at a height of eighty-nine miles above a point in the English Channel about twenty-five miles south-east of Dartmouth. Moving very slowly to the north-east it entered upon the English coast near St. Alban's Head ; then, successively passing over Bournemouth, Southampton, Alton, and Aldershot, it finally disappeared at an elevation of twenty-five miles over a point five miles north-east of Bisley. The flight was directed upon an earthpoint at Braintree in Essex, and, seen from this district, the object must have appeared stationary in the heavens. The whole length of its observed flight was one hundred and sixty-two miles, and if the time of its duration is considered to have been fifteen seconds its velocity must have been only eleven miles per second. The radiant point was in Monoceros at 121° − 1°, but it does not correspond with that of any known meteoric shower. This fireball was an exceedingly interesting one from its brilliant aspect, and long, graceful flight, and it is also notable as a typical specimen of the very slow-moving and isolated meteors often directed from radiants low in the western sky.

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THE FACE OF THE SKY FOR MAY.

By Herbert Sadler, f.r.a.s.

THE minimum period of sunspots has not arrived yet. Mercury is a morning star, and is in inferior conjunction with the Sun on the **1st**. On the **14th** he rises at 3h. 49m. a.m., with a northern declination at noon of 10° 51′, and an apparent diameter of 11″. On the **21st** he rises at 3h. 31m. a.m., or about half an hour before the Sun, with a northern declination of 10° 42′, and an apparent diameter of $9\frac{1}{2}''$. On the **31st** he rises at 3h. 9m. a.m., or about three quarters of an hour before the Sun, with a northern declination of 13° 20′, and an apparent diameter of $7\frac{1}{2}''$. He is at his greatest western elongation on the **28th**. While visible he describes a direct path in Aries, without approaching any very bright star very closely.

Venus is well placed for observation as an evening star. On the **1st** she sets at 9h. 9m. p.m., or one hour and three quarters after the Sun, with a northern declination at noon of 20° 24′, and an apparent diameter of $10\frac{1}{2}$. On the **11th** she sets at 9h. 38m. p.m., or about two hours after the Sun, with a northern declination of 22° 57′, and an apparent diameter of 11″, about ninety-three one-hundredths of the disc being illuminated. On the **21st** she sets at 10h. 2m. p.m., with a northern declination of 24° 25′, and an apparent diameter of 11″. On the **31st** she sets at 10h. 18m. p.m., or about two hours and a quarter after the Sun, with a northern declination of 24° 44′, and an apparent diameter of $11\frac{1}{3}''$. She will be occulted by the Moon on the afternoon of the **22nd**, the disappearance taking place at 6h. 54m. p.m., at an angle of 115° from the vertex, and the reappearance at 7h. 32m. p.m., at an angle of 184° from the vertex; of course, in both cases, before sunset.

Mars is, for the purposes of the amateur, invisible.

Jupiter is an evening star, and is still very well placed for observation, rising on the **1st** at 3h. 20m. a.m., with a northern declination of 0° 52′, and an apparent equatorial diameter of 43″. On the **7th** he rises at 2h. 54m. p.m., with a northern declination of 1° 1′, and an apparent diameter of $42\frac{1}{2}''$. On the **14th** he rises at 2h. 24m. p.m., with a northern declination of 1° 8′, and an apparent diameter of 42″. On the **21st** he rises at 1h. 56m. p.m., with a northern declination of 1° 11′, and an apparent diameter of $41\frac{1}{3}''$. On the **31st** he rises at 1h. 15m. p.m., with a northern declination of 1° 10′, and an apparent diameter of $40\frac{1}{2}''$. During the month he describes a retrograde path in Virgo without approaching any naked-eye star.

Saturn is in opposition to the Sun on the **30th**, but his southern declination is so great as to prevent any satisfactory observation of him in these latitudes, and the same remarks apply to Uranus. Neptune is invisible.

There are no well-marked showers of shooting stars in May.

The Moon is full at 6h. 34m. a.m. on the **6th**; enters her last quarter at 9h. 36m. p.m. on the **12th**; is new at 0h. 58m. p.m. on the **20th**; and enters her first quarter at 5h. 14m. p.m. on the **28th**.

◆

Chess Column.

By C. D. Locock, b.a.

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

Solution of April Problem.

(By A. C. Umlauff.)

Key-move.—1. Kt to Kt7.

If 1. . . . K to Kt3,	2. Q to K8ch, etc.
1. . . . Kt to B4,	2. Kt to K5ch, etc.
1. . . . Any other,	2. Q to K6ch, etc.

[There seems to be a dual after 1. . . . Kt to Kt7 which has escaped notice.]

Correct Solutions received from Alpha, B. Goulding Brown, W. de P. Crousaz, Capt. Forde.

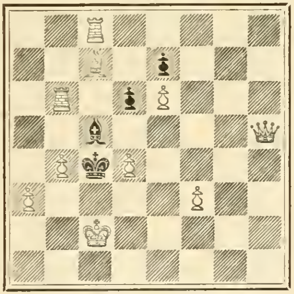
A. C. Challenger.—Many thanks for the problems, which shall appear shortly. Much regret your abstention in the other matter.

PROBLEMS.

By P. G. L. F.

No. 1.

Black (4).

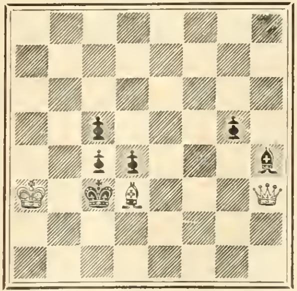


White (10).

White mates in two moves.

No. 2.

Black (6).



White (3).

White mates in three moves.

CHESS INTELLIGENCE.

The Cable Match between teams representing the British Isles and the United States was played on March 18th and 19th, an exciting contest resulting, as last year, in a victory for the British team by the odd game. It will be noticed that the three American players new to these contests (at boards Nos. 8, 9, and 10) met with no success. Our opponents would, perhaps, as they seem inclined to admit, have done better to rely on well-tried players, even at the risk of complaints as to the "New York clique." The following is the score:—

GREAT BRITAIN.		AMERICA.	
J. H. Blackburne (London)	½	H. N. Pillsbury (New York)	½
A. Burn (Liverpool) ...	0	J. W. Showalter (New York)	1
H. Caro (London) ...	0	J. H. Barry (Boston) ...	1
H. E. Atkins (Leicester)	½	E. Hymes (New York) ...	½
G. E. H. Bellingham (Dudley) ..	0	A. B. Hodges (New York)	1
D. Y. Mills (Edinburgh)	1	E. Delmar (New York) ...	0
C. D. Locock (London)	½	D. G. Baird (New York)	½
E. M. Jackson (London)	1	F. K. Young (Boston)	0
Herbert Jacobs (London)	1	A. K. Robinson (Philadelphia)..	0
H. W. Trenchard (London)	1	J. A. Galbreath (New Orleans)..	0
	5½		4½

A brief description of each game is appended. The American players had the move at boards 1, 3, 5, 7, and 9.

No. 1.—Mr. Blackburne, in defending the Queen's Gambit, obtained an inferior game, and was compelled to give his opponent the advantage of a passed Pawn. After many fruitless attempts to utilize his advantage, Mr. Pillsbury, most unselfishly playing to the score, gave up his best Pawn on the chance of a win. In the end Mr. Blackburne was a Pawn ahead, but this was probably insufficient to win.

No. 2.—Mr. Burn obtained a slight advantage in a close game, but after nearly all the pieces were exchanged, Mr. Showalter made a most brilliant combination out of the small material left, the sacrifice of a piece leaving him ultimately with two Pawns to the good and a won game.

No. 3.—Mr. Caro disregarded his opponent's King's side advance in a close game, and obtained a (perhaps) winning advantage on the Queen's side; but he overlooked a most ingenious saving and winning resource, and was compelled to resign.

No. 4.—Mr. Atkins obtained a slight advantage in a French Defence (2. Q to K2), but the sacrifice of a piece did not turn out so well as he expected, and he was glad to have an opportunity of giving perpetual check.

No. 5.—Mr. Bellingham, defending the "close Ruy Lopez," found himself under a violent attack. He defended himself with great care and patience, and most of the pieces were exchanged; but the attack came again with Q and R on each side, and the Black Pawns could not be saved.

No. 6.—Mr. Mills had not much difficulty in disposing of the eccentric variation of the French Defence played by his opponent. He won the exchange first, and then the game, having only to steer clear of a few traps.

No. 7.—Mr. Locock's Two Knights Defence was promptly converted into a Giuoco Pianissimo. Black obtained a slight advantage early, but was unable to prevent the exchange of all the minor pieces. White after that should have made some desperate attempt to win or lose (a draw being useless to his side), but neither side attempted anything, and the position at the end of the second day was practically the same as at the end of the first.

No. 8.—Mr. Jackson waited until his opponent had finished his eccentric development in a French Defence, and then proceeded to take vigorous advantage of the various flaws in his opponent's position, winning first the Queen and two Pawns for Rook and Knight, and afterwards what he liked.

No. 9.—Mr. Jacobs played P to KB4 in answer to 1. P to Q4. His opponent injudiciously exchanged the centre Pawns, thereby freeing Black's game for an attack on the King's side. Mr. Jacobs won a Pawn, and the Bishops of opposite colours made winning all the easier. The actual process chosen was very pretty, Mr. Jacobs sacrificing the exchange in an end game in order to permanently block in his opponent's Rook.

No. 10.—Mr. Trenchard attacked a little prematurely on the King's side in a close game. His opponent weakly blocked the Queen's side, and afterwards sacrificed the exchange rather unnecessarily. After that Mr. Trenchard picked up Pawns till his opponent resigned.

The Inter-University Match was played at the British Chess Club on March 25th. The following is the score:—

OXFORD.		CAMBRIDGE.	
E. G. S. Chnrchill (Magdalen) ..	0	C. E. C. Tattersall (Trinity) ...	1
E. R. W. George (New College)	0	L. McLean (King's)	1
A. P. L. Hnlbert (Keble) ...	1	H. G. Softlaw (Trinity Hall) ...	0
A. H. Currie (Brasenose)	1	A. Fotheringham (Emmannel) .	0
F. Soddy (Merton)	½	A. W. Foster (St. John's) ...	½
F. A. Babcock (Wadham)	½	R. S. Makower (Trinity)... ...	½
L. T. Dodd (Merton) ...	0	H. R. Cullen (Caius)	1
	3		4

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THE MOURNE MOUNTAINS.

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

It is one of the many advantages of a thinly populated country that its barren regions are left very much to lovers of scenery. The Mourne Mountains, though situated on the easily accessible coast of the county of Down, have remained but little visited, even by dwellers in Ireland. Despite the admirable introductions that have been made to them in recent years,* the scientific observer and the keen pedestrian need have little fear of being hampered in their pursuits by the presence of the purely casual tourist.

Those, however, who may not find it convenient to leave the beaten track, can, in a few inspiring drives, complete the circuit of the Mournes, and can even cross at one point from the western meadows to the sea. The character of the mountain group, in all its isolated individuality, can, indeed, be best grasped from a preliminary survey of its spurs. From Newry, at the head of the long Carlingford inlet, we climb to the upland formed by the "Caledonian" granite in this district, and presently, across the Silurian foot-hills, we see upon our right the grey-green ridges of the Mournes. At Hilltown we meet the first road that cuts into the silent area, and we gain some notion of the steep-sided valleys that lie between these smooth round domes. On certain of the nearer summits, little "tors" of rock stand out, much as they do on Dartmoor, but on a more impressive scale. Then, as we follow the steadily rising road, we are cut off for a time from distant views; but in four miles the finest of them all bursts on us—the seemingly sheer face of Slieve Meel, the grass, as it were, sliding away on it and leaving the bare white rock exposed; and beyond, across a romantic bend of the valley, the craggy *arête* of Slieve Bernagh—without question the noblest summit of the Mournes.

And so down, mile after mile, under the wooded slopes to Bryansford, where the corner is turned and we see the northern aspect of the highland. Slieve Commedagh and Slieve Donard, with a rocky pass between them, dominate the landscape here, the latter being the highest mountain of them all. Its two thousand seven hundred and ninety-six feet bring it, in fact, only a little short of Cader Idris.

On the east, this compactly arranged highland falls steeply to the sea, so that the summit of Slieve Donard is only two miles from the actual coast. The splendid road is carried, as best it may be, between the heather of the moorland and the sea, and crosses at intervals the alluvial fans that stream down from the eastern valleys. A pebbly raised beach that runs along part of the coast also provides a convenient terrace.

At Bloody Bridge, only two miles south of Newcastle, the old roadway, of bitter memory, is seen a little further up the glen; and behind it, and stretching high towards the notch from which the stream descends, is one of those huge cones of detritus that assure one of the reality of denudation. It may have been formed, in the first instance, by a landslide; but it no doubt was freely added to when the mountains above were at their highest. Now the stream has cut a clear section through it, down to the granite floor, and grass has climbed across the slopes of Slieve Donard, from which much of the material fell. The outer edge of the cone has, moreover, been removed by the sea; but in its remaining mass, and the beauty of its form, it is still an admirable picture of a talus-fan, such as may be seen in full vitality at the foot of any ravine in Norway, Tyrol, or Karinthia.

At the tiny port of Annalong, we cross one of the larger rivers of the Mournes, which rises in a superb steep-sided valley under the rock-terraces of Slieve Commedagh. A second large stream, the waters of which are about to be stored up for Belfast, comes down out of a similar valley at Kilkeel; and soon the road turns westward, passes along the beautiful sea-inlet up to Rostrevor, Warrenpoint, and Narrow Water, and reaches Newry, where the fifty-mile circuit is complete.

When we examine this mountain-mass in detail, we find that we are not dealing with a range, but with a great boss of granite, shaped somewhat like a dumbbell, the narrow part being crossed by the road from Hilltown to Kilkeel. The principal valleys have been cut far back from north or south. The watershed is consequently sinuous, between the short streams flowing to the Irish Sea and the rivers that reach the Atlantic with the Bann;

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* R. Lloyd Praeger, M.R.I.A., "The Mourne Mountains," *Science Gossip*, new series, Vol. II. (1895), p. 85; and "Guide to County Down and the Mourne Mountains," published by the Belfast and County Down Railway Company, 1898, with one hundred illustrations, price 1s. (Marcus Ward & Co.)

but it has, when mapped out, a fairly north-east and south-west trend. A bold line of summits lies along it, from Slieve Meel More to Eagle Mountain; but their average elevation is surpassed by those rising from the wall between the Annalong and Kilkeel valleys, beginning with Slieve Commedagh (2512 feet), and ending in the castellated crags of Slieve Bingian (2449 feet), from which a long spur descends southward on Kilkeel. The depth of the valleys, in proportion to their width, is one of the fine features of the Mournes, and is only fully realised by walking along the watershed, and looking down over granite cliffs into these veritable grooves, the combes at their heads girt about with crags, and their mouths crossed by the blue horizon of the sea.

Fig. 1.—View in the Valley of the Kilkeel River, Mourne Mountains, showing cliff, taluses, and distant summits. The peak of Slieve Bernagh is on the right. [*R. Welch, Photo.*

The north-and-south trend of the valleys is not due to any special structure of the Mournes, for it is one common to the district. So constant is it, whether the Mourne granite, or the Silurian strata, or the older granite of the Newry axis is traversed by the streams, that it probably points back to a time when the rocks exposed at the surface were more uniform in character, and when a highland of Silurian and Ordovician strata concealed the Mourne granite altogether. The watershed then may have run east and west, and on its surface the streams received a uniform trend. As they cut away this surface, particularly in the region of their head-waters, they came down upon the concealed granite boss, and worked against that more slowly. At one point, the streams running northward have found no granite as yet beneath them, and have notched back the old watershed conspicuously, forming the long valley leading over to Kilkeel.

According to this view, the domes and valleys of the Mourne Mountains have been carved out of an obstacle, discovered by the agents of denudation on the side of an older ridge. The former covering of Silurian strata is actually left to us in a few admirable outliers—a patch half a mile across on Thomas Mountain, about half way up Slieve Donard; another on Slievemaganmore, midway between Hilltown and Kilkeel, at a height of 1830 feet; and another, fifty feet higher, on Finlieve, some three miles to the south.* It has been stated that these flakes of strata have been floated up on the surface of the invading granite; but the Silurian beds *in situ* reach 1940 feet upon Slieve Muck, and 2200 feet on Shanslieve, north of Slieve Commedagh, and may thus easily, at no distant period, have covered the whole area of the Mournes.

Slieve Donard, in that case, would be one of the first knobs to protrude through the slates and sandstones as denudation had its way; while the low south-western portion of the granite has far more recently come to light. The boldness of outline, and the existence of so many contrasted domes and peaks (Fig. 1), point equally to the modern character of the group. Granite masses readily become worn down, in our climate, to round and uniform moorlands. On a fine day an observer on the Hill of Howth, near Dublin, has only to compare the outlines of the old Leinster granite with those of the blue peaks of

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* The geological details are described in Traill, "Explanation to Sheets 60 and 71," *Geological Survey of Ireland* (1878), and Hull, "Explanation to Sheets 60, 61, and 71" (1881); but recent advances already necessitate some revision.

Mourne, some sixty miles north across the sea, to admit that the northern group has at least a supremacy of form.

This is apparent, also, in the details of the landscape, as one may come across them in the higher passes of the mountains. We have referred to the bold peak-like tors of Slieve Bernagh, and to the frequent vertical rock-walls; but the most impressive scene of all is, perhaps, the group of granite pinnacles weathered out on the south side of Slieve Commedagh. We may come upon these suddenly as the mist lifts from the great dome of Donard, leaving the deep valleys filled with cloud below us; and close against us is, as it were, a fantastic temple, the columns rising on each side of a little gorge. The vertical joints have here had a dominant effect, while the horizontal ones cut up the pinnacles with a fictitious air of masonry. The neighbouring cliffs also display the level tabular joints, so characteristic of granite, in a remarkable degree, and the whole hill-side suggests an acropolis given over to decay. The same air of titanic masonry is seen in the analogous granite mass of Goatfell in the Isle of Arran.

This brings us to the petrological characters of the granite of the Mournes. While, as in the quarries that scar the hills near Annalong, the rock is often coarsely crystalline, the general mass is of finer texture, with a ground in which the quartz and the alkali-felspar may be intergrown with one another. The ferromagnesian constituent is a dark mica. Throughout the whole region a drusy structure is very common—that is, cavities occur, varying from a microscopic size up to four or five inches across, in which minerals have developed out freely, with all their proper forms (Fig. 2). The orthoclase felspar here appears in dull white or yellowish white crystals, as clean and neat as the wooden models that are placed before students of mineralogy. The quartz in these cavities is usually a smoky variety, forming prisms capped by pyramids, in complete contrast to its ordinary mode of occurrence in igneous rocks. The mica forms the most exquisite little hexagonal tables, standing up on edge; and, in addition, blue-green beryl and colourless topaz are not uncommon, and have been much sought for by collectors. One must conceive such a rock as having been saturated with liquids under pressure, each knot, if we may so say, of the liquid acting as a hydrothermal laboratory—at first delaying crystallisation, but finally allowing of free growth, and of the production of the most delicate prismatic forms. Few pleasures can be greater to the mineralogist than the breaking up of these granite blocks in the high passes of the Mournes, and the sight of the perfect little crystal-groups, lying there fresh as when made, and never before bared to human eye.

The granite of Arran, above referred to, is closely similar to that of the Mourne Mountains,[†] and we meet allied, but less drusy, masses in the heart of Mull and Skye. The latter rocks are among the more recent products of the great period of volcanic activity in the Hebrides, which opened in Lower Eocene times.[‡] Hence the peculiar fine-grained granites of Mull and Skye are, at the earliest, of Eocene age.

South of Carlingford Lough there is another granite mass, which is intrusive in the dark gabbro of the Carlingford promontory. The relations of these rocks have been admirably described by Prof. Sollas;[*] and there is no doubt as to the correlation of the granite with that of the Mourne Mountains. The gabbro is represented on the Mourne coast by a multitude of dykes of basaltic andesite and basalt, which form a marvellous picture of the fracturing to which the Silurian rocks were subjected. These dark ribs of igneous rock have altered the Silurian shales and sandstones, which appear as a fringe along the coast; but they are cut off abruptly by the granite of the adjacent hills. The flakes of Silurian strata that remain here and there on the surface of the mountains are similarly seamed by dykes; but the granite cuts off all of them, and is clearly later than this first eruptive series. A few basic dykes, however, which may be well seen as grey-green bands in the granite north of Slieve Bernagh, cut through the granite, and represent a return of basaltic conditions. Hence we have three igneous series, two being basic, with a highly siliceous one between them.

This is precisely the order of events in the Eocene volcanic centres of Mull and Skye; and, even in microscopic details, the rocks of the one area may be paralleled by those of the other. Moreover, in the county of Antrim, the outpouring of the sheets of the "Lower Basalts" was followed by local eruptions of rhyolite, a highly siliceous lava, agreeing in composition with the granite of the Mournes.[†] This series was in turn buried by the "Upper Basalts." All this volcanic material in Antrim seems to be of Eocene age; and the sequence of events practically clinches the argument that the Mourne granite belongs also to the Eocene period.

Fig. 2.—Specimen of Mourne Granite, showing crystals developed in a drusy cavity. The pointer, marked T, indicates a crystal of topaz.

Here, then, we have a granite, one of those rocks formerly supposed to be of very ancient origin, brought near the surface as a fluid mass as recently as Cainozoic times, and probably not exposed, even in its upper layers, until shortly before the glacial epoch. The geological history of the Mournes, of Carlingford Mountain, and of the high volcano of Slieve Gullion in Armagh, is seemingly, then, a very modern matter compared with that of the adjacent Newry granite and the old weather-beaten core of Leinster.[‡]

Possibly the little dome of Ailsa Craig, which has suffered so heavily from denudation that its pebbles lie

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[*] See the fine illustration in Sir A. Geikie's "Ancient Volcanoes of Great Britain," Vol. II., p. 419.

[†] See Judd, "Secondary Rocks of Scotland," *Quarterly Journal Geological Society*, Vol. XXX (1874), p. 275; and Teall, "British Petrography," pp. 328 and 330.

[‡] See J. Starkie Gardner, "Lower Eocene Plant-Beds of Ulster," *Quarterly Journal Geological Society*, Vol. XLI. (1885), p. 82, and "Leaf-Beds of Ardtun," *ibid.*, Vol. XLIII., p. 292.

[*] "The Volcanic District of Carlingford and Slieve Gullion," *Trans. R. Irish Acad.*, Vol. XXX. (1894), p. 477.

[†] See A. McHenry, "Age of the Trachytic Rocks of Antrim," *Geol. Mag.*, 1895, p. 264; also G. Cole, "Rhyolites of County Antrim," *Sci. Trans. R. Dublin. Soc.*, Vol. VI. (1896), pp. 84 and 104.

[‡] See Knowledge, Vol. XXI. (1898), p. 76.

scattered by hundreds all down the Irish coast, was a bold mass of the same age as the Mournes and Arran, and became almost destroyed by the severities of glacial times. In any case, we can now follow out the line along which granite intruded in Eocene times, from the south of Carlingford Lough to the smooth Red Hills of Skye. As yet denudation has discovered only the higher knobs, the fine-grained and the drusy surface-layers, of the great bar of crystalline rock that has here been added to the crust. Some day, perhaps, on the rising edge of Europe, the whole axis may become revealed, worn and rounded into one long moorland, extending north and south for two hundred and twenty miles.

Granites of Cainozoic age are naturally seldom met with, owing to the depth at which such rocks consolidate. It would be interesting to compare with the Mourne granite that described by M. Choffat from Cintra in the west of Portugal,* which penetrates Upper Jurassic strata, and which is probably of Eocene age. The granite of Elba is actually later than the Eocene; and, in the elevated regions of the Western Alps, which have been severely attacked by denudation, the central gneissic-granite may even belong to the Pliocene period.

We have already† pointed to the great north-and-south line, along which materials were erupted in Cainozoic times in Western Europe, as being possibly connected with the movements that determined our present continental edge. Certain it is that the signs of unrest spread eastward, and, by the close of the Miocene period, the central plateau of France, the brown-coal region of Bohemia, the fringe of the Hungarian plain, and the whole north-west of Italy, had already become involved. Then the great Alpine series of chains rose in their full vigour, and the volcanoes of Auvergne, Catalonia, the Eifel, and the eastern Rhinelands, piled up the cones that remain, scarcely denuded, at the present day. The Italian region, down to the sea between Sicily and Tunis, is still active and unstable; and, when compared with these vigorous manifestations, the land of Mourne assumes quite a cold and ancient aspect. The great lava-plateaux to the north of it were probably broken up and partly submerged by the forces that were raising Central Europe;‡ and the bold attempt at western elevation, which allowed of the ascent of the granite of the Mournes, seems to have ended merely in weakening the crust and in enlarging the bounds of the Atlantic.

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THE PETROLEUM INDUSTRY.

By George T. Holloway, assoc. r.c.s. (lond.), f.i.c.

Although the use of petroleum and its products, on what may be called a commercial scale, has only arisen within the last forty years, crude petroleum has been known and used from the earliest times. The "everlasting fire" of the Guebers, or fire worshippers of Baku, was fed by natural gas—really only the most volatile of the products of crude petroleum; but the most important of the early uses of this "rock oil" was for medicinal purposes—mainly skin diseases—for which purpose its value is even now recognized by the medical profession.

Numerous references to petroleum occur in the Scriptures, and, in the opinion of Lord Playfair, the "word translated as 'salt' in reference to its loss of savour on exposure, should have been rendered 'petroleum,' which, in the air, loses its more volatile constituents, and leaves asphalte, good only to be 'trodden under foot of men.'"

Petroleum appears to have been collected and sold at Baku, in Russia, and in the Burmese Empire earlier than in other districts; however, its exploitation on a large scale may be considered to date from the year 1859, when the celebrated "Colonel" Drake, acting on behalf of the Pennsylvania Rock Oil Company, sank the first well drilled avowedly in pursuit of oil, at Oil Creek in Pennsylvania. The hilarity which the public had previously indulged in immediately gave place to the "oil fever" when this well was found to yield to the pump twenty-five barrels of oil in a single day. Rapid development ensued down Oil Creek and along the Alleghany River, so that the output of two thousand barrels, each of forty-two American gallons, with which 1859 was credited, had risen to five hundred thousand barrels in 1860, and over two million barrels in 1861. Since then the yield has steadily increased, almost without any setback, until now the United States production amounts to over forty-seven million barrels.

The earlier wells yielded their oil only to the pump, but, in the summer of 1861, a well drilled to a depth of four hundred and sixty feet discharged its oil under pressure at the rate of three hundred barrels daily. This was followed by numerous other flowing or "spouting" wells, delivering, in some cases, as much as three thousand barrels daily, thus keenly accentuating the oil fever, which became so intense that the drilling of a successful well in a new district was the signal for a rush of prospectors, and, in case of further success, soon gave birth to a substantial town, which, when the oilfield became exhausted, might vanish as quickly as it had grown up.

A typical instance is found in Pithole City, which, about nine months after the discovery of oil, in January, 1865, had in its vicinity a population of between twelve and sixteen thousand, and, in importance, ranked but little below the flourishing town of Pittsburg. Within two years of its origin, however, its oil was practically all removed, and the founders deserted it in favour of numerous other fields which had meanwhile been developed.

In Russia the petroleum industry is of much greater antiquity than in the United States, and oil is said to have been exported from that country as early as the tenth century. The oil occurs in certain localities in much larger quantity than in the States, and is more cheaply produced; indeed, there is no doubt that the Russian industry will be flourishing when the American oilfields have been practically denuded of their contents, although, at present, the business ability, the enormous capital, and the perfect organization of the Americans, enable them to command the principal markets of the world.

The "spouting" wells of Russia entirely eclipse those of America in output. The first was struck in 1873 by the Kalify Company of Baku, and was followed by many others, the oil of most of them, as in the case of the American oil fountains, being wasted on account of lack of storage tanks to receive the sudden and enormous discharges. The most celebrated oil fountain known, although not the largest, was the "Droojba" well, which was struck on the 1st of September, 1883, and commenced flowing at the rate of about one million eight hundred thousand gallons daily, an amount of oil which was valued at eleven thousand pounds. The oil rushed from the well in a column about eighteen inches in diameter and nearly three

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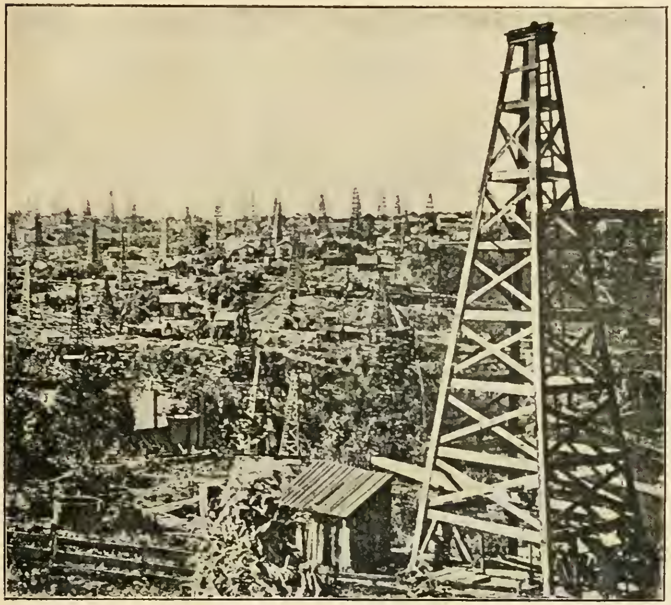
* See De Lapparent, "Traité de Géologie," 3me éd., p. 1457.

† Knowledge, Vol. XX., p. 209; also Vol. XXI., p. 77.

‡ See the striking remarks of Sir A. Geikie on subsidence between the Inner Hebrides and Iceland, in "The Tertiary Basalt-Plateaux of North-West Europe," *Quarterly Journal Geological Society*., Vol. LII. (1896), pp. 399-405.

hundred feet high, and then fell, forming, together with the sand which it had carried up from the well, banks of sand enclosing lakes of oil, much of which ran out in a broad channel towards the sea. When, after about three months, the well was brought under control and capped, it was estimated to have yielded between two hundred and twenty thousand and five hundred thousand *tons* of petroleum, most of which was wasted. Mr. P. Stevens, our Consul at Baku, states that early in 1893 a well drilled in the district yielded oil at the rate of seventeen thousand seven hundred and forty-two tons daily, an amount far in excess of that of the Droojba well. Most of this oil also was wasted.

Oil is mainly obtained from the districts already mentioned; still, petroleum occurs in many countries and in most of the strata comprised between the older Laurentian rocks and the newer members of the Tertiaries. In the United States the principal deposits lie in Pennsylvania and New York (which are generally taken as forming one field), and in Western Virginia, Ohio, and Indiana. Notwithstanding the new fields that are being opened up, the amount of unprospected country is now by no means large; whereas, in Russia, enormous areas of proved oil territory, as well as still larger tracts of presumably oil-bearing land, are lying fallow because the small areas actually under the drill are capable of more than supplying the immediate demand. In Grosnia, and in the Kouban and the Crimea, as well as on the Apsheron peninsula, of which the oil district of Baku forms a small part, we have, for instance, proved tracts of land the output of which is likely to be enormous when the exigences of the market call for their development.



Derricks in the Oilfield of Bradford.

Petroleum occurs in commercially workable quantities in Canada, Galicia, Roumania, India, Java, and Sumatra; also in Japan, China, Peru, Germany, and many other countries; and it has been found in several parts of England, though not in sufficient quantity to admit of profitable working.

Taking the oils of America and Russia as the most important and typical, it is interesting to consider the different geological conditions under which they occur. The American oil is found in strata of the Silurian and Carboniferous epochs, and belongs to what is known as the "paraffin" series of compounds; while that of Russia may be referred to the Eocene and Miocene strata of the newer Tertiary series, and consists of compounds of the "benzene" family.

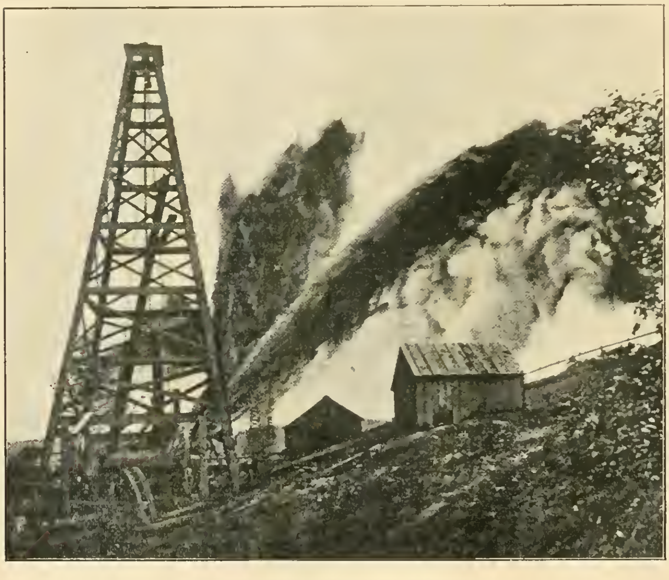
The American oil yields on distillation about seventy per cent. of kerosene oil suitable for ordinary lamps, together with lighter products forming the various petroleum "spirits," heavier oils used in gas manufacture, lubricating oils, paraffin wax, vaseline, and residuum utilized as liquid fuel. The Russian oil, on the other hand, yields less than half as much kerosene and light distillation products as does the American oil, and practically no paraffin, but it gives a higher and better yield of lubricating oil and a larger proportion of residuum, which, under the name "astatki," is used as fuel more in Russia than in any other country.

In America, as in all other countries, the earlier developments were due to the appearance of petroleum on the surface of the land, or to its occurrence in wells sunk for water or brine; but now the oil wells are very deep, those in the deepest drilled district—the Washington district of Western Virginia—averaging two thousand four hundred feet. The oil occurs mainly in the interstices separating the grains of sandstones, or between the crystals of a dolomitic rock; and experience has shown that it is necessary to raise the oil without regard to market requirements, or the whole may be pumped up through the wells of the neighbouring leaseholders, a condition of things which has led to a common practice of drilling round the boundary of the holding before commencing operations elsewhere.

In Russia, however, the conditions are different; the oil is usually found at comparatively shallow depths, often not more than one-fourth of the depth of the American wells. A loose sand, consisting of independent grains, comes up with the oil, and these grains of sand are a cause of serious trouble in the flowing wells on account of their cutting action on the caps with which the drillers endeavour to close the top of the well-casing to control the outflow. In the case of some of these flowing wells, the blast of sand has been known to cut through several thick steel caps before the flow could be stopped. The strata in which the oil occurs are also so disturbed as to practically constitute a large number of independent oil reservoirs, so that closely contiguous wells are found to be practically independent of each other, and there is no necessity for raising the oil until required.

Had space permitted, it would have been interesting to trace the development of the modern drilling plant employed for the sinking of the oil wells, from the simple hand-worked appliances which, first used in the States for the sinking of brine wells, have become gradually superseded by the rapid and beautiful drilling plant comprised in what is known as the "American system." This, although not the only system in use, will be described as representative.

The first necessity is the "derrick"—a strong wooden framing resembling the structure at the pit-head of a colliery, and serving to support and control the working of the string of drilling tools. The derrick varies in height from about thirty feet, in the case of shallow wells, to seventy feet, in the case of the deeper wells, and the drilling tools are suspended from it on a stout rope, which is operated by an engine to raise and lower the tools. Somewhat complicated in their construction, the drills act by giving a blow at the bottom of the boring each time they are allowed to descend. A special appliance known as the "jars" is arranged to prevent the drill becoming jammed. It consists of two parts which slide upon each other and give a jar to the tool on the up-stroke, so that any tendency to jam is overcome. The total weight of a set of drilling tools is nearly four thousand pounds, and, in addition to this, a series of ingenious tools known as "fishing tools" has to be provided for finding and raising any part of the drilling tools which may become detached and remain in the well.



Well after being "torpedoed." A Side Discharge.

At intervals the tools are withdrawn, and the sand produced by the drilling is removed by pumps or balers. As the well is sunk it is cased throughout with metal tubing to avoid choking up by detritus or caving-in of the strata.

When the oil stratum is struck, or, more usually, when the well begins to show a decreased yield, it is common in America to explode a charge of dynamite—known as "torpedoing"—at the bottom of the well, in order to loosen the strata, and so facilitate the oil's access to the well. The oil is either pumped, or flows naturally, into a tank, from which it is conveyed by pipe lines to the refineries, as will be described later on.

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ECONOMIC BOTANY.

By John R. Jackson, A.L.S., etc., *Keeper of the Museums, Royal Gardens, Kew.*

PAPAVERACEÆ.—Though this is a comparatively small order in the number of genera and species, and though the plants themselves are of the nature of small herbs, the order is one of considerable economic importance and interest. The plants are natives of temperate climates, particularly of Europe, and are well marked by their narcotic properties. By far the most important plant of the family is the opium poppy (*Papaver somniferum*), which, though it cannot be said to be known at the present time in a truly wild state, is probably a native of South-Eastern Europe and Asia Minor. The poppy has been cultivated from early antiquity for the sake of its dried juice, well known as opium. It is now very widely spread, but Asia Minor, Egypt, Persia, and India yield the principal supply; China also yields a large quantity. In Asia Minor, from whence the best opium used in medicine is obtained, the juice is collected by making incisions around the circumference of the poppy head or fruit while the plants are yet growing. The milky juice exudes slowly, soon becoming plastic or semi-solid, and turning brown; it is scraped off with a knife and placed on a leaf of dock (*Rumex*), which is carried in the left hand by the collector. When sufficient has been thus obtained to form a moderate-sized lump it is rolled up in the leaf and allowed to harden. In India the mode of collection is somewhat different; the fruits are scarified longitudinally by a kind of small lancet, the juice is scraped off in little scoops, and poured into bowls, in which part of the moisture separates. In the factory it is mixed or stirred in vats to insure uniformity of substance, and then made into balls of about six inches diameter and covered with the dry poppy petals. In this condition it is stacked in racks in the opium store, and when required for exportation to China it is packed in chests divided into numerous compartments, each division holding one ball. Indian opium contains a much lower percentage of morphine than that from Asia Minor, and is consequently of much less value for medicinal purposes. It is, however, largely used for eating and smoking.

The cultivation of the opium poppy in cool countries is chiefly for the sake of the capsules and seeds, the former for supplying the shops with "poppy heads" for making fomentations for allaying pain as well as for making syrup of poppies, and the latter for the sake of the oil they contain, which, when clarified, is of a sweet nature and of a pale straw colour, and is used for mixing with, or as a substitute for, olive oil for culinary purposes, and the residue or marc is used for feeding cattle. Under the name of "maw seeds" they are given to cage birds. In this country the opium poppy is cultivated in many medicinal gardens, notably at Bodicote, near Banbury, Hitchin, and other places.

Cruciferæ.—The plants constituting this order are mostly of an herbaceous character, particularly abundant in the temperate parts of the northern hemisphere. Though they mostly possess pungent or biting properties, none are poisonous, but, on the contrary, are eminently wholesome and antiscorbutic. The following best known examples of the order will illustrate this. Horse radish (*Cochlearia armoracia*), a perennial herb naturalized in this country, occurring in damp, waste places, and found throughout the greater part of Europe. Under cultivation it forms a thick, somewhat fleshy root, and is much valued as a condiment. Mustard is another condiment of equal or greater value, and is the finely pulverized seeds of two species of *Brassica*—*B. alba* the white, and *B. nigra* the black mustard. They are annual plants widely distributed over Europe, *B. alba* occurring also in Asia Minor, Algeria, and China, and cultivated in the home counties of Essex and Cambridgeshire; while *B. nigra* is also found in Asia Minor, as well as in North Africa and North-West India, its cultivation in this country being chiefly carried on in Lincolnshire and Yorkshire. In the preparation of mustard, or flour of mustard of commerce, the seeds of both species are used mixed, and great care is taken in reducing them to a very fine powder which is sifted through a fine silk gauze. Besides the use of mustard for table purposes, it is an important medicinal agent on account of its powerful stimulant and rubefacient properties. The cabbage (*Brassica oleracea*) is another illustration of a valuable esculent belonging to this important order of plants. In its wild state it is abundant on the cliffs by the sea-coast in many parts of England, especially in the south-eastern counties. The effect of cultivation has produced marvellous changes in this plant, giving us all the varieties of brocoli, Scotch kale, Savoy, Brussels sprouts, cauliflower, and even the red cabbage. The same power of culture has also changed the woody root of the common wild turnip (*Brassica campestris* var. *Rapa*) into the fleshy, globular root of our gardens, while the Swede turnip has sprung from another variety of the same species; and the rape, again, so largely grown by us as a green fodder, and on the Continent for the sake of its seeds, from which is expressed rape or colza oil, has originated from still another variety.

The radish (*Raphanus sativus*) is still another of the esculent cruciferous roots. The plant is unknown in its wild state, but it has been suggested that it may have sprung from an allied species of the Mediterranean coast. In the early ages it was extensively cultivated in Egypt, and found its way into England about the middle of the sixteenth century. Gerard mentions four varieties as being known in 1597. We cannot leave this interesting family of plants without a reference to woad, the blue colouring matter used by the ancient Britons to stain their skins, and produced by *Isatis tinctoria*. At that early period its culture seems to have been general for the purpose mentioned above, as well as for dyeing cloths, but in later times the general introduction of indigo seriously interfered with the use of woad; and though it is still manufactured in some parts of the Continent, its preparation in this country is fast dying out, and at the present time is carried on only in the neighbourhood of Wisbech, and there it is still made in the most primitive fashion.

Cappabideæ.—This comparatively small order is composed of herbs and shrubby plants, very rarely trees, chiefly tropical, abundant in Africa, America, and India. The order is marked by the presence of pungent and stimulant properties, in this respect somewhat resembling the crucifers. Only one plant, however, in the order has any special economic value, and that perhaps of more interest than actual commercial value. We allude to capers, which are the flower buds of *Capparis spinosa*, a scrambling bush of the Mediterranean region. The plant is cultivated in some parts of France, as well as in Italy, for the sake of the flower buds, which are gathered and pickled in vinegar. The imports to this country are very small, the use of capers being only for culinary purposes.

Cistineæ.—Shrubs or herbs generally known as rock roses, natives chiefly of Southern Europe and Northern Africa. They are noted for the presence of a fragrant balsamic resin. The best known plant is *Cistus Creticus*, a native of Crete and Cyprus, Macedonia, Rhodes, and other Greek islands. A resin known as ladanum is collected from the leaves and branches by whipping or bruising them with an instrument consisting of long leathern thongs attached to a rake-like frame. The thongs become coated with the resin, which is afterwards scraped off and moulded into small cakes. In Cyprus, ladanum is often collected by combing the resin from the fleeces of the sheep, which become loaded with it while they are pasturing among the plants. It possesses stimulant and expectorant properties, but it is seldom or never used in medicine at the present time; it nearly all goes to Turkey, where it is used for fumigation and as a perfume.

Bixineæ.—A group of shrubs or trees, natives of the tropics, and found mostly in the East and West Indies and Africa. The principal economic plant of the order is the anatto (*Bixa orellana*), a tree twenty to thirty feet high, native of tropical America, but now cultivated in many tropical countries for the sake of the seeds, which are small, of a bright red colour when fresh, and of a waxy nature. It is this red coating of the seeds that forms the anatto of commerce, and it is removed by placing the seeds in water, which is stirred till the colouring substance is detached, when it is strained and evaporated to different consistencies and used for colouring cheese and butter, as well as for dyeing silks. Large quantities of these seeds are regularly imported.

Amongst other economic plants of this order of less importance may be mentioned the chaulmugra (*Gynocardia odorata*), a large Indian tree, producing hard-skinned globular fruits about four inches in diameter. These contain numerous seeds embedded in the pulp, and from these seeds an oil is expressed known as "chaulmugra oil." It has an established reputation in India as a medicinal oil, and was introduced a few years ago to this country for the treatment of rheumatic affections and skin diseases. Its use has now, however, quite died out.

Guttiferæ.—Trees and shrubs are the plants which compose this order, and they are all natives of tropical countries. They are for the most part resinous, besides which many of them yield oils or fats. The best known resinous products are those furnished by species of *Garcinia* and collectively known as "gamboge." The most important of these are *Garcinia Hanburyi*, yielding the best quality, or Siam gamboge, and *Garcinia Morella*, giving the Ceylon kind. Gamboge is obtained from the first-named plant by making a spiral cut through the bark of the tree as it stands; the yellow juice readily flows and is received into the hollow joints of bamboos, where it is left until it solidifies, after which the bamboos are broken away, leaving what is known in commerce as "pipe gamboge," which is the best and purest quality, the second quality being that which is collected in lumps. In Ceylon gamboge is collected either from incisions made in the bark or by cutting out pieces of it, from which the yellow juice oozes and hardens on exposure, and the lumps are then scraped off. Gamboge possesses powerfully purgative properties, and was at one time used in medicine. At the present time it is only used in veterinary practice. Its chief use, however, is as an ingredient for lacquering brasswork and as a pigment in water-colour drawing. The well-known mangosteen is the fruit of a *Garcinia*—*G. mangostana*. It is a moderate-sized tree of Malacca and the Malay Archipelago, but it has been introduced into other tropical countries. It is the juicy pulp surrounding the seeds which is the delicious morsel that has caused the mangosteen to be classed as the best of all tropical fruits.

Many other plants of this order might be mentioned as yielding important economic products, but space will not permit us to do so.

Ternstrœmiaceæ.—This is an order of trees and shrubs chiefly tropical. It is not marked by any characteristic property. In some of the South American species the trees are noted for their hard and heavy woods and the sweetness of the seeds, or nuts, as they are called, the Souari nut of our shops (*Caryocar nuciferum*) being one of them. The most important plant in the order—indeed, one of the most important in the whole vegetable kingdom—is the tea plant (*Camellia thea*). From its early and very extensive cultivation in China it was for a long time supposed to have been a native of that country. It has, however, been more recently shown to have originated in Upper Assam, and to have been introduced to China at a very early period. In like manner it was supposed for a very long time that the black and green teas of commerce were the produce of distinct species. This has likewise been shown to be a fallacy, and it is now well known that black and green teas are prepared from the same plant by different methods of drying and curing. Thus, for green tea, the leaves after gathering are not allowed to lie so long as those intended for black tea before they are rolled and roasted. By this means the fermentation during the process of withering is avoided, and the leaves in consequence retain much of their natural green colour. Many details, which cannot be explained here, also have to be followed, resulting in the two commercial kinds of tea—black and green. In connection with the increased demand for tea the world over, it will be interesting to note that to meet that demand the range of the cultivation of the plant has considerably extended in recent years. Thus we find it thoroughly established in Ceylon, while in Japan, Java, and in Natal, excellent tea is grown and prepared.

The following figures will give an idea of the proportions of the commerce in tea so far as Great Britain is concerned:—The total imports for the year 1897 amounted to two hundred and sixty-nine million, thirteen thousand, four hundred and eighty-two pounds, of the value of ten million, four hundred and forty-three thousand, one hundred and four pounds.

Dipterocarpeæ.—The plants composing this order are for the most part large forest trees of India, noted for the strength and durability of their timber and for the valuable resinous products they yield. The best known in the first category is the sal or saul tree (*Shorea robusta*), a tree forming extensive forests over a wide range in India, where the timber is almost, if not quite, of equal value as teak, and is in great demand for gun carriages, railway sleepers, and building purposes generally. It, moreover, yields a quantity of resin known as "dammar," and used for preserving the woodwork of boats. From several species of *Dipterocarpus*, notably *D. alatus*, *D. turbinatus*, and *D. trinervis*, an oleo-resin known as "wood oil," or "Gurjun balsam," is obtained, chiefly from the coast of Burma and the Straits of Malacca. To collect the balsam, the trees are tapped at the end of the dry season by making several deep incisions with an axe into the trunks and scooping out a good-sized cavity. Fire is lighted in this hole, and when the wood has become heated or scorched the balsam begins to flow. After collection it is allowed to settle, when the clear liquid or oil separates from the more solid or resinous portion. It is said that as much as thirty or forty gallons has been obtained from a single tree in one season. Though it is used in India as a substitute for balsam of copaiba, its chief use is as a natural varnish for preserving woodwork from atmospheric effects or the attacks of white ants. The Sumatra camphor tree (*Dryobalanops aromatica*) is of considerable interest in consequence of its peculiar habit of forming masses of camphor crystals in clefts of the trunks. It is much less volatile than ordinary commercial camphor, and fetches a high price amongst the Chinese, by whom nearly the whole of the produce of Sumatra is taken, and these people believe it to possess many remarkable properties. It does not reach Europe, except occasionally as an article of curiosity.

The only other product of the *Dipterocarpeæ* that space will allow us to mention is that known as "piney resin," or "Indian copal," the produce of *Vateria indica*, a tree of Malabar. This resin is of a semi-fossilized character, and is used slightly in the preparation of varnish. From the large fleshy seeds a kind of fat or tallow is obtained, which is used in India for making candles, and is known as "piney tallow."

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WEATHER ACCOUNTS.

By Alex. B. MacDowall, m.a.

AN analogy might be traced between the fluctuations of weather and those of a banking account. And we might deal with the plus and minus values of the former (with reference to an average) as we might with sums deposited in a bank and sums withdrawn, so as to show the position of affairs at any given date in relation to a previous date.

Thus, suppose a man opens a banking account, which he is allowed to overdraw. The first week he deposits ten pounds and the next ten pounds. Next he draws five; then deposits ten; then draws thirty. The final result obviously is that he is five pounds "to the bad." And this set of transactions, and the position each week, might be simply represented thus:—

	1	2	3	4	5	
Transactions	...10	+ 10	− 5	+ 10	− 30	= −
State of Account	...10	+ 20	+ 15	+ 25	− 5	

On the other hand, take as a simple case of weather the monthly amounts of rain in London last year. Mr. Symons, in his magazine, gives us the plus or minus values in which these are referred to an average. We proceed accordingly thus:—

Jan.	Feb.	Mar.	April.
+ ·43	+ ·87	+ 1·81	− ·17, etc.
+ ·43	+ 1·30	+ 3·11	+ 2·94, etc.

The second line, completed, we may plot as a curve (H, Fig. 3).

We often hear questions like this, "Have we had more or less than our share of rain?" This curve supplies answers for the months of 1897. The first three months were wet. This excess was brought down in the next four; so that by the end of July we had had nearly our proper amount. But by the end of the year there was about two and a half inches (as we may say) still due.

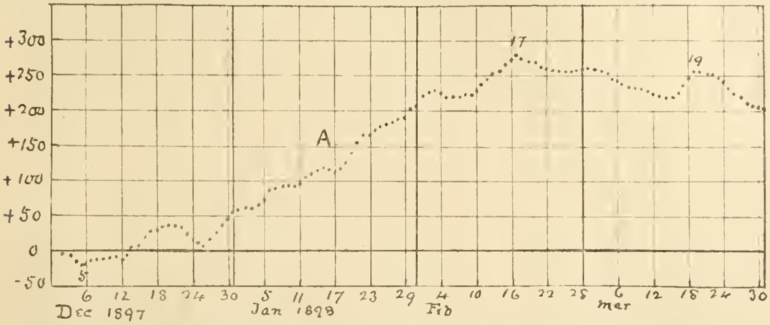

Fig. 1.—Gain and Loss Curve of Daily Temperature at Greenwich last Winter.

Let us see what kind of curve we get from the daily temperatures (at Greenwich) in the remarkably mild winter we have lately passed through. (The relation of these to the average is given in the *Weekly Return.*) The curve is that marked A (Fig. 1).

In these curves a rise means a plus value, and a fall a minus; we may speak of the one class as "gains," the other as "losses"; and we see that in this curve, from the beginning of December to February 17th, the gains were much more than the losses. Neglecting for the present the individual amounts of gain or loss, we find that the warm days were much more numerous than the cold. After February 17th the balance was the other way. Here are some figures: from December 1st to February 17th we had sixty-one warm days and only eighteen cold; thereafter thirty-two cold days and only ten warm. Will this downward course of the curve continue some time? It would be difficult to say.

We may take a wider survey in this matter of temperature. Consider the years as hot or cold. Here is a curve (B, Fig. 2) which shows, in the case of Greenwich, the result of the method as applied to the years since 1841. Up to 1878 there has been a general rise; since 1878, a general fall. More hot years than cold in the former case (twenty-three to fifteen), more cold than hot in the latter (twelve to seven). The rise since 1892 may be the beginning of a long general ascent; but it seems not inconsistent with our being still on the "down grade."

Can we go further back with confidence? Earlier figures are in some uncertainty. If we take a table of estimated Greenwich temperatures, by Mr. Glaisher, in the *Philosophical Transactions* for 1850, and extending from 1771 to 1849, and apply our method, we get the curve C. An interesting table by Dr. Buchan, for the North-East of Scotland (chiefly Gordon Castle and Culloden), from 1764 to 1892, yields the curve D. There is a degree of similarity between these two curves, and they may be taken to afford a general idea of the truth. They dip down to low points in the second and third decades of this century; after which comes a long rise to the seventies. The first twenty years of our century evidently included some very intense cold. Perhaps the severest winter of the century (thus far) is 1813-14, when a fair was held on the Thames, and there was a snowstorm lasting forty-eight hours.

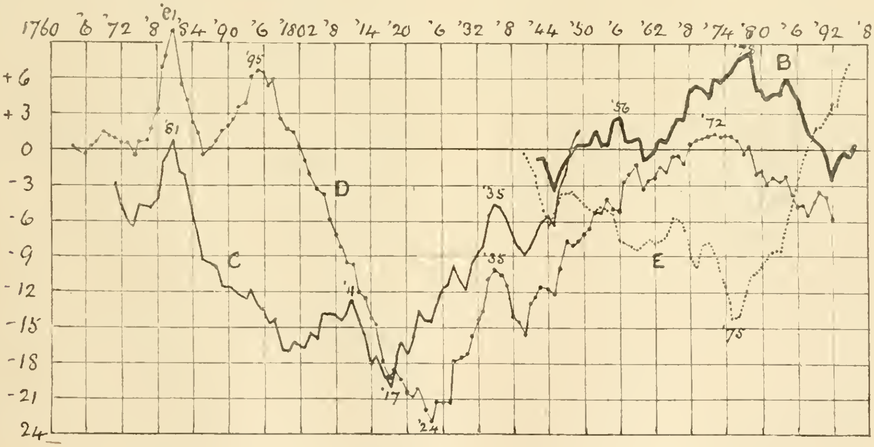

Fig. 2.—Gain and Loss Curves of Annual Temperature, Greenwich, North-East Scotland, and Harvard.

It is a curious fact that in America the weather is often opposite to ours. Thus, if winter is severe on the continent of Europe it is generally mild in America, and *vice versâ.*

How does America show in temperature from our present point of view? E is a "gain and loss" curve, as we may call it, for Harvard Observatory, from 1841. It is distinctly opposite in character to that for Greenwich. Up to 1875, more cold years than hot; since 1875, more hot years than cold. A similar kind of variation might be shown for Chicago, and, doubtless, other places.

In all these curves, we may here note, it is the general trend of the curve that has to be considered, rather than the relation to the average line. For the starting point is chosen arbitrarily, and we always commence near the average line. Referring to curve D, if we commenced in 1824 we should get a curve wholly above the average line, instead of mostly below it, as in the diagram.

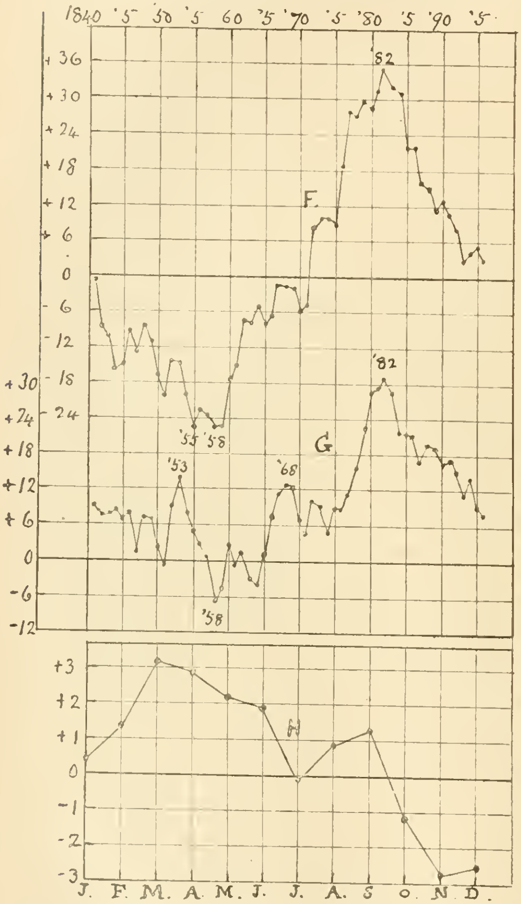

Fig. 3.—Gain and Loss Curves of Rainfall, Edinburgh and Greenwich (years), and London (months of 1897).

We may now, in conclusion, briefly glance at rainfall. The annual rainfall at Edinburgh from 1841 to 1896 (according to Mr. Mossman's figures), treated by our method, yields the curve F (Fig. 3); and that for Greenwich the curve G.

In both of these we may observe a gradual rise from 1858 to 1882; more wet years than dry. Thus, in the case of Edinburgh, of these twenty-five years, sixteen were wet and only nine dry. Since 1882, again, the dry years have preponderated; in Edinburgh ten dry to four wet. From the general aspect of these curves we may, perhaps, be inclined to think the preponderance of dry years may continue some time further.

The method here illustrated does not seem to have been much used in this country, but is capable, I believe, of throwing some light on the vagaries (as we often call them) of our weather.

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THE PRISMATIC CAMERA AT THE RECENT ECLIPSE.

By J. Evershed, f.r.a.s.

Spectroscopic research formed an important feature in the work of most of the astronomical parties who went to India to observe the total solar eclipse of last January, and photographic methods, which have so largely replaced eye observations at recent eclipses, were, it is needless to add, employed at every station where this analytical method was in vogue.

Owing to the ideal condition of the weather all along the line of central eclipse, a large number of very beautiful photographs are the result. The amount of interesting material thus secured, and which is now available for discussion, certainly exceeds anything obtained at any previous eclipse.

Among the various lines of research undertaken by spectroscopists, perhaps the largest share of attention was given to the study of the spectrum of the layer of gases lying immediately above the dazzling photosphere, and known as the "flash spectrum."

It may be well to explain, for the benefit of those who are unfamiliar with the subject, the conditions under which this spectrum is revealed during an eclipse. Outside the visible surface of the sun, and covering the entire sphere pretty uniformly, there exists a stratum of gas of considerable depth and comparatively simple composition, known as the "chromosphere." Its spectrum of bright lines indicates the presence of the three elements calcium, hydrogen, and helium. This layer and the prominences arising from it may be seen at all times by the aid of powerful spectroscopes; but the base of the chromosphere—that is, the region lying within one or two seconds of arc of the photosphere—is not accessible to ordinary spectroscopic observation, on account of the perpetual unsteadiness of the telescopic image of the sun, and the very intense atmospheric illumination so near to the sun's edge.

Now, during the progress of a total eclipse, the moon, advancing from the west, gradually covers up the photosphere until only a thin crescent remains on the east side, and this rapidly narrows down and finally vanishes altogether; when this occurs, however, the chromosphere lying outside still remains uneclipsed on the east limb, and even the very lowest strata are uncovered near the point where the last streak of photosphere disappeared.

It is just here that the most interesting and beautiful spectral phenomena are revealed; bright lines flash out in hundreds—there seems literally to be a *shower* of bright lines all along the spectrum the moment the photospheric light is withdrawn—but it is only momentary; the steadily advancing moon almost immediately occults the lowest gaseous strata and only the ordinary chromospheric spectrum remains.

This beautiful phenomenon can therefore only be seen or photographed at the moments of disappearance or reappearance of the photosphere at the beginning and end of the total phase respectively. Under the average conditions of an eclipse, perhaps not more than two seconds are available just as totality comes on in which the flash spectrum may be photographed in its full splendour; and if the observer is discerning enough to know exactly when the sun is going to burst out again at the end of totality, he will have another two seconds in which to expose a second plate!

It has been estimated that our opportunities for studying the corona do not amount in the aggregate to more than some hours per century, and the progress of knowledge is, in consequence, not rapid. How long it will take to unravel the mysteries of the flash spectrum it is hard to say, seeing that the time available for its study must be reckoned in *minutes* per century. This method of estimation is, however, certainly unjust to the photographic plate, which enables us to study at leisure so very transient a phenomenon.

A great variety of photographic spectroscopes were used at the recent eclipse, but all may be classed under two heads, viz., slit spectrographs and prismatic cameras. The great advantages possessed by the latter for eclipse work were first pointed out by Sir Norman Lockyer, who employed them with great success at the eclipse of 1893, and again in 1896, when Mr. Shackleton first succeeded in photographing the flash spectrum at his station in Novaya Zemlia. The crowning success for the prismatic camera is the splendid photograph of the flash which Sir Norman Lockyer has obtained at the recent eclipse with his six-inch instrument in the hands of Mr. Fowler.

The photographs which accompany this article were obtained at the recent eclipse with a small instrument of this class, which I constructed in 1896 for the eclipse of that year. Without going into details as to the design of this particular instrument, I may say generally that the prismatic camera is the simplest of all spectroscopic appliances. It consists essentially of a prism placed in front of a camera lens. There is no slit or collimator, which in the ordinary spectroscope are used to give purity to the spectrum, and consequently it is not possible to photograph spectra from extended sources of light, such as the disc of the sun. But the prismatic camera is particularly well adapted for photographing the spectrum of the solar atmosphere during an eclipse, because, as before explained, when the disc is entirely covered by the moon there remains a thin crescent of light due to the layer of gases outside, and which acts the part of a curved slit. If the moon and sun were precisely equal in apparent size this would extend all round in a ring, and would produce considerable confusion in the spectral images; but under ordinary circumstances the moon is slightly the larger in angular diameter, so that early in the total phase the chromospheric gases appear as a half circle or crescent on one side only, while later on this is in turn eclipsed and the opposite portion is uncovered.

In the succession of photographs given in the plate it will be noticed that the spectral images of these crescents exhibit this change, which occurs about the time of mid-totality (between Nos. 4 and 7). It will of course be understood that, owing to the essential nature of gaseous radiation, and to the wonderfully complete mixture of gases existing at the base of the chromosphere, an enormous number of distinct images or spectrum "lines" are shown in the photographs taken near second and third contact. The pair of very strong images to the left hand of the central portion of each spectrum are those due to the well-known radiations of calcium vapour, namely, H and K; they give complete images of the chromosphere and prominences—or, rather, as much as was uncovered by the moon at the time each photograph was taken.

Before proceeding to describe in detail the results obtained, I will give a brief description of the arrangements I made for this work at the camp of the British Astronomical Association stationed at Talni.

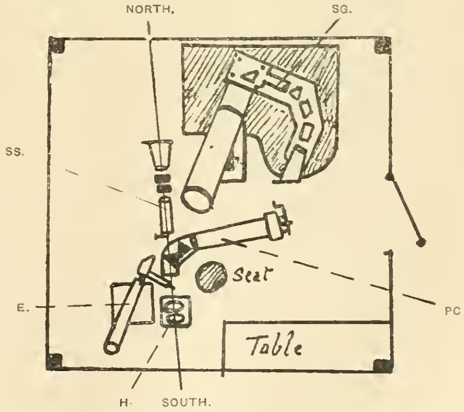
My plan of work was first to obtain a series of ten photographs with the prismatic camera during totality, and including, if possible, the flash spectrum at both second and third contacts; secondly, to photograph the flash spectrum on a larger scale with a large slitless spectrograph attached to a six-inch telescope; and, thirdly, to expose a single plate to the spectrum of the corona during the whole time of totality by means of a slit spectrograph containing quartz prisms.

Besides these three photographic instruments I had available a four-inch polar heliostat, kindly placed at my disposal by Mr. W. H. Maw; and a three and a quarter inch equatorial telescope provided with a powerful solar spectroscope, with which I intended to actually observe the flash of bright lines at second contact, and thus determine the exact moment when to expose the photographic instruments.

The heliostat, which I arranged with two four-inch mirrors instead of one, was used to supply light to the prismatic camera and to the slit spectrograph, both these being mounted on fixed supports firmly bedded in cement. The six-inch telescope with its spectrograph was mounted equatorially, but without any driving gear, and was pointed directly at the eclipsed sun.

As there would be no one available on the day of the eclipse to assist me, the three photographic instruments had to be arranged with their exposing shutters near together, so that I could work them all while seated near the telespectroscope.

The diagram will show better than any description the disposition of the various instruments within the observing hut.



Plan of Observing Hut.

E. Equatorial Telespectroscope; H. Heliostat; PC. Prismatic Camera; SG. Spectrograph with Six-inch Object Glass; SS. Slit Spectrograph with two Quartz Prisms.

Thanks to the facilities afforded by the Indian Government in providing workmen and materials, and to the very attentive way in which all our needs were provided for by the Deputy Commissioner of the district, Lieutenant Morris, I was able to get everything erected and in working order during the fortnight preceding the eclipse. In adjusting the instruments and putting together the six-inch telescope and spectrograph I had also the advantage of receiving most efficient help from Captain Molesworth, R.E., without whose skilled assistance it would have been impossible to get all ready in time.

On the day of the eclipse the actual procedure was as follows :—About ten minutes before totality the heliostat was started going and the mirrors adjusted. Then the exposing cap of the prismatic camera was put on and the first plate drawn up into position by means of a rack-and-pinion arrangement which I had made for this instrument to obviate the necessity for "changing plates" after each exposure. Next, the exposing shutter of the slit spectrograph was closed and the dark slide drawn out ready.

At eighty-eight seconds before second contact the six-inch telescope was adjusted and clamped in such a position that the diurnal motion would carry the image of the eastern edge of the sun exactly into the middle of the field of the spectrograph at the moment of second contact. This was effected by moving the telescope until the image of what remained of the sun touched a certain mark previously made on a screen placed in the focal plane, and keeping it there by following in R.A. until the chronometer I was using indicated eighty-eight seconds before totality.

During the last half-minute before the eclipse was total I began exposures with the prismatic camera, taking two instantaneous photographs of the cusp spectrum, and then drawing another plate into position ready for the "flash."

Now, all being ready, only a few seconds remained before the bright lines of the flash spectrum might be expected to appear. The gloom of the approaching shadow was already increasing at an alarming rate. I turned to the visual spectroscope, took off the slit head, and watched the spectrum of the last remaining thread of sunlight without any slit. The well-known groups of dark lines composing the ordinary solar spectrum were seen at first just as though the slit had not been removed, but they were curved arcs instead of straight lines, each taking the form of the little crescent of photosphere remaining uncovered.

The band of continuous spectrum in which these dark lines appeared was seen to be rapidly narrowing, but, instead of thinning down to a single thread, the roughness of the moon's edge caused it to suddenly break up into a number of strips with dark spaces between, and at this instant the bright lines flashed out in hundreds between and across the streaks of continuous spectrum. I was astonished at the suddenness of the reversal from dark lines to bright, and at the brilliancy and extreme sharpness of the lines ; many of them extended for thirty degrees or more round the limb of the moon, but interrupted here and there by the projecting lunar mountains.

Without waiting for further developments I immediately exposed the prismatic camera and the large spectrograph, in hopes that the photographic plate would be equal to the occasion and duly record this wonderful display.

In the resulting photograph (No. 3) certainly not all of the finer lines are depicted which I could see reversed in the part of the spectrum I was observing. But in the ultra-violet, where the definition is best, an extraordinary wealth of fine lines are shown ; and this end of the photograph gives a good idea of what I actually saw near the group *b* in the green.

Immediately after second contact I made an instantaneous exposure with the prismatic camera—the fourth of the series—and then started a series of long exposures, at the same time opening the shutter of the slit spectrograph.

During the first long exposure I left the seat near the heliostat and closed the slide of the large spectrograph, reversed it, and opened again ready for the second flash. Then I had to turn the right ascension handle four revolutions to bring the west limb into the field of the spectrograph at third contact. The forty seconds occupied in this way with my back to the eclipse was an ordeal which I trust I may never again have to undergo! After returning to the seat I closed the long exposure and started another ; then I had a look, for the first time, at the corona. With a pair of binoculars I examined the beautiful streamer on the south-west side which was so successfully photographed by Mrs. Maunder (*see* the May Number of Knowledge). But almost before I could gain any very distinct impressions I was interrupted by the time caller, only twenty more seconds remaining before the sun would reappear ! It was necessary to close the long exposure, expose another short one, and then look out for the flash again.

Fortunately I made the exposure for the second flash spectrum just as the first points of sunlight burst into view on the west limb, forming what is known as "Bailey's Beads." (*See* No. 8.)

Two more snap shots with the prismatic camera taken in rapid succession completed the programme.

The whole performance seemed to have gone off without any serious hitch, but too late I discovered the slit spectrograph still open, with the crescent sun right across the slit ! I had forgotten to close the shutter in the hurry of the last moments of totality.

The number of photographs secured altogether was thirteen ; one with the slit spectrograph, two with the large spectrograph, and ten with the prismatic camera.

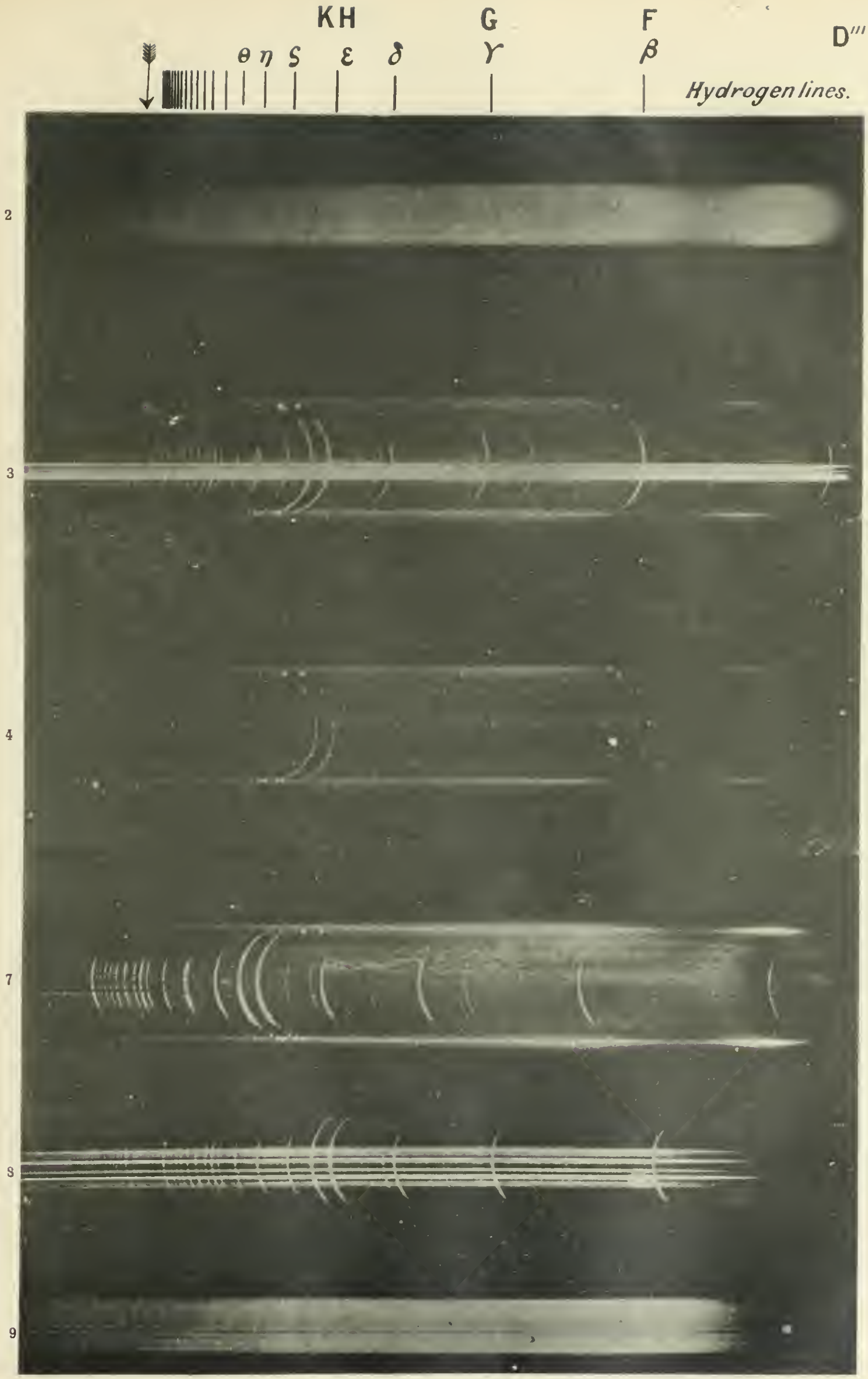
The single photograph obtained with the first named failed from the above-mentioned cause, the direct sunlight and halation nearly obliterating the faint coronal spectrum.

The large spectrograph yielded two negatives of the flash spectrum which show a considerable number of lines in a limited region of the spectrum, but on the whole they do not quite come up to expectation. The best results were those obtained with the prismatic camera. This instrument gave images of the spectrum extending from λ 600 in the orange to λ 338 in the ultra-violet. The scale of the original negatives is ·33 inch to the moon's diameter and one inch from F to H, the total length of spectrum photographed being 2·8 inches.

All the ten exposures yielded good negatives. Nos. 1, 2, 9, and 10 of the series give the spectrum of the cusps just before and just after the total phase. They show the Fraunhofer dark-line spectrum bordered with bright lines, and in No. 10 *all* the dark lines in the ultra-violet end in a short bright line.

The flash spectrum lines are shown in Nos. 3, 7, and 8. In No. 3 they are beautifully defined in the ultra-violet from H upwards, and this photograph is certainly the finest of the set. It will be necessary to study it in great detail by means of enlargements and with the help of the Fraunhofer spectrum (obtained under precisely the same angle of incidence) given in Nos. 1 and 2.

Of the remaining plates, No. 4 reveals a very curious feature in the prominence spectrum. In the ultra-violet are seen a succession of little dots due to the hydrogen radiations, and at the point where these terminate (at λ 3666) the spectrum abruptly changes its character and becomes a continuous one, a delicate line running from the last dot to the end of the plate.



ECLIPSE SPECTRA.

Photographed with Prismatic Camera, 2¼ inches Aperture, 36 inches Focus.

The long exposures made near mid-totality show the distribution of "coronium" in the corona. The well-known radiation of this gas, 1474 K, is, in these, shown to correspond more or less with the general structure of the corona; but it is very much brighter on the east side than on the west, where it is hard to trace it at all.

Six out of the ten photographs taken are reproduced in the plate, enlarged about two and one-third times. The series number is given beside each spectrum. Much of the delicate detail shown on the original negatives is inevitably lost in the reproduction, although the main features are well brought out. In referring again to the flash spectrum, as seen in Nos. 3 and 7, I would call attention to the beautiful sequence of the hydrogen lines (the positions of these referring to No. 3 are given at the top of the plate). I do not know that these lines have ever before been photographed in such completeness in the chromosphere spectrum. In the original negative twenty-six or twenty-seven lines can be counted, starting with the line α at the red end. In the ultra-violet they become so closely crowded together that it is not easy to say exactly how many there are and where the series ends. According to the well-known empirical formula of Balmer, which expresses with such extraordinary accuracy a series of numbers given by nature, the limit should be at λ 3647, a position in the spectrum which is indicated by an arrow at the top of the plate. In the photograph, however, there is a beautifully regular gradation in the intensity of the lines, which become fainter and fainter as this limit is approached, so that line No. 27 (λ 3661) is so exceedingly faint as to be barely distinguishable, and it apparently forms the termination of the series.

Another point which is well shown in No. 3 is that, if we except the ordinary chromosphere lines (those of calcium, hydrogen, and helium), all the fainter lines due to the flash spectrum proper are of the same length and form, a well-defined band of even width running from end to end of the spectrum. This shows that the low-lying gases at the base of the chromosphere form a well-defined layer pretty definitely bounded, and not fading by insensible gradations into the higher portions of the chromosphere.

An estimate based on the width of this band of bright lines gives for the depth of the layer about one and a half seconds of arc—or say seven hundred miles—the total depth of the chromosphere itself being some eight seconds of arc, or three thousand six hundred miles.

The limits of this article preclude my entering upon the discussion as to the relation between the flash spectrum lines and the Fraunhofer spectrum, beyond saying that, from a careful consideration of the facts so far brought to light, I am inclined to believe that the flash spectrum does in fact represent the upper portion of the layer which by its absorption gives us the ordinary dark-line spectrum, as was held by Prof. Young, who first discovered the so-called "reversing layer" at the eclipse of 1870.

I think that too much stress has been laid upon the fact that, while the flash spectrum lines correspond in position with the Fraunhofer lines, yet in relative intensity there are marked differences. This, it seems to me, is only what we should expect to be the case when we consider that in the one case we are looking tangentially through the higher parts of the layer (which, it is to be remembered, is some seven hundred miles in depth, with a probable enormous increase of density at the base), while in the other the line of sight passes entirely through the layer from top to bottom.

OCCULTATION OF 26 ARIETIS OBSERVED PHOTOGRAPHICALLY.

The disappearance of a bright star when occulted by the moon is always a striking phenomenon. There is no celestial event whose time is susceptible of more precise determination. For many years various plans have been suggested, both here and elsewhere, by which this time could be determined with greater accuracy than by ordinary visual observation. In fact, the apparatus for photographing the eclipses of Jupiter's satellites, used here for several years, was devised in part for this purpose.

On February 25th, 1898, Mr. Edward S. King for the first time succeeded in satisfactorily photographing the occultation of a star. The apparatus used was an improved form of that constructed for photographing the eclipses of Jupiter's satellites, and described in the *Astrophysical Journal*, Vol. I., p. 146. The plate was moved automatically every second by means of an electro-magnet. A motion of about 3·03 cm. was given to the plate whenever the circuit was closed, and of an equal amount when it was opened. Connecting the apparatus with the standard clock, Frodsham 1327, two images alternately faint and bright were obtained every second. As the faint images are three magnitudes fainter than the bright images, the ratio of the durations was about one to sixteen, so that the absolute durations were 0·06s. and 0·94s. It is here assumed that, as the times of exposure were very short, the chemical action was proportional to the time. This assumption is verified by actual measurement.

Considering only the images taken during the minute following 6h. 35m. 0s., the bright images of 26 Arietis, as shown, are equally intense, including that having an exposure lasting from 50·06s. to 51·00s. Since this image appears to be as bright as the others, the light of the star could not have begun to diminish much before the time 51·00s. If the star had disappeared suddenly at 50·9s. the last image would be at least 0·12 of a magnitude fainter than the others, an amount readily measurable. The next image is apparently invisible. Had the disappearance taken place at 51·06s. the image would appear, and would be as bright as the other faint images. A slight darkening of the film is perceptible near the position the next image would have had, with an intensity nearly equal to that of the fainter images. If this were due to the star it would denote that the latter suddenly disappeared at about 51·12s. The absence of the preceding image would indicate a more gradual disappearance. In any case, the time is fixed at 51·1s., to within one-tenth of a second. As the clock was 2m. 19·4s. fast, not including armature time, the corresponding Greenwich mean time is 12h. 54m. 26·5s. By using shorter exposures the uncertainty in the time of disappearance can doubtless be greatly reduced, especially in the case of the brighter stars. Since satisfactory images of 26 Arietis, magnitude 6·1, were obtained in 0·06s., it is

Occultation of 26 Arietis. (Enlarged 10 times.)

probable that occultations of stars as faint as the ninth magnitude can be observed photographically.

Measures were next made of the intensity of the last five images of 26 Arietis, to see if there was any diminution in light due to the absorption of a lunar atmosphere. The distances of these images from the moon's limb were 1·8″, 1·4″, 1·0″, 0·6″, and 0·2″, respectively. The corresponding changes in light expressed in magnitudes as compared with ten more distant images were +0·03, +0·03, —0·02, +0·03, and —0·02. A positive sign denotes that an image was fainter than those at a greater distance from the moon. From this it appears that no diminution in light was perceptible. No correction need be applied to any of the above calculations for the diameter of the star's disc, since, assuming its intrinsic brightness equal to that of the sun, its time of disappearance would be only 0·002s. (*Proc. Amer. Acad.*, XVI., p. 1.

In this connection it is interesting to note that the determination photographically of the position of the moon by means of a star about to be occulted, was one of the subjects investigated by Prof. G. P. Bond forty years ago. He obtained a number of photographs of the moon and α Virginis shortly before the occultation of the latter on June 2nd, 1857.

A VARIABLE BRIGHT HYDROGEN LINE.

The presence of the bright hydrogen line $H\beta$ in the spectrum of the star A. G. C. 9181 was found from the Draper Memorial photographs in 1895, and was announced in the *Astrophysical Journal*, Vol. I., p. 411. From a comparison of photographs of this object taken on different dates Miss A. J. Cannon finds that this line is variable. On October 5th, 1892, it was invisible. On November 28th, 1894, it was about half as bright as the corresponding line in A. G. C. 9198, ω Canis Majoris. On April 27th and 30th, 1895, the line in A. G. C. 9181 was distinctly the brighter of the two, while in January, 1897, it was again invisible. From a large number of photographs of this object taken recently it appears that this line, which was bright in October, 1897, is now, December 27th, invisible.

A NEW SPECTROSCOPIC BINARY.

From an examination of the Draper Memorial photographs Mrs. Fleming finds that the star A. G. C. 20263, β Lupi, is a spectroscopic binary. The period has not yet been determined, but photographs are being taken for this purpose.

Measures of the spectroscopic binaries, μ^1 Scorpii and A. G. C. 10534, show that the relative velocities of the components are approximately 460 km. and 610 km. respectively. The velocities are therefore much greater than in the case of ζ Ursæ Majoris and β Aurigæ. The separation of some of the lines amounts to as much as nine tenth-metres.

PHOTOGRAPHIC SPECTRUM OF THE AURORA.

Various attempts have been made at this observatory to photograph the spectrum of the aurora. In 1886 on several occasions long exposures were given to plates during bright auroras, but no result was obtained. On April 1, 1897, Mr. Edward S. King succeeded in obtaining a photograph in which four bright lines were visible, but uncertainty existed regarding their wave lengths. The exposure was one hundred and forty-seven minutes. During the bright aurora of March 15th, 1898, he obtained a photograph showing two bright lines. The exposure was one hundred and forty-one minutes. The brightest of these lines extends in wave length from about 3892 to 3925, and the wave length of the second is 4285. Assuming the two brighter lines photographed in 1897 to be identical with these, the four lines on that plate have the wave lengths 3862, 3922, 4288, and 4694. The first of these lines is very faint.

The errors of measurement of these lines do not exceed one or two units, but much greater uncertainty exists in the reduction owing to difficulties in comparing them with the lines of the solar spectrum, which was photographed upon the same plate. Probably the two auroras gave different spectra. That in 1897 was taken with a wide slit, but the images of the lines were well defined on the edges and of equal width, so that the line 3922 was probably really narrow and coincident with the edge of greater wave length of the line 3892 to 3925. The spectroscope used was not especially designed for photographing faint surfaces, and it is hoped that better results may be obtained with a new instrument now in course of construction. As is the case with all results announced in these circulars, it is expected that full details will be published later in the annals of the observatory.

Harvard College Observatory. Edward C. Pickering.

Notices of Books.

The Smithsonian Institution, 1846-1896: the History of its First Half-Century. Edited by George Brown Good. (City of Washington.) When James Smithson, in 1826, drew up his will containing this most significant provision, "I bequeath the whole of my property to found at Washington, under the name of the Smithsonian Institution, an establishment for the increase and diffusion of knowledge among men," he laid the foundation of an organization which, for half a century, has been one of the most important agencies in furthering the intellectual development of mankind. The institution is a rallying point for workers in every department of scientific and educational activity, and the chief agency for the free distribution of books, apparatus of research, and of scientific intelligence throughout the world. Its publications, which include some hundreds of volumes, are sent to all the most important libraries in the world, and many of them, it is safe to say, are found on the work-table of every scientific investigator. In view of the present enthusiasm for the idea of the federation of the Anglo-Saxon races, it may not be inopportune to point out that James Smithson was an Englishman who graduated at Oxford in 1786. "The best blood of England flows in my veins," he once wrote; "on my father's side I am a Northumberland, on my mother's I am related to kings." This sumptuous volume contains a complete history of the Institution, and appreciative notices (each by a distinguished man of science) of the various branches of work carried out under its auspices during its existence. Though the plan of the volume is due to the late Dr. Goode, the enormous labour involved in seeing the work through the press has fallen upon Prof. S. P. Langley, the present secretary of the Institution, whose own contributions to science have placed him in the foremost rank among investigators of natural phenomena. The volume is in every way a worthy jubilee memorial; the printing, the plates—in fact, the whole *format*—leave nothing to be desired; and whoever is fortunate enough to obtain a copy may well be gratified at his possession.

Memorials of William Cranch Bond and of his Son George Phillips Bond. By Edward S. Holden. (1897. San Francisco, C. A. Murdock & Co.; New York City, Lenicke Buechner.) It is not given to every man to be a Boswell, but the pity of it is that would-be Boswells do not recognize the fact, and assume the *rôle*. The first part of this book is extremely dull. It consists largely of autobiographical or biographical sketches of a Bond by himself or by another Bond, and the rest is a repetition of the same, paraphrased by Prof. Holden. The second part is not so dull, consisting as it does of Prof. George Bond's diary during his visits to Europe. Its interest chiefly lies in the comments of a personal nature on contemporary philosophers. We confess to being interested in hearing that he "found M. Plantamour a young man of thirty, and very good looking *for a savant*"; that he noticed "that the most distinguished scientific men are bad. hesitating speakers—except, perhaps, Sir John Herschel." The last part of the book consists of letters from or to the Bonds from other scientists, which are simply the short epistles that one astronomer must write to another in the ordinary course of business. We fail to see why they were inserted, except that they occupy some sixty pages.

A Treatise on Magnetism and Electricity. By Prof. Andrew Gray, LL.D., F.R.S. (London: Macmillan and Co.) 14s. net. Students of physics have been long awaiting the publication of Prof. Gray's treatise on magnetism and electricity, the first volume of which is now before us. The plan adopted is to "regard electric and magnetic forces as existing in a space-pervading medium in which the electric and magnetic energies are stored, and by which they are handed on from one place to another with a finite velocity of propagation." We need hardly say that this modern plan of regarding the subject has, in the hands of Prof. Gray, resulted in a book which no serious student of physics can afford to neglect. Though an elementary acquaintance with electric phenomena and apparatus is assumed, the reader possessed of a fair knowledge of the calculus will have no difficulty in intelligently following the subject as it is here presented. As stated in the words of Bacon, quoted upon the title page: "All true and fruitful natural philosophy hath a double scale or ladder, an ascendant and descendant, ascending from experiments to the invention of causes and descending from causes to the invention of new experiments." Prof. Gray is concerned with both these processes; and by showing how, first, electrical phenomena can be satisfactorily explained by action in a medium, he is able to also indicate the consequences to which they lead. This treatment is the natural outcome of the pioneer work of Maxwell, who, following the ascendant ladder, elaborated a mathematical theory of electricity which was not only retrospective but prophetic. The volume, of nearly five hundred pages, includes an account of the ordinary facts of magnetism viewed from a theoretical standpoint, a discussion of electrostatics and electric currents, of electro-magnetism, and of the electro-magnetic theory of light. It will undoubtedly occupy a prominent place as a book of reference in every well-equipped library, and will be read wherever the modern aspects of magnetism and electricity are studied.

Memory and its Cultivation. By F. W. Edridge-Green, M.D., F.R.C.S. (Kegan Paul, Trench, Trübner, & Co.) The author of this addition to the "International Scientific Series" claims that the facts he has discovered enable him to learn a subject in about a fifth of the time that it previously took him. With such a tempting allurement, one sets about the task of reading the manual with no little avidity. Unfortunately, however, it is difficult to maintain this preliminary enthusiasm. Though a few of the instances given to exemplify the statements made are interesting reading, we very much doubt whether the volume will find many appreciative readers. The idea of using a physiological basis for the analysis of memory is good, but it needs more careful treatment than it receives in the present book. Physiologists and psychologists will be content to differ from Dr. Edridge-Green's view, that "memory is a definite faculty, and has its seat in the basal ganglia of the brain, separate from, but associated with, all the other faculties of the mind" (page 3). As for the author's elaborate scheme of thirty-seven faculties, it would perhaps be kindest to limit ourselves to the statement that scientific men consider them fantastical and that the general reader will find them misleading. Whoever purchases the book with the idea of improving a bad memory will be disappointed; and few people will be deeply interested in the views which the author has taken the pains to expound.

Ambroise Paré and his Times. By Stephen Paget. (G. P. Putnam.) This is a very attractive volume, beautifully printed and well illustrated. As most of our readers will know, Paré was contemporary with a number of distinguished men whose names are familiar to everyone. We need only mention Shakespeare and Rabelais, Calvin and Knox, to enable Paré's place in history to be located. He was born three years before the battle of Flodden Field, and died (after an eventful life of eighty years) a year and four months after the destruction of the Armada. The volume, upon which we cordially congratulate Mr. Paget, is well worth reading. It is brimful of interesting matter, and though it is but natural that the "Journeys in Diverse Places" from Paré's own pen should attract most attention, yet Mr. Paget's work is well able to sustain the reader's interest throughout. To medical students and practising surgeons this biographical sketch should be particularly readable. How many of them would be content to do as Paré did at Turin? This is what he says in the "Journey to Turin," 1537: "I found a surgeon famed above all others for his treatment of gunshot wounds, into whose favour I found means to insinuate myself, to have the recipe of his 'balm,' as he called it, wherewith he dressed gunshot wounds. And he made me pay my court to him for two years before I could possibly draw the recipe from him. In the end, thanks to my gifts and presents, he gave it to me." (Page 35.) Knowledge is more easily gained nowadays and is less highly prized.

SHORT NOTICES.

The Centuries. Second Edition. (Newman & Co.) 5s. 6d. post free. Intended to supply a skeleton conspectus of general history, and to serve at the same time as a note-book for the reception of additional memoranda, this book is designed as a study-table companion for readers in biography or history. It forms a chronological synopsis of history on the "space-for-time" method, a page being allowed for every century, which is divided into ten-year periods, and each event is inserted as nearly as practicable in its proper position. The year "*one*," it is edifying to note, in this work is placed ten thousand years before the Christian era!

Modern Architecture. By H. Heathcote Statham. (Chapman & Hall.) Illustrated. Mr. Statham has treated a very intricate subject in a lucid style. At the present day bridges, theatres, and many buildings of a commercial kind are too frequently constructed rapidly and without any serious effort at artistic effect. Believing that the sight of artistic buildings will produce ennobling results on the rising generation, the author in his book—which is comprehensive, and embraces street, public, and domestic architecture—exerts himself to arouse greater enthusiasm for decorative effect in those who have never been able to raise themselves above the purely utilitarian.

Elementary Botany. By Percy Groom, M.A., F.L.S. (George Bell & Sons.) Illustrated. 3s. 6d. "Though by no means a 'cram book' for elementary examinations, a thorough knowledge of the contents of this book will enable a candidate to pass with distinction." This is what the author says in his preface. Mr. Groom insists on the free use of the simple microscope in commencing the study of botany, and in these lessons the compound microscope is deemed unnecessary.

A somewhat novel departure in the work consists in the study of vegetable physiology prior to a knowledge of the histology of plants; a plan which, we think, is open to criticism, inasmuch as it is fairly comparable to entering upon the study of a steam engine before having mastered the principles involved in the simple mechanical powers.

The Building of the Intellect. By Douglas M. Gane. (Elliot Stock.) 5s. The author of this book endeavours to present to the reader some of the leading views pertaining to man's education in all its aspects. He says: "Education being now regarded as a question of such vital importance, and opinions differing so widely as to its method, character, and scope, a summary of the views of those best qualified as guides and teachers cannot fail to arrive at something like unanimity of opinion." The volume, which is happily hung together, consists mainly of extracts from recognized authorities, the author modestly preferring this method rather than the bolder plan of clothing their opinions in his own words.

We have received from Messrs. Darlington & Co., of Llangollen, a parcel of their excellent handbooks for tourists, including their new "Guide to London," by Mrs. E. T. Cook. This latter is probably the most complete handbook to London ever issued. It is fully illustrated with maps, plans, and views of the great city; contains a most informing index; and is both well written and admirably planned. Finally, Mr. E. T. Cook has himself contributed the chapters on the British Museum, the National Gallery, and the National Portrait Gallery.

BOOKS RECEIVED.

The Flora of Perthshire. By Francis Buchanan W. White. (Blackwood.) 7s. 6d. net.

The Cid Ballads. By the late James Young Gibson. Edited by Margaret Dunlop Gibson. (Kegan Paul.) Portrait. 12s.

The First Philosophers of Greece. By Arthur Fairbanks. (Kegan Paul.)

The Epic of Sounds. An Interpretation of Wagner's "Niebelungen Ring." New Edition. (Novello.) Illustrated. 3s. 6d.

Elementary General Science. By A. T. Simmons and L. M. Jones. (Macmillan.) Illustrated. 3s. 6d.

First Stage Magnetism and Electricity. By R. H. Jude. (Clive.) Illustrated. 2s.

Return—Technical Education—Application of Funds by Local Authorities. (Spottiswoode.) 1s. 6d.

Text-Book of Physical Chemistry. By Clarence L. Speyers. (Spon.)

Electro-Physiology. By W. Biedermann. Translated by Francis A. Welby. Vol. II. (Macmillan.) Illustrated. 17s. net.

The Story of Photography. By Alfred T. Story. (Newnes.) Illustrated. 1s.

Responsible or Irresponsible? Criminal or Mentally Diseased? By Henry Smith, M.D. (Watts & Co.) 1s.

Scientific Method in Biology. By Dr. Elizabeth Blackwell. (Elliot Stock.)

Industrial Electricity. Edited by A. G. Elliott. (Whittaker.) Illustrated. 2s. 6d.

The Process Year-Book for 1898. (Penrose.) Illustrated.

London in the Time of the Diamond Jubilee. By Emily Constance Cook. (Darlington & Co., Llangollen.) Illustrated.

Letters.

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

"THE MASSES AND DISTANCES OF THE BINARY STARS."

To the Editors of Knowledge.

Sirs,—Referring to Mr. Gore's paper on the "Masses and Distances of the Binary Stars." In his paper of December, 1894, he used −25·5 as the stellar magnitude of the sun. In his present paper he assumes −27, but assigns no reason for the change. Will he explain?

The word "brightness" seems to be used by Mr. Gore in a sense in which I think it implies something he does not intend. I may be wrong, but I think he means "quantity of light." We cannot tell how "bright" a star is when we only know its *mass* and distance. We could if we knew its *surface* and distance. Assuming that Mr. Gore is right in his data for γ Leonis, for instance, and that its mass equals that of the sun, while it emits two hundred and sixty-three times as much light as the sun: this may be accounted for either on the supposition that it is two hundred and sixty-three times as bright, or a little over sixteen times the diameter of the sun, or evidently any compensatory variations in the two data. Of course Mr. Gore knows all this, but the double use of the word "brightness" gives trouble in reading his papers, and leads him into such a sentence as, "Hence we see that Sirius is nearly ten times brighter than it would be had it . . . the same brightness of surface as the sun has." It cannot be *brighter* if of the *same brightness.* When I light a second candle I get twice the surface and twice the light of the one, but neither candle is *brighter* than the one first lighted.

Edwin Holmes.

MERCURY.

To the Editors of Knowledge.

Sirs,—Mr. C. B. Holmes's detection of Mercury on April 12th, seven minutes after sunset, would certainly establish "a record for a London view" if the object he saw can be unquestionably identified as Mercury. The planet Venus was, however, in the very same region of sky, and not more than about six and a half degrees distant, in a south-westerly direction, from Mercury. If Mr. Holmes really observed the latter, then he must naturally have also seen the far more brilliant object Venus.

Your correspondent's observation is such a remarkable one that I am induced to suggest that Venus may possibly have been mistaken for Mercury. On consulting my note-books, I find that though I have obtained at least ninety-four naked-eye observations of Mercury, I have never been able, under the most favourable conditions, to distinguish the planet within half an hour of sunset.

Bristol, 1898, April 29th. W. F. Denning.

"DESERTS AND THEIR INHABITANTS."

To the Editors of Knowledge.

Sirs,—Mr. Lydekker, in your last issue (p. 101), ridicules "the idea that flints and other stones grow." As one with "more or less intimate acquaintanceship with science" I think his illustration unfortunate and misleading, for if segregation means growth—which I assume it does—then, startling as it may appear, stones do "grow."

G. Abbott, M.R.C.S.

[Your correspondent fails to realize the difference between *rocks* and *stones.* Rocks, during their formation, such as the sand and shingle of our beaches, may, in a sense, be said to grow; but the stones composing such shingle grow only in one way—that is, less. Similarly, congretions and segregations, such as flints, grow while in course of formation in their native rock, but, when denuded and reduced to the condition of stones, only alter in size by diminution. I must decline further discussion on the matter.—R. L.]

Science Notes.

A little pamphlet giving "Local Particulars of the Total Eclipse of the Sun on May 27th, 1900," has just been issued from the *Nautical Almanac* office. In America, the path of the moon's shadow reaches from New Orleans in Louisiana to Norfolk in Virginia; and in the Eastern Hemisphere, from Oporto in Spain to Algiers in Northern Africa.

Raoul Pictet, of Geneva, and Louis Paul Cailletet, of Paris, received the Davy medal of the Royal Society, in 1878, for their researches on the liquefaction of gases—including hydrogen, which, however, was scarcely more than a mere fog in the glass tube. Prof. Dewar has during the past month performed the unprecedented feat of liquefying hydrogen to the amount of half a wineglassful in five minutes. The boiling point of hydrogen is −240° C., and the density of the liquid, there is reason to believe, is about 0·6, water being taken as the unit.

Prof. Boyd Dawkins, in a letter to the "Times" dated 7th May, protests against the removal of the Jermyn Street Museum and Library to South Kensington, recommended in an interim report of the Select Committee. He says: "It would be worse than a mistake to uproot it and make it a mere unit in the fortuitous concourse of atoms known as the Science and Art Museum at South Kensington. . . . If technical education is to be encouraged our museums must be multiplied and made more accessible to the many, instead of being diminished or concentrated in a suburb where they can only be a luxury of the few."

On Monday, the 7th May, the Council of the Royal Geographical Society awarded one of the two medals to Dr. Sven Hedin for his work in Central Asia, and especially for his survey of the glaciers of Mustagata. The Doctor was the first explorer to cross the Takla-Makan desert, and has done much good work in further advancing our knowledge of the physical geography of the Lob region. The other medal was awarded to Lieut. E. A. Peary, for his explorations in Northern Greenland, begun twelve years ago, and especially for his sledge journey across the Greenland ice, and the discovery of its northern termination.

We understand that the valuable collection of meteorites formed by Mr. James R. Gregory is to be disposed of as a whole. As the collection includes about five hundred specimens, rich in fine examples of the earlier "falls," and has occupied nearly forty years in the compilation, it might be a useful acquisition for some museum.

The Royal Photographic Society's Exhibition at the Crystal Palace was a great success, and almost all branches of photography were well represented. The most striking feature of the exhibition was the degree of perfection which photography has attained as an art, many beautiful enlargements being "as good as pictures." Photography, as applied to science, was in quality excellent, but one would like rather more of it. A few choice astronomical subjects (the eclipse being well shown), also a fair proportion of photomicrographs and radiographs, deserved careful study. There were, too, some very successful flash-light photographs in coal mines, and a marvellous panoramic view from a balloon taken by means of the telephoto lens.

Ornithological Notes.—Owing to the absence from England of Mr. Harry Witherby, these have to stand over until next month.

AFRICA AND ITS ANIMALS.

By R. Lydekker, B.A., F.R.S.

If we take a map of the world, and, after tracing upon a sheet of thin paper the outline of the British Islands, cut out the tracing and lay it upon India, we shall find that it covers a mere patch of that great area. Repeating the same process with India, and placing the tracing thus obtained on Africa in such a manner that the sharp angle on the tracing formed by Assam overlies the projecting point of Somaliland, which it almost exactly covers, it will be found that the area embraced in the tracing occupies only a small patch in the middle of the eastern side of the Dark Continent. As a matter of fact, the patch thus marked out ends in a blunt point northwardly some distance above Khartum, thence it runs south to the neighbourhood of the Victoria Nyanza, from which district it rapidly narrows to terminate in a sharp point some distance to the southward of Zanzibar. Allowing for some slight overlaps, no less than six Indias can be traced on the map of Africa; and as these leave between them and on their margins considerable spaces of the country still uncovered, it would be but a moderate estimate that Africa includes at least seven times the area of British India. Some idea, especially to those familiar with our vast Indian dominions, may in this manner be most readily gained of the huge extent of the African continent.

Having made these comparisons of the actual size of the three areas under consideration, I must ask my readers to regard them for a moment from another point of view. Everyone familiar with the birds and mammals of the British Isles is aware that, even excluding Ireland, the same species are not found over the whole area. The Scottish hare, for instance, is specifically distinct from the ordinary English kind, while the red grouse is unknown in the southern and eastern counties of England, and the ptarmigan is confined to the colder districts of Scotland. There are accordingly indications that even such a small area as the British Isles contains local assemblages of animals, or faunas, differing more or less markedly from those of other districts.

Turning to India, we find such local faunas—as might be expected from its larger area—more distinctly defined, and more markedly different from one another. One great fauna occupies the southern slopes of the Himalaya from the base to about the upper limit of trees; this fauna, which includes many peculiar types unknown elsewhere, being designated the Himalayan. The second, or typical Indian fauna, occupies the whole of India from the foot of the Himalaya to Cape Comorin, exclusive of the Malabar coast, but inclusive of the north of Ceylon. The third, or Malabar fauna, occupies the Malabar coast and some of the neighbouring hills, together with the south of Ceylon; the animals of these districts being very different from those of the rest of India. The fourth, or Burmese fauna, embraces only the province of Assam, in what we commonly term India; and many of its animals, again, although of the general Oriental type, are very different from those of the other districts. But even such divisions by no means give the full extent of the local differences between the animals of the whole area. In the second or typical area, for example, the creatures inhabiting the open districts of the Punjab and the North-West Provinces display remarkable differences from those dwelling in the forests of Southern India (the home of the strange loris); while the dwellers in the jungly tract of the south-western districts of Bengal are equally distinct from those of either of the other areas.

Seeing, then, that while slight differences are observable in the local faunas of such a small area as the British Islands, and that much more important ones characterize the different zoological provinces of the vastly larger extent of country forming British India, it is but natural to suppose that distinctions of still higher value would be characteristic of different parts of Africa, accordingly as they differ from one another in climate, and consequently in vegetable productions.

As a matter of fact such differences do occur to a most marked degree; but when the vast superiority in size of Africa over India is taken into consideration, the marvel is that the fauna of the greater part of that area is not more dissimilar than it is, and that it has been found possible to include the more typical portion of the continent in one great zoological region or province.

But the reader will naturally inquire what is meant by calling one portion of a continent more typical than the rest. As has been pointed out in an earlier article in this journal,* Northern Africa has, so far as its animals are concerned, been cut off from the districts lying south of the Tropic of Cancer by the great barrier formed by the Sahara; and as the animals of the districts to the north of that desert are for the most part of a European type, while Southern Europe and Northern Africa were evidently joined by land at no very distant epoch of the earth's history, the districts north of the Sahara are for zoological purposes regarded as part of Europe and Asia. Typical, or Ethiopian Africa, as it is more generally termed, includes, therefore, only such portion of the continent as lies to the south of the northern tropic.

But the critical reader may perhaps here be led to remark that some at least of the animals of Northern Africa are common to the South; the lion, whose range extends from Algeria to the Cape, affording a case in point. To this it may be replied that, popular prejudice notwithstanding, the lion cannot in any sense be looked upon as a characteristic African animal. Although year by year growing rarer, it to this day still lingers on in certain parts of Western India, while it is likewise found in Persia and Mesopotamia, and within the historic period was common in South-Eastern Europe. At a still earlier epoch, as attested by its fossilized remains, it was an inhabitant of our own island. It may, therefore, to a certain degree be regarded as a cosmopolitan animal, which may have obtained entrance into Africa by more than one route. In a minor degree the same may be said of the hippopotamus, which was formerly found in the lower reaches of the Nile, and at a much earlier epoch in many parts of Europe, inclusive of Britain. Being an aquatic animal, it can avail itself of routes of communication which are closed to purely terrestrial creatures.

Of the fauna of typical Africa, as a whole, some of the most striking features are of a negative nature; that is to say, certain groups which are widely spread in most other districts of the Old World are conspicuous by their absence. This deficiency is most marked in the case of bears and deer, neither of which are represented throughout the whole of this vast expanse of country. Pigs allied to the wild swine of Europe and India are likewise lacking; their place being taken by the bush-pigs and the hideous wart-hogs, both of which are among the most characteristic of African animals. Except for a couple of species of ibex in the hills of the north-east, sheep and goats are likewise unknown in a wild state. Among other absentees in the fauna, special mention may be made of marmots, and their near allies the susliks, as well as of voles, beavers, and moles.

Of the mammals (and space permits of scarcely any reference to other groups) which may be regarded as characteristic of typical Africa as a whole, the following, in addition to the bush-pigs and wart-hogs already mentioned, are some of the most important. Among the monkeys the most widely distributed are the hideous baboons (*Papio*), now restricted to Africa and Arabia, the southern portion of the latter country being included in the same great zoological province. The guenons (*Cercopithecus*), species of which are the monkeys commonly led about by organ-grinders, have also a wide distribution on the continent, although of course more abundant in the forest regions than elsewhere; and the guerezas (*Colobus*), one of which was described some months ago in Knowledge,* have also a considerable range. In a totally different group, the curious little jumping shrews (*Macroscelides*) form a peculiarly characteristic family of African mammals belonging to the insectivorous order. There are also many peculiar genera of mungooses, but as most of these have a more or less local distribution they can scarcely be considered characteristic of the continent as a whole; still, they are quite different from those found elsewhere. A very curious carnivorous mammal known as the aard-wolf (*Proteles*), strikingly like a small striped hyæna, is not the least peculiar among the animals of Africa, where it has a comparatively wide range. The hunting dog (*Lycaon*), which presents a considerable resemblance to the spotted hyæna, is an equally remarkable representative of the dog family. Although formerly found in Europe, the spotted hyæna itself is now exclusively African.

Passing by the rodents, or gnawing mammals, as being less familiar to non-zoological readers, we have the two species of hippopotami absolutely confined to Africa at the present day; we are all familiar with the common species in the "Zoo," but the small West African kind, which has more the habits of a pig, is much less commonly known.

The stately giraffes are solely African, but appear to be mainly confined to the more open districts. The herds of antelopes, for the most part belonging to generic types unknown elsewhere, with the exception of a few in Arabia, form one of the most distinctive features of African life. Many of them, like the strange gnus and the graceful gemsbok group, are confined to the open districts of the south and east; but others, such as the bush-bucks and the harnessed antelopes, have representatives in the forest districts of the west. Both species of African rhinoceros are quite different from their Oriental relatives, but only one of these, the common species, has a wide distribution in the country. Zebras, and the now extinct quagga, are familiar and striking African animals, although they are confined to the open plains and mountains. On the other hand, the African elephant, which differs so widely in the structure of its teeth from its Asiatic relative, has a much more extensive distribution, and may therefore be classed among the most characteristic of Ethiopian animals. Even more peculiar are the little hyraces (*Procavia*), the miscalled coneys of our version of the Bible, which form a family absolutely peculiar to Africa, Arabia, and Syria; some of the species dwelling among rocks, while others are active climbers, and frequent the forest districts. But perhaps the strangest mammal that may be regarded as characteristic of Africa as a whole is the aard-vark (*Orycteropus*), commonly known to the colonists as the ant-pig. It is a strangely isolated creature, having at the present day no near relations, either poor or otherwise.

The African buffaloes, with their several races or species, also belong to a type quite peculiar to the continent. To a great extent the ostrich is characteristic of Africa and Arabia, although there is evidence to show that it formerly enjoyed a considerable range in parts of Asia.

The above are only a few of the more striking instances showing how different are the animals of Africa as a whole from those of the rest of the world. Many others might be added, but they would only weary my readers. Of course, there are many groups, like the cats, common to other

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* "Deserts and their Inhabitants," Knowledge, May, p. 101.

* June, 1897, p. 130.

countries, the lion and the leopard being found alike in Africa and India; but such do not detract from the peculiarity of the African fauna as a whole. And here it may be mentioned that a large proportion of the types now peculiar to the Dark Continent appear to have come from India or some adjacent country, fossil remains of baboons, giraffes, hippopotami, ostriches, antelopes of an African type, and not improbably zebras, having been discovered in the Tertiary deposits of India.

But if the animals of Africa as a whole stand out in marked contrast to those of the rest of the world, much more is this the case when those characteristic of certain districts of that huge continent are alone taken into consideration. And most especially is this so with the inhabitants of the great tropical forest districts extending from the west coast far into the interior of the continent—reaching, in fact, the watershed between the basins of the Congo and the Nile in the neighbourhood of Wadelai. Since a large number of the peculiar animals of this district are more or less exclusively confined to the west coast, extending from Sierra Leone to the Congo, the area is appropriately termed the West African sub-region. It is here alone that we find the gorilla and the chimpanzee, the former being restricted to the neighbourhood of the coast, whereas the latter ranges far into the heart of the continent. And this district is likewise the exclusive home of the pretty little mangabys, or monkeys with white eyelids (*Cercocebus*). The galagos, which are near relatives of some of the lemurs of Madagascar, extend throughout the forest region; but the even more curious pottos, or thumbless lemurs, are confined to the west coast. Huge and forbidding fox-bats, some of them with remarkable tufts of long white hairs on the shoulders, are likewise restricted to this portion of the tract, as is the insectivorous otter, or *Potamogale*, first discovered during the travels of Du Chaillu. The equatorial forest tract is also the sole habitat of the African flying squirrels, distinguished from the very different flying squirrels of Asia by the presence of a number of scales on the under surface of the tail. Most of these belong to the genus *Anomalurus*, but the smallest of all forms a genus (*Idiurus*) by itself, and will be familiar to readers of this journal by a life-sized portrait published some years ago. Dormice of peculiar types and tree mice are also very characteristic of this tract. But far more generally interesting are the pigmy hippopotamus of Liberia and the water chevrotain (*Dorcatherium*) of the west coast, an ally of the true chevrotains of India and the Malay countries. So far, indeed, as the equatorial forest tract fauna has any representative in other parts of the world, it is to the Malay peninsula and islands that the resemblance is closest. It is there alone that the other large manlike ape—the orang—dwells; and there is a group of brush-tailed porcupines common to these two districts, and unknown elsewhere throughout the wide world. Both faunas, however, in all probability trace their descent from the animals inhabiting Europe during the Pliocene and Miocene epochs, among which was an extinct species of water chevrotain.

The other great sub-regions include the open grazing grounds and mountains of South and East Africa, the fauna of which is quite different from that of the equatorial forest tract. Minor divisions may also be recognized in this area, the Cape having many animals not found further north. Among the latter are the so-called white rhinoceros, the pretty little meerkat (*Suricata*), the long-eared fox (*Otocyon*), and the Cape sand mole (*Bathyergus*), which, by the way, has nothing to do with the true moles, being a member of the rodent order. This tract as a whole may be termed the east-central sub-region; and to it belong the great hosts of antelopes, the zebras, and the aard-wolf and hunting dog. Very characteristic of the southern and eastern parts of this tract are the beautiful golden moles (*Chryschloris*), unique among mammals for the lovely play of iridescent colours on the fur, and which have comparatively nothing in common with the moles of Europe and Asia. To the northward, in Abyssinia, this tract is the home of another very remarkable animal, the great gelada baboon (*Theropithecus*), easily recognized by the lionlike mantle of long hair on the fore quarters, whose nearest relatives are the ordinary baboons of Africa.

Whether Somaliland should be included in this area, or should have a division to itself, may admit of argument; but at any rate it has many peculiar animals, among which are a number of antelopes, some of which have but recently been made known to science.

Lastly we have the Saharan sub-region, which contains a comparatively limited fauna, passing by almost insensible degrees into that of Northern Africa.

In some respects, especially in its galagos, the fauna of Africa presents a certain resemblance to that of Madagascar; but the connection between that island and the mainland was evidently very remote, and must have taken place before the great incursion of antelopes, zebras, rhinoceroses, monkeys, elephants, etc., from the north, as none of these are found in the island. Madagascar, therefore, is best regarded as forming a zoological province by itself.

Within the limits of a single article it is manifestly impossible to give anything like an adequate sketch of the fauna of such an extensive area, but such points as have been noticed serve to show in some faint degree its richness in peculiar forms of animal life.

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THE VINEGAR FLY AND THE VINEGAR MITE.

By C. Ainsworth Mitchell, B.A., F.I.C.

The vinegar eel, of which a description appeared in a recent number of Knowledge (page 53), is not the only creature with a marked partiality for vinegar, for two other animals have become so associated with its manufacture that they are known as the vinegar fly and the vinegar mite.

The vinegar fly (*Drosophila funebris*) is of very common occurrence, and may be found in any vinegar works during the hotter months of the year. It is about a tenth of an inch in length, and is characterized by large red eyes, red thorax, and red legs. The abdomen is black with yellow stripes, and the wings are somewhat longer than the body. According to Brannt the larva is white, has twelve segments to its body, and four wart-like structures on its back, two of these being yellow. After eight days it is transformed into a yellow chrysalis.

Vinegar makers are not in the habit of paying much attention to the presence of the vinegar fly, since, as far as is known, it does not in any way affect the manufacture; and it is readily prevented from becoming a nuisance by keeping the works thoroughly clean and not allowing any spilt vinegar to lie about on the ground.

The vinegar mite, unlike the fly, must be regarded as a distinct enemy to the acetic bacteria, though not, perhaps, to the same extent as the vinegar eel. When once it has obtained a footing within an acetifier it multiplies with amazing rapidity, interferes with the oxidation process, and is not easily exterminated. Dr. Bersch describes the state of an Italian factory about which he was consulted in 1881. Every drop of vinegar produced contained one or more of these mites, which were present in myriads on every part of the acetifiers, and which finally had brought the manufacture to a complete standstill—the manufacturer being unable to account for their presence beyond stating that they were derived from the soil beneath his apparatus.

In its simplest form an acetifier consists of a large vat with a perforated false bottom. The space above this is filled with shavings or other porous material on which the bacteria settle, and the alcoholic liquid is pumped over and over through the shavings until the whole of the alcohol has been converted into acetic acid. The necessary air is admitted through holes made in the side of the vat, whilst smaller holes at the top allow the waste air to escape. Many modifications of this apparatus are in use, in which means are taken to exactly regulate the air supply and the temperature; but it is in this simple form, as first invented by Schützenbach in 1823, that most of the acetifiers in England and Germany are constructed. Prior to Schützenbach's invention, which is still known as the "quick vinegar process," vinegar was made by placing the alcoholic liquid with a little vinegar containing the bacteria in barrels, which were turned and aërated from day to day by workmen. It is through the holes for aërating the acetifier that the vinegar mite finds its way into the interior, and attempts have been made to prevent this by placing birdlime round the outside of the holes, whilst in some of the more recent patents fine wire gauze is employed for the same purpose. At first the acetic bacteria do not appear to be much affected by the presence of the mites, but as these increase and then die off and fall to the bottom their dead bodies begin to putrefy, and the putrefaction bacteria or their products sooner or later have an injurious effect, and if not removed will eventually completely master the acetic bacteria.

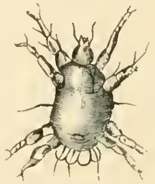

FIG. 1.—From the under side. × 120 diameters. After Bersch.

The vinegar in which the mites have thus gained the upper hand has a peculiar yellowish shade, and contains what appear to the naked eye to be a large number of white specks. When examined under the microscope these have the appearance shown in Figs. 1 and 2.

These two forms, apparently those of the male and female, are always found, many of the individuals being only one quarter or one half of the size of the others. Bersch assigns them to the class of *Sarcoptidæ*, but little appears to be known about their life history.

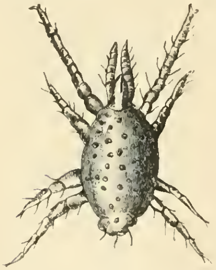

FIG. 2.— × 120 diameters. After Bersch.

When once vinegar mites have established themselves within an acetifier they can only be expelled by destroying them simultaneously with the acetic bacteria. For this purpose the vat must be emptied of vinegar as completely as possible, and the interior thoroughly washed with hot water, well fumigated with burning sulphur until all life is destroyed, and then washed again. It is then charged afresh with the alcoholic liquid and a little crude vinegar containing the bacteria, but of course it is some time before the apparatus gets into working condition again.

A CLASSIC LEGACY OF AGRICULTURE.

By JOHN MILLS.

ALL great discoveries are the result of much study, and often arise out of those truths of science which appeared least promising on their first announcement. The time is past when practice can go on in the blind and vain confidence of a shallow empiricism, severed from science like a tree from its roots. Scientific principles are now extensively applied in problems concerned with the improvement of the artificial means employed for increasing the fertility of the soil. During the last sixty years, more especially, the transmuting power of the "philosopher's stone" has been displayed, and many triumphs have been achieved through the painstaking researches of men who, like Sir John Lawes and Sir Henry Gilbert,* are not content to adhere strictly to the rule-of-thumb methods which have been in vogue for untold ages.

Agriculture is both an art and a science. On the scientific side chemistry plays an important part, and is called into request for the investigation of the composition of soils, manures, and of the vegetable and animal substances which it is the aim of agriculture to produce. All the conditions of the life of vegetables, the origin of their elements, and the sources of nourishment, are secrets which can be elicited by the aid of science. Given a barren tract of country, which has been unproductive from generation to generation, the scientific agriculturist will improve the parts by transporting and transposing the different soils. The analysis of the soils will be followed by that of the waters which rise or flow through them, by which means he will discover those proper for irrigation. A knowledge of chemistry teaches us when and in what condition to use lime, and the difference in the properties of marl, peat, dung, mud, ashes, alkali, salt, soap-waste, sea-water, etc., and consequently which to prefer in all varieties of soil—a knowledge which thus imparts a new character to the agriculturist, and renders his employment rational. Environed by an endless variety of processes and results, scientific agriculture is constantly disclosing surprises. The nineteenth century has witnessed developments greater than those of all previous time. It is as true to say now that agriculture is in a state of transition and development as it was a century ago to say it was in a state of inanition and even stagnation. The position of agriculture is now hopeful, for the age is progressive. It is a period of adaptation, of new departures, new energy, and greater economy. Foreign competition is understood and expected. To know what it is provides the means of meeting it.

We purpose in this article to afford a glimpse of the artificial aids to agriculture which Sir John Lawes and Sir Henry Gilbert have for upwards of fifty years practised at the Rothamsted Agricultural Experimental Station—the model of all agricultural stations, and the methods there introduced are everywhere regarded as classical. The researches carried on by these collaborators have elicited information which will ever serve as the foundation of a truly scientific knowledge of the correlation of plant-growth and manurial constituents of the soil, and will be of the utmost value in all discussions of the chemistry of plant life. The immense number of exact data which they have placed at the disposal of chemists is without parallel in the annals of science. As Sir Joseph Hooker has said, in the whole history of science, never have two of its greatest divisions been brought into more profitable cor-

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* We are much indebted to both Sir John Lawes, Bart., F.R.S., and Sir Henry Gilbert, F.R.S., for generous assistance in explaining the arrangement of the experimental plots at Rothamsted, the conduct of the laboratory, and in placing records, etc., at our disposal in preparing this article.

relation than chemistry and botany have been in the Rothamsted experiments. The far-seeing intelligence which devised the details affords results which have completely reformed the practice of agriculture, and the carrying on of a single research without interruption during a period of over fifty years is unexampled—a research which has taught those concerned how to estimate the actual mean fertility of the earth's surface, and, in the subordination of permanent pasture to the practical advantage of the farmer, to successfully employ readily available chemistry to modify at pleasure the entire character of the vegetation.

Sir John Lawes, apart from his scientific researches in conjunction with Sir Henry Gilbert, is probably the oldest practical farmer in England, and inherited all the traditions of a long ancestry, so that he may truly be regarded as an adherent to the motto, "Practice with science." The manor house of Rothamsted is situated in the midst of a beautifully wooded park, at Harpenden, near St. Alban's, and the experimental grounds are in the estate adjoining the park. Sir John first commenced operations in 1834, soon after succeeding to his property, first with plants in pots, and afterwards in the fields, using different manuring substances. The researches of De Saussure on vegetation were the chief subject of his study to this end. The most striking results were obtained by the use of neutral phosphate of lime, in bones, bone-ash, and apatite, rendered soluble by means of sulphuric acid. The mixture so obtained answered well for root-crops. In 1843, the date at which the researches commenced in real earnest, and when Dr. (now Sir Henry) Gilbert entered into the work, more systematic field experiments were initiated. These researches relate not only to the growth of cereal and other crops under the most varying conditions, but also to the economic effect of different foods on the development of the animals of the farm. They have embraced, moreover, most important researches concerning the sources from which plants derive their supply of nitrogen.

Following in the wake of the Rothamsted experiments, Germany has worked in the same field, and to-day she can number twenty-five experimental stations, which institute both scientific researches and deal with their adaptation to practice. Germany is indebted to experimental stations for the progress she has made during the last decade, especially in agriculture. Yet while the German stations have been founded by associations of agriculturists and maintained at the public expense, the Rothamsted experiments are due to the activity of two eminent men, and are maintained by private funds; from the commencement they have been entirely disconnected from any external organization, and have been maintained at the sole cost of Sir John Lawes. For the continuance of the investigations after his death, Sir John has made the munificent endowment of one hundred thousand pounds, besides the famous laboratory and certain areas of land, and has nominated some of the most distinguished scientific men of the day to administer the trust.

While it is a fact, affording some cause for self-satisfaction, that the farmers of Great Britain grow a larger produce per acre than the farmers of any other country in the world (the average yield of wheat per acre in 1888 was twenty-eight bushels, while that of the United States, for example, was eleven bushels), it is a noteworthy fact in connexion with these investigations that they have not been of the same benefit to our own nation as they have to some other nations. Thus, while, as in the case of Germany, Government has come to the aid of agricultural research to a praiseworthy extent, enterprise in this country is carried on by private resources, save in the college at Glasnevin, near Dublin, to which a Government grant is allotted; the colleges at Cirencester, Downton, and the Colonial Training College in Suffolk, being self-supporting, and these all draw to a considerable extent upon the researches at Rothamsted for exact information.

The investigations were commenced upon truly orthodox lines, and with truly orthodox views; but as it was not possible to alter the laws of nature, it was soon found that the results brought out did not agree with the views of the recognized authorities of the day. Among other things it soon became woefully apparent how small after all was the available leverage for artificially assisting the processes of nature. Too conspicuous to be mistaken, the weather announced itself as the great factor in producing crops. Every day in the year makes its impression, good or bad, on the final issue, which appears to be something very like the algebraic sum—the positive and negative result of the favourable and unfavourable weather of all the days in the year leaving us the victims of circumstance in spite of all the refinements of science. These investigators also saw clearly the explanation of an experiment which Hale performed more than two hundred years ago. Hale had carefully tended a plant in a pot, and noticed that, although the soil lost very little in weight, the plant increased by an amount tremendously in excess of that lost by what appeared to be the parent soil. Whence came, then, the elements of the plant? The Rothamsted experiments show clearly that about ninety-five per cent. come from the atmosphere, and only some five per cent. from the soil, thus driving home Dumas' saying that "at last analysis we are nothing but condensed air."

Some idea of the magnitude and importance of the researches carried on at Rothamsted may be gleaned from the list of field experiments given in the accompanying table.

Crops.	Duration.	Area.	Plots.
	Years.	Acres.	
Wheat (various manures) ...	54	11	34 (or 37)
Wheat, alternated with fallow	46	1	2
Wheat (varieties)	15	4–8	about 20
Barley (various manures) ...	46	4¼	29
Oats (various manures)	10*	¾	6
Beans (various manures)	32†	1¼	10
Beans (various manures)	27‡	1	5
Beans, alternated with Wheat ..	28§	1	10
Clover (various manures)... ..	29‖	3	18
Various Leguminous Plants ...	20	3	18
Turnips (various manures) ...	28¶	8	40
Sugar Beet (various manures)...	5	8	41
Mangel-Wurzel (various manures)	22	8	41
Total Root Crops ...	55		
Potatoes (various manures) ...	22	2	10
Rotation (various manures) ...	50	3	12
Permanent Grass (various manures)	42	7	22

* Including one year fallow.
† Including one year Wheat and five years fallow.
‡ Including four years fallow.
§ Including two years fallow.
Clover, twelve times sown (first in 1848), eight yielding crops, but four of these very small, one year Wheat, five years Barley, twelve years fallow.
¶ Including Barley without manure three years (eleventh, twelfth, and thirteenth seasons).

Many of the experiments were commenced without any idea of long continuance, and it was only as the results obtained indicated the importance of such continuance that the plan eventually adopted was gradually developed. It is, however, to long continuance that we owe some of the most interesting and the most valuable results.

The table further shows the area and the number of plots under experiment in each case; and it may be stated that the total area under exact and continuous experiment has been for some years, and is at the present time, about forty acres.

To cultivate and simultaneously investigate scientifically the products of such an extensive series of plots of ground, a staff of workers of no mean order is of course necessary. A number of general assistants, therefore, are engaged to superintend the field experiments—that is, the making of the manures, the measurement of the plots, the application of the manures, and the harvesting of the crops; also the taking of samples, the preparation of them for analysis or preservation, the determination of dry matter, ash, etc., and the keeping of the meteorological records. There is a permanent laboratory staff of two, and sometimes three, chemists, and three or four computers and record-keepers for calculating and tabulating field, feeding, and laboratory results, copying, etc. In addition to a large staff of this kind, the best professional assistance has been called in from time to time. Among these may be mentioned Prof. Frankland, who determined the nitrogen as ammonia, as nitric acid, and as organic nitrogen in many samples both of the rain and of the various drainage waters collected at Rothamsted; Prof. W. J. Russell estimated the sulphuric acid in some of the monthly mixed samples of rain water; the late Dr. Voelcker determined the nitrogen, and likewise the incombustible constituents, in sixty-five samples of the drainage waters; Dr. Richter has made more than eight hundred analyses of the ashes of various products, animal and vegetable, of known history; and the late Dr. Pugh took a prominent part in the experiments to determine whether plants assimilate free nitrogen, and also various collateral points.

Samples of all the experimental crops are taken and brought to the laboratory. Weighed portions of each are partially dried, and preserved for future reference or analysis. Duplicate weighed portions of each are dried at 100° C., the dry matter is determined, and it is then burnt to ash on platinum sheets in cast-iron muffles. The quantities of ash are determined and recorded, and the ashes themselves are preserved for reference or analysis. In a large proportion of the samples the nitrogen is determined; and in some the amount existing as *albuminoids*, *amides*, and *nitric* acid. There is now a collection of more than forty-five thousand bottles of samples of experimentally grown vegetable produce, of animal products, of ashes, or of soils, besides some thousands of samples not in bottles; and the laboratory having become very inconveniently full, a new detached building—a "sample house"—was erected in the autumn of 1888, comprising two large rooms for the storing of specimens and for some processes of preparation, and also a drying room. The general scope and plan of the field experiments has been to grow some of the most important crops of rotation, each separately, year after year for many years in succession on the same land, without manure, with farmyard manure, and with a great variety of chemical manures; the same description of manure being, as a rule, applied year after year on the same plot. Experiments on an actual course of rotation without manure, as well as with different manures, have also been made.

Having thus indicated the scope of the researches at Rothamsted, the resources available, and the disposition of the estate, we shall endeavour in a subsequent article to present some of the remarkable results which have been derived therefrom, and the bearing of the conclusions arrived at on practical agriculture.

NOTES ON COMETS AND METEORS.

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

Lewis Swift.—The famous American astronomer, Lewis Swift, well known for his discoveries of nebulæ and comets, furnishes a remarkable example of the retention of brilliant observational capacity to an advanced age. Though the time of his birth dates back to 1820, February 29th, he still discovers numbers of exceedingly faint nebulæ, and occasionally announces a new comet. The most recent of his cometary discoveries was in 1896, April, when he was in the seventy-seventh year of his age! His success has certainly been astonishing. No other comet-finder appears to have effected discoveries at a period so late in life as the veteran of whom we are speaking. Pons was about sixty-six years old, Mechain fifty-five, and Messier sixty-eight, when they sighted their last comets. Let us hope that Swift will yet be spared some years to add to his laurels by the discovery of further objects in the fields where he has already laboured so long and with so much distinction.

Perrine's Comet (March 19th).—This object is still visible, though becoming very faint. At the early part of June its brightness will be only one-fifth that at discovery. An ephemeris was given in the last number of Knowledge.

Periodical Comets.—The comets of Wolf, Encke, and Tempel (1867, II.), are shortly expected to appear, but the circumstances are not favourable. Pons-Winnecke's comet is now exceedingly faint. The following are ephemerides:—

Comet Wolf.

Date.	R.A.			Declination.		Distance in millions of miles.
	h.	m.	s.	°	′	
June 3	1	36	19	+18	33·0	204
,, 11	1	59	58	+19	19·0	199
,, 19	2	23	48	+19	51·3	194
,, 27	2	47	43	+20	8·7	190

Comet Encke.

June 1	6	7	12	+20	15·5	82
,, 10	6	46	3	+13	16·6	60
,, 14	7	1	41	+ 9	15·8	51
,, 18	7	18	43	+ 4	24·2	44
,, 22	7	38	59	− 1	38·7	38
,, 26	8	4	46	9	16·8	33
,, 30	8	39	19	−18	45·8	28

Comet Pons-Winnecke.

June 3	1	56	4	− 1	7·0	174
,, 11	2	14	26	− 0	12·2	177
,, 15	2	23	3	+ 0	11·4	178
,, 19	2	31	17	+ 0	32·3	179

Comet Tempel (1867, II.).

June 1	11	41	11	+13	50·1	177

Comet Wolf is approaching the earth, but it will not come as near as in 1891, and will probably remain a faint object during the whole of this apparition. It will reach its perihelion on July 4th, though it will continue to become very gradually brighter until the close of October. Comet Encke is rapidly advancing nearer to the earth and its apparent brightness increasing, but its position is not favourable for northern observers, as its motion carries it very quickly southwards. During the month the comet passes from the north-west extremity of Gemini to the south-east border of Monoceros. Tempel's comet will be close to β Leonis at the beginning of June, but its exact place is doubtful.

M. Legarde has recently published a new determination of the orbit of Tempel's comet of 1871. The comet was observed during an interval of one hundred and nine days, and its orbit appears to be that of a very excentric ellipse, with a periodic time of about two thousand and thirty years.

The April Meteors.—Prof. A. S. Herschel, at Slough, registered the paths of sixty-eight meteors observed on clear nights between April 12th and 24th. The sky was hazy on April 19th, and only one uncertain meteor was seen in a watch of two and a half hours' duration. On April 20th clouds prevailed. Very few, if any, Lyrids were observed, but the meteors recorded indicated a large number of minor showers in Corvus, Libra, Ursa Major, Draco, and the region of Hercules. At Bristol, on April 17th, 18th, 19th, and 22nd, meteors were found to be somewhat rare, and very few Lyrids were noticed. Four of the meteors observed at Bristol were also recorded by Prof. Herschel at Slough, but in two cases the observations do not match very well, as the meteors were very indifferently seen at Bristol. Of the other two, one appeared on April 17th, 10h. 28m. It was a small, very slow moving meteor, with a radiant near the southern horizon. Its heights were from seventy-two to seventy miles over Malmesbury to Evesham, and it traversed a path of about thirty-four miles. The other was seen on April 22nd, 10h. 32m. It was directed from a radiant at 252°+49°, and fell from a height of seventy-two to fifty-two miles from above Alcester to Malvern.

The brighter meteors seen by Prof. Herschel were as under:—

Date.	Time.		Mag.	Path.					Duration in Seconds.
	h.	m.		R.A. °	Dec. °		R.A. °	Dec. °	
April 16	10	47	1	290	+52	to	327	+52	2·5
„ 16	11	27	1	92½	+44	„	91	+37	0·4
„ 17	9	38½	1	44	+73	„	61	+60	1·0
„ 19	9	53	1	280	+61	„	286	+55	0·8
„ 23	12	43	1½	158	+30	„	138	+37	2·2
„ 23	12	48½	1	232½	− 5	„	231	+ 1	0·4

Mr. W. E. Besley, of Westminster, watched the sky on April 21st and 22nd during an aggregate period of three and a quarter hours, and recorded twenty meteors, of which twelve were Lyrids. The principal radiant appeared to be very well defined at the usual position, viz., 273°+33°.

If observers at other places noted any of these objects the data would be valuable as affording the materials for computing their real heights in the atmosphere.

Fireball of April 5th.—Mr. G. N. Stretton's description of this object, as observed at Fulham (Knowledge, May, p. 114), agrees remarkably well with the radiant point at 121°−1°. As seen by your correspondent, the meteor must have ascended in a perfectly vertical course; but if it actually reached the zenith, as he remarks, then the place I gave for the disappearance must be shifted some miles to the north-east, and the height at disappearance must have been a little less than that stated. But in discussing and endeavouring to harmonize materials of this character, one has to adopt the path which best satisfies the majority of the observations. Mr. Stretton's position was evidently very near the point of the meteor's disappearance. The fact that at Bournemouth it fell vertically downwards in north-east, while at Fulham it ascended straight up to the zenith from south-west, affords the clearest proof that the direction of flight of the meteor was on a line joining those two places, and that it successively passed over Bournemouth, Southampton, Alton, and Aldershot, as stated in my paper in your May Number.

THE FACE OF THE SKY FOR JUNE.

By Herbert Sadler, f.r.a.s.

Groups of, and small detached, spots are still to be detected on the solar surface.

Mercury is, theoretically speaking, a morning star, but cannot be conveniently observed for any practical purpose by the amateur during the month, owing to his proximity to the Sun. He is in superior conjunction with that luminary on the **30th**.

Venus is an evening star, and is conveniently situated for observation. On the **1st** she sets at 10h. 17m. p.m., with a northern declination of 24° 42′ at noon, and an apparent diameter of 11½″. On the **11th** she sets at 10h. 26m. p.m., with a northern declination at noon of 23° 42′, and an apparent diameter of 12″. On the **18th** she sets at 10h. 24m. p.m., with a northern declination at noon of 22° 19′, and an apparent diameter of 12¼″. On the **25th** she sets at 10h. 18m. p.m., with a northern declination of 20° 27′ at noon, and an apparent diameter of 12½″. On the **30th** she sets at 10h. 15m. p.m., with a northern declination at noon of 18° 51′, and an apparent diameter of 13″. During the month she describes a direct path through a great part of Gemini into Cancer.

Mars is practically invisible.

Jupiter is an evening star, and is still well placed for observation. On the **1st** he rises at 1h. 16m. p.m., with a northern declination of 1° 9′ at noon, and an apparent equatorial diameter of 40½″. On the **11th** he rises at 0h. 35m. p.m., with a northern declination at noon of 1°, and an apparent diameter of 39½″. On the **18th** he rises at 0h. 10m. p.m., with a northern declination of 0° 49′, and an apparent diameter of 38½″. On the **30th** he rises at 11h. 25m. a.m., with a northern declination of 0° 24′, and an apparent diameter of 37½″. During the month he describes a very short path in Virgo.

Our remarks last month about the futility of attempting to observe either Saturn or Uranus in these latitudes apply with equal force to the present month. Neptune is invisible.

There are no very well marked showers of shooting stars in June.

The Moon is full at 2h. 11m. p.m. on the **4th**; enters her last quarter at 6h. 4m. p.m. on the **11th**; is new at 4h. 19m. a.m. on the **19th**; and enters her first quarter at 4h. 54m. a.m. on the **27th**.

◆

Chess Column.

By C. D. Locock, b.a.

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

Solution of May Problems.
(By P. G. L. F.)

No. 1.

1. Q to B5, and mates next move.

No. 2.

Key-move.—1. Q to B3.
If 1. . . . K moves, 2. Q to K2ch, etc.
1. . . . Anything else, 2. Q to Qsq, etc.
[There is a near "try" by Q to Qsq at once.]

Correct Solutions of both problems received from Alpha, K. W., Capt. G. A. Forde, W. F. Denning, E. W. Brook, W. de P. Crousaz, H. S. Brandreth.

Of No. 1 only from G. G. Beazley, W. Clugston, J. M'Robert.

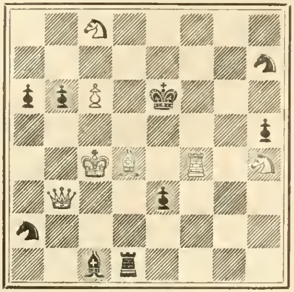
J. Nield (Crompton).—Many thanks; we hope to find space for them this summer.

PROBLEMS.

No. 1.

By A. C. Challenger.

BLACK (9).



WHITE (7).

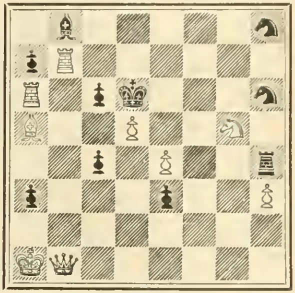
White mates in two moves.

No. 2.

By J. T. Blakemore.

(From the *Birmingham Weekly Mercury*.)

BLACK (10).



WHITE (9).

White mates in three moves.

CHESS INTELLIGENCE.

It is with the greatest regret that we learn the news of the death of the Rev. W. Wayte, for many years honorary treasurer of the St. George's Chess Club, and formerly professor of Greek at London University. Prof. Wayte, who was for twenty-three years a classical master at Eton, was certainly one of the very strongest amateur players in England. His knowledge of the whole theory of the game was profound, the openings being perhaps his especial *forte*. He was a most successful competitor at the annual meetings of the old Counties Chess Association, and was captain of the southern team when the North *v.* South contests were instituted. Prof. Wayte was the editor of an annotated edition of Plato's "Protagoras," and other classical works. His interesting "Chess Reminiscences" appeared in the *British Chess Magazine* (March and April, 1898). It will surprise many who knew him to find that he was in his seventieth year.

We omitted last month to record the result of the Pillsbury-Showalter match. Mr. Showalter did not play nearly so well as last year, and was defeated by seven games to three, with two draws. Mr. D. G. Baird has tied with Mr. Köhler for the championship of the Manhattan Chess Club.

Herr Marco has won the latest Vienna Club tourney, Herr Schlechter being as low as fifth. The international tourney at Vienna begins this month. Considerable dissatisfaction is expressed at the necessity for playing two rounds; so unpopular, in fact, is this condition that the committee have been compelled to extend the time for entries, owing to the paucity of desirable competitors. It is stated that Herr Lasker will be among the abstainers on this account, and possibly, too, Mr. Pillsbury. Messrs. Blackburne, Burn, and Caro will represent England.

Mr. P. F. Blake, the eminent problem composer, has won the level tournament of the Manchester Chess Club. Mr. Lawrence has again won the City of London tournament, although he started badly owing to ill-health. Messrs. L. Seraillier and W. Ward were leading for the greater part of the tournament.

REVIEW.

The Art of Chess. By James Mason. Second Edition. (Horace Cox.) This is an extension of the edition of 1895 from three hundred and eleven to four hundred and twenty pages. The price is increased from five shillings to six shillings net. Apart from a very interesting and suggestive introduction, we find that the section on end games is increased by forty pages; the part dealing with middle-game combinations being practically the same as in the former edition. The section on openings, which Mr. Mason rightly and logically places last, is considerably enlarged, and again the introductory remarks are most useful. Mr. Mason has during the last few years attained the position of the leading English chess author. He is the first Englishman to treat the game as a science to the extent of adopting a scientific method and scientific language in expounding it. Mr. Mason's style is terse and epigrammatic—at times even Carlylean, but, above all things, Masonic. In other words, the book is eminently readable.

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CONTENTS.

THE KARKINOKOSM, OR WORLD OF CRUSTACEA.—IV.

By the Rev. Thomas R. R. Stebbing, M.A., F.R.S., F.L.S.

Seeing that the mammalian tail is allowed to contract or expand the number of its joints at discretion, it looks like a kind of obstinacy in natural arithmetic that has assigned seven vertebræ alike to the neck of the hippopotamus and the neck of the giraffe. Attention has already been drawn to a similar case of numerical persistence in the Karkinokosm. The whole of the great and diversified sub-class of the Malacostraca is bound together by the circumstance that the body segments never exceed twenty-one, and only fall short of that number when motives of personal convenience have induced a broad Cancrid, for example, to consolidate, or a threadlike Caprellid to relinquish, some of its somites. But the other great sub-class, the Entomostraca, prefers always to have a number of body segments greater or smaller than twenty-one. Between these two sub-classes some authors give an independent position to the little group of the Nebaliidæ.

Nebalia bipes has a wide distribution in the northern hemisphere. You may find it at Spitzbergen and in the Mediterranean. You may find it also under stones on the south coast of Devon, always exquisitely neat, however untidy the surroundings may be. In this half-inch of animal organism there can be counted twenty pairs of appendages, exactly the full number allotted to the Malacostraca, and implying a corresponding number of segments; but at the tail end of this creature there are two extra segments and a pair of caudal branches. Moreover, in *Nebalia* the eight pairs of limbs which follow the maxillæ are all of a peculiar pattern. The leglike character of the main stem is overshadowed by the great leaflike expansion of the subsidiary branches, which have a respiratory function: they act as branchiæ, or gills.

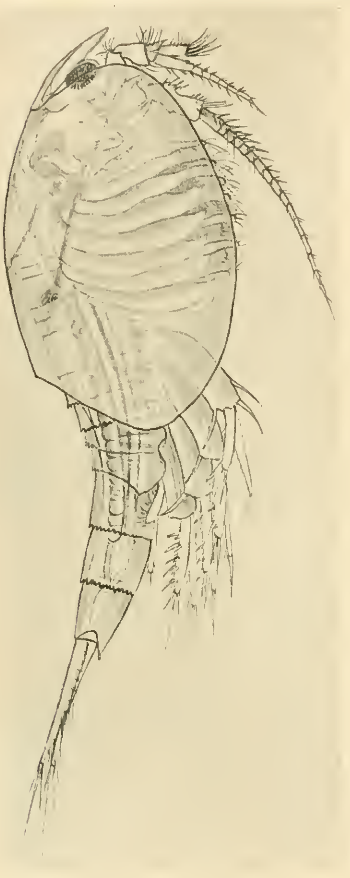
Though in Crustacea the gills are commonly enough connected with the feet, yet the order Branchiopoda has a special claim to take its name from this connection, because the branchial character of the feet, instead of being, as elsewhere, subordinate or modestly withdrawn from view, is here monstrously developed and prodigiously obtrusive.

The order Branchiopoda is so extensive a division of the Entomostraca that it has to be again divided into four suborders, with names that may not sound to all ears alluringly mellifluous, but which are moderately handy and in their measure significant. The four names are Phyllocárida, Phyllópoda, Cladócera, Branchiúra. These names, being interpreted, are Leafy Shrimps, Leafy Legs, Branching Antennæ, Gill Tails. Unfortunately the interpretation needs an interpreter, just as it is not enough for us to know that Hiawatha is the Teacher, and that his wife's name, Minehaha, means Laughing Water, or that Mudjekeewis is the West Wind, and that the Kingdom of Ponémak is the Land of the Hereafter. The poet needs five or six thousand lines to unfold the story of these names, and to bring the hero to the haven where he would be.

The Phyllocarida are represented by the border tribe of the Nebaliidæ. Till the voyage of the *Challenger* that little group contained but one genus. Now it has three, and it is a curious thing that in one of the two new forms the breathing legs are exceedingly long, while in the other they are exceedingly short, the old northern genus standing intermediate between them.

At no great distance from the Phyllocarida may be set the Phyllopoda, with a name that differs little from theirs either in sound or sense. It refers to the same feature in their construction—the leaflike limbs. The Phyllopods have been divided into three groups, closely connected, but, in one respect, singularly unlike. One set have a dorsal shield, leaving a long caudal part exposed; another set are enclosed in a pair of valves in such a way that they might well be mistaken for little molluscs; while the third set are really quite too informal, almost indecorously negligent of the conventionalities observed by the respectable class of Crustacea. These have no dorsal shield, no covering valves, no encrusting carapace; but each swims about unencumbered, a vagrant "neat and slim, without a rag to cover him."

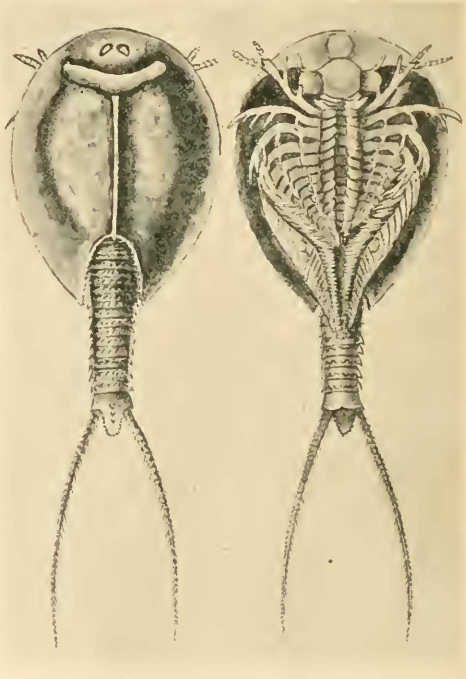
Of the last-mentioned group two forms were at one time well known in England, though of late years no one seems able to come across them. One of these, *Artemia salina*, the brine shrimp, occurred at Lymington, in Hampshire, myriads of these graceful little creatures curvetting and gambolling about in the strong brine of the salterns. They are not marine animals. None of the known Phyllopods exist in the sea. Not too many tears need be shed over our lost Lymington species, for it is known to inhabit in countless numbers shallow brackish-water ponds along the shores of Europe, and a very similar form abounds in the Great Salt Lake at Utah, in the United States of America. Our other missing species is *Chirocephalus diaphanus*, the fairy shrimp. The name of the creature is deservedly prepossessing and rightly suggestive of its real beauty. Of this no picture conveys any adequate idea, because the great antennæ, or "hands on the head," to which the generic name refers, distract attention and look clumsy in a drawing; while the pellucid limpidity of the whole organism, its iridescent colouring, and the graceful vivacity of its motions belong to nature rather than art. One point in the history of this fairy is apt to excite a smile of incredulity, for it is said to be found in places quite out of harmony with the birth of an Oberon or a Titania—"in stagnant water, very often in the ditches and deep cart-ruts on the edges of woods and plantations." These woodland cart-ruts, as everyone knows, though soft and brimming with water at times, become at other times perfectly dry and of a stony hardness. It may seem, therefore, like one of Baron Munchausen's miracles to people these transient troughs with crustaceans an inch in length. They cannot fall from the sky. Spontaneous generation has never been accused of producing shrimps. The fact is that inland Entomostraca accommodate themselves, like the Rose of Jericho, to the exigencies of recurrent drought and varying seasons. Though they are inhabitants of water, their eggs can retain vitality unimpaired for long periods after complete desiccation of the mud in which they have been deposited. For observing the development and habits of numerous species belonging to the remotest lands, it is no longer necessary for the student to extend his survey by toilsome travel from China to Peru. He can engage a correspondent to send him by post a small piece of Australia or Egypt, a sample of Siberia or Ceylon. It is a pleasing experience to find a handful of earth, dug out of a pond at the other side of the globe, teeming with foreign species responsive to the gift of a cup of cold water poured upon the thirsty soil. In these experiments it is expedient in Great Britain to wake up a tropical brood, not amidst our frosts and fogs and chilling east winds, but when warm nights and summer sun, in which such broods delight, will favour their quick developing, until it can be said that—



Nebalia bipes (O. Fabricius).

> "Cupid, empire sure,
> Flutter'd and laugh'd, and ofttimes through the throng
> Made a delighted way."

These Phyllopods go through strange metamorphoses, for whereas in the full-grown condition they come to have from ten to more than sixty pairs of legs, they almost always begin life in what is called the *nauplius* stage, with no true legs whatever, having to be content with two pairs of antennæ and a pair of "mandibular legs" that are not permanent. With this limited apparatus they manage to jerk about in their watery world with tolerable activity. Instead of a pair of compound eyes the young ones are provided only with a central ocellus, the nauplian eye—sufficient, no doubt, for their childish wants. Like crustaceans in general, Phyllopods pass from stage to stage of development and of growth by shedding the skin. Their exuviæ are easy to collect and examine when the pond containing them is a bowl on a table. With the eye-



Dorsal View. Ventral View.

Lepidurus arcticus (Pallas).*

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* "Fauna Norvegiæ," Bd. I., Tab. XI. By G. O. Sars. 1896.

cases and antennæ, the oral parts and the respiratory limbs, the bright spines and feathered hairs—all the delicate structure, glassily transparent, is exposed to view, like the wreathed pearls, the unclasped jewels, and the rich attire which Madeline had put off on that famed Eve of St. Agnes, when, enamoured and entranced, "Porphyro gazed upon her empty dress."

The Phyllopod's story, however, is not exclusively romantic. The cultivation of many species in a small bowl is convenient for the observer, but it also gives the stronger forms great and not always unwelcome facility for preying on the weaker. A couple of the *Estheria gihoni*, figured in the first chapter, caused me much surprise one summer for two reasons. First, the pair attained an unwonted size, which implied that the conditions were healthy; but, secondly, contrary to custom, all other animals, even those of the same species, though grown under the same conditions, speedily disappeared. At last the pair that had waxen fat were put to death, just to see what would happen, and straightway a brood of young *Estheriæ* grew up and prospered. It seems scarcely uncharitable to infer that the long-dominant pair had thriven on cannibalism. In the kindred genus, *Limnadia*, there is another strange circumstance which interferes with romance. Of this genus only two species are as yet known—one European and one American—and in neither of them has any specimen of the male sex been observed. The propagation, according to Prof. G. O. Sars (an unsurpassed authority), is exclusively parthenogenetic. "Males," he says, "in spite of the most careful investigation, have not yet been found, and probably do not exist." It is not a little wonderful that these Amazons should occur in a group which commonly has both sexes abundantly represented. But perhaps the effacement of the inferior sex will prove even here not to be quite so absolute as for the moment it seems, although the Russian and Hungarian naturalists, Krynicki and Chyzer, who claim to have observed the males, may have been deceived as to the species they examined.

The division of the Phyllopods with a carapace or dorsal shield contains the largest of all the species, *Apus australiensis* Spencer and Hall, nearly three inches long, and *Lepidurus macrurus*, exceeding an inch and a half in length. It is in this division also that the legs reach the surprising number of a hundred and twenty-six. This being the case, it will appear an odd thing that the primary genus, which is scarcely or not at all to be distinguished from *Lepidurus*, should have been called *Apus*—that is to say, "the legless." The explanation is this. The ingenious Dr. Johannes Leonhard Frisch, who in 1732 published the first description and figures of what he called "the fin-footed lake worm with the shield," did not overlook the little packet of almost innumerable leaflets under the trunk, but decided that they were more like fins than feet. He therefore obligingly left it open for those who thought them legs to call this "insect" or "water worm" a *polypus*—that is, "many legs," while for him it was preferentially an *apus*, or "no legs."

In the Apodidæ it may be noted that the males are very rare; and abundant as the females are in some parts of the world, the student in England may not always find specimens at his command. He can always solace himself by having recourse to the Cladocera. These are distinguished by the conspicuously branched second pair of antennæ, which are their swimming organs. They content themselves with a comparatively parsimonious number of legs—from four to six pairs—and have the whole body except the head encased in valves, which, for the benefit of the naturalist, are often conveniently transparent. In all countries may be found some puddle, pool, or pond, some swamp, or tarn, or lake; and therefore in all countries the zoologist may recognize a link with home by finding *Daphnia pulex* or one of its near relations. In numbers numberless may members of this prolific tribe be obtained by dipping a net into almost any horsepond. Their movements can be studied by transferring a few to a tumbler of water: their organization by isolating one in a watch-glass under the microscope. No Röntgen rays are needed. The living works of the machine are plain for all folk to see. It is worth taking a little trouble to observe the winking of that ever-trembling eye, the motions and adornment of the branchial feet, the little pulsating heart, the strokes of the spiniferous tail, the curious sinuosity of the intestine. One may chance to see the eggs pouring from the ovary and taking shape in the maternal pouch. Often within that pouch may be seen numerous eggs or young ones forward in development. *Daphnia* is like *Apus*, the prevalent method of reproduction being, as Dr. G. S. Brady expounds the matter, "not sexual at all, but parthenogenetic, the female producing and detaching in rapid succession broods of young, which are the result of the development, not of fertilized eggs, but of mere buds or "pseudova." The fertilized eggs, the winter eggs, the eggs which keep and pass the winter

Fig. on left, *Daphnia carinata*, var. *intermedia* Sars, female with ephippium.
Fig. on right, typical form of *Daphnia carinata* King, ovigerous female.*

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* "On Fresh-water Entomostraca from the Neighbourhood of Sydney, partly raised from Dried Mud." By G. O. Sars. Pl. I. 1896.

independent of maternal care, are laid in the so-called "ephippium"—a case developed in the mother for this special purpose, and subsequently detached. An old writer has been scoffed at for speaking of *Daphnia pulex* as a "wonderful insect." It is not in modern classification an insect. Of forms now known which belong to the same social set it is by no means the most eccentric. It is not rare, but, on the contrary, multitudinously common. None the less, it is to my mind easy to sympathize with Bradley when he called it wonderful.

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A CLASSIC LEGACY OF AGRICULTURE.—II.

By John Mills.

THERE is no more beneficial creation of wealth than that which arises from the complete development of the resources of the soil and the correct manipulation of its products. Better education in agriculture would contribute largely to an intelligent appreciation of the problems which arise in farming as a business, and increase the efficiency of the mental machinery destined to direct operations in the field. Farmers of the future, whose minds are thus counterpoised and adjusted so as to retain their equilibrium under all conditions—favourable and unfavourable—will play an important part in the struggle for supremacy between civilized countries; and, so equipped, complete confidence may be placed in the ability of the tillers of the soil in our own country to maintain a secure place in the markets with rivals, distant and near, who make it their chief occupation to supply our population with food. In the attainment of such knowledge a great multitude of facts present themselves for consideration, each of which requires due thought to discern its bearing on the whole and to assign it a place in agriculture so as to render the science of maximum usefulness. Thus, the quantity and quality of the crops, the character of the soil and of the climate, differences in the habits of plants, general economy of the farm, and so on, give rise to a number of questions which form a sort of algebraic equation involving many unknown quantities, and to solve which requires not only a vast amount of exact observation, but also profound skill in the marshalling of facts and manipulation of data. The experiments at Rothamsted, conducted by Sir John Lawes and Sir Henry Gilbert, are of this complicated description, some of the results being merely tentative.

The object to be attained in the cultivation of root crops is to encourage, by artificial means, a quite abnormal development of a particular part of the plant. If, for example, the turnip plant were grown for its natural seed-product oil, a heavier soil would be more suitable than when the object is to develop the swollen root. When grown in ordinary soil without manure, either for a few years in succession or even in rotation, root crops soon revert to the uncultivated condition; they depend for luxuriant growth on an abundance of nitrogenous as well as mineral constituents within the soil, and they are therefore generally highly manured. In the accompanying table, the results obtained with Norfolk white turnips are shown, and it will be noted that when grown without manure the crop dwindles down almost to zero, whilst with farmyard manure there is a marked increase year by year. The form of the unmanured root resembles that of a carrot more than a turnip, and its composition is totally different from the cultivated root. There is, indeed, much more nitrogen taken up by the latter, but the percentage of that element—apparently lower than in the unmanured plant—is masked by the accumulation of a large amount of other matters which render the plant an important food crop. The average proportion of leaf to root under different conditions as to manuring clearly indicates the susceptibility of these plants to artificial influences: to one thousand of root with mineral manure alone, the yield of leaf being three hundred and twenty-nine; with mineral and ammonium salts, four hundred and thirty-four; and with mineral and ammonium salts and rape cake, six hundred.

Norfolk White Turnips, without Manure, and with Farmyard Manure.

Year.	Roots per Acre.				Leaves per Acre.			
	Without Manure.		With Farm-yard Manure.		Without Manure.		With Farm-yard Manure.	
	Tons.	cwts.	Tons.	cwts.	Tons.	cwts.	Tons.	cwts.
1843	4	4	9	10	not weighed		not weighed	
1844	2	4	10	15				
1845	0	14	17	1	0	14	7	8

Potatoes have been grown on the estate for twenty-two years in succession, different sorts being selected on the supposition that in growing the crop year after year change was desirable, especially with a view to the avoidance or lessening of disease. It is now an established fact that season has much to do with the development of the potato disease, and these experiments show that there was on the average much more disease in the wetter seasons. When the unsuitable weather comes, those tubers suffer the most which have the richest juice—that is, the least fixity of composition. The first material change in the development of the disease is, apparently, the destruction of starch and the formation of sugar; there is also a considerable loss of organic and chiefly *non*-nitrogenous substance, due in part to the decomposition of the produced sugar, but probably in some measure to the evolution of carbonic acid, as a coincident of the growth of the fungus at the expense of ready-formed organic substance, this being a characteristic of the growth of such non-chlorophyllous plants. Regarding the cultivation of the plant under varying conditions, it is somewhat interesting to observe that the produce of starch per acre was about one thousand one hundred pounds without manure, nearly two thousand pounds with purely mineral manure, and with nitrogenous and mineral manures together about three thousand four hundred pounds. In other words, the increased produce of starch by the use of the mineral and nitrogenous manures together was more than one ton per acre. That is to say, there was a great increase in the production of the *non*-nitrogenous constituent, *starch*, by the use of nitrogen in manure—a striking result, indeed, and one more hint that nature will have her own way, paradoxical though it may seem to us. In truth, it is for the production of the non-nitrogenous substances—starch, sugar, and cellulose—that our direct nitrogenous manures are chiefly used!

The fixation of free nitrogen directly from the atmosphere is a subject which has engaged the attention of many inquirers, notably Sir John Lawes and Sir Henry Gilbert at Rothamsted; and a theme of much controversy among scientific men for many years past has been—"How is the fixation of nitrogen to be explained?" Diversity of opinion still obtains on this question, and, unfortunately, there is yet much to learn before a satisfactory answer can be given; but though the explanation is wanting there can be no doubt that the fact of the fixation of free nitrogen in the growth of leguminosæ—clover, vetches, peas, beans, sainfoin, lucerne, and so on—under the influence of suitable microbe infection of the soil, and of the resulting nodule formation on the roots, may be considered as fully established. What, then, is the basis of this conclusion? Recent experiments at Rothamsted show that, by adding to a sterilized sandy soil growing leguminous plants a small quantity of the watery extract of a soil containing the appropriate organisms, a marked development of the so-called leguminous nodules on the roots is induced; and that there is, coincidently, increased growth and gain of nitrogen. For example, in growing peas, there was limited growth in pot 1 (*see* figure) with sand without soil extract, and also an entire absence of nodule formation on the roots. The increased growth in pots 2 and 3, with soil extract, was coincident with a very great development of nodules. In pot 4, with garden soil, itself supplying abundance of combined nitrogen and doubtless micro-organisms as well, there was also a considerable development of nodules, but distinctly less than in either pot 2 or pot 3 with sand and soil extract only. Further, without soil extract and without nodules there was no gain of nitrogen, but with soil extract and with nodule formation there was much gain of nitrogen. Experimental results, in fact, clearly prove that there is immense gain of nitrogen under some conditions. It has also been conclusively shown that due infection of the soil and of the plant is an essential to success. The available evidence at the same time points to the conclusion that the soil may be duly infected for the growth of some descriptions of plants, but not for some other descriptions. Moreover, land which is, so to speak, quite exhausted so far as the growth of one leguminous crop is concerned, may still grow very luxuriant crops of another description of the same order, but of different habits of growth, and especially of unlike character and range of roots.


Peas grown in Experiments on the Fixation of Free Nitrogen.

Not only the facts ascertained in the Rothamsted experiments and in other investigations, but also the history of agriculture throughout the world, so far as it is known, clearly show that a fertile soil is one which has accumulated within it the residue of long periods of previous vegetation, and that it becomes infertile as this residue is removed. That this exhaustion proceeds slowly may be gathered from the fact that wheat has been grown at Rothamsted for more than fifty years in succession on the same land, and, setting aside fluctuations due to season, the produce has only been reduced by an average of about one-sixth bushel per acre per annum, due to exhaustion. Without any manure whatever, the average annual produce for over fifty years was thirteen and a half bushels—a yield exceeding the average of the United States under ordinary cultivation, including their rich prairie lands, and about the average of the whole world. The accompanying table shows that with farmyard manure the average annual produce over the fifty years of continuous growth was thirty-three and a half bushels—a result not far short of three times the average produce of the United States, and more than two and a half times the average of the whole of the wheat lands of the world. Artificially manured plots show that mineral manures alone gave very little increase of produce; that nitrogenous manures alone gave considerably more than mineral manures alone; but that mixtures of the two gave very much more than either separately. An inspection of the following table of results, as indicating the amounts of produce in the best and in the worst seasons of the forty years, will show how easy it is to form wrong conclusions as to the effects of different manures if experiments are conducted for one season only, or in only a few seasons, and if the characters of the seasons are not studied and due allowance made accordingly in drawing inferences from results obtained. Thus it will be seen that all the plats suffered severely in the bad season. Compare columns *a* and *b*. In most cases (*see* columns

Averages.	14 Tons Farmyard Manure every Year.	Without Manure every Year.	Mixed Mineral Manure alone.	Ammonium Salts alone.
	Bushels.	Bushels.	Bushels.	Bushels.
8 years, 1852-59 ..	34⅜	16⅛	19	32⅜
8 years, 1860-67 ...	35¾	13½	15¼	31¼
8 years, 1868-75 ...	35⅜	12¼	14	28½
8 years, 1876-83 ...	28⅝	10½	12⅝	27¾
8 years, 1884-91 ...	39¼	12¾	13¾	32½
20 years, 1852-71 ...	35⅞	14½	17	31⅝
20 years, 1872-91 ...	33½	11½	12⅞	29½
40 years, 1852-91 ...	34⅞	13	15	30½
50 years, 1844-93 ...	33½	13½	—	—

Wheat Year after Year on the Same Land.—Produce of the Best Season, 1863; of the Worst Season, 1879; and the Average of Forty Years, 1852-1891.

Description of Manures (Quantities per Acre).	Dressed Grain (per Acre).			
	Best Season, 1863.	Worst Season, 1879.	Difference.	Average, 40 years, 1852-91.
	Bushels. *a.*	Bushels. *b.*	Bushels. *c.*	Bushels. *d.*
Unmanured	17¼	4¾	12½	13
Farmyard manure	44	16	28	34⅞
Mixed mineral manure alone .	19⅝	5⅝	14	15
Mixed mineral manure and 200 pounds ammonium salts = 43 pounds nitrogen	39⅝	10½	29⅛	24⅛
Mixed mineral manure and 400 pounds ammonium salts = 86 pounds nitrogen	53⅝	16¼	37⅜	33⅜
Mixed mineral manure and 550 pounds nitrate soda = 86 pounds nitrogen	55⅝	22	33⅝	35⅜
Mixed mineral manure and 600 pounds ammonium salts = 129 pounds nitrogen	55¾	20⅝	35⅛	36½

c and *d*) the difference between the produce of the best and the worst season approached, and in two cases actually exceeded, the average produce of the plats.

More than two thousand years ago the Romans recognized the fact that leguminous crops enriched the soil for succeeding crops—in short, discovered what is termed the "rotation of crops," a practice which is admitted to be the foundation of the improvements in our own agriculture. How, then, are the admittedly beneficial effects of alternate, as distinguished from continuous, cropping to be explained? Liebig's first definite theory on this subject assumed that the excreted matters of one description of crop were injurious to plants of the same description, but that they were not so, and might even be beneficial, to other kinds of plants. Later, he considered that, as the different plants had such diverse mineral requirements, the alternation of one kind with another relieved the soil from exhaustion, and discerned after many years that nitrogen probably played some important part in the matter. Boussingault, in chemical statistics extending over ten years, came to the conclusion that the difference in the amounts of nitrogen taken up by various crops constituted a very important element in the explanation of the benefits of rotation. Prof. Daubeny, of Oxford, in testing De Candolle's theory that the excretions of one kind of plant were injurious to plants of the same description, arrived at a negative conclusion, and recognized the validity of Boussingault's argument that the same kind of plant may continue to grow healthier on the same land for long periods of time; and experience at Rothamsted also is conclusive against the theory of injurious or poisonous excretions. Upon the whole the results at Rothamsted show that the benefits of rotation are very various. The opportunities which alternate cropping affords for cleaning the land constitute a prominent element of advantage. The difference in the amounts available within the soil of the various mineral constituents is one element in the explanation; but the facts relating to the amount and to the sources of the nitrogen of the different crops are of still greater significance. The varying requirements of the different crops, habits of growth, and capabilities of gathering and assimilating the necessary constituents have to be considered; with a variety of crops the mechanical operations of the farm, involving horse and hand labour, are better distributed over the year, and are, therefore, more economically performed.

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"THE MIMIC FIRES OF OCEAN."

By G. Clarke Nuttall, B.Sc.

Nature dazzles the eye of man with many wonderful phenomena, but perhaps never more so than when she turns the gloomy night waters of the sea into a sheet of silvery fire. At these times every movement of the wave, every cleavage of the water by oar or prow, reveals in its dark depths a hidden fire which scintillates and sparkles with weird and mysterious light. The spectacle is one of absolute fascination, for the Spirit of Enchantment rests upon the waters and reality becomes fairyland.

The ancients, keenly alive to a sense of the supernatural, saw in this luminosity a manifestation of some unknown power, and wondered; the ignorant read in it a portent of judgment and terror; while in all ages the curious and the searchers after knowledge have speculated as to its cause. But just as nature has invested its appearance with a halo of mystery, so she has also wrapt in much obscurity its immediate cause; and thus, though in the course of centuries varying suggestions have been put forward, nothing with any finality about it has been arrived at. It was asserted truly that certain fishes were luminous; sharks have glowed and shone, shoals of herrings, pilchards, or mackerel have been moving masses of light, and the fish drawn out of the water have lain in great shining heaps, the glow of which vanished as they dried and died.

Many writers have described the passages of ships through such shoals—the sheet of moving flames—the beautiful pale greenish elf-light that the fish exhibited; while poets have apostrophized the "mimic fires of ocean" and the "lightnings of the wave," and scientists and naturalists have in turn tried to account for their power of luminosity. Some have attributed it to the presence of certain substances of a fatty nature excreted by the fish and adhering to the surface of their bodies; others have declared that it is due to a subtle power of the fish itself—a form in which the energy of life shows itself under certain conditions, just as this energy may be exhibited in heat, or motion, or electricity; others, again, have ascribed it to direct absorption and transmission of the light of the sun, and so on. Many theories have been elaborated, but none convincingly.

But now, it is asserted, the secret is laid bare.

It is wonderful how many secrets the searching light of the nineteenth century is claiming to reveal. It is, perhaps, a matter for still more wonder whether in the far future our descendants will endorse all our solutions, or whether they will not smile at some of them just as we, half contemptuously, discredit those of our ancestors. However that may be, we have, in this case, a solution offered to us that apparently approaches nearer the heart of truth than any yet put forward, in that it satisfies the various phases of the phenomenon and gives a unity and coherence to its manifestations.

It is only lately that any very serious effort has been made to study this phenomenon, but the research has been abundantly rewarded, for it is now pretty certain that the luminosity is due to the presence in the water of various kinds of bacteria.

Now, bacteria are the very smallest living organisms of which we have cognizance. Millions of them can lie on a penny; therefore, to produce the gleaming appearance recognized by us as phosphorescence, they must be present in numbers too enormous even to contemplate with our finite minds. It would be immeasurably easier to reckon with the stars for multitude than with these phosphorescent bacteria. They are colourless, rodlike bodies, only known to us in the land revealed by the highest powers of the microscope, and careful comparison shows minor differences among them. For instance, some of them are capable of independent motion—we can hardly call it swimming—others are non-motile, some are enclosed in a jelly-like covering, others are without this sheath. Their power of motion is probably due to excessively fine hairs at their extremities, which, moving to and fro in the water, act the part of oars. These cilia have not been found in all forms of bacteria which move, but their presence is inferred, since every advance in the study of motile forms increases the number of bacteria which are seen to possess them.

These light-producing bacteria are known as photo-bacteria, and so far some half-dozen varieties have been distinguished and named. The names in such cases are usually either given from the locality of their appearance (thus, photo-bacterium Balticum, found in the Baltic), from their discoverer (for example, photo-bacterium Fischeri, after Prof. Fischer), or from some striking attribute (to wit, photo-bacterium phosphorescens, the commonest light-giving species).

That they lie at the bottom of the matter—that phosphorescence is due to their presence—has been and can be proved in several rather pretty ways. It is not sufficient, of course, that we should always detect them in any examination of luminous sea-water; to prove that they are the cause of light we must be able to procure luminosity by introducing them into water that did not previously show this quality, and this can be done thus:—

Place a few of these tiny organisms into sea-water or broth prepared from fish, and keep at a suitable temperature; they can then be cultivated without much difficulty, and as they spread and develop phosphorescence appears, so that a removal of the vessel into another room shows unmistakably the glow of the familiar light. It only appears, however, at the surface of the liquid, where the oxygen of the air has free access to the bacteria; if, for experiment's sake, the supply of fresh air be cut off—that is, if no oxygen be allowed to come near them—then the little colony of bacteria loses its fascinating power and remains dull and shorn of its glory. But restore the air, and the microbes again recover their normal condition and luminosity seems a natural corollary. There is a tale told that a lady, whose husband made bacteria his study, took a leaf out of his book, and cultivated these bacteria on gelatine in such a way that as they developed they shone out the message, "Hommage à M. Pasteur." The shining letters were then photographed and the picture sent to the great bacteriologist, thus conveying in graceful form the warm appreciation in which he was held by those following in his steps.

The explanation, too, of the luminous shoals of fish is now made plain, and we can apparently get "fiery herrings" at will. No longer are we to believe that the herrings themselves, by the exercise of some marvellous power, or by the excretion of an extraordinary substance, give rise to the striking luminosity, but rather that their brightness is due to myriads of these infinitesimal bodies, which cling to their surfaces and invest them in a coat of shining light. Thus, if some herrings, newly caught, and with the sea-water still fresh on them, be placed on one plate and covered down with another, and then put into a suitable temperature and left for a day and a night, glints of light can, at the end of the time, be detected at various points on their bodies when they are examined in a dark room. If they are yet again put away for another twenty-four hours, the points of light spread until the whole of the fish are enveloped in a beautiful bluish glow. The light is then at its best, and gradually fades away as the fish putrefies and the sea-water dries up. If a little of the light-giving matter be scraped off the skins of the herrings and examined under the microscope, it shows itself to be nothing but colonies or collections of bacteria, all living at a great pace, dividing, multiplying, and developing at a tremendous rate. Each member of a colony is normally roundish in shape, but in this stage of reproduction it is continually elongating into a long ellipse, a constriction appears at the middle, and it divides into two. Each of these two in their turn elongate, become constricted, and divide. And so it goes on, the process being often so rapid that short chains are formed, the various portions being unable to break away in time. The particular bacterium which affects herrings and cod is remarkable for its great luminosity; in fact, it exceeds all other species in this quality.

It is a curious fact that the addition of a little sugar to the liquid or the gelatine on which these phosphorescent bacteria are being cultivated increases very much their power of producing light; the sugar must, however, be used with great moderation, as too much of it has a contrary effect and checks the luminosity altogether. The reason for this is that nearly all this class of bacteria require carbon as nourishment if they are to develop to their highest powers. Like much of the food we eat, it is not essential to them; they can manage very well without it, but they are all the better for having it. Now sugar is very largely composed of carbon; hence the good results which follow its presence. Glycerine, which is of similar composition, will do almost as well; from both bacteria can easily withdraw carbon. Two photo-bacteria have, however, been observed which are somewhat differently constituted; one is found round the West Indies and the other in the North Sea, and neither apparently requires sugar or glycerine in any form—in fact, either of these substances, even in the smallest quantity, appears to be directly injurious. But why this should be so it is not easy to define.

A Dutchman named Beyerinck has lately made a special study of these photo-bacteria, and has experimented with them in a great number of ways to determine, if possible, why they should thus become illuminated, and if the light plays any notable part in their life history; but his results are, seemingly, all more or less of a negative nature. He cannot find that it has any very important function. The breathing of these tiny organisms is not, apparently, in any way bound up with it; their nutrition, growth, and development go on quite well even if they are placed under such conditions that their luminosity is arrested; in no way, indeed, is it a vital process. It only seems to depend on the food which the bacteria feed upon and the presence of oxygen. Given suitable food and plenty of fresh air, and they exhibit their characteristic light; deprive them of one or the other and they no longer shine.

This knowledge helps us to understand, then, the phenomenon of phosphorescence. It is visible only at night because in the full glare of day the greater light overpowers the lesser; it is visible at certain times and seasons because the conditions are such as to evoke it. And what is favourable for the lighting up of a single bacterium is favourable for all; hence the myriad multitudes of infinitesimal units, each set glowing with its tiny light, is sufficient in the sum total to put a whole ocean aflame.

It would, of course, be presumptuous, and doubtless erroneous, to say that all the phosphorescence of the sea is due solely to photo-bacteria; it can only be asserted in the present state of our knowledge that they are certainly responsible for a great share of it. But this wonder of nature must now be regarded as yet another instance of the mighty results accomplished through the agency of the smallest of living things.

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THE PETROLEUM INDUSTRY.—II.

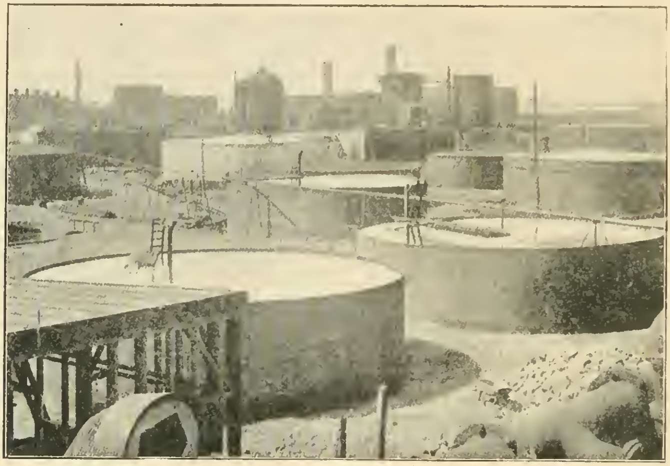
By George T. Holloway, assoc. r.c.s. (lond.), f.i.c.

In the earlier days of the petroleum industry the crude oil was carried from the wells to the refineries in barrels containing forty-two American gallons, at such heavy expense as to enormously increase the cost to the consumer. By land the barrels were conveyed on rough waggons over the almost roadless tracts where the oilfields were mainly located, while, where river transport was possible, barges were used as the vehicles of transportation. In 1862, however, a branch railway was carried into the oil regions of Pennsylvania, and in 1866 railway tank waggons were introduced. At first constructed of wood, and having a capacity of about two thousand gallons, these waggons were soon replaced by the boiler-iron tanks with which we are now familiar.

These tanks, of which over ten thousand are in use in the States, usually have a capacity of eight thousand American gallons.

The introduction of pipe-lines—which are now laid from all the important oilfields to the central refineries—constitutes the greatest factor among the many innovations which have, as a whole, led to the present cheap production of petroleum in the States. Each well-owner, as his oil is passed into the pipes, receives a certificate stating that he is entitled to so much oil, and these certificates are negotiable like bank-notes among those interested in the trade. Of course, all the oil passes into the common stock, so that no producer can obtain his own oil from the refinery; and for this reason any special oil, such as the heavy and valuable oils of Franklin and Smith's Ferry, is still conveyed in barrels.

The use of pipe-lines was proposed in 1860, but the first successful line was laid in 1865. Notwithstanding the opposition of the teamsters, who had formerly enjoyed the monopoly of the transport of petroleum, the laying of these lines proceeded rapidly from the first, and it is said that between twenty-five thousand and thirty thousand miles of pipe-lines now exist in the States.



Oil Refinery at Philadelphia.

The main pipes are usually from four to six inches in diameter, the small feeders which pass from them to the wells being about two inches. As the pipes are liable to become choked by dirt or solid hydrocarbons, a small brush, known as a "go devil," is occasionally passed through to clear them. This brush, which travels along with the oil as the latter is pumped through the pipes, is provided with ball-and-socket joints, to facilitate its progress round the bends; and it is also fitted with vanes, which ensure its rotation as it advances.

The pumps now invariably used for these pipe-lines are of the Worthington type, and work at a pressure which sometimes rises as high as one thousand five hundred pounds per square inch. The seven hundred and sixty mile length of six-inch pipe extending along the New York line is supplied by pumps of from six hundred to eight hundred horse-power, and conveys about thirty thousand gallons daily. There are eleven pumping stations, each containing two pumps. In one case a pair of these pumps forces the oil through a distance of one hundred and ten miles, but as a rule each pair serves about half that length.

Kerosene—the product of the distillation of crude petroleum used as lamp oil—is mainly conveyed in tank waggons or railway cars, tank barges, and tank steamers; but a small proportion is still sold in barrels, and, especially in the Eastern markets, considerable quantities are disposed of in tin "cases," each fitted with a screw cap and wire handle, and holding about five American gallons. So great is the sale of these cases that as much as forty thousand tons of tinplate is said to have been used in their manufacture in one year.

For ocean transport the oil is now usually conveyed in tank steamers and sailing vessels, in which the whole hold is formed in compartments or tanks to contain the oil. In order to prevent injury to the vessels from the rolling about of the oil in bad weather, the tanks are kept absolutely full, small auxiliary "expansion tanks" being fitted to them to receive any overflow when the oil expands from rise of temperature, or to supply oil to the main tanks when the bulk decreases. Practically the whole of the ocean traffic, both of kerosene, crude oil, and liquid fuel, is now controlled by these vessels, although lubricating oil and petroleum spirit, and other of the lighter petroleum products, are still conveyed in barrels. The credit for the introduction of this method of transport is due to Mr. Ludwig Nobel, who, in 1878, had two small tank steamers constructed for use on the Caspian. They were built at Motala, in Sweden, in sections, for conveyance to the Caspian, where they are said to be still in use.

In the earlier days the escape of gas and inflammable vapours from the oil led to many disastrous explosions, but the more efficient methods of ventilation now in vogue have minimized these dangers. The tanks are also now so arranged that they may be thoroughly cleansed by workmen and used for the conveyance of ordinary cargo on the return journey, and the most perishable goods are so transported.

As the crude petroleum consists of a large number of constituents in admixture, from dissolved gas and highly volatile "petroleum spirits" to such solids as paraffin wax and vaseline, it is resolved by distillation into the various components used in commerce. For this purpose various types of still have been devised, the Russians largely using the "continuous" still, in which the crude oil is supplied as fast as the distillate passes off; while, in the States, large non-continuous stills, which are cooled down and the residuum removed after each distillation, are principally in use. It is well known that, in distilling any such mixture as petroleum, some of the constituents are decomposed into other bodies which are mainly more volatile than the substance producing them. In what is known as the "cracking process" this decomposition is accentuated by allowing a portion of the distillate to condense on the cooler upper part of the still, and run back upon the hotter liquid at the bottom. This action is not allowed to take place until the bulk of the lighter oils and "natural" kerosene have been distilled off, as it is the heavier and less valuable constituents of the crude petroleum which it is desired to decompose in order that the maximum of kerosene may be obtained. The distillate is agitated with sulphuric acid followed by a treatment with caustic soda lye, and it is finally washed by agitation with water, from which it is drawn off after settlement. The exact action of the chemical treatment is not known, but it appears to consist mainly in the removal of the tarry matters, the aromatic hydrocarbons, and the sulphur compounds, all of which injure the quality as well as mar the appearance of the oil.

The nature of the products obtained at different distilleries varies according to the market for which they are intended. The oil allowed to be burnt in lamps in England, for instance, must not "flash"—that is, give off inflammable vapour in a *closed* vessel—at a temperature below seventy-three degrees Fahren., while in some countries the standard is higher and in others lower. The principal products recognized in the trade are:—(1) The lightest, *i.e.*, the most volatile constituents, known as petroleum spirit or naphtha, which is sometimes again divided up into rhigolene or cymogene, gasoline, benzoline, benzine, etc. (2) Kerosene for burning in lamps. This, the most important of the products of petroleum, constitutes about seventy per cent. of the yield from the oil of the United States and about half as much from that of Russia—a feature which has had much to do with the greater success of the Americans. (3) Oil somewhat heavier than kerosene, but still capable of burning in suitably constructed lamps. (4) Lubricating oil, which, on account of its feebler action on metals and its less tendency to clog machinery, as compared with the animal and vegetable oils formerly exclusively used, has now practically displaced the latter in the markets of the world. (5) Paraffin wax. (6) Vaseline. And (7) residuum, or waste, now used on an enormous scale as liquid fuel. Anthracene and other compounds from which dye-stuffs may be obtained have also been separated from the residuum, but the cost has so far proved prohibitive.

The uses to which these various products have been put are very numerous. The earliest use of petroleum was, as already stated, for medicinal purposes—an application now mainly confined to vaseline and the softer paraffin waxes, which are largely used in preference to lard in the manufacture of pomatum, etc. It is stated that vaseline, as well as much of the heavier petroleum oil, is used instead of butter in the manufacture of pastry on a large scale, but it is doubtful whether it possesses any value whatever as a food.

The lightest of the petroleum spirits are used as local anæsthetics, those of lesser volatility being largely employed as solvents for waterproofing materials, varnishes, and as cleansing agents for the removal of grease spots; also in the processes of "dry cleaning" for fabrics. It is, of course, as a lighting agent that petroleum is most used, the distillates known as kerosene being employed for that purpose, and the bulk of the candles now in use are prepared from the paraffin wax obtained from petroleum.

The use of the heavier oils as lubricants has already been referred to, but it may be mentioned that the Russian oil holds the field as the best for this purpose, although its kerosene has not so good a name as that of America, mainly on account of the fact that the lamps (especially those in use in England) are especially designed for burning the American oil, which does not require so good an air supply for its combustion as does the Russian.

For use as fuel, the Russian residuum is preferred to that of America on account of its greater fluidity. Under the name "astatki," or "masut," it is largely employed as fuel for stationary and locomotive engines, marine boilers, furnaces, etc., a jet of the sprayed residuum blown into the furnace by a blast of air or steam from a nozzle being the usual method of applying it. On account of the ease with which this residuum may be stored, and, above all, of the almost total absence of smoke and dirt during its combustion and the little attention and stoking which is required, it is probable that in the near future its use on board ship will be greatly augmented.

Finally, the use of petroleum distillates for enriching coal gas, either by merely passing the gas through the highly volatile gasoline, or by decomposing the heavier oil into illuminating gas, which is mixed with the coal gas, must be mentioned, together with the large and increasing use for "petroleum engines," in which vaporized or gasified petroleum spirit, or even kerosene, is exploded with air as in the gas engines, which some practical men consider will ultimately be replaced by those using petroleum.

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ON THE ECLIPSE THEORY OF VARIABLE STARS.

By Lieut.-Colonel E. E. Markwick, F.R.A.S.

THE theory that the variations in light of such stars as Algol are due to the presence of a dark or opaque companion star, which periodically passes between us and the bright star, is generally accepted as satisfactorily accounting for the observed changes in brightness. Vogel's almost classical determination of the elements of the system of Algol, uniting as it does the visual and spectroscopic observations, seems to have clinched the theory, and it has crystallized into a recognized fact in the text-book and lantern-slide worlds. It is with no idea of controverting this theory that this paper is written, but simply to examine some of the conditions which are attached to it, and study them from different points of view.

For this purpose five different systems, each of two bodies revolving round their centre of gravity, are propounded. The two bodies are denominated A and B respectively, and the following table gives the particulars of each:—

System.	Diameter of		Remarks.
	A.	B.	
I.	10	9	B, dark or opaque.
II.	10	7	
III.	10	5	
IV.	10	9	B, bright.
V.	10	9	B's albedo half that of A.

With these data, the diminution in the light of A by the central transit of B was calculated for every one-tenth of diameter of A that B advances on its course, supposing B to move from right to left. Thus in Fig. 1 the area of the lune D E F G was calculated when the advancing limb of B had arrived respectively at 1, 2, 3, etc. Fig. 1 shows the occulting satellite (System I.) arrived at point 3. In this particular case the area of the lune is 14 31, the distance G E (a) being 3. Taking the light of globe A to be represented by unity, the light cut off is ·182; the remaining light is ·818. Assume the "magnitude" of A when quite unobscured as 1·0; then the resulting magnitude of the partly eclipsed globe is 1·22, based on the light ratio, 2·512. It is supposed that the distance of the bodies from us is so great that the telescope would only show them (even if both bright) as a single star.

In this way the five systems have been treated, and a series of points plotted as in Fig. 2. The abscissa represents a unit of time, *i.e.*, the period occupied by B in advancing one-tenth of the diameter of A. The motion is supposed uniform and transverse to the line of sight. The ordinates are star magnitudes divided into tenths, so that the length representing one-tenth of a magnitude equals that representing a unit of time. A curve is then drawn through the points, which we may call the theoretical light curve.

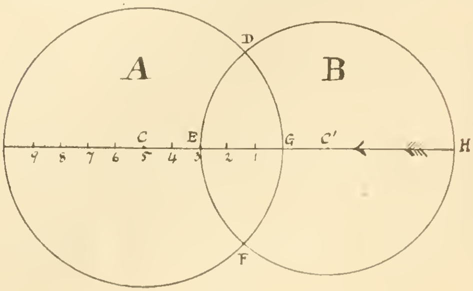

Fig. 1.

It should be noted here that the shape of the light curve may be altered indefinitely by changing the ratio of time to "magnitude." But the light curves of different stars are strictly comparable provided the same ratio is maintained for all. For this reason the shape of the Algol curve, as given by Prof. Pickering in Fig. 3, differs widely from the theoretical curve in Fig. 2, simply because the above ratio adopted in the two cases is different.

In System I. the diameter of the dark globe is one-tenth less than that of the bright one. This is pretty nearly the proportion as given by Vogel for the system of Algol. Hence a very considerable diminution or drop in light of A results, owing to so much of its face being obscured by the dark globe when central.

In System II. the diameter of B is assumed seven as against ten of A. Hence the light curve is not so deep, and the central flat is longer; for, the occulting globe being smaller than in I., and supposing it to travel at same rate as before, it is, for a relatively longer time, wholly contained visually within the globe or projected superficies of A. While so contained the light of A is reduced to a minimum and theoretically does not change.

In III. the small globe is half the diameter of the large one. Here the resulting light change is so small (only 0·13 of a magnitude) that it would be practically unnoticed and undiscoverable by a method of visual observation such as Argelander's. Hence it would seem that any companion or planet smaller in diameter than ·5 of the larger could never be discovered by present methods of visual observation. If all the planets of our system could be seen projected on the sun, as seen from a star, the resulting diminution in his light would be absolutely unnoticeable.

IV. Suppose now that globe B is bright—in fact, just the same brightness, surface for surface, as A. Then we have a binary system like many known ones, except that we are supposing the distance from us so great that it is beyond the power of any telescope to "split" the pair. In this case we regard the normal light as that of globe A plus globe B. Any portion of B projected on A makes no difference, seeing that any light obscured is replaced by a similar quantity. The quantity of light, therefore, outside the central globe—that is, the lune D G F H—must be calculated and result added to that of A. This has been done for the various positions when $a = 1, 2, 3$, etc., and the fourth light curve results.

In System V. the diameter of B is still regarded as nine, against ten of A, but the albedo, or light-reflecting power, only half that of A, surface for surface. In this case the total light when the globes are separated is that of A plus that of B. When in transit, as in Fig. 1, the total light is proportional to area of A, plus half area of B, minus area of lune D E F G. This has been worked out for different positions, and the fifth light curve obtained.

All these five curves are similar in character, and the light curves of all possible varieties of binary systems can be thus represented. The amplitude of the curve will vary according as the size of the occulting body is varied. Again, the speed of the occulting body may vary, and the transit be accordingly fast or slow; also it may occupy all positions when in mid-transit, from being exactly concentric with A to just touching it externally.

With regard to the smaller globe passing behind the larger, if B is perfectly opaque and dark, the light of A is not affected. If B is luminous, and of same albedo as A, then the total light of the system will be diminished by B passing behind, exactly to the same amount as when B transits in front of A. If the albedo, as in Case V., is half that of A, then when B is partially behind A (Fig. 1) we get the total light proportionate to area of A plus half area of D G F H (the portion of B outside A). Hence with an albedo of B differing from A we get a different light curve for a transit of B in front from a transit behind A. In the latter case the light at minimum is simply that of globe A; in the former it is $A - B + \frac{1}{2}B$: that is, area of A minus half area of B. Hence the light curve for a back transit is not so deep as for a front transit.

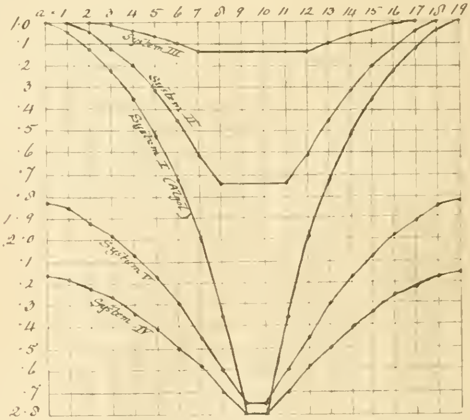

Fig. 2.—Theoretical Light Curves of Different Binary Systems.

The question now arises, Is it possible to observe and record the light changes in a star with sufficient accuracy to mark the distinguishing features of the curves as given above? All observers of variable stars know the great difficulties and sources of error attendant on visual observations. The change in position angle, change in altitude, varying transparency of the sky, and other causes conspire to prevent us determining brightness accurately to one-tenth of a magnitude, let alone anything less than this. Yet if we want to get a light curve with accuracy, we ought to have it to the one-hundredth of a magnitude.

With the photometer there seems more hope and greater promise. Fig. 3 is a reproduction of a diagram by Prof. Pickering, showing the light curves of four variable stars as resulting from photometrical observations. In the case of W Delphini it will be seen that the dots representing the observations are exceedingly close to the curve, the average deviation being between one and two hundredths of a magnitude.* However, in none of the four stars is the curve absolutely flat at minimum. I think we may conclude that for Algol type stars the shape of the light curve can only be thoroughly determined by continued observations made with some form of photometer.

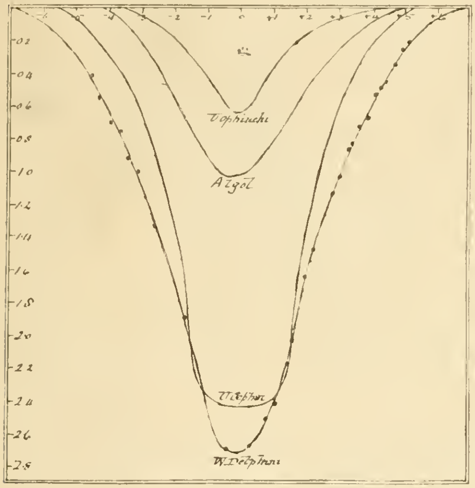

Fig. 3.—Light Curves as observed with Photometer (Pickering).

In the above notes we have supposed each star to have a sharply defined limb. In nature this may not always be the case. If we could see our sun projected on the blackness of space, the corona with its streams and wisps of light would appear to surround it, and the limb would not perhaps be so sharp as we see it through the glare of our illuminated atmosphere, which cuts off the corona. Again, some stars, for all we know, are in an earlier stage of existence than the sun, and only partially condensed from the primitive nebulous matter. So their limb or boundary would be of a cloudy, nebulous nature. In such cases our hard-and-fast light curve would be considerably modified; the change of light would be more gradual, and there would be a tendency to a rounded curve at the central depression.

Again, the bright globe might have an absorbing atmosphere, so that the light faded away towards the edges and the centre would be brighter than the limb. This might modify the typical light curve, as the eclipsing body would stop out more or less light according to the different positions occupied on the disc of the larger globe, irrespective of the actual area covered.

We have only referred to the period during which the light changes markedly; but there has been much discussion of late years as to whether Algol varies when in full light, and the matter seems at present more or less *sub judice*. When we read, however,* that under Prof. Pickering's direction, one thousand eight hundred and fifty-six photometric observations have been made of W Delphini, three thousand two hundred and ninety-six of U Cephei, two thousand five hundred and ninety-two of S Cancri, one thousand five hundred and eighty-four of S Cephei, etc., etc., we may be quite certain that the subject will sooner or later be thoroughly thrashed out, probably long before the telescope is made which will reveal to direct vision the occulting globe passing in front of its primary.

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THE RECENT ECLIPSE.

THE LICK PHOTOGRAPHS OF THE CORONA.

By E. Walter Maunder, F.R.A.S.

The two photographs of the corona which are reproduced in the accompanying plate are copies of transparencies which were most kindly presented to us by Prof. W. W. Campbell. It will be remembered that the late Colonel C. F. Crocker, who had on two previous occasions provided the funds for eclipse expeditions organized from the Lick Observatory, had undertaken the cost of one to observe the late eclipse in India. The astronomer in charge of the expedition was Prof. W. W. Campbell, the spectroscopist of the Observatory, and he was accompanied by Mrs. Campbell and Miss Rowena Beans as volunteer assistants, travelling at their own private expense. Prof. Campbell was also assisted in India by Captain Fleet and Mr. Garwood of the Royal Navy.

Prof. Campbell's chief instrument was the great photographic telescope of five inches aperture and forty feet focal length. This was firmly fixed, and the sensitive plate was made to follow the sun. With the sun more than fifty degrees high at mid-totality, the mounting of such a monster was a very serious business; the more so as Prof. Campbell was by no means satisfied with such native carpenters as he could procure. To support the object-glass end, he built a firm wooden tower—well seen in the accompanying photograph—some twenty-three feet in height, whilst the camera end was received in a pit some eight feet deep. The plates used with this great telescope were seventeen inches long by fourteen wide, and the image of the moon was very nearly four and a half inches in diameter. The larger of the two photographs in the plate is copied from one of these, and was given an exposure of one second.

Beside this great telescope, two other photographic telescopes—the Dallmeyer and Floyd—were also employed, with focal lengths of three and five feet. With these two smaller instruments eight beautiful negatives were obtained, and the smaller photograph in the plate is an enlargement from one of these taken with the Floyd telescope with an exposure of ten seconds. The forty-foot telescope gave twelve negatives, of which nine were extremely satisfactory. The exposures varied from an "instantaneous" one up to sixteen seconds.

Beside the photographic cameras, Prof. Campbell had a number of spectroscopic cameras, his principal objects

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* *Astrophysical Journal*, Vol. IV., No. 5.

* Fifty-second Annual Report of the Harvard College Observatory.

being to photograph the changes in the spectrum due to the "reversing layer," and also to secure photographs of the 1474 K line for the purpose of determining the question of the rotation of the corona. The two smaller photographic telescopes, together with the spectroscopes, were all carried on the same mounting, which was practically one of the English form, and may be seen in the centre of the photograph just beyond the base of the great telescope.

Speaking generally, the recent eclipse has been specially remarkable for two classes of photographs—those of the corona on a large scale, and those of the spectrum of the "flash." Mr. Evershed's photographs are well entitled to stand as representatives of the latter, and we may well take Prof. Campbell's beautiful picture as a representative of the former.

Prof. Campbell's Observing Station at Jeur, India, during the Total Eclipse of January 22nd, 1898.

These large-scale photographs were undertaken at three stations: at Sahdol, where Prof. Michie Smith used a forty-foot camera like Prof. Campbell's, rigidly fixed and pointed directly to the sun; and where the Astronomer Royal used the nine-inch Thompson photographic lens of Greenwich Observatory, in combination with a Dallmeyer telephoto lens, by which the image was enlarged from a diameter of one inch to one of four. This, the most powerful photographic instrument in use in the eclipse, was fed by a cœlostat. Prof. Copeland, at Goghli, also used a lens of forty-foot focus, but mounted it horizontally and used a heliostat. There was, therefore, a wide range of method, though the resulting photographs were approximately on the same scale.

In the March Number of Knowledge we pointed out that of coronæ, as seen directly, there were three well-marked types. In the May Number we drew attention to the correspondence between long-exposed photographs and the visual appearance. In the present case we wish rather to speak of those details of the lower corona which are probably common to all types, and which are very well exemplified in the present photographs.

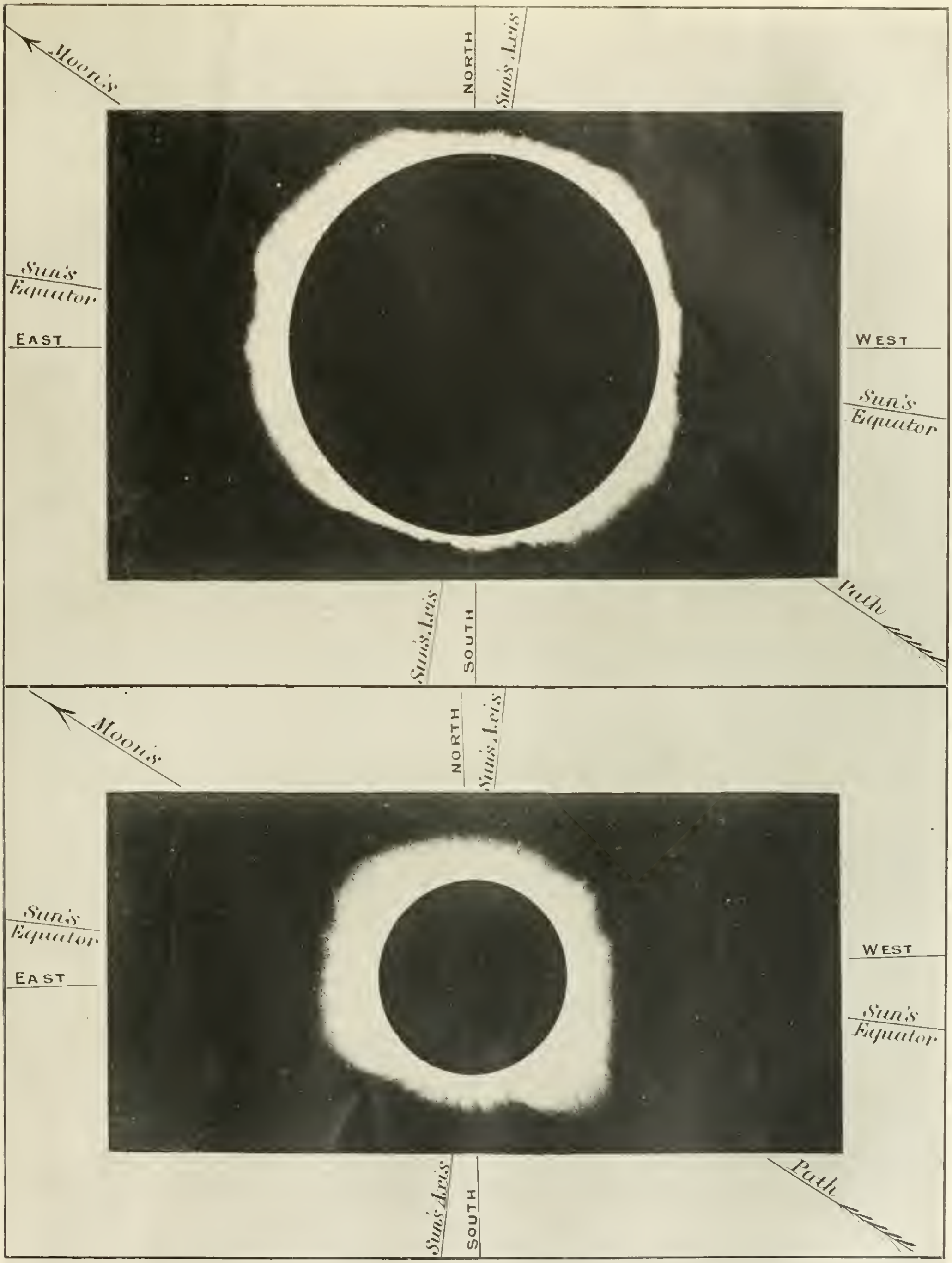
1. *Polar Rays.*—These are seen with exceptional clearness in many of the photographs of the late eclipse. They seem to spring almost from an actual point on the sun's surface, and to diverge nearly in straight lines, but with a tendency on the part of those diverging the most widely to curve over towards the equator. Generally speaking the corona gives the idea of a flat picture, not of a body based upon a sphere and having depth as well as extension. But, on the present occasion at any rate, the polar rays seem distinctly placed at different distances, and some appear foreshortened while others are seen in their full length. It might be added here that Prof. Campbell's photograph shows better than any other with which we are acquainted a pretty little group of prominences near the north pole.

2. *Re-entering Curves.*—A prominent feature of the 1893 eclipse (at sunspot maximum) was the number of instances in which a bright group of prominences was arched over by a bright coronal line which formed a complete bridge above it. Not only so, but the coronal structure was distinctly less brilliant below this arch and round the prominence. The prominences appeared, therefore, as if they were covered by glass shades or bell jars, and it would seem as if the prominence exercised some repulsive effect upon the corona matter. In some cases arch succeeded arch, the prominence group being enclosed beneath a succession of more or less perfect re-entering curves.

3. *Radial Lines.*—The great streamers or extensions of the outer corona are usually bordered by bright lines of a very peculiar and characteristic form, lines of double curvature which give those streamers their well-known lobed or leaflike shape. These lines often start almost tangentially to the disc. In the present eclipse there are several marked cases in which these curves, starting thus tangentially, and curving round almost concentrically with the sun, become caught by a vehement repulsive force, and are swept outward in a straight line radial to the sun. The triple ray in the north-west is, perhaps, the most striking instance of this.

Notices of Books.

Thermo-Geographical Studies. By C. L. Madsen. (Williams & Norgate.) This general exposition of the analytical method applied to researches on temperature and climate, gained for the author both an honourable mention and a silver medal in the competition for the Hodgkins prizes offered by the Smithsonian Institution, Washington, in 1893. Equations are deduced for the determination of the normal mean yearly temperature of the parallels, of the mean yearly temperature of places of given geographical latitude and longitude, and of the yearly movement in the temperature of places in the northern temperate and polar zone. A comparison is instituted between the actually observed and calculated mean yearly and monthly temperature of one hundred and twelve places situated in the middle Atlantic zones of the northern hemisphere. There is, in addition, a mass of observations and data dealing with other branches of this



THE SOLAR CORONA, 1898, JANUARY 22.
Taken at Jeur, India, by Prof. W. W. Campbell,
of The Lick Observatory, Mt Hamilton,
California, U.S.A.

interesting branch of natural knowledge. The volume will be a most valuable work of reference for future investigators in meteorology and physical geography, and we congratulate the author upon his worthy contribution to science.

The Flora of Perthshire. By Francis Buchanan W. White, M.D., F.L.S., F.E.S. Edited, with an Introduction and Life of the Author, by James W. H. Trail, A.M., M.D., F.R.S., Professor of Botany, Aberdeen University. (Edinburgh: W. Blackwood & Sons.) Dr. Buchanan White was an enthusiastic investigator in the realm of natural history, and most of his work as a botanist was done with a view to the publication of a "Flora of Perthshire." It is, therefore, a matter of congratulation that the materials he collected during a number of years have been brought together in the present volume. The book is a worthy memorial of an esteemed naturalist, and its value is much enhanced by the introduction and memoir from the pen of Prof. Trail, whose expert knowledge of the subject and personal regard for Dr. White have together given a wider interest to this publication than is usually possessed by a local flora.

A Student's Text-Book of Zoology. Vol. I.—Protozoa to Chætognatha. By Adam Sedgwick, M.A., F.R.S. (London: Swan, Sonnenschein, & Company, Limited. New York: The Macmillan Company.) 18s. It is now generally admitted that to successfully study zoology the student should begin by making a thorough examination of the structure of individual animals, learning the functions of their several parts as well as their relation to the external world and to one another. This constitutes what is known as the "study by types," which method owes its popularity in this country to the pioneer efforts of Huxley, who, planning courses of instruction at the old Normal School of Science, now called the Royal College of Science, adopted this plan. In this way a basis for more extended studies is secured, and it is to assist such extended studies that Mr. Sedgwick has prepared this first volume of his book, which will be completed by a second volume. But, as the author says in his preface, the book should have an additional use. It makes an admirable and handy book of reference to others interested in natural history, who will here find the general nature and habits of a large number of animals described in a readable style. When we add that the volume is provided with four hundred and seventy-two illustrations, is liberally supplied with references to original papers and other sources of information, and has all matters in dispute printed in small type, it will be seen that no efforts have been spared to make the path of the young zoologist as easy and pleasant as possible. Mr. Sedgwick tells us that he originally intended to publish a new edition of Claus's *Lehrbuch*, but subsequently departed from his intention. We think the student of the subject in this country has hereby reason to congratulate himself. The book is, beyond question, one of the best volumes on zoology at present available.

Theoretical Mechanics. By A. E. H. Love, M.A., F.R.S. (Cambridge University Press.) 12s. This recent addition to the excellent series of mathematical treatises published by the Cambridge University Press is intended for students who have some acquaintance with the elements of the differential and integral calculus and some knowledge of plane co-ordinate geometry. The book is divided into three parts: the first is preliminary in character, and is intended to accustom the student to the idea of acceleration, and to the fact that a precise description of any motion can be given by a statement of the accelerations involved; the second part is devoted to an explanation of the principles of dynamics; the last part is taken up with exemplifications of the ways in which the general theory is applied. The book is attractively printed, the subjects of the paragraphs being boldly defined by Clarendon type and the chief theorems by Italics. It is altogether an admirable treatise and will take a high place among modern works on the subject.

The First Philosophers of Greece. By Arthur Fairbanks. (London: Kegan Paul, Trench, Trübner, & Co.) 7s. 6d. Mr. Fairbanks has, in this most interesting book, prepared for the student a Greek text of the fragments of the early philosophers which represents, as accurately as possible, the results of recent scholarship; he has also added such critical notes as may be necessary to enable the scholar to see on what basis the text rests. From this text Mr. Fairbanks has prepared a translation of the fragments into English. and along with this a translation of the important passages bearing on these early thinkers in Plato and Aristotle. The reader is thus enabled to see exactly the views held by early Greek philosophers as to natural objects and phenomena, and the book will be of great value as a concise epitome of the early history of scientific opinion. It is well known that many correct ideas were held by these Greek philosophers. Thus, Thales, the founder of the school (640 B.C.—548 B.C.), taught that the moon reflects the sun's light to us, and that "eclipses of the sun take place when the moon passes across it in direct line, since the moon is earthy in character; and it seems to the eye to be laid on the disc of the sun" (p. 7). Similarly, Empedokles (494 B.C.—434 B.C.) speaks of the moon as "a borrowed light, circular in form —it revolves about the earth, as if following the track of a chariot"; and of night, "solitary, blind-eyed," as being the result of the earth "coming in front of the lights" (p. 177). Now that the idea of a gradual evolution of human thought, as well as of organic forms, is universally recognized, such a book as Mr. Fairbanks has compiled will prove of the greatest value to all intellectual readers and workers, and we are confident they will experience keen pleasure in consulting it.

SHORT NOTICES.

The Miner's Arithmetic and Mensuration. By Henry Davies. (Chapman & Hall.) 4s. net. Although the appearance of this book is at first rather forbidding, a closer inspection will reveal to the mining student who happens to look into it what a valuable treatise it is. Arithmetic and mensuration are here subordinated to the actual requirements of the practical miner—that is, examples are given which apply to mining and mine engineering, such, for example, as the calculation of the available coal in various seams. Numerous problems of this kind, with full solutions, form a conspicuous feature, and the many examinations in connection with mines and public bodies are represented by a large number of fully worked examination papers. Many of the questions, however, on the steam engine and other branches of mechanics and physics cannot be solved by the aid here given, but the examples thus brought together will be useful in classes where the several sciences required by mining students are taught; and that, presumably, is the intention of the author.

The Process Year-Book for 1898. Edited by Wm. Gamble. Price 3s. 6d. (London: Penrose & Co.) The editor is certainly to be complimented on the general excellence of this book. He has obtained a great number of beautiful illustrations and a long list of articles from eminent photographers, full of information. The whole is a splendid result of present-day skill in book illustration.

French Self-Taught. By C. A. Thimm, F.R.G.S. (Marlborough & Co.) 1s. Mr. Thimm has compressed a great number of phrases into this little book, which will minimize the student's labour in acquiring just sufficient knowledge of the language to enable one to get through a tour in France with tolerable comfort as regards making inquiries, shopping, the conversation at hotels, and so on, the useful and necessary idiomatic expressions and phrases for this purpose constituting a principal feature in the book.

BOOKS RECEIVED.

The Making of a Daisy, "Wheat out of Lilies," and other Studies in Plant Life. By E. Hughes-Gibb. (Griffin.) Illustrated. 2s. 6d.

Birds in London. By W. H. Hudson, F.Z.S. (Longmans.) Illustrated. 12s.

Essai Synthétique sur la Formation du Système Solaire. Gal. Lafouge. (Martin Frères, Chalons-sur-Marne.) Illustrated.

French Self-Taught. By C. A. Thimm. (Marlborough & Co.) 1s.

The Wonderful Century: its Successes and its Failures. By Alfred Russel Wallace. (Sonnenschein.) Portrait. 7s. 6d.

Creation Records. By George St. Clair. (David Nutt.) 10s. 6d.

Elementary Practical Zoology. By Frank E. Beddard, F.R.S. (Longmans.) Illustrated. 2s. 6d.

Krömsköp: Colour Photography. By Frederic Ives. (Photochromoscope Syndicate, Limited.) Illustrated.

English National Education. By H. Holman. (Blackie). 2s. 6d.

Elements of Descriptive Astronomy. By Herbert A. Howe. (Philip & Son.) Illustrated.

Smithsonian Report: U.S. National Museum, 1895.

A Catalogue of Earthquakes on the Pacific Coast, 1769 to 1897. By Ed. S. Holden. (Smithsonian Collections.)

Ackworth Birds. By Major W. B. Arundel. (Gurney & Jackson.)

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

Weather Lore. By Richard Inwards, F.R.A.S. (Elliot Stock.) Illustrated. 7s. 6d.

A Text-Book of Entomology. By Dr. Alpheus S. Packard. (Macmillan.) Illustrated. 18s. net.

Introduction to Algebra. By G. Chrystal. (A. & C. Black.) 5s.

Types of Scenery and their Influence on Literature. By Sir Archibald Geikie. Romanes Lecture, 1898. (Macmillan & Co.) 2s.

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Obituary.

By the death of Lord Playfair, which occurred on Sunday, 29th May, science—more particularly applied science—has lost one of her chief ornaments. Lyon Playfair was born in Bengal, in May, 1819, his father at that time being Inspector-General of Hospitals out there. He studied chemistry under Graham at Glasgow, and subsequently in London, in the capacity of assistant, after that distinguished chemist migrated southwards. Playfair next became a pupil of Liebig's at Geissen, in Germany, several of whose works he translated into English; and on his return to England he undertook the management of a large calico print works. About this time (1842) he travelled through England on a lecturing tour with Liebig, and was thus instrumental in arousing public attention to the advantages of combining practical science—especially chemistry—with operations in agriculture. The immediate effect of this tour was to make chemistry a popular science, and to induce colleges to open laboratories; hence it was that the Royal College of Chemistry was founded in 1845, since known as the Royal School of Mines and Normal School of Science, and, finally, as the Royal College of Science. In the early days of the history of this college, Dr. Playfair, as Professor of Chemistry, had to content himself with a laboratory fitted up in the cellar-kitchen of a house in Duke Street, Westminster. In 1851, after the Great Exhibition, he became Gentleman Usher to the Prince Consort—an appointment due to the Prince's desire to have about him a sort of scientific adviser. Probably no other man of the time was so influential in formulating the scheme which was announced from the throne at the opening of Parliament in November, 1852, when Her Majesty stated: "The advancement of the Fine Arts and of Practical Science will be readily recognized by you as worthy the attention of a great and enlightened nation. I have directed that a comprehensive scheme shall be laid before you, having in view the promotion of these objects, towards which I invite your aid and co-operation." Thus, in the following year the Department of Science and Art was born, and Playfair became one of the joint secretaries. In 1858 he was appointed Professor of Chemistry in the University of Edinburgh, the Prince of Wales and Prince Alfred being among his pupils. He published two lectures in 1870—"On Primary and Technical Education"—and had the suggestions then made been carried into effect we should not have had to wait twenty years for the adoption of the technical education scheme. His lordship was always prolific of advanced ideas relative to the practical utility of scientific education; indeed, but few men, if any, have had a more direct and practical effect on at least the physical well-being of their times. His writings have an eminently practical trend; thus—"On the Nature and Causes of Decay in Potatoes," "On the Gases evolved from Iron Furnaces," "On the Food of Man in Relation to his Useful Work," "The Disposal of the Dead," "Petroleum as the Light for the Poor"; and among the subjects he was appointed to inquire into in the interests of the public may be mentioned the herring fisheries and the cattle plague. He was one of the early Presidents of the Chemical Society; became associated with the Civil Service by what is known as the "Playfair Scheme"; he was a Privy Councillor; and served in the capacity of Postmaster-General, Chairman of Ways and Means in the House of Commons, and Vice-President of the Council. Among the numerous honours showered upon him from nearly all the learned societies of Europe, in addition to those of our own country, may be mentioned, Commander of the Legion of Honour, Commander of the Austrian Order of St. Joseph, Knight of the Portuguese Order of Conception, Knight of Wurtemberg, and Knight of the Swedish Order of the Northern Star.

Mr. Osbert Salvin, F.R.S., who died on the 1st June, will be greatly missed among ornithologists, for there were but few naturalists whose opinions were more frequently sought on controversial points in his line of study. He was born in 1835, and educated at Trinity Hall, Cambridge, where he graduated as Senior Optime in the Natural Science Tripos of 1857, after which he undertook several exploration expeditions in Algeria, Guatemala, Central America—localities which will always be associated with his name. In 1874 he accepted the Strickland Curatorship in the University of Cambridge, and filled that office till his father's death in 1883, to whose estate at Hawksfold, near Haslemere, he succeeded. Mr. Salvin will be perpetuated in literature in connection with "Biologio Centrali Americani," "Catalogue of the Strickland Collection," and his numerous papers on birds, particularly humming birds and petrels.

We regret to record the death of Mr. Herbert Sadler, F.R.A.S., who was for many years a very useful contributor to this magazine. Born on the 14th of May, 1856, he was the eldest son of the Rev. Prebendary Sadler, and he died on the 1st of June at the comparatively early age of forty-two. His education was commenced at Sherborne School and completed at Cambridge, where he distinguished himself as a linguist—particularly in Hebrew. His astronomical work was mainly connected with double stars, on which he was an authority; and, in collaboration with Mr. Latimer Clarke, he compiled a book on this subject. Mr. Sadler was elected a Fellow of the Royal Astronomical Society in November, 1876. The deceased gentleman fully appreciated the beauties of nature, and was devotedly attached to animals and flowers. As an instance of his enthusiasm for astronomy, it may be mentioned that Mr. Sadler learnt the Russian language for the sole purpose of availing himself of astronomical literature in that language.

[Mr. A. Fowler, F.R.A.S., Demonstrator of Astronomy in the Royal College of Science, has kindly undertaken to supply matter for the column, "Face of the Sky," which Mr. Sadler sustained so long and so well.]

Letters.

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

THE SUN'S STELLAR MAGNITUDE.

To the Editors of Knowledge.

Sirs,—Mr. Holmes had evidently not seen Mr. Gore's article in Knowledge for June, 1895. The method adopted in that article seems to me an improvement on the earlier ones.

But now that the spectra of stars are being carefully studied, I think another method has become available. Select the binary stars with pretty certain orbits whose spectra approach most closely to that of the sun. If the surface brilliancy of these stars appears to be pretty nearly the same in all cases, we shall have a fair measure of the surface brilliancy of the sun. If, then, we can get one of these stars whose parallax as well as its orbit (in angular measure) is ascertainable, and whose stellar magnitude is known, we have the requisite data for comparison. The star best suited for this purpose is, I think, Procyon. At present the orbit is not certain, owing to the very recent discovery of the satellite whose existence had previously been only a subject of computation. But the photometric measures and determinations of parallax in the case of Procyon are remarkably concurrent, and the type of the spectrum appears to be decidedly solar. If the spectrum approaches that of the sun as closely as I believe it does (I have no spectroscope of my own), a good orbit for Procyon is probably all that we require in order to make a better estimate of the sun's stellar magnitude than has hitherto been accomplished. We have got so much into the habit of calling stars *bright* that give a large quantity of light that it seems useless to attempt to use the word in any other sense. The word *brilliant* seems less appropriated to this use, and we might therefore, perhaps, employ the word *brightness* with reference to the magnitude of the star (or quantity of its light), and the word *brilliancy* with reference to its intrinsic luminosity. Though there may be little difference in the popular use of the two terms, it is desirable to have two different words to express these qualities when we are dealing with them scientifically. But the *brilliancy* of a star, as thus explained, only represents the luminosity of the surface unit on the assumption that all stars have the same density. A diminished density will have the same effect as an increased luminosity of the surface unit, and as long as we are unable to measure the disc of the star we can hardly form a decisive opinion as to which of these causes a high or low degree of brilliancy is to be ascribed. The phenomena of Algol and some other stars of the same type, however, seem to indicate a low density in the Sirian stars, and it is, therefore, not unlikely that their high brilliancy is due rather to their great extent of surface than to the great luminosity of the surface unit. Mr. Gore's figures were based on this supposition of greater surface, or, in other words, greater diameter. In a paper which I contributed to the British Astronomical Association nearly at the same time, I proceeded on the assumption of greater brilliancy of the surface unit. Most probably both causes combine. As a star cools and condenses the surface shrinks and becomes less luminous at the same time. But figures worked out on either theory can be easily translated into the other. They represent facts which may be interpreted in different ways; but different modes of interpretation cannot change facts to fictions.

W. H. S. Monck.

To the Editors of Knowledge.

Sirs,—In reply to Mr. Holmes, I beg to say that if he will again refer to my paper in Knowledge for March, 1898 (bottom of first column), he will find that I refer to my paper in Knowledge for June, 1895, in which I have computed the sun's stellar magnitude as – 27, and this is, I think, a more probable value than – 25·5, which was formerly adopted.

With reference to the term "brightness," Mr. Holmes is right in thinking that I mean "quantity of light." If he will read my paper again he will find that when I refer to *brightness of surface*, I use the term "intrinsic brightness," or "brightness of surface." In the case of Sirius, I have shown that, taking its mass as 2·36 times the sun's mass (as computed by Dr. See), and assuming its density and *brightness of surface* to be the same as that of the sun, the *quantity of light* which it would emit would be only 1·773 times what the sun would emit at the same distance as Sirius; but its apparent "magnitude" shows that it is 17·38 times brighter than the sun would be at equal distances. Hence, the "quantity of light" which Sirius emits is about ten times greater than it should be, considering its mass. I think the sentence quoted by Mr. Holmes expresses this with sufficient clearness. The term "brightness" used *alone*, always, I think, means "quantity of light." Thus a first magnitude star is said to be 2·512 times brighter than a second magnitude star, etc. Mr. Holmes speaks of γ Leonis, but this star is not mentioned in my last paper, as its orbit has not been accurately determined.

J. E. Gore.

Dublin, June 10th, 1898.

Science Notes.

Experiments are in progress, under the Essex Technical Instruction Committee, having for their object the destruction of charlock in barley and other crops; and it appears that a two per cent. solution of copper sulphate, applied at the rate of twenty-five to fifty gallons an acre, by means of a "knapsack strawsometer," during dry weather, and at an early period of growth, has been found completely successful in suppressing the charlock without injuring the barley.

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During the past month the South-Eastern Union of Scientific Societies has held its annual congress (the third) in Croydon, the president elect being Prof. G. S. Boulger, and the retiring president the Rev. T. R. R. Stebbing, f.r.s. The place of meeting for next year is Rochester. The aim of the Union is "to win for science such benefits as are found to accrue in manufactures from division of labour; and in trade, commerce, and finance from co-operation." A perusal of the local reports of the papers read by the members in the Town Hall, where the congress was graciously received by the Mayor and Mayoress, indicates that the scope of study and research extends to every branch of natural history; and the mutual enthusiasm and goodwill which prevailed among both hosts and visitors augurs well for the future of the Union.

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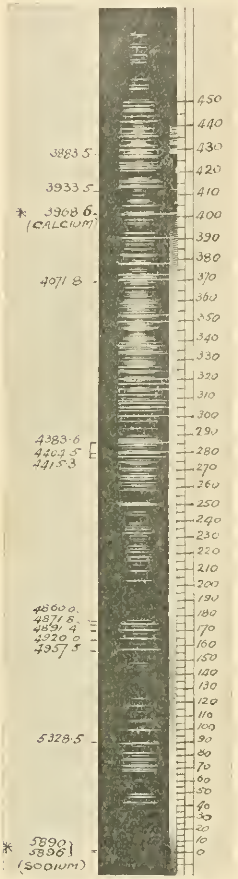
Experiments in wireless telegraphy are, we understand, in progress under newspaper auspices by Mr. C. Dolbear, son of Prof. Dolbear, and messages, it appears, have thus far been successfully transmitted over a distance of some fifteen hundred feet. Prof. Slaby has also devoted some attention to the subject, and is said to have sent intelligible Morse signals thirteen and a quarter miles, using two balloons filled with hydrogen to elevate the ends of the conductors to the height of one thousand feet in the air.

A very ingenious contrivance has lately been devised by Mr. Edwin Edser, a.r.c.s., and Mr. C. P. Butler, a.r.c.s., which may be utilized for the purpose of facilitating the reduction of prismatic spectra in terms of wave-lengths. Two pieces of plate-glass, each thinly silvered on one surface, are arranged with these surfaces parallel and nearly in contact. This simple combination is adjusted in front of the slit of a spectrometer, so that a ray of slightly convergent white light, when passed through, gives a spectrum consisting of white bands separated by dark intervals due to the interference of the direct ray with that twice internally reflected. If the wave-lengths corresponding to any two interference bands be known, that corresponding to any other band can be calculated or determined graphically with extreme accuracy. In order to adjust for parallelism, a spot of light, or the filament of a glow lamp, is viewed through the silvered surfaces. A long train of images, of course, is visible, and these must be brought into coincidence. If a sodium flame is now viewed through the air film, interference bands appear, which must be regulated by pressure to a maximum width, an arc lamp being employed for illuminating the collimator slit. The chief advantage of this system of calibrating spectra consists in the enormous saving of time which it will effect. A simple graphic method thus serves to determine wave-lengths—corresponding to an immense number of spectral lines—by mere inspection. When once the observer has photographed the spectrum, with the accompanying scale, all he has to do is to index the scale, and then he can commit it to the care of an ordinary attendant devoid of scientific knowledge, who may perform the reductions mechanically, in a manner somewhat comparable to the way in which a carpenter measures his boards and planks.



Comparison Scale for reduction of Spectra.

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Crypton, or the "hidden stuff," is the name given by Prof. Ramsay to the recently discovered atmospheric element—a gas—the existence of which was suspected when argon was eliminated from air three years ago. The principal lines of the spectrum of crypton are green and yellow, but although heavier than argon its atomic weight has not yet been worked out. Minute in quantity, it was at first exceedingly difficult to obtain air in sufficiently large volumes as to reveal any appreciable trace of the new gas. Thanks, however, to Prof. Dewar—who can now supply gallons of air, in the liquid form, within the compass of a test-tube—in the hands of Prof. Ramsay the potency of liquid air as an instrument of research has been manifested, and one of the first chemial products obtained by its aid is, it would appear, nothing less than a new element! Its proportion in the air is about one in twenty thousand. The brilliant yellow-green is believed by Sir Wm. Huggins to be identical with the green auroral line.

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"The Microbe in Agriculture" forms the subject of an article in the June Number of the *Nineteenth Century* by Dr. Aikman, in which he dwells at some length on *nitragin*,* and more particularly *alinite*—a pure culture of the *bacillus megatherium*—designed for inoculating the soil with nitrogen-fixing bacteria. He says: "When we reflect that in a phial barely a couple of inches in length, and less than a quarter of an inch in diameter, there may be contained the means of enriching an acre of ground in its most valuable of all fertilizing constituents, we realize the great advantage such a process possesses over the more costly and troublesome mode of strewing large quantities of artificial manure." It would appear that a system of co-operation obtains among these minute soil workers. While some are instrumental in initiating the first stages of decomposition, others carry on its development through successive stages, and the microbic inhabitants of the soil are classified according to the nature of the products they give rise to.

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Messrs. Seeley & Co. will shortly publish a short popular account of wireless telegraphy by Mr. Richard Kerr. It explains in simple language the methods devised by Mr. Preece, Signor Marconi, Dr. Oliver Lodge, and others who have worked on this marvellous discovery. Mr. Preece will contribute a preface.

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SELF-IRRIGATION IN PLANTS.

By the Rev. Alex. S. Wilson, m.a., b.sc.

Absorption of water in terrestrial plants takes place almost exclusively through the roots; very little of the rain or dew that falls on the foliage finds its way into the interior of a plant directly through the leaves or other aërial parts. The bark of the stem and branches prevents loss of water by evaporation; so does the impervious cuticle which covers the leaves; but any covering which hinders the passage of water outwards must necessarily offer a corresponding resistance to the entrance of water. For this reason those portions of their surface which plants expose to the air are, as a whole, ill adapted for imbibition. The freshening effect observed when the leaves of a parched plant are damped, arises not so much from absorption as from diminished evaporation; the water supplied by the roots to the leaves does not escape so rapidly, and the leaf-cells are in consequence kept distended.

Quite other conditions obtain in plants which grow submerged in water; the cuticle is but slightly developed, and imbibition takes place through the general surface. Aquatics accordingly quickly dry up and shrivel when

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* *See* Knowledge, Vol. XX., p. 201.

exposed to the air, the thin cuticle affording little protection against loss by evaporation.

At a certain depth in most soils underground water exists; in some cases this approaches the surface, but land plants, as a rule, do not thrive where the soil is in this over-saturated condition: they depend mainly on water precipitated from the atmosphere percolating through the upper porous layers of earth in which their roots are situated.

From what has now been stated it will readily be understood that to plants growing in a region subject to occasional drought, any arrangement by which rain falling on the leaves can be quickly transferred to the neighbourhood of their roots must necessarily be highly advantageous. Many provisions of this kind exist. The rain caught by the leaves is not generally allowed to disperse at random, but is led along specially prepared courses. Were the water to lie on the leaves till it evaporated, or were it spilt irregularly, loss and miscarriage would result; but so accurate is the adjustment of plants to their environment that even this apparently insignificant loss is safeguarded by a variety of contrivances.

The first of these we shall mention is the general inclination of foliage. Many of our readers must have noticed how on a wet day in winter the rain runs down the leafless branches and descends the trunks of trees; the bark, in consequence of being kept constantly moist, assumes a green tint from the development of mosses and lichens. During summer, on the contrary, the surface of the trunks and branches of most of our trees is quite free from moisture, and the ground underneath the branches is dry. The foliage, in fact, forms a kind of thatch; the leaves slope outwards and overlap like tiles on a roof, so that the water drips from the outer extremities of the branches, producing a moist zone on the ground around the tree. Now, as the roots commonly extend in a horizontal direction as far as the branches, it is quite obvious they must benefit by this arrangement; and on extending our observations we find this principle to be of very general application.

The relative positions of the foliage leaves and absorbent roots are in most cases such as to secure to a greater or less degree the benefits of self-irrigation. The drainage of the foliage may be either centripetal or centrifugal. As examples of the latter, where the slope of the foliage is outwards, may be mentioned the lime, birch, apple, pear, plane, maple, ash, horse-chestnut, poplar, and alder. The needle-like leaves of the pine and larch are also so arranged that nearly all the rain is conducted outwards, the ground underneath the branches remaining in consequence remarkably dry. The drooping or weeping habit of many trees admits of a similar explanation.

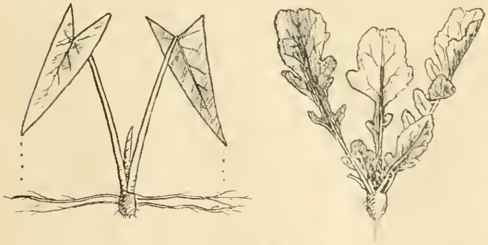

Fig. 1.—Centrifugal and Centripetal Irrigation.

Palms, bananas, tree-ferns; bulbous monocotyledons like the tulip and hyacinth; the turnip and beetroot, and most plants with tufted foliage, have the drainage centripetal. The radical leaves of the rhubarb, plantain, dandelion, thistle, and many others, are arranged like a rosette, and the rain flows down towards the central root-stock. In these cases the stem is either prolonged downwards into a tap-root, or the roots form a central mass of no great horizontal extent.

With centripetal drainage several secondary adaptations usually appear. Where the inclination of the foliage is outwards, as a rule the leaf-stalk is not channelled; in plants, on the other hand, which have central roots, there is usually a very conspicuous groove on the upper surface of the petiole. The common cow-parsnip is an exceedingly good example of this; its long petiole has a deep groove above. The raised edges of the groove almost close over it, and practically convert the leaf-stalk of Heracleum into a pipe down which the rain flows towards the stem. An instructive contrast is seen on comparing an aroid, such as Callocasia or Calladium, which has widely spreading roots and leaves sloping outwards, with the rhubarb, which has a central root-stock, grooved petioles, and inward-sloping leaves.

Fig. 2.—Nodding and Auriculate Leaves.

The lamina or blade of the leaf in numerous instances exhibits a further peculiarity. The surface of the veins and midrib may be depressed, as in the primrose, below the general level of the leaf, giving rise to a series of shallow converging channels, which conduct the rain into the grooved petiole. As the raised portions of the leaf have a thin coating of wax, which renders them practically waterproof, the rain falling on these parts assumes the form of globules, and readily rolls off into the courses prepared for it. The wax-coated parts repel water; but the channels, being entirely free from wax, are easily wetted, so that rain soaks into them and speedily finds its way. Wax or bloom is seen on the leaves of the pea, woodbine, poppy, fumitory, pink, and is present more or less on all leaves. From the leaves of the cabbage water rolls off as from a duck's back, without wetting the surface. Roots are devoid of wax. On herbaceous plants with an erect stem the leaves diminish in size from below upwards; the upper ones are either sessile or but slightly stalked; they may be expanded at the base into auricles or decurrent with a fringe running down each side of the stem. The course followed by the water in its descent depends to some extent on the phyllotaxis. With the opposite arrangement the rain collected by each pair of leaves escapes between the bases of the petioles, and is led down by a groove on each side of the stem into the axils of the leaves below. In the dead-nettle, centuary, pimpernel, and several St. John's worts, this occurs. Grooved, fluted, or ridged stems are also characteristic of such plants as the bedstraw, violet, ragwort, groundsel, knapweed, dock, wild mustard, shepherd's purse, pennycress, horsetails, umbelifers, and others; and it is interesting to observe in some of these how one cauline groove is made to serve a number of leaves. In the laboratory it is often important, when pouring a solution from one vessel into another, not to lose a drop; the chemist effects the transference easily by using a glass rod to guide the liquid. Grooved and striate stems act in the same way. The rain sometimes takes a spiral course, as in the sow-thistle. The stem of this plant is round, smooth, and coated with wax. There are no grooves, but each leaf on the stem is sessile and has large auricles at its base, which shoot the water over on to the leaf next below. Some splashing results from the falling water—grooved stems are designed to avert this—but in the sow-thistle there is little loss, for the large leaves at the base of the plant form a capacious basin, in which most of the spray is caught. The water is projected in this instance upon the next lowest leaf, and, therefore, in its descent follows the genetic spiral; but the rain may be thrown on a leaf more remote, and then there are several spiral streams circulating round the stem.

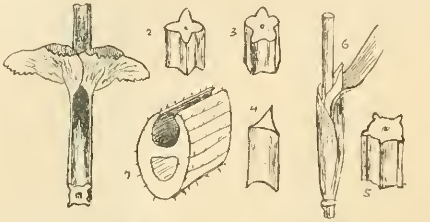

Fig. 3.—Rain-conducting Channels: 1, Dead Nettle; 2, Vetch Stem; 3, Bedstraw; 4, Carex; 5, Pennycress; 6, Ligule of Grass; 7, Leaf-stalk of Cow-parsnip.

The foxglove and mullein have nodding leaves; one portion of the rain drains inwards, but as the upper part of each leaf slopes outwards, some water flows to the apex and drops down on one of the lower leaves, where it is again deflected towards the stem. As the lowest leaves are much larger than the others, the great proportion of rain falling on the plant is ultimately collected in the vicinity of the root, and the loss through splashing is reduced to a minimum. But it must not be assumed that this is the end of all the grooves which occur on leaves and stems; many of the narrower furrows resist the entrance of water, and are probably of use in preventing rain from gaining access to the stomata. Furrows of this description are found in a number of grasses. There are also some grasses with an arrangement which prevents water lodging between the sheathing petiole and the haulm or stem; the ligule acts as a kind of dam, which forces the water that flows down from the leaf-blade to escape at the sides of the lamina and descend on the outside of the sheathing petiole. On the leaf-stalk of the Nile lily, whose white trumpet-shaped spathes are familiar objects in florists' windows, there is a similar contrivance.

The absence of wax and a peculiar smoothness of surface enables one easily to distinguish those channels which act as rain conductors. They recall irresistibly the shallow gutters of clay employed for the distribution of water, seen in Egypt and other lands where from time immemorial artificial irrigation has been practised.

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

A British-taken Shearwater identified for Forty-five Years as *Puffinus obscurus*, now found to be *P. assimilis*.—In the 1889 edition of Mr. Howard Saunders's well-known "Manual" will be found, under the heading of the Dusky Shearwater (*Puffinus obscurus*), a description of a bird which was brought to Yarrell by Mr. B. Blackburn, who said that it was caught on a small sloop off Valentia Harbour, in County Kerry, on May 11th, 1853. This specimen was exhibited at a meeting of the Linnæan Society. Another specimen was found dead in Suffolk about April 10th, 1858, and was exhibited by Mr. Osbert Salvin at a meeting of the Zoological Society. At a meeting of the British Ornithologists' Club, held on March 16th, 1898, Mr. Howard Saunders exhibited the Valentia specimen, and remarked that "recent investigations by Mr. Ogilvie Grant in the islands near Madeira, as well as Mr. Boyd Alexander in the Cape Verde Archipelago, had aroused a suspicion that there might be an error in the identification of the Irish specimen. The authorities of the Science and Art Museum of Dublin, having kindly forwarded the example in question, for comparison with the specimens of *P. obscurus* in the British Museum, it is clearly established that this is not *P. obscurus*, but the closely allied *P. assimilis* of Gould. This may be distinguished from *P. obscurus* by its smaller size, by the white or pale centres to the inner webs of the primaries, the white under tail-coverts, and a more decided white line on each side of the neck. The identification is confirmed by Mr. Osbert Salvin. *P. assimilis* breeds in the islands of the Madeira and the Canary groups, as well as in the Cape Verde Islands, while *P. obscurus* breeds in the Bermudas and the Antilles. Both species have a wide range."

Early Arrival of the Swallow (*H. rustica*).—I saw the first swallow this year on March 14th. This is to me a record date for swallows, my previous earliest date being March 25th. Perhaps the general mildness of the season may account for this. Has anyone else seen one so early?—E. Sillence, Church Street, Romsey.

White Wagtail in County Mayo (*The Field*, May 21st, 1898).—Mr. Robert Warren reports that Mr. Kirkwood found a party of five of these birds on Bartragh Island, County Mayo, on April 30th, and a flock of fifteen on May 10th. Mr. Kirkwood secured in all six specimens. *Motacilla alba* has now been recorded only six times for Ireland, and it is a curious fact that five of these occurrences have been on Bartragh Island, the other being on Achill Island. Further search along the west coast of Ireland, which has been much neglected by ornithologists, may result in establishing the White Wagtail as a regular spring visitor to 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.*

Note.—The first issue of Knowledge containing British Ornithological Notes was that for October, 1897.

BOTANICAL STUDIES.—IV.

MNIUM.

By A. Vaughan Jennings, F.L.S., F.G.S.

In our last study[*] we examined the reproductive process and life history of a *Jungermannia* as a type of the lower mosslike plants which are grouped together under the name of *Hepaticæ* or *Liverworts*. It was observed that in these forms—among the lowest of truly terrestrial plants—the *oöspheres* or egg-cells are contained in special flask-shaped structures or *archegonia*: that the fertilized egg-cell gives rise to a *sporophyte* consisting of a globular *spore case* or *capsule*, borne on a colourless stalk or *seta* which has its base embedded in the tissues of the parent shoot; that the whole contents of the capsule break up into spores and elastic filaments (*elaters*), which are liberated by the bursting of the capsule wall into four segments; and that the germination of these spores produces a more or less developed cell filament (*protonema*), from which buds a new *Jungermannia* plant to bear when mature the reproductive organs in its turn. It is now proposed to compare with this story the life cycle of one of the true mosses.

We may safely start with the statement that the life history of a moss resembles in its main features that of a Liverwort, though there are important differences in detail. In selecting a type for study one looks for a form that is at once abundant and widely distributed, easy to recognize, habitually fertile, and large enough for easy manipulation. The genus *Mnium* is less universally obtainable than *Funaria* or *Polytrichum*, but it combines a typical sporophyte borne on a leaf-bearing plant which is at once conspicuous, beautiful, and easy of study, even with a lens and knife if a microscope is not at hand. It is one of the forms with hanging bell-like capsules, and was formerly included in the wide generic type *Bryum*. The species of *Mnium* have stems from one to three inches in height, and broad, dark green, large-celled leaves. They may be found on wet banks in woods, and especially in the shady hollows among the rocks of our mountain districts. Taking any of the species, we may start our story, not with the anatomy of the plant, but with the single cell from which the plant has arisen.

M. punctatum is perhaps the commonest and best for study. It has large, wide, entire leaves, blunt at the tip; while *M. hornum* has the leaves longer, narrower, pointed, and toothed at the margin. *M. undulatum* (Neck) is the largest and most beautiful species, with long, narrow, wavy leaves, but is only rarely fertile. The specimens used for this article were collected in Switzerland in May last, and I am not sure of the exact species. Probably the first (E and F) is a small-leaved variety of *M. hornum*: the other seems nearest to *M. affine* (Schwaeg). The question of species is, however, of no importance for our present purpose.

When the moss spore falls on a suitable spot under conditions favourable for germination, its protoplasmic contents, covered by the delicate inner spore wall, protrude through an opening in the outer wall and grow out in the form of a thread, which soon becomes divided into consecutive cells by transverse walls, gives off side branches, and develops root filaments or rhizoids. This cellular thread is, as in the Liverworts, known as the *protonema*. The cells which are exposed to light develop chlorophyll granules, and the whole can thus live for a time as an independent plant. Repeated branching of the filaments and the interlacing of their ramifications with those developed from other spores frequently results in the formation of bright green patches of felted threads, such as may be commonly seen on moist clay banks. Apart from characteristic colour, texture, and appearance under the microscope, which soon become familiar by observation, the most distinctive feature of the moss protonema is the appearance on it of minute buds, which, as they increase in size, are seen to be young moss plants.

At various points on the protonemal thread little side outgrowths appear, which become divided into upper and lower cells by oblique partitions. From the lower cells new threads grow out like those of the protonema, but they remain colourless, penetrate the soil, and develop into "root" filaments or rhizoids. The upper cells, by continued elongation and repeated subdivision by longitudinal and transverse walls, grow up into aërial shoots, giving off leaves in succession behind the growing apex and constituting the moss plant. The protonema, by spreading over a relatively wide area, living and assimilating food, and then producing numerous buds at different points, is evidently of great importance in increasing the chances of survival.

It is with the reproductive processes of the plant that we are at present concerned. Almost everyone knows by sight the graceful capsules carried on slender stalks which rise from the moss tufts of walls and woodland banks, tree-trunks, and mountain rocks; and almost everyone is content to regard them as a "moss fruit," growing at the top of a continuation of the stem. It is only by a careful—though by no means difficult—study of the tips of the moss stems that we can find out the real meaning and mode of origin of the "moss fruit."

In the genus we have selected, fruiting is common and conspicuous in most of the species. The *antheridia* and *archegonia* occur on separate plants in the axils of leaves at or near the apex of the stem. In the male plants the tip of the stem is flattened out into a sort of "head" or "capitulum," reminding one of the inflorescence of a daisy or dandelion; and on this will be found numerous antheridia closely crowded together, but surrounded by barren "hairs" or *paraphyses*—structures not met with in the Liverworts. Looked at from above these give the appearance of a round brown or black spot as large as a pin's head, surrounded by a ring of spreading green leaves considerably larger than those of the stem and often differing in detail from them. In the female plants there is no such marked modification of the tip of the stem, though it is slightly enlarged in some species, and the leaves round the archegonia may be slightly larger than the ordinary leaves. It is best to select a tuft in the early fruiting stage and examine those on which young sporophytes occur, or the apparently sterile plants occurring among these.

To study these organs more carefully it will be best first to cut longitudinally through the middle of a male flower with a sharp knife, and examine with a lens. Among the bases of the terminal leaves the antheridia will be seen as elongated, straight, or slightly curved sacs. Mixed with them are the numerous club-shaped hairs known as *paraphyses*, which do not occur in the Hepatics, and the use of which is doubtful. By cutting a thin section with a razor from the surface already exposed, and examining it under a microscope, further details may be observed. The antheridia will be seen to possess a thin wall composed of one layer of cells; and their granular contents appear divided, by vertical and transverse walls, into a vast number of minute cells. If one of them is in a ripe

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[*] Knowledge, May, 1898.

condition, the addition of a drop of water, or slight pressure of the cover-glass, will cause part of the contents to escape by an aperture formed at the apex. The *antherozoids*, or *spermatozoids*, may then be seen coiled up, each in a thin membrane, which soon bursts and sets it free.

The female plants are, as has already been noticed, less conspicuous. The top of the stem is not expanded to form a "capitulum," and the surrounding leaves are but slightly, if at all, modified. A section through the end of such a shoot will show numerous archegonia surrounded by paraphyses, which in this case have the form of long jointed hairs, without the inflated terminal cells seen in those of the male flower. The archegonia are long and slender; the "venter" or chamber containing the egg-cell is of an oval shape, narrowing below into a cellular stalk of considerable length. The elongated neck consists of the typical four rows of outer cells surrounding the channel filled with mucilage through which the spermatozoids reach the oösphere.

When fertilization has been effected there is an immediate increase in size of the oöspore, followed by division into several cells, forming the commencement of the sporophyte. The latter soon comes to consist of a cylindrical mass of cells, growing down for some distance into the tissues of the parent stem, but growing more rapidly upward. This physiological activity is not, however, confined to the sporophyte proper. The walls of the archegonium and the tissues round its base are also wakened into fresh activity, and for a time keep pace with the increase of the new generation. For a considerable time the developing sporophyte is thus surrounded by a tissue of cells representing the original wall and part of the neck of the archegonium, with others due to an increase of the tissues round its base. In time, however, the upgrowth of the sporophyte is too rapid for its surrounding wall; the latter is torn across transversely, leaving a basal portion as a sheath or "vaginula" round the base of the new plant, while the rest is carried upward as a cap or "calyptra" covering the tip.

The sporophyte grows on as a long slender rod, often till it equals in length the stem of the parent plant before there is any marked appearance of the capsule at its apex. In time the thickening of the terminal portion of the sporophyte indicates the development of the sporangium, and in this instance the successive stages are accompanied by gradual change of position; the original vertical apex becomes oblique, then horizontal, and finally pendent. During these changes the little cap or calyptra is dropped or carried away by the wind. It is only slight in this genus, but is seen at its best in the silky bells of *Polytrichum* and the long "extinguisher" of *Eucalypta*. When it has fallen the end of the capsule will be seen to be closed by a distinct circular lid, the *operculum* sharply separated by an annular ridge from the capsule wall.

The capsule changes from green to yellow and then to brown as the spores within it are ripening. In time the operculum is thrown off, and with its removal may come a burst of gold dust as the spores scatter to the winds. I say "may come" because, though the fall of the operculum probably coincides in nature with favourable conditions, yet nature has provided a second safeguard against premature dispersal of the spores. This is the *peristome*, one of the most remarkable and beautiful structures in the cryptogamic world. Originating as a series of thickenings on the walls of the cells internal to the annulus, and stretching over the end of the columella, the structure finally takes the form of a membrane divided radially into a number of wedge-shaped teeth. In some cases only one layer of cells is thus modified—one set of "teeth" produced—and the peristome is then said to be "simple." In others, such as the type we are considering, there is an inner and an outer layer, so that the peristome is double. The *outer peristome* consists of sixteen triangular teeth, marked by transverse thickening bars. In the dry state their tips meet at the centre, and close the opening of the capsule; when moist they separate and curve upward or backward. The *inner peristome* is a continuous membrane in its outer half, but toward the centre is radially divided into sixteen forked teeth opposite those of the outer circle, and sixteen pairs of jointed hairlike threads alternating with them. These inner structures are also "hygroscopic," or sensitive to changes in the moisture of the air; and their consequent expansion or contraction causes the escape or retention of the spores, according to atmospheric changes.

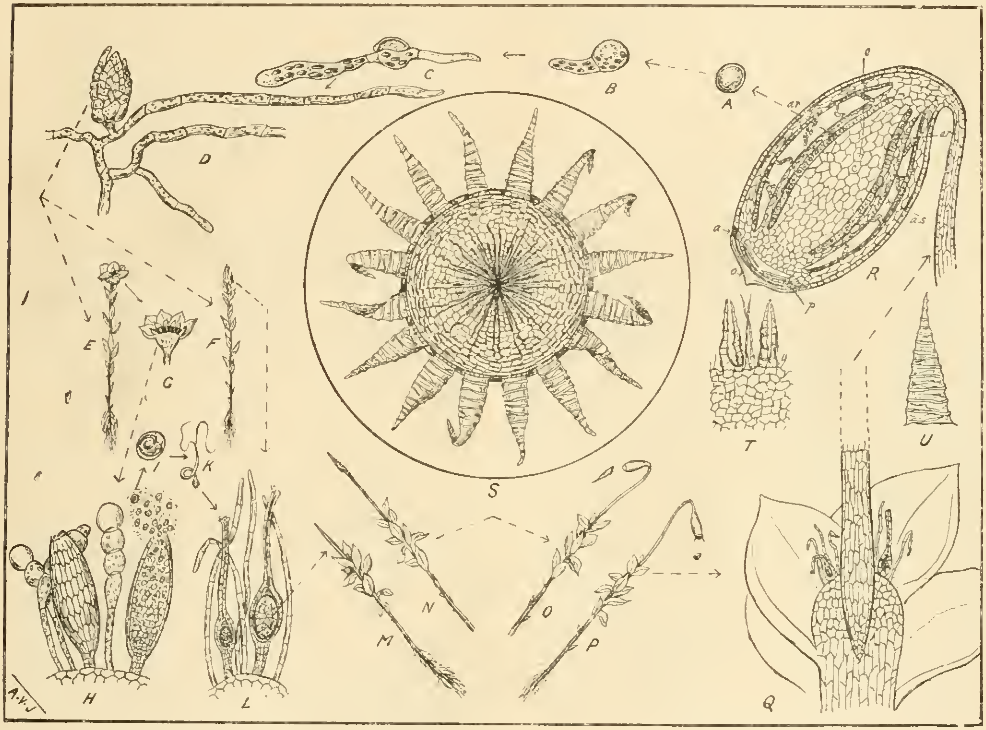
If a fair-sized capsule which has not yet begun to turn dry and brown is selected, it will be found possible, though not without some trouble, to cut a thin longitudinal section through the middle, and examine it under the microscope.

Fig. R in the illustration is a somewhat diagrammatic representation of the more important features to be observed. There is an outer *epidermal* cell-layer and two or three rows of cells internal to it, forming the *capsule wall;* a solid cylindrical tissue of cells, the *columella*, occupies the centre, and is separated from the wall by an *air space* crossed by irregular strings of cells. The outer layers of the columella, the inner layer of the wall, and the threads crossing the air space are all green, from the presence of chlorophyll granules in them. Internal to the outer green cells of the columella is a specialized layer which will vary in appearance according to the stage of development of the specimen examined. This is the *archesporium*, or layer from which the spores are developed. In an early stage it appears in section as a single row of large, square, dark, and granular-looking cells with large round nuclei. At a later stage the cells will be found in a condition of active multiplication, dividing into two and four by walls at right angles to each other. The new cells thus formed are termed the *spore mother-cells;* they subsequently become free within the capsule, lying in a semi-fluid material formed by the degeneration of surrounding cells and their cell walls. In this position they divide again, and the resulting cells assume a spherical shape, develop an outer covering of two layers (endospore and exospore), and ripen into spores. As they ripen the other contents of the capsule dry up and disappear; a drop of water on the ripe capsule causes the cells of the annulus to swell, the operculum is thrown off, the peristome teeth rise up, and separating from one another give the spores free exit to the air. Spores falling on favourable spots commence to germinate, and we thus return to the stage in the life history with which we started.

The result, then, of our study of the moss plant may be summarized somewhat as follows:—(1) The general structure and life history of a moss is similar to that of a leafy Hepatic like *Jungermannia:* but (2) there is far greater specialization in detail than in any members of the latter group, both in the oöphyte and sporophyte generations. In the sporophyte the chief differences are: (*a*) that only part of the cells of the capsule—a special layer or archesporium—develop into spores; (*b*) that no elaters are formed; (*c*) that the sporophyte grows up, protected by the calyptra, before the development of the capsule; (*d*) that the capsule wall does not split into four segments, but remains entire, the spores escaping by a terminal opening which is closed in early stages by a lid, and subsequently by a special structure, the peristome.

From a physiological point of view the stomata and chlorophyll grains of the moss sporophyte are of no less importance. Knowing, as we do, that these structures are constantly associated with active and *independent* plant life—its respiration, nutrition, and metabolism—it is evident that the sporophyte of the moss has advanced much further than that of the Liverwort towards establishing its claim to be a separate plant. We have no evident link connecting the Liverworts and the mosses. The little mountain moss, *Andrœa*, is peculiar in possessing a capsule which bursts into four segments. Unlike the *Jungermannia*, the segments remain joined at the apex, and the general structure and habit of the plant are those of a moss. Again, in the curious minute mosses such as *Ephemerum* the protonema persists throughout the life of the plant—an apparently archaic character.

The strange *Buxbaumia*, with its rudimentary leaves and partly persistent protonema, its reproductive organs rising (as Prof. Goebel has shown) almost direct from the protonema, suggests at first sight a very primitive type of moss. Yet its capsule is large and specialized in structure, and may be a degeneration from some higher form rather than a representative of an ancestral stage. It is, in fact, impossible to say what is the lowest and simplest type of moss; and it is safer to regard the Liverworts and mosses, with their several aberrant relatives, as separate modifications descended from some type we have lost.



A.—The Spore. B.—Commencement of germination of the Spore. C.—Later stage; the Spore is throwing out a green protonemal Filament on the left, and a colourless Rhizoid on the right. D.—Protonema of *Mnium*, with a lateral Bud which will grow into a Moss Plant. (Magnified.) E. and F.—Male and female Plants of *Mnium hornum*, var. (Natural size.) G.—Section through the male "Flower." (Enlarged.) H.—Antheridia and Paraphyses of *Mnium affine*. The Antheridium on the left is empty; that on the right is discharging its contents, Spermatozoids in their Capsules, embedded in mucilaginous material. I.—Spermatozoid enclosed in Capsule. K.—Free Spermatozoid. L.—Archegonia and Paraphyses of *Mnium affine*. The Archegonium on the left is not yet fertilized; that on the right has been fertilized, and the Oöspore has begun to divide to form the young Sporophyte. M.—Plant of *Mnium affine*, var., showing young Sporophyte. N.—The same at a later stage, showing the Calyptra carried up. O.—The same, showing developed Capsule shedding the Calyptra. P.—The same at the ripe stage dropping the Operculum. Q.—Diagrammatic section through the apex of the stem and the base of the Sporophyte, showing the latter embedded in the parent tissue, and the withering Archegonia and Paraphyses round its base. R.—Diagrammatic longitudinal section of the Capsule, showing the Columella (*c*); the Archesporium (*ar*); the Air Space (*a-s*); the Annulus (*a*); the Peristome (*p*); and the Operculum (*o*). S.—The Peristome seen from above, with the sixteen outer teeth turned back. The mouth of the Capsule is still closed by the inner Peristome, consisting of an outer or basal membrane, sixteen pairs of teeth opposite the outer ones, and sixteen pairs of cilia alternating with them. T.—Teeth and cilia of the inner Peristome. U.—One of the outer Peristome teeth.

NOTES ON COMETS AND METEORS.

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

Encke's Comet.—This comet will be comparatively near the earth, but quite invisible to observers in this country. Early in July moonlight will prevent observation, and at the middle of the month the comet will have reached a southern declination of nearly fifty degrees.

Wolf's Comet.—The brightness of this object is slowly increasing. It is situated in Taurus, and moving eastwards at the rate of about forty minutes of arc per day. In the *Observatory* for May, Mr. Crommelin points out that the comet will be only twenty-seven minutes of arc distant from Mars on July 18th.

Tempel's Comet (*1867, II.*).—Gautier computes that the perihelion passage will occur on October 4th, but the prospect of redetecting the comet is a slender one, on account of its great distance. It has not been observed since 1879, and the comet's orbit appears to have suffered considerable disturbance in the interim, from the action of Jupiter.

Perrine's Comet (*March 19th*).—Rapidly increasing distance from the earth will probably soon render this object a difficult one. In regard to its position, it is, however, favourably placed for telescopic observation, as it is traversing the northern borders of Auriga, and remains visible during the whole night. Mr. Perrine, from observations at the Lick Observatory, Mount Hamilton, on March 19th, April 8th and 28th, has computed elliptical elements for this comet. He finds the period three hundred and five years, and points out that there are some suggestive orbital resemblances between the comet and those of 1684 and 1785, I. His conclusion is that these several bodies probably belong to the same family, but do not represent an identical object.

The following are ephemerides :—

Comet Wolf.

Date. 1898.	R.A. h.	m.	s.	Declination. °	′	Distance in millions of miles.
July 9	3	23	22	+20	4·6	183
,, 13	3	35	7	+19	54·9	181
,, 17	3	46	41	+19	40·9	179
,, 21	3	58	15	+19	22·7	177
,, 25	4	9	35	+19	0·2	175
,, 29	4	20	45	+18	33·4	173

Comet Tempel (1867, II.).

July 9	12	20	57	+ 5	43·1	206
,, 13	12	26	25	+ 4	46·4	209
,, 17	12	32	4	+ 3	48·9	212
,, 21	12	37	55	+ 2	50·9	215
,, 25	12	43	57	+ 1	52·3	218
,, 29	12	50	10	+ 0	23·6	221

Comet Perrine (March 19th).

July 3	4	59	25	+54	49·4	250
,, 7	5	9	10	+54	31·1	253
,, 11	5	18	19	+54	12·6	256
,, 15	5	26	47	+53	54·2	259
,, 19	5	31	29	+53	35 8	262

Cometary Discovery.—It is a little remarkable that during the last eighteen months only two new comets have been discovered. Several periodical comets have been redetected, but these objects being well-assured members of the solar system their orbits and positions were known, and re-observations of this character, though important in their way, cannot be considered in the light of new discoveries. The apparent rarity in the recent visits of unknown comets is probably to be attributed, not altogether to a real scarcity of these bodies, but to the fact that they have not been thoroughly searched for by a sufficient number of observers. There is no doubt that many small comets come to perihelion and pass beyond the limits of visibility without being detected. This is evident from the fact that some of these bodies have only been first discerned long after perihelion, and when near the vanishing point, owing to their great distance from the earth. The best period for effecting cometary discoveries is in July and August, and it is to be hoped that more observers will apply themselves to this work, so that comparatively few of these interesting objects may be permitted to elude suitable record.

April Meteors.—Mr. E. R. Blakeley, at Dewsbury, observed four Lyrids on the night of April 19th, and the paths indicated a radiant at 268° + 36°, which is nearly identical with his position for the same shower on 1895, April 19th, viz., at 269° + 37° (nine meteors). These positions for April 19th, when compared with Mr. W. E. Besley's, obtained on 1898, April 21st 22nd, at 273 + 33 , strengthen the idea of a shifting radiant, in accordance with similar observations at Bristol in 1885 and 1887.

The comparison of various lists of paths by Prof. A. S. Herschel at Slough, Mr. Besley of Westminster, Mr. A. King at Leicester, and myself at Bristol, has proved that nine meteors, recorded during the April period, were observed at two stations; and I have computed their real paths as follow :—

Date. 1898.	G.M.T. h.	m.	Height at first. Miles.	Height at end. Miles.	Path. Miles.	Velocity per sec. Miles.	Radiant. °	°	Observers.
April 16	9	46	72	55	52	..	212 −	11	A. S. H. A. K.
April 16	10	48	60	48	91	24	189 −	31	A. S. H. A. K.
April 17	9	40	85	71	81	41	261 +	14	A. S. H A. K.
April 17	9	55	57	55	24	20	236 −	13	A. S. H. A K.
April 17	10	28	72	70	34	23	176 −	35	A. S. H. W. F. D.
April 17	11	12	67	44	24	23	194 +	40	A K. W. F. D.
April 17	11	28	65	61	25	36	291 +	13	A. S. H. W. F. D.
April 18	11	55	65	58	19	32	274 +	11	A. S. H. W. F. D.
April 22	10	30	72	52	26	...	252 +	49	A. S. H. W. F. D.

The average heights were 68·3 miles at first appearance, and 57·1 at disappearance. These extremes are less than that usually found, but the difference is readily explained by the low altitudes of the majority of the radiants, and the nearly level flights of the meteors directed from them.

July Perseids.—The well-known shower of Perseids commences at about the middle of July, but the exact date has not yet been ascertained. Its radiant point on 1887, July 19th, was definitely observed at 19° + 51°, and this represents the earliest position hitherto determined. There will be little moonlight to interfere with observation this year between July 12th and 30th. The radiant moves to the east-north-east, and its position on successive nights in July, as determined from observations at Bristol during the last thirty years, is as follows :—

		° °			°
July 19	...	19 + 51	July 26	.	29 + 53
,, 20	...	20 + 51	,, 27	...	30 + 54
,, 21		22 + 52	,, 28	. .	31 + 54
,, 22	. .	23 + 52	,, 29	...	32 + 54
,, 23		25 + 52	,, 30		33 + 55
,, 24	...	26 + 53	,, 31	. .	34 + 55
,, 25	..	27 + 53			

It is to be hoped that clear weather will enable the ensuing shower to be fully recorded during its earlier stages, and allow the radiant point to be accurately fixed on several different nights of observation. Meteors are always plentiful during the second half of July, for, in addition to the Perseids, there are meteors from Aquarius, which often become strikingly numerous towards the close of the month.

◆

THE FACE OF THE SKY FOR JULY.

By A. Fowler, F.R.A.S.

Although there now seems to be a decline in sun-spot activity, small spots may frequently be detected, and occasionally one may be seen which will repay minute examination. Even in the absence of spots, faculæ are often well worth careful observation. On the **18th** there will be an annular eclipse of the Sun, which, however, will not be visible in this country.

Mercury will be an evening star, but as it does not reach its greatest easterly elongation until August **9th**, it will not be well seen until the latter part of the month. The planet will be in conjunction with the Moon, 4° 16′ to the north, on the **20th**, at 7h. P.M., the Moon being then two days old; this circumstance may assist the observer in identifying the planet. On the **27th**, at 10h. A.M., the planet will be in conjunction with Regulus, and will be close enough to appear in the same telescopic field of view. The movement during the month is from Gemini, through Cancer, to a little east of Regulus in Leo.

Venus is an evening star throughout the month, the easterly elongation and brightness both increasing. She is now a very conspicuous object in the western sky after sunset, and in the telescope presents a phase like the Moon a few days from full, three-fourths of the disc being illuminated. She will be in conjunction with the Moon, 5° 55′ to the north, on the **22nd**, at 11h. A.M., the Moon being a little more than three and a half days old. The apparent diameter of the planet increases from 13·0″ to 15·6″ during the month. On the **10th** she sets at 9h. 57m. P.M., and on the **30th** at 9h. 15m. P.M.

Mars, during the greater part of the month, does not rise until after midnight, and will be of no interest to amateurs.

Jupiter, in Virgo, continues to be well situated for observation in the early evening. During the month his apparent polar diameter diminishes from 33·2″ to 30·8″. On the **20th** he sets at 10h. 24m. P.M.

Saturn, in spite of its low declination, is a fairly conspicuous object in Scorpio. The northern surface of the ring is visible, the apparent major axis of the outer ring on the **19th** being 41·25″, and the minor axis 17·89″. The apparent polar diameter of the planet itself diminishes from 16·8″ to 16·2″ during the month.

Uranus, with its southerly declination of about 20°, is not well placed for observation in these latitudes. It is a little east of λ Libræ. The apparent diameter of the planet is 3·8″.

Neptune, in Taurus, cannot be observed.

The Moon will be full on the **3rd** at 9h. 12m. P.M.; enters her last quarter at 4h. 43m. P.M. on the **10th**; is new at 7h. 47m. P.M. on the **18th**; and enters her first quarter at 1h. 40m. P.M. on the **26th**. She will be partially eclipsed on July **3rd**, and the phenomena will be partly visible at Greenwich. The first contact with the shadow will take place at 7h. 46m. P.M., fifty-eight minutes after contact with the penumbra, and the last contact with the shadow at 10h. 49m. P.M., finally passing clear of the penumbra at 11h. 47m. P.M. The eclipse will be almost total, its magnitude (Moon's diameter = 1) being 0·934. The Moon will rise, partially eclipsed, at Greenwich at 8h. 18m. P.M. The first contact with the shadow takes place at 49° to the east of north, and the last at 70° from north towards west.

λ Sagittarii, magnitude 3, will be occulted on July **30th**, the disappearance occurring at 7h. 31m. P.M., 98° from the vertex, and the reappearance at 8h. 41m. P.M., 283° from the vertex, reckoning eastwards.

◆

Chess Column.

By C. D. Locock, B.A.

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

Solutions of June Problems.

No. 1.

(By A. C. Challenger.)

1. R to Bsq, and mates next move.

No. 2.

(By J. T. Blakemore.)

Key-move.—1. R to Kt7.

If 1. . . . K to K4, 2. B to B3ch, etc.
1. . . . K to B4, 2. R × Pch.
1. . . . B to B2, 2. B × Bch, etc.
1. . . . Kt to B2, 2. Q × Bch, etc.

Correct Solutions of both problems received from Alpha, W. de P. Crousaz, H. le Jeune.

Of No. 1 only from W. F. Denning, J. M'Robert, H. S. Brandreth, W. Clugston, Capt. Forde.

[Evidently a difficult pair, judging from remarks and results.]

G. G. Beazley.—1. Q × Kt is met by R to Q7.

G. A. Forde.—In No. 2, if 1. R to KR7, K to K4; 2. B to B3ch, K to B5, and there is no mate.

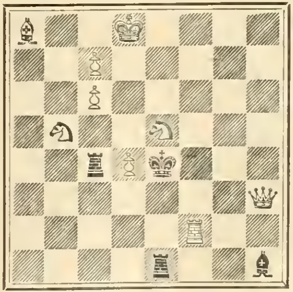
W. F. Denning.—Kt to B3 is probably answered by 1. . . . . B to B2.

PROBLEMS.

No. 1.

By A. G. Fellows.

Black (4).



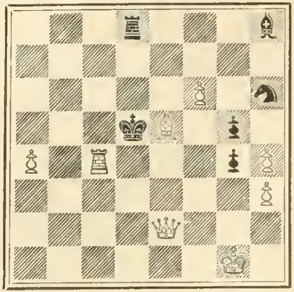
White (9).

White mates in two moves.

No. 2.

By A. C. Challenger.

BLACK (6).



WHITE (8).

White mates in three moves.

◆

CHESS INTELLIGENCE.

The Vienna tournament is now in full progress. The most remarkable feature at present is the conspicuous success of M. Alapin. At the conclusion of the tournament, a match between two old opponents, Messrs. Showalter and Max Judd, is probable. The latter was formerly a resident in the United States, but now lives at Vienna.

The Vienna Club have won one of their two correspondence games with St. Petersburg, an Evans Gambit, in which the brilliancy was on the side of the defence. The other is adjourned till after the Vienna tournament.

The Sussex championship has been won by Mr. Shoosmith, of Brighton, who did not lose a game in the contest. Mr. Reed, a former champion, was second.

Game played in the Vienna tournament :—

" Caro-Kann Defence."

WHITE. (H. N. Pillsbury.)	BLACK. (H. Caro.)
1. P to K4	1. P to QB3
2. P to Q4	2. P to Q4
3. Kt to QB3	3. P × P
4. Kt × P	4. Kt to B3
5. Kt × Ktch	5. KP × Kt
6. Kt to B3	6. B to Q3
7. B to Q3	7. B to Kt5
8. P to KR3	8. B to R4
9. P to KKt4 (*a*)	9. B to Kt3
10. Kt to R4	10. Kt to Q2
11. Kt to B5	11. B × Kt
12. B × B	12. P to KKt3
13. Q to K2ch	13. Q to K2
14. B × Ktch (*b*)	14. K × B
15. B to K3	15. QR to Ksq (*c*)
16. P to Q5 !	16. P to QB4 (*d*)
17. Q to Kt5ch	17. K to Bsq
18. Castles QR	18. Q to B2
19. R to Q3	19. R to K5
20. R to B3	20. P to QR3 (*e*)
21. Q to Q3	21. KR to Ksq
22. B × P !	22. K to Q2 (*f*)
23. B to K	23. Q to R4
24. P to R3	24. P to QKt4 (*g*)
25. R to B6	25. B to B5
26. K to Ktsq	26. B × B
27. P × B	27. R × KP (*h*)
28. Q to Q4	28. R to K8ch
29. K to R2 !	29. R × R
30. Q to R7ch	10. Resigns (*i*)

NOTES.

(*a*) A bold course, but no harm seems to come of it.

(*b*) In order to avoid the exchange of Queens, but the game should be drawn now.

(*c*) Q to K3 or K to B2 are alternatives. The move made weakens the Queen's side, a fact which Mr. Pillsbury is not slow to perceive.

(*d*) Q to K5 has some points. The move chosen gives White a passed Pawn, and something else.

(*e*) There is no apparent objection to 20. R to QKt5 ; 21. Q × R, P × Q ; 22. R × Qch, K × R.

(*f*) If 22. . . . B × B ; 23. P to Q6, Q to B3 ; 24. R × B, etc.

(*g*) A desperate attempt to get some attack : but his opponent sees a little further than expected.

(*h*) This is fatal, but having regard to the dominant position of the White Rook, there is really nothing to be done.

(*i*) Mate following in two more moves.

KNOWLEDGE, PUBLISHED MONTHLY.

Contents of No. 151 (May).

PLATE.—Nebulæ near γ Cassiopeiæ.

Contents of No. 152 (June).

PLATE.—Eclipse Spectra.

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CONTENTS.

THE PETROLEUM INDUSTRY.—III.

By George T. Holloway, assoc. r.c.s. (lond.), f.i.c.

It was not until 1859 that the use of petroleum for illuminating purposes commenced to be general, although lamps for burning the very similar coal oil and shale oil had been introduced some six or seven years previously by Stobwasser, of Berlin, and by Young's Paraffin Light and Mineral Oil Company of this country. Prior to the introduction of these oils, only animal and vegetable oils (excepting oil of turpentine, which was employed to some extent under the trade name "camphine") had been used; they possessed many of the qualities of tallow, and were capable of being burned with a small wick and with free exposure to the air. The petroleum oils, however, are of an entirely different nature, containing much more carbon and hydrogen than do the animal and vegetable oils, and are far more volatile and inflammable; they must be supplied in a regulated quantity to the flame, and with a proper amount of air, or a smoky and objectionable flame results.

The enormous number of lamps which are now in use, and the necessity for fixing an arbitrary limit for the volatility and inflammability of the oil which may be used in them, and the conditions under which the oil may be stored, conveyed, and sold, has given rise to much legislation in this and other countries. The differences in the laws of various countries on this subject show how difficult it is to decide on the standard which shall be at the same time safe for the consumer and fair to those who produce and supply the illuminant. As this matter is still under consideration by a committee of the House of Commons, it is not the intention of the writer to express an opinion on the subject; but it may be of interest to trace some of the more important steps in the evolution of the mineral oil lamp which have led to its present efficiency. It may, however, be taken as an axiom that no oil is safe in a badly constructed lamp, or when used by the careless.

The first important improvement which fitted lamps for use with mineral oils was the introduction, by Argand, of the chimney, by which the requisite draught of air was caused to impinge on the flame, and thus produce a greater efficiency as regards illuminating power and an absence of smoke. This was followed by the invention of Roberts, whose lamp, specially constructed for burning camphine, was fitted with a disc known as the "Liverpool button," which was fixed some distance above the circular wick, so as to deflect the air current downward upon the top of the flame. Next came the dome which fits over and round the wick, and has a slit through which the flame passes; this appliance, which is now fitted to practically all oil lamps, still further directs the air between the dome and the wick so that it is applied at the point of maximum efficiency. In the Wanzer, and certain other lamps, air is blown by clockwork or other device upon the flame. Finally, we have those lamps in which two or more wicks are employed, as flames thus impinging one upon the other give a greater light than when burned separately.

The principal danger with oil lamps lies in a badly fitting wick—which is liable to be dropped, while still alight, into the reservoir—and in the use of breakable vessels. Metallic reservoirs are now largely employed, and various safety appliances are attached to the best forms of modern lamps: for example, a flap or other appliance may close over the flame and extinguish it when the lamp is overturned or unduly tilted; and the cage of wire gauze, suggested by Mr. Boverton Redwood, in which the wick is enclosed so that no flame can pass from the wick to the oil in the reservoir. While most accidents are not due to a true explosion, but to the simple ignition of the oil through the overturning or breaking of the lamp, explosions may occur from the production of an explosive mixture of the vapour of the oil with air in the reservoir; and the question which has been so much under discussion of late hinges on whether this can be prevented by raising the "flashing" point of oil, or whether it can best be dealt with by insisting on the use of such lamps only as are properly suited for burning the oil as at present sold.

Legislation in this and other countries is mainly based on what is known as the "flashing" point, which means the temperature at which the oil gives off an inflammable vapour. This is, of course, lower than is shown by the fire test, *i.e.*, the temperature at which the oil itself will take fire.

The Acts of 1862 and 1868 in the United Kingdom included under the term "petroleum" such oil as gave off an inflammable vapour at less than one hundred degrees Fahrenheit by what is known as the open test—that is, when warmed in a vessel exposed to the air; but as this test was found to give varying results in different hands, it was replaced in the Act of 1879 by the closed cup, or Abel tester, in which the oil is warmed in a closed vessel, and is only exposed to the air at the moment that the testing flame is applied. A series of tests made by Mr. Boverton Redwood on a thousand samples of American kerosene having proved that the Abel tester showed a flashing point about twenty-seven degrees *lower* than the open tester indicated, a "flash point" of seventy-three degrees Fahrenheit was decided upon, so that the actual flash point now recognized may be considered as identical with that originally decided upon over thirty years ago.

The Abel tester has been found so efficient and regular in the results it has yielded in the hands of different operators, that it has been legalized in many other countries, either in its original form or with some slight modifications. It is shown in Figs. 1 to 3, and consists of the metal cup, Figs. 1 and 2, into which the oil to be tested is poured up to a fixed point; an outer metal cup serving as a water bath, and an enclosing metal cylinder forming an air jacket. A lamp swivelled on one leg of the apparatus is also fitted to the tester (Fig. 3), and thermometers indicate the temperature of both the oil and the water.

The oil cup has three square holes in its cover which are normally closed by a sliding plate having three corresponding openings. The slide is shown closed in Fig. 1 and open in Fig 2. It carries a pin, which, when the slide is opened, catches a small metal lamp swinging on pivots and tilts its nozzle downwards over the surface of the oil through one of the three openings, as shown in Fig. 2. This test lamp consists of a box with a hinged lid and a tubular nozzle, through which passes a tiny wick from the body of the lamp, which is charged with cotton wool saturated with oil. The wick is trimmed to give a flame exactly the size of the small bead shown at the end of a pin on the oil cup. All parts of the apparatus are made to a standard size, and are tested by the Weights and Measures Department of the Board of Trade before they may be used officially.

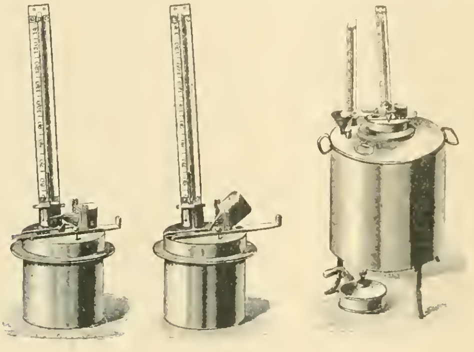
Fig. 1. Fig. 2. Fig. 3.

The Abel Tester for the "Flash Point."

In using the apparatus, the water bath is first charged with warm water through the funnel shown, and the temperature brought to one hundred and thirty degrees Fahrenheit by the addition of hot or cold water or by use of the lamp beneath the apparatus. The oil cup is then charged with the oil to be tested, the little test lamp lighted, the lid of the oil cup closed, and its thermometer watched. A pendulum, twenty-four inches long, is then set swinging, and when the temperature of the oil has reached about sixty degrees Fahrenheit, the test is commenced. For each degree of rise in temperature the slide is drawn open slowly by hand while the pendulum makes three oscillations, and is closed during the fourth oscillation. When the flashing point is reached, a slight blue flame is seen to pass over the surface of the oil, and if this occurs at a temperature not lower than seventy-three degrees Fahrenheit, the oil is said to have passed the test.

In the application of this test everything depends on adherence to the specified conditions. Tables for variations in the atmospheric pressure must be used.

So many testers are or have been in use that it would be impossible even to give their names here, and the Abel tester has been selected as the one most generally employed.

For many technical and commercial purposes other tests have to be applied. Thus the analyst must sometimes employ chemical tests to ascertain freedom from sulphur compounds, etc.; distillation tests to ascertain the amount of the oil which volatilizes between certain temperatures; colour tests, in which, by means of Lovibond's tintometer, or Wilson's or Stammer's chromometer, the colour according to the commercial standards between "water white" and "good merchantable" is determined; viscosity tests, in which the value of the oil as a lubricant is ascertained; photometric tests to determine the illuminating power of the oil; and, finally, the odour test, by which an experienced operator can tell whether the oil has been properly refined and kept.

AN OLD-WORLD HIGHLAND.

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

THERE is a corner of wilder Connaught, on the very border of Galway and of Mayo, where the features of the west of Ireland seem grouped together and epitomised. In a brief season of summer it is known to tourists as Leenane; but, in the more transparent and sunnier days of spring or autumn, the lover of quiet will find it a haven of content. Before the hospitable doorway, the sea stretches in gentle ripplings, at the head of a fjord which runs down west to open water. There is little suggestion here, whether the day be dark or clear, of the great surge that beats ever on the islands, on Inishbofin and lofty Inishturk, ten miles away in the Atlantic. Northward lies the mountain-land of Mayo, a district as large as Sutherland, over-populous on its seaboard, yet wild and desolate within. Southward lies the still finer highland of Galway, a land of peaks, and terraced moorlands, and abundant lakes, into which even the broad Lough Corrib sends up romantic tongues of water. Except for one encircling road, these fastnesses east of the Twelve Bens, the barren valley of Bealanabrack, or the deep grey hollow of Lough Nafooey, are as little known to most of us as Corsica.

The remark has some appropriateness, for in these grim surroundings, without communications, girt about by the precipiced cirques of Formnamore, a race has grown up to whom the law of *vendetta* has seemed nearer and far simpler than the complex legality of the east. Cast down by years of failure, weakened by the emigration of the strong, driven by topographical details to repeated intermarriage, this population has presented the problem of an island cut off within an island. Nowadays the railways have crept nearer to the mountains; public bodies have employed both men and women in turning the unfenced tracks into some of the finest roadways in our islands;

and, when we are chatting at tea-time in the farms, or exchanging a greeting with some old peasant on the way, it is hard to recall or to realise the bitter stories of the glens. When, however, we turn off the mail-car routes, we perceive, even now, the isolation of this old-world highland. The vivid colouring of the costumes of the peasantry in itself shows lack of intercourse; English is but little spoken: and the women work out of doors, not only with the men, but for the men, as in the primitive countries of this world. But such scenes, and the strangeness of them, have high attractions for those who view them from without. Here, on a corner of the pass, comes a woman, her basket on her arm, riding over to one of the villages on Lough Mask. With her white cap, her deep red skirt, her shawl of brilliant hues, in which scarlet and crimson predominate, she forms a vision of colour against the moorland, such as one scarcely looks for short of the Hungarian east. Down below, a sober distance in advance, we see her master, also riding, and gathering the week's news by calling to his friends, it may be a field or two away. Behind us, a grey rain-drift creeps up across the Joyces' country; on the left, the huge wall of Maamtrasna rises so sheer that it seems in the gloom to overhang; while, in front and below, the great lake stretches, white, like a sea, into the plain.

Behind these obvious features lies a long geological history; and it is the history of the whole north-west of Ireland. The rocks that are now laid bare belong mainly to the old "Caledonian" chains; that is to say, they were upheaved and folded at the close of Silurian times. Here and there, we have proofs that they sank in part beneath the Carboniferous sea, and were again upraised during the great "Hercynian" movements. One or two patches of Carboniferous sandstone and conglomerate remain as outliers on the heights around Maamtrasna, that on Ben Wee now lying at an elevation of more than two thousand feet.* The mountains that were lost for a time beneath the waves have reasserted themselves, and have thrown off the covering of Carboniferous deposits; and we find exposed at their bases the still older surface on which their own materials were laid down.†

The prominent stratified rocks on either side of the fjord of Killary Harbour are the Ordovician conglomerates. These can be studied in almost every fallen block along the shore for miles west of Leenane; on the gentler slopes of Ben Gorm across the water; and, to name no other region, in massive exposures, worn by glaciation, on the steep descent to Lough Nafooey. Few rocks are more handsome in themselves; few tell better the tale of long waste and denudation, as the oldest Irish land gave way before the breakers of an Ordovician sea. The great

Fig. 1.—View up the head of the fjord of Killary Harbour, showing its continuity with the valley of the Erriff River. The tide is running out. The terraced scarp of the Formnamore group bounds the valley on the right. (From a photograph by Mr. R. Welch.)

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* Memoir to Sheets 73, 74, 83, and 84, *Geological Survey of Ireland* (1876), p. 53. The later annual reports of the Survey include a considerable revision of the Killary district. See that for 1896, pp. 49 to 51 (published in 1897).

† These older rocks are part of the conveniently named *Dalradian* group of Sir A. Geikie.

pebbles often lie well separated in a dark green-grey matrix of coarse sand. Among them are granites, and quartzites, and compact flinty lavas—evidences of the long gap that divides them from the underlying igneous and metamorphic series. The beds below are more highly tilted, and everywhere the unconformity is a marked one. The ancient land, the floor of the country, at whatever period it first arose, was pierced by igneous masses, and was baked and altered; its shales became slates and schists, its limestones marbles; and the invading rocks had cooled down in the form of granite before the period of denudation occurred that formed the conglomerates of Killary Harbour. In this area, then, we have the old land of unknown age, perhaps even a remnant of the pre-Cambrian chains; it comes rapidly into view as we go south along the Joyces' River, and culminates in the quartzite ridges of the Maam Turk Mountains and the Twelve Bens. Then we have the grand scarps and cirques of Formnamore, and the impressive and close-set group of summits that form the Mweelrea range on the north side of the fjord; these represent the thick deposits on the Ordovician and Silurian shoreline, in a sea that lay open to the north.* Then came the widespread Caledonian movements. In Devonian times, our highland was thus already well established, looking down into lake-basins that lay many miles away on the north-east and the east; and then a second great subsidence brought it below the Carboniferous sea, and for a time saved it from denudation. We do not know when it made its next appearance; but probably the covering was worn away from its bolder summits soon after the uplift of the Hercynian chains.

The complex details have even yet to be worked out; but the district is clearly one of those that have remained highlands by the force, as it were, of pure tradition. Many parts of the west of Scotland, the English Lake District, the volcanic precipices and *arêtes* of Wales, have similarly proved their powers of resistance, and their tendency to reappear as knots through any covering forced upon them. In this they resemble Suess's favourite "horsts" of Central Europe; and it is easy to predict that they will remain as the bare skeleton of Britain, long after the films of the London Clay, the Chalk, or the soft Triassic sandstones, have been washed away into the North Sea and the Channel.

The vitality of Ireland similarly lies in the great ribs of the west, holding their own against the Atlantic and its warm soft air. Even if the oscillations of the continental edge again submerge her, Connaught will still exist, a core of mountains, in the depths.

At present, the stratification of the series of rocks out of which the hills have been carved is still well marked around us. The north scarp of the Formnamore group is seen in Fig. 1, where the terraces of Ordovician and Silurian strata form a feature of the steep hillside. In Tonalee, again, above the Maam valley, the unconformity between the old "Dalradian" series and the overlying Ordovician conglomerates is traceable even at a distance.

North of Killary Harbour, a road traverses the Mweelrea Mountains by a low pass, and brings us into the most exquisite landscapes of the range. For two miles, along the west shore of Lough Doo, the purple crags of Glancullin, ledged with green, rise some two thousand five hundred feet above the water, and the steep southerly dip of the beds adds to the serration of the mountain-face. The scene is even finer if we turn up the valley to the east, and view it from the moorland level, with Doo Lough answering to its name, and lying black below us.

Still further to the east, the Dalradian floor is met with in the lonely bogland through which Lough Tawnyard extends. Here the fine cirques and mountain-crests are still formed of the upper stratified series, the masses of which rise in great outliers upon the worn-down edges of the older rocks.

We have already hinted at the prominence of the floor itself, the "pre-Caledonian" ridges, in the fine region of the Twelve Bens of Connemara. If we follow the fjord of Killary down to its mouth, we can look across thirty miles of blue but restless water, until the eye is caught by the huge cone on Achill Island; this is cut in half on its west side, where its cliffs drop more than two thousand feet into the sea. Here, again, the older series still asserts itself, bared from any covering of Silurian or Carboniferous deposits.

As we return eastward up the inlet to Leenane, the strange aspect of the fjord itself is impressed upon us, and our thoughts are transferred to the most recent of geological epochs. The deep groove-like nature of the hollow that is occupied by the sea is well seen as we climb the moors upon the south; and thence we look down into the water, where the fresh tide has covered all the sandbanks, and has pressed back the flow of the river with a curving line of foam. This groove is ten miles long, and is rarely more than half a mile in width. At its head (Fig. 1) it passes continuously up into the valley of the Erriff, which is bounded by the same steep green or cliff-set walls.

At the hamlet of Aasleagh, where we reach the actual river, there is a pleasing little waterfall over a step in the valley-floor; and below it there is a second tumbled fall, where the seaweeds and the wild-flowers meet, and where the former clothe all the rocks out in the stream. Here we see the excavation of the valley still going on.

But this is only a feature of low water. At high tide the sea reaches the bridge of Aasleagh, and the clump of fir trees looks down upon ephemeral waves. All evidence of the activity of the river on its rocky bed has disappeared.

There is at this point an obvious connexion between the valley and the marine inlet. As the river, in the interspaces of low water, erodes its bed, the sea can spread further, though imperceptibly, inland at each successive tide. Will not this cutting back of the head of the fjord, year by year, account for the long intrusion of the sea upon the land?

In this case, however, and still more strikingly in that of other fjords on our coasts, examination of the Admiralty charts will show that stream-erosion alone is not sufficient. Killary Harbour happens to deepen fairly uniformly from Aasleagh to the open water; but its depth at its mouth is twenty-two fathoms, while off Mweelrea and Salruck it is still ten fathoms. The cutting action of the river cannot be responsible for excavating a groove of this depth, a great part of which lies below the level of low water.

But if the land were uplifted, the bottom of the inlet would become a portion of the ordinary valley-floor. The river would reach the sea between Inishbofin and Inishturk, and would be able, above this point, to deepen its valley until a level slightly below low water was attained. The history of Killary Harbour is no doubt embodied in the reverse of this suggested process. The land at no distant time stood distinctly higher above the sea, and the Erriff River, from Aasleagh down, had a fairly rapid fall. The great groove, in fact, severing Mweelrea from Benchoona, is an ordinary river-valley, cut by a stream that started in pre-glacial times. The floor of this valley gradually approached the sea-level, the level of no ex-

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* See Sir A. Geikie, *Ann. Rep. Geol. Survey for 1896*, p. 51.

cavating action; and at last, in the ordinary course, the sea would have crept up a little at the valley-mouth. But then came the subsidence that has affected our islands so profoundly, accompanied, doubtless, by considerable warping of the old continental floor. Levels were everywhere disturbed, and disturbed irregularly; but the main result on the west coast of Europe, from the "rias" of Spain[*] to the peaked isles of northern Norway, was the admission of the sea into the intricacies of the denuded land. The lower ten miles of the Erriff valley became converted into Killary Harbour, while the deep clefts in the braes of Bergen admitted the Atlantic for more than a hundred miles.

It has often, however, been pointed out that, for the production of a true fjord, with its sides free from débris and going down like cliffs into the water, another agent must be introduced. There was a time when fjords were believed to have been excavated, to great depths below sea-level, by the eroding power of glacier-ice. The physical difficulties opposed to this view proved to be considerable; and dwellers in countries where glaciers are still common have long set their faces against it. But the presence of a glacier in any valley prevents it from becoming choked by detritus from the mountain-walls. The excavating action, which was begun before the ice spread down all the hollows of the country, may still be carried on by the subglacial streams; while the ice all the time moulds the valley-walls as it moves forward, and converts each projection in the floor into a characteristic *roche moutonnée*. Hence, when subsidence occurs, the sea may for some time be banked out of the valley by the presence of the ice. As the glacier shrinks, the sea follows it up the well-preserved groove, in which the only deposits are those of the spreading terminal moraine. For a long period the fjord may thus retain its most typical form; but at length a delta may spread down from its head, sandbanks may be swept in by the sea, and ordinary taluses may descend upon it and mar the smoothness of its walls.

Killary Harbour has reached this later stage; but there is no doubt as to the original prevalence of glacial conditions in the district. The whole lower ground of Letterfrack, Tullycross, and Salruck, is ice-worn and mammillated, and the peat forms as yet only a thin covering across the *roches moutonnées*. The larger of these stand out bare and uncorroded; and the striæ on their surfaces, whether the rock is slate or quartzite or conglomerate, are still marvellously fresh. Probably, as the glaciers withdrew, banks of mud and gravel, washed out from the terminal moraines, covered this lowland in the place of confluent ice; and the coating that was thus formed helped to preserve the bed-rock from denudation. But here, as elsewhere in our islands, we are led to regard the retreat of the glaciers as a very recent matter. The abundant cirques in the high levels of the mountains, though not so bare and stern as those of Snowdon, still preserve their outlines, much as when the last ice melted from their floors. One of the latest phases of this old-world highland may have been the most magnificent from a scenic point of view, when the contrasts of crag and snow in Connaught rivalled the glories of Norway or Alaska.

Even now, are these western mountains of necessity doomed to obliteration? Though the breaches of Mweelrea lie open to the Atlantic storms, and though the grass creeps across the summits, helped by the soft summer rain, may we not read in the long and complex history a tale of regeneration, of vitality rather than decay?

SELF-IRRIGATION IN PLANTS.—II.

By the Rev. Alex. S. Wilson, M.A., B.Sc.

THE arrangements possessed by plants for collecting and conveying rain to their roots, described in the previous article, derive their value from the circumstance that leaves have but little absorbent power. If greatly parched they will no doubt take up water, but the whole structure of an ordinary leaf is that of an organ highly adapted to the function of eliminating water. Not only are the superficial cells provided with a cuticle through which water can only penetrate very slowly, but moistening causes the stomata to close, cutting off access to the cells in the interior of the leaf.

Nevertheless, a limited amount of absorption by leaves does occur, and in exceptional cases groups of thin-walled leaf-cells exist which are specialized for this very end. It is principally in species growing under peculiarly adverse conditions, such as shore and desert plants, that marked absorption through leaves occurs. The experiments of Garreau show that the cuticle of many leaves is absolutely impervious to water. This is so especially in old and fully developed leaves. Young leaves, on the other hand, in which cuticularization has not gone far, absorb to a greater or less degree. Washing with soap and water removes wax and increases the absorbent power of leaves. Over the midrib and veins the cuticle is thinner than on other parts of the leaf, and water can penetrate more easily. By far the greater proportion of the absorption takes place, however, at the base of the petiole—in the axil of the leaf, in fact.

Some of the best established instances of imbibition by leaves occur among plants such as the fuller's teasel, which are provided with leaf-cups. The leaves of the teasel are arranged in pairs; the broadened base of each leaf unites with that of its opposite neighbour, encircling the stem and forming a receptacle in which a quantity of water collects. That this source supplements the supply furnished by the roots is shown by the fact that cut specimens retain their freshness as long as the leaf-cups are supplied. Leaf-cups of this description are seen in Silphium—one of the gentians—and in a number of other plants. Many epiphytic Bromelias, Tillandsias, and others of the pineapple family retain considerable quantities of water in their expanded leaf-bases, and of this a portion is absorbed by means of certain thin-walled cells.

These examples have an important bearing on the case of the chickweed, now to be considered. The rapidity with which this plant spreads over garden soil must be attributed in large measure to its very complete system of self-irrigation. The sheathing bases of each pair of leaves on the chickweed form a kind of leaf-cup where the rain collects. Particles of dust and earth are also washed down into the leaf-axils. Hairs on the margins of the petioles

Fig. 1.—Leaf-cups of Teasel.

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[*] See Knowledge, Vol. XX., p. 210. (September, 1897.)

help to retain the water, so that the quantity detained at the nodes is greater than one would expect; indeed, these little reservoirs, relatively to the size of the plant, have, perhaps, quite as large capacity as the leaf-cups of the teasel. The leaf-stalks are channelled, but instead of grooves the chickweed stem has a line of hairs placed on one side, which conducts the overflow from one leaf-cup down to the next, so that after a shower all the leaf-cups are replenished. These hairs on the stem are deflexed, easily wetted, and are evidently arranged to act as rain conductors.

Each hair consists of several cells which still retain their protoplasm. In a dry condition the walls of the basal cell present a striated appearance, and this has led Kerner to assign to the hairs an absorbent function. But this explanation is unsatisfactory. In the first place, precisely similar striations appear on the leaves and stem if the plant be somewhat dry. Again, the hairs have no direct connection with the vascular system, from which they are separated by a thick cellular cortex. Cut off from the internal circulation their power of transmission must be very limited, and whatever water they absorb is quite likely to be lost again on the air becoming dry. The evidence of special adaptation is, at least, not conclusive; moreover, a circumstance overlooked by Kerner seems to render such special adaptation superfluous. From many of the leaf-axils of chickweed one or two little rootlets emerge. Even where none are visible a transverse section of the stem reveals their presence beneath the epidermis. It is a very reasonable supposition that the arrangement of conducting hairs and leaf-cups in the chickweed, by which its nodes are kept moist, is designed to promote the formation of these lateral rootlets. Gardeners, at least, when they wish to induce the formation of roots, often adopt a similar expedient. In propagating certain plants recourse is had to *marcottage*, or the application of moist earth to the base of a branch to stimulate the development of roots. Sir Joseph Hooker, in his *Himalayan Journals*, states that the roots which descend from the boughs of the banyan tree are induced to sprout by wet clay and moss tied to the branches, underneath which a little pot of water is hung. So dense is the foliage that the ground beneath the branches gets very dry and hard, the descending roots are unable to penetrate it, and the natives assist matters by conducting the roots through bamboo tubes and by breaking up and moistening the soil at the points where they enter it. At first these roots are very slender, but they soon swell and tighten from the rooting part dragging down the aërial.

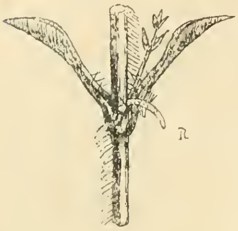

Fig. 2.—Irrigation of the Chickweed. R, Rootlet.

The water and particles of earth that accumulate in the leaf-cups of the chickweed not only conduce to the formation of roots—the conducting hairs serve to water them after they are developed. Each rootlet is most conveniently placed to catch the rain descending from the leaves; indeed, were it placed under a running tap the position of the rootlet could hardly be more favourable. On the whole, therefore, it seems much more probable that the use of the hairs is to conduct water to the roots, where it is absorbed, than that the hairs themselves are absorbent organs.

If we remove a quantity of chickweed from ground where it has been growing luxuriantly, we are often struck by the remarkable dryness and hardness of the earth. On reaching the soil its rootlets would, therefore, experience difficulty in penetrating were it not that there is an additional point of resemblance to the banyan. The water which drips frequently from the tips of the rootlets keeps the earth soft and moist just at those spots where the rootlets enter it. When they have established themselves they drag down the stem; each internode and each young shoot become practically independent; hence the rapidity with which this weed spreads.

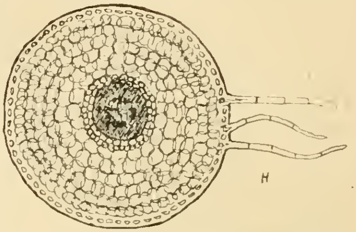

Fig. 3.—Transverse Section of Chickweed Stem. H, Hairs.

Another circumstance worthy of mention is the obvious relation between the conducting hairs and the axillary buds. Although the hairs are differently placed in successive internodes, they are always on the same side as the axillary bud below. The latter is consequently drenched from time to time by rain descending along the conducting hairs. As young leaves are to some extent capable of absorbing, the developing shoots must, therefore, participate along with the rootlets in the benefits of this system of automatic irrigation.

The special necessity for this curious arrangement in the chickweed may possibly arise from the small amount of lignified tissue possessed by the plant. Its rapid growth does not, indeed, admit of much lignification, which is a process requiring time. Not only is the vascular cylinder running up the centre of the stem of small dimensions, but the four lignified strands (dark coloured in the figure), through which the water rises from the roots, are very slender relatively to the thickness of the stem. We might almost compare the chickweed to a house where the pipe from the main is of narrow calibre, and an additional supply has to be obtained by collecting the rain from the roof into cisterns. As the tendency of cultivation is to render soil dry, this double water-supply is also advantageous, no doubt, in relation to the peculiar habitat of the plant.

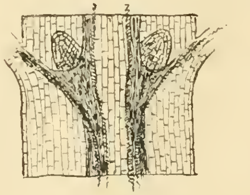

Fig. 4.—Vertical Section of Chickweed Stem, with two Rudimentary Rootlets. The Spiral Vessels show the course of the ascending Sap.

Aqueducts consisting of lines of hairs similar to those of the chickweed occur in a number of plants. The Germander speedwell has a line of hairs on both sides of its stem, and in allied species there may be three or more such lines corresponding in position exactly to the grooves by which rain is led down the stems of so many plants. Those speedwells which occur as garden weeds emit rootlets, and have the same creeping habit as the chickweed. Their delicate transparent rootlets are often exquisitely beautiful, being covered with microscopic fibrils so exceedingly sensitive that they contract at once if exposed to dry air.

The spiderwort, commonly grown as a hanging plant, has sheathing leaves capable of retaining water, and emits rootlets in the same way. There are a few hairs at each node, but they are not continued down the stem. The spiderwort has, however, a special provision against desiccation; the upper layer of the leaf consists of aqueous tissue, composed of clear prismatic cells filled with water. A piece of this plant may be carried about in one's pocket for more than a week without quite losing its freshness. Leaf-cups, however, occur chiefly on plants growing in places where there is little risk of desiccation; hence it is supposed by some that in aërial absorption the object is not so much water as to obtain a supply of nitrogen. Nor is it at all improbable that the rootlets of the chickweed take up nitrogenous compounds and other substances dissolved in the rain-water which accumulates in its leaf-cups. But this question must be reserved for future consideration.

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CELEBES: A PROBLEM IN DISTRIBUTION.

By R. Lydekker, B.A., F.R.S.

PROBABLY at least nine out of every ten of the readers of Knowledge who do me the honour to peruse the present article, would pronounce the name of the island mentioned in the heading with the second syllable short—Celĕbes; and if it were an English name they would be right in so doing. But the Malays have a habit of accenting the middle syllable of three-syllabled words, and we thus have Saráwak, Basílan, Celébes, etc. In this respect Malay names are the exact opposite of South American, in which the accent falls on the third syllable, as in Panamá, Bogotá, and Ecuadór. Doubtless it is a small matter, but it is well to be correct even in the pronunciation of names.

Having put matters right in this respect, the next point is to inform my readers why Celebes has been selected as the subject of an article at all; and why Borneo, Sumatra, or Java would not have done just as well. To render this point clear I must refer briefly to the geographical position of Celebes and the neighbouring islands. Borneo, Sumatra, and Java, as my readers are no doubt well aware, are the three largest of the Malayan islands lying nearest to the Malay Peninsula; and although they possess many peculiar animals—notably the orang, which is confined to Borneo and Sumatra—yet their fauna as a whole is very similar to that of the Malay mainland, and thus intimately connected with that of India. Accordingly, naturalists are pretty well agreed in including these islands in what is called the Oriental region of zoological distribution, of which the Philippine Islands likewise form a part.

Now, Celebes lies due east of Borneo, from which it is separated by the Macassar Strait, and also nearly midway between the Philippines on the north and the small islands of Lombok, Sumbawa, and Flores on the south; these three latter islands forming the continuation of the line of Sumatra and Java, which evidently indicate an old peninsula. Eastward of Celebes lie the Moluccas (or Spice Islands) on the north, and Ceram (which forms the lowest member of the same group) in the south; both these being nearly midway between Celebes and Papua, or New Guinea. And when we reach the latter country we are practically in Australia, the animals being quite unlike those of the typical Malayan islands and the other countries of the Oriental region; we have, for instance, in New Guinea, tree kangaroos, cuscuses, flying phalangers, bandicoots, echidnas or spiny anteaters, cassowaries, cockatoos, birds of paradise, and bower birds, all of which are essentially Australian types, although some, like the birds of paradise, attain their maximum development in New Guinea itself. The little island of Ceram has also a fauna of an Australian type, including, among other forms, a cassowary. Accordingly, all naturalists are agreed that Australia, New Guinea, Ceram, and the other Moluccas, together with the Aru and some of the other small islands in the neighbourhood, form one great zoological province, which may be called the Australasian. But the problem has been in which region to place Celebes, whose fauna is in some respects intermediate between that of the Australasian and Oriental regions. By Dr. A. R. Wallace, the great authority on the geographical distribution of animals, it was at first classed with the former, although subsequently given a doubtful position; and his views have been followed by most later writers. Quite recently, however, Mr. W. L. Sclater, the Director of the South African Museum, has come to the conclusion that it should be included in the Oriental region.

A glance at the map will show that Celebes is an island of very peculiar and unusual shape. It consists of an irregular central region, from which are given off four still more irregular peninsulas, of which the one running in the direction of the Moluccas is considerably the largest. Its general outline is more like that frequently assumed by an amœba than anything else, and it is quite clear from this remarkable shape that the island is situated in a subsiding area, and once formed a portion of a much larger land mass. From the peculiarity of its animals it is evident that Celebes has existed as an island since an epoch comparatively remote; and the question naturally arises whether its last connection was with Borneo and the other Malayan islands, or with Ceram and New Guinea. In a question of this nature the depths of the surrounding seas have, of course, a most important bearing. There is reason to believe that recent investigations will do much towards clearing up this question, but as they have not yet been published they cannot be further referred to on this occasion.

Putting, then, the evidence of soundings on one side, we may endeavour to find out how much light the animals of Celebes are capable of throwing on the problem.

Those of my readers who have any acquaintance with the subject of the geographical distribution of animals, are doubtless aware that no marsupials at all are found to the westward of Celebes, and that to the eastward of that island monkeys are quite unknown, while hoofed animals are represented only by a deer in Timor and a second in the Moluccas, and likewise by a semi-wild pig in Ceram and another in New Guinea. In fact, the quadrupeds of the Australasian region, apart from bats and these exceptions, consist exclusively of egg-laying mammals, marsupials, and various peculiar kinds of rats and mice; while, as already said, their birds include cassowaries, cockatoos, birds of paradise, bower-birds, and a host of other kinds more or less completely unknown in the regions to the westward.

But, unfortunately, there is another element in the problem which introduces a further complexity. The Malays, as we know, are bold and clever sailors, fond of voyaging from island to island in these summer seas. And they are also wonderful adepts in taming animals of various kinds. Many of these they carry about with them in their voyages—some probably for food and others as pets. When they land on a strange island some of these animals may occasionally escape, or possibly may be turned loose intentionally. Now there is a very considerable probability that the wild pigs of Ceram and New Guinea have been thus introduced; and if this be the case, the fauna of the Australasian region is made more absolutely distinct from that of the Oriental province. The deer of the Moluccas and Timor present a case of greater difficulty; but, as the Moluccas cannot well be separated from the Australasian region, they would seem, in these islands at least, to have been introduced, and, if so, the same will hold good with certain smaller mammals of an Oriental type, such as civets.

We are now in a position to consider how the animals of Celebes compare with those of the neighbouring islands. Now, the only mammals of a purely Australian type found in that island are two species of cuscuses—sleepy creatures, with beautifully soft fur, often very brilliantly coloured, and showing great individual or sexual variation in the markings. They are near relatives of the so-called opossums (phalangers) of Australia, and are purely arboreal creatures, passing the day comfortably coiled up in slumber, and feeding at night. If these creatures were of a type which might be regarded as near to that from which the other marsupials of Australia might have sprung, they might be considered as survivors from the migration of marsupials which probably took place at a remote epoch from Asia to Australia. But they are not so, and it is therefore clear that this hypothesis will not account for their presence in the island. As they are so completely arboreal in their habits, they are, however, just the kind of creatures which we might naturally expect to be wafted from one island to another on floating timber; and it is far from improbable that it is to this mode of transport they owe their presence in Celebes.

All the other mammals are of an Oriental type, although several of them are quite unlike their relatives on the mainland and other islands. Among them one of the most remarkable is the babirussa, a curious little pig, in which the tusks of both jaws in the males attain a most extraordinary development, the lower ones curving straight upwards, while the upper ones grow right through the skull to curve backwards in a bold sweep towards the eyes. Although nothing definitely is known as to the origin of this strange animal, yet it is evidently a highly specialized offshoot from the ancestral pigs of Asia. Equally peculiar is the tiny little black buffalo, or anoa, which is not much larger than a good-sized ram, and has upright horns quite unlike those of the ordinary Asiatic buffalo. In the island of Mindoro, near the centre of the Philippine group, there is, however, a considerably larger buffalo, known as the tamarau, which serves to connect the anoa with the ordinary Asiatic species. More important still is the occurrence in the Tertiary deposits of Northern India of several species of buffaloes intimately related to the anoa. Clearly, then, this animal has originated from an Oriental stock, and the occurrence of an allied species in the Philippines tends to show that these islands were connected at no very remote epoch with Celebes. Now the Philippines themselves, as shown by their deer, have intimate relationships with Borneo, and thus with the mainland.

The deer reported to occur in the island is a variety of the rusa of Java, and apparently identical with the form found in the Moluccas. It is generally considered to have been introduced, but as Celebes shows so many signs of affinity with the more western Malayan islands in its animals, this does not appear by any means certain. Anyway, the Moluccan race may well have been exported from Celebes by the Malays.

The next most noteworthy animals in the mammalian fauna of the island are two species of monkeys, both remarkable for their black colour. The first of these is the short-tailed black baboon, a species representing a genus by itself, and with relationships to the true baboons of Africa and Arabia. Such relationship, from a geographical point of view, might seem difficult to account for, and to those who neglect the animals of a past epoch it would appear well-nigh inexplicable. But it happens that extinct baboons occur in India; and as they doubtless also existed in other parts of the Oriental region, there is no difficulty in accounting for the origin of the Celebesian representative of the group. The other species—the Moor macaque—belongs to a widely spread Oriental genus.

But the most curious of all the mammals of the island is a species of tarsier—a small creature with enormous goggle eyes, slender lanky limbs, and toes terminating in suckers—distantly related to the lemurs. Now, these tarsiers are strictly limited to the islands of Sumatra, Borneo, Java, Celebes, and Mindanao, together with some of the neighbouring islets; and are totally unknown to the eastward of the Molucca Sea. Although, being arboreal animals, it may be argued that, like the cuscuses of Celebes, they have been carried about by floating timber, it seems in the highest degree unlikely they should have reached all the islands with an Oriental type of fauna, and avoided all those where the true Australian type comes in. Moreover, they are very delicate animals, exceedingly difficult to keep alive in captivity, and there is accordingly a strong probability that they are native to the islands where they occur. Like so many of its other animals, the tarsier of Celebes is black—as, indeed, are the species from the other islands.

So far, then, as their mammals are concerned, it seems probable that at no very distant epoch Celebes, Borneo, and the Philippines formed one land area; while Borneo itself was connected with the mainland, probably by way of Sumatra, the orang and some other species being common to these two islands and unknown elsewhere. It is further probable that Celebes, and most likely a portion of the Philippines, became isolated before Borneo ceased to be connected with Sumatra—or at all events with the mainland. But the south-western portion of the Philippine group, namely, the island of Palawan, shows evidence of a closer connection with Borneo than with the rest of the archipelago to which it belongs. On the other hand, the mountains of Luzon, in the Northern Philippines, contain a remarkable group of rats, some of which show affinity to those inhabiting Australia; and it therefore seems highly likely that the Philippines mark a portion of the line by which Asia was probably in communication at a still earlier epoch with New Guinea and Australia. Still, there are some difficulties in this view of the case, because the more primitive types of marsupials now found in Australia are at present unknown in New Guinea. Possibly, however, some still remain to be discovered in the unexplored mountains of that country; while, as the exploration of the Luzon Mountains by Mr. John Whitehead has yielded such wonderful zoological results,* there is a hope that when the mountains of the other islands have been as carefully worked we may find a few marsupials still surviving. Should such a fortunate "find" turn up, we should have almost conclusive evidence that the ancestors of the present fauna of Australia travelled from Asia by way of the eastern archipelago.

There are many other points connected with the present distribution of animal life in this wonderful region, and their bearing on the former relations of the various islands to one another, to which the limits of this article forbid

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* The mammals from these mountains have been worked out by Mr. O. Thomas, of the British Museum.

reference. A word may, however, be said in reference to Timor, which, as already mentioned, forms the eastern extremity of the line of the Sunda Islands—that is to say, the line including Sumatra, Java, and Flores, which is evidently a broken-up peninsula. By most writers that portion of the chain lying to the eastward of Java and Bali has been assigned to the Australasian region, and it has consequently been assumed that the deer found in Timor must have been introduced by man. Timor and Flores also contain several other mammals common to the Oriental region, notably a monkey, a civet, a porcupine, and a palm civet; and although it is quite possible that they may have been introduced by the Malays (as some of them appear to have been into the Moluccas), the absence of any typically Australasian mammals except a cuscus (whose presence may be accounted for in the same way as in Celebes) is, to say the least, very remarkable. Moreover, the birds of Timor show at least as many Oriental as Australasian features, and it accordingly seems more consonant with the known facts to regard the whole chain of the Sunda Islands, which are geographically one, as having formed a part of the old Asiatic continent.

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British Ornithological Notes.

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

Pied Flycatcher in Caithness.—A pair of these birds took up their quarters in our garden about the middle of May. The male appeared first and remained four days. Two days after it disappeared the female put in an appearance, but did not remain. Messrs. J. A. Harvie-Brown and T. E. Buckley, in their "Fauna of Sutherland and Caithness," say: "The first known to have occurred in the county was obtained by ourselves in a very wild burn some eight or nine miles from Brora on the 27th of May, 1872." Now this appears to be a mistake, because in May, 1867, I shot and preserved a pair, male and female, which they notice on the next page from Mr. Osborne's MS. On May 10th, 1881, I again saw several specimens, one of which I preserved.—James Sutherland, Wick.

Red-backed Shrike in Caithness.—A pair of these birds, obtained in the neighbourhood of Wick on the 20th of May, has been sent to me for preservation. In the "Fauna of Sutherland and Caithness" it is stated: "One is recorded as being in Dunrobin Museum, but there is no history attached to it." A young bird of this species is in the Duke of Portland's collection at Welbeck Abbey, but there is no precise date or locality given beyond the general statement that all the birds in the collection were shot on the Duke's property in Caithness. A specimen of this bird is mentioned by the late Dr. Sinclair, of Wick, as having been killed in the county.—James Sutherland, Wick.

Protection of Birds in Scotland. — The question of the protection of birds by law has again been under consideration. In Scotland, as was foretold in the appendix to the last annual report of the Society for the Protection of Birds, an excellent proposal by Lord Balfour of Burleigh is now before the various County Councils of that country. The suggestion is to divide Scotland into two districts, northern and southern, the dividing line being the southern boundary of Argyll and Perth (Bute and Arran to be included in the northern division), and for the County Councils in each of these areas to seek identical Orders under the Wild Birds Protection Acts, so that all concerned can readily make themselves acquainted with the provisions of the Orders in force for the protection of birds and their eggs.

A list of thirty-two birds is given, which shows what species should receive protection in *both* districts, and also lists of the *additional* birds which should be protected—fifteen species in the northern and eleven in the southern district.

Bird lovers will be glad to note that some species are recommended for protection all the year round. Cannot some of our ornithological friends help to draw up a similar scheme for the grouping of counties in England?

The Home Secretary would no doubt welcome such a scheme, were it presented in a practical form.—M. L. Lemon, Hon. Sec. Society for the Protection of Birds, July 15th, 1898.

The Long-tailed Duck in Killala Bay and the Estuary of the Moy. By Robert Warren. (*Irish Naturalist*, May, 1898, pp. 121-124.)—We have here detailed accounts of the various occurrences of this duck (uncommon in Ireland) in the districts named.

Mr. Robert Patterson records in the *Irish Naturalist* for July, 1898, p. 170, the following rarities which he believes have not been before recorded:—

Rough-legged Buzzard.—A male was shot at Portaffery, Co. Down, on November 8th, 1895.

Grey Phalarope.—One was picked up at Ballymoney, Co. Antrim, in October, 1896.

Hawfinch.—A male was shot at Hillsborough, Co. Down, on December 30th, 1897.

The Whinchat, Ortolan Bunting, and Pied Flycatcher in Shetland (*Annals of Scottish Natural History*, July, 1898, p. 178).—Mr. W. E. Clarke here records the capture of the above species by Mr. Thomas Henderson, jun., in Shetland, during a remarkable visitation of migrants. All three species are new to the avifauna of Shetland.

Marsh Harrier in Dumfriesshire (*Annals of Scottish Natural History*, July, 1898, p. 182).—Mr. R. Service records that a male Marsh Harrier (a very rare species in Scotland) was shot in Carmichael early in May, 1898.

Ring Dove nesting in the City of Edinburgh (*Annals of Scottish Natural History*, July, 1898, p. 183).—While so much attention has lately been directed to the nesting of Wood Pigeons in London, it is interesting to hear from Mr. Arch. Craig that a pair of these birds is nesting in Edinburgh.

On Birds observed in the Island of Tiree. By Peter Anderson (*Annals of Scottish Natural History*, July, 1898, pp. 153-161).—This is a list of one hundred and twenty-eight species of birds observed on Tiree during the author's twelve years' residence in the island.

On the nesting of the Pintail (Dafila acuta) in the Forth Area. By William Evans, F.R.S.E. (*Annals of Scottish Natural History*, July, 1898, pp. 162-164).—Up to the time of the publication of this article there were only two or three reliable records of the nesting of the Pintail in the British Islands. It is, therefore, very satisfactory and of the greatest interest to learn from Mr. Evans, in this careful and incontrovertible report, that several pairs (perhaps six or seven) of Pintails have nested this year on Loch Leven, in Kinross-shire. Mr. Evans carefully identified the birds which rose from the nests he found, and even went so far as to hatch two of the eggs in an incubator.

Woodchat Shrike in Sussex (*Zoologist*, June, 1898, p. 267).—Mr. G. W. Bradshaw records the occurrence of a male Woodchat near St. Leonards-on-Sea on May 1st, 1898.

Hawfinch in Midlothian (*Annals of Scottish Natural History*, April, 1898, p. 114).—Mr. W. Eagle Clarke reports that on March 9th an adult female Hawfinch was picked up dead at Arniston. In August, 1894, a young Hawfinch was captured at the same spot, and Mr. Clarke points out that these two records are of great interest, since the Hawfinch was formerly only regarded as a rare winter visitor to Scotland. Although large and conspicuous, the Hawfinch is of a shy nature and retiring habits, and a little further search may result in adding the species to the list of birds which are resident in Scotland.

Melodious Warblers in South-East Devon (*Zoologist*, June, 1898, p. 265).—The Rev. Murray R. Mathew describes how he watched and listened to quite a number of Warblers, which he identified as *Hypolais polyglotta*, in a wooded undercliff at Ware, near Lyme Regis, in the beginning of May this year. Clear views of the birds were obtained at the distance of a yard. The Melodious Warbler very closely resembles the Icterine Warbler (*see* note, Knowledge, November, 1897, p. 257).

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.*

"INSECT MINERS."

By Fred. Enock, f.l.s., f.e.s., etc.

INSECT miners, though somewhat rare in the "Black Country," are only too plentiful in the London district. Being no respecters of persons, they invade even Royal gardens, where we find whole families of them working together in the most orderly, systematic, and determined manner. I might truthfully say that thousands of these insects are brought into London every morning by ship, road, or rail.

Let us take one of the favourite flowers of the Londoner—the white Marguerite—a flower to be seen in every street from Belgravia to Whitechapel. When the first crop of flowers begins to fade, and the leaves are thus exposed to view, those of us who have eyes for such things can at once detect a peculiar appearance about the leaves. Many of them are disfigured with variously shaped yellow-looking markings. Some people imagine the plant to be dying, and hasten its end by consigning it to the dustbin. Others wonder what is the matter with their Marguerite, and frequently set to work and wash the plant—which is a very good plan, as it invigorates the growth, causing new shoots to form as well as buds, but it does not prevent the miners going on with their work, and even extending operations to the fresh growth.


Fig. 1. — Golden Marguerite affected with "the Maggot."

Some few years ago I was privileged to conduct some lectures on economic entomology for the Essex County Council, and was much encouraged to find some of my audience bringing various specimens of insect and plant life which had attracted their attention. The beautiful yellow Marguerite was brought suffering from "the black fly," which the grower could not get rid of from many of his old stock plants; and no sooner had he started a fresh stock for the coming season than this "fly" made its appearance, and, in many instances, completely ruined the plants for sale.


Fig. 2.—The Marguerite Fly (*Phytomyza affinis*). (× 12 Diameters.)

Fig. 1 is from a photograph of one of these afflicted yellow Marguerites. The plant has scarcely a sound spray of leaves—nearly all being "eaten up" by the "fly," or rather maggot of this injurious insect. I bred a large number of *P. affinis* (Fig. 2) from the golden Marguerite. It is a minute, two-winged fly about one-twelfth of an inch in length, slatey black, with black bristles on head and thorax; the head is pale yellowish brown, legs dark, with yellowish tips and *haltères*. It has a decided objection to being watched, and some patience is required to overcome the "now on the upper, now on the lower" surface of the leaf; then, just when you think you have it settled, it hops right away out of sight, and you must wait for its return or seek another.

Much patience and some gentleness of movement will be required before you succeed in observing its method of oviposition. After selecting a spot on the upper surface it protrudes the rasped point of its telescopic ovipositor, which it forces through the upper cuticle; and then between that and the lower (Fig. 4) it inserts an egg of an oval form. Withdrawing its ovipositor it rapidly reverses its position, and protruding its tongue proceeds to hermetically seal up with saliva the aperture made (Fig. 5). Numbers of eggs are so laid in each leaf, great care being taken to carefully seal up each one. The next day minute blisters appear over the egg, which hatches on or about the fourth or fifth day into a tiny legless maggot, our first representative of a "miner" (Fig. 6). Nature has taught it that it must work for its living, and being provided with the necessary muscular power it immediately commences to use its excavating tools, which are in its mouth (centre of Fig. 6). With these tools it obtains nutriment, and at the same time levers its way between the cuticles, the "working" gradually though slowly increasing in width and length. In the yellow Marguerite it is straighter than is the case in the broader leaves of the white Marguerite, where it not unfrequently follows the serrated margin of the leaf for a distance of an inch or more. At other times the insect works a somewhat tortuous course across the leaf, and occasionally, after making a narrow mine, it seems to hit upon an exceedingly nice-flavoured piece of leaf, around and about which it lingers and makes a well-formed harbour (Fig. 7). The course of the mining larva is marked by the minute pellets of frass which are plainly visible through the bleached upper cuticle (Figs. 7 and 8). In less than a fortnight the miner has finished its excavation; its work, so far as mining is concerned, is done, and its tools are no longer required. At the head of the larva (left hand of Fig. 6) will be noticed two short prominences. These appear to be used as


Fig. 3.—Leaves of Golden Marguerite, showing Larvæ of *Phytomyza affinis*. (Natural size.)


Fig. 4.—Marguerite Fly ovipositing in Leaf. (× 12 Diameters.)

holdfasts, and are driven through the upper cuticle, and the pupal stage is reached (Fig. 8), though sometimes the larva quits the leaf and falls to the ground to undergo this change. The fly is soon matured, and, bursting through the dry larval skin, it emerges to continue its species; and under the artificial though favourable conditions of plants kept and propagated under glass, numbers of broods emerge in the course of each year.

Like all other insect "pests," it has its parasites—minute and busy Hymenoptera, quite black in colour, which hover about the infected leaves (Fig. 6), ever ready to attack the larva and insert one of their own eggs in the body of the miner (*see* Fig. 8).

When the parasitic maggot has reached its full growth (and of course destroyed the maggot of the Marguerite fly) it passes on to the pupa stage within the dried skin of its host, which is now bleached to a light colour. The enclosed *black* pupa of the parasite is now a conspicuous object to even an ordinary observer, and care should be taken not to destroy these *black* coloured ones. If growers of Marguerites and other flowers would just note a few of these apparently slight differences, a great deal of good might be done towards increasing these parasites, which are the natural enemies of the injurious maggots.

Fig. 5.—Marguerite Fly sealing up the Egg. (× 12 Diameters.)

Fig. 6.—Larva, Head of ditto, and Pupa of Marguerite Fly. (× 12 Diameters.)

Another favourite flower with everyone, especially Londoners, is the chrysanthemum; and yet how very few growers, amateur as well as professional, know the fly, *Trypeta chrysanthemi*, which is the cause of the mining maggot that excavates between the cuticles, eating all the life away, until the leaves begin to twist up and fall, leaving the plant totally unfit for exhibition. The finger-and-thumb treatment is the quickest way of destroying the miner, which can easily be felt, if not seen; but the perfect insect is generally overlooked altogether. I own that it is not a particularly easy one to capture, but it is worth the attempt, as one female is capable of laying a great number of eggs, distributed over one or two dozen plants, and can easily blight all chances of prize-taking at an exhibition. I have noticed the fly all through the summer months, for there are several broods. Before the heat of the day is the best time for observing it, and it is worth observation, as, apart from the advantage of knowing enemies from friends, the fly is an exceedingly interesting one to watch. It is smaller than the ordinary house fly, and of an ochreous colour; its eyes of the most brilliant shining green, which at certain angles appear golden red; its wings are ample, with several diffused spots on them. In graceful movements of the wings few flies can equal this one. The wings are gently raised and lowered together, then suddenly one is twisted at a peculiar angle, whilst the insect itself walks round in a circle. Sometimes the wings are allowed to drag along the leaves, after the manner of a strutting turkeycock; then they are suddenly raised high up together, and the fly seems to take fright and run under cover, only to return and indulge in other strange movements. Should one of the opposite sex approach, these movements are increased, and quite defy description. Those chrysanthemum growers who really wish to capture these flies should use a small net, made of fine book muslin, fixed on a ring of cane four inches in diameter, the net of the jelly bag from about eight to ten inches in length. With a little practice many flies can be caught without injury to the plants. Observation of the mines will soon reveal the parasite peculiar to this fly.

Fig. 7.—Egg (Cuticle raised), Part of Mine, and Parasite of Marguerite Fly. (× 12 Diameters.)

Fig. 8.—Continuation of Mine and Pupa of Marguerite Fly, in which Parasite is ovipositing. (× 12 Diameters.)

(*To be continued.*)

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Notices of Books.

Electro-Physiology. Vol. II. By W. Biedermann, Professor of Physiology in Jena. Translated by Frances A. Welby. (London: Macmillan & Co.) 17s. net. We have here a good translation of the second volume of a standard work. The range of subjects treated is the best evidence of the progress which has been made in this branch of science since the inception of the subject by Galvani's experiment in 1790, when, working at Bologna, he observed the curious convulsive movements in the muscles of a recently killed frog when touched at different points by iron and copper which were in contact. The volume before us, beginning with the electro-motive action in vegetable cells, goes on to deal, in separate chapters, with such subjects as the structure and organization of nerve, the conductivity and excitability of nerve, the electrical excitation of nerve, the electro-motive action in nerve, electrical fishes, and the electro-motive action in the eye. While the book is full of interesting experiments, such examples as that with the uninjured leaf of *Dionæa*, or, as it is more familiarly called, "Venus's fly trap"—where, electrodes being applied to the opposite ends of such a leaf, and a galvanometer included in the circuit, a regular current flows from that end of the leaf nearest to the stalk to the other—will perhaps appeal most to the ordinary reader. The wonderful physiological properties of certain fishes have been known and dreaded from the earliest times. Francesco Redi showed in 1666 that this mysterious power was, at all events in the electric ray, associated with special organs, situated symmetrically on both sides of the head. In the present volume we are given an exhaustive account, profusely illustrated and extending to upwards of a hundred pages, of the present state of our knowledge of all these animals. For the results of these and many other equally fascinating studies we must refer to the book itself, which in the style of its production is quite up to the high standard of excellence one always associates with the names of its publishers.

William Moon, LL.D., and his Work for the Blind. By John Rutherford, M.A., B.D. (London: Hodder & Stoughton.) 5s. Of the many systems of embossed characters by means of which the blind are enabled to read, that invented by Dr. Moon is undoubtedly the simplest and most easily acquired. Not only is it suitable for educating children who are blind, but it is also admirably adapted for older people who have lost their sight. In fact, it is in this respect that the system elaborated by Dr. Moon stands pre-eminent. More than half of the total number of persons who are unable to see are over fifty years of age, and in a large number of these cases the fingers have become hardened by manual labour, and the sense of touch has lost much of its acuteness. These facts make it impossible for such persons to master the more elaborate systems which were previously in vogue; and when it is remembered that often the loss of sight is attended by a more or less complete nervous collapse, it will be seen that embossed alphabets based upon systems of phonography are altogether unsuitable because of the degree of concentration required to master them. Dr. Moon's alphabet consists of only nine characters placed in various positions. Thus, the character ∧ stands for A, K, V, X, in the varied positions of ∧ < V >. Dr. Moon himself became totally blind at the age of twenty-one, and from that time devoted his life to the work of lightening the darkness of his fellow-sufferers. His perfected alphabet was the crowning point of a series of less successful experiments, and was soon applied to the production of books for the blind in a variety of foreign languages, including even Chinese. But the education of the blind was, in the hands of Dr. Moon, carried much further than mere reading, for by means of an embossed atlas of geographical maps and drawings in relief showing the constellations, the solar system, phases of the moon, eclipses, tides, etc., he gave evidence alike of his perseverance and ingenuity, and provided the blind with sources of instruction and enjoyment. After so useful a career we can partly understand the spirit which prompted Dr. Moon when he said: "God gave me blindness as a talent to be used for His glory. Without blindness I should never have been able to see the needs of the blind."

Ethnological Studies among the North-West Central Queensland Aborigines. By Walter E. Roth, B.A., etc. (Brisbane: E. Gregory. London: Queensland Agent-General's Office. 1897.) It is satisfactory to be given this further evidence of systematic inquiry into the language, customs, and habits of Australian aboriginals. The spread of civilization in these new countries inevitably results in the elimination of the native races, and it becomes a positive duty of the invaders to gather and record accurate information concerning the superstitions, beliefs, and ceremonial rights of the races they displace. This duty is fully recognized in the United States, where the Bureau of Ethnology is continuously employed in collecting and publishing similar facts about the North American Indians. We are, therefore, glad to see this officially published contribution to the ethnology of the natives of Queensland. Of course, the first essential in conducting such an inquiry is the confidence and trust of the aborigines in the expert observer. In this respect Mr. Roth had unrivalled opportunities, and he seems to have made the most of them. The book is filled with details of interest to anthropologists, but a particular value is to be attached to the chapter on the expression of ideas by manual signs. These are not only fully described in the text, but are also illustrated by a profusion of figures on several plates.

Text-Book of Physical Chemistry. By Clarence L. Speyers. (New York: D. van Nostrand Company. London: E. & F. N. Spon.) 7s. 6d. Physical chemistry, though a subject of distinctly modern growth, has become a very important branch of science, scarcely a day passing without some new development of it. But though it is a comparatively new subject, there are certain fundamental ideas in physical chemistry which will not suffer change, and these Mr. Speyers has put into his book, though some theories have been included which will almost certainly have to be modified. The book is intended for senior students, and should prove useful in those advanced chemistry courses where it can be fairly assumed that an efficient mathematical knowledge is part of the student's intellectual stock-in-trade. The non-existence of working hypotheses connecting light energy and so-called chemical energy, has decided the author to omit any reference to light relations and crystallography. The historical development of the subject has, we think wisely, been disregarded whenever the clear presentment of the subject has been thereby aided. The excellent series of problems scattered throughout the volume will, if conscientiously worked, prove of particular value to the student.

SHORT NOTICES.

The Arrangement of Atoms in Space. By J. H. Van't Hoff. Second Edition. (Longmans.) 6s. 6d. Organic compounds of similar formulæ do not always possess the same properties. For example, tartaric acid exists in different forms, yet the formula of each modification contains exactly the same number of atoms. To explain this and similar cases, a new branch of organic chemistry has arisen, called "stereo-isomerism." The author says, in the introduction to the book before us, that "the facts compel us to explain the difference between isomeric molecules possessing the same structural formulæ by the different arrangement of their atoms in space"—a conception of atoms which is essentially a continuation of Kekule's law of tetravalent carbon. A preface is added by Prof. Wislicenus, who, by the way, states that the opposition to the theory is directed against special applications of the principle to explain particular facts, and not against the general principle itself. A new section has been added by Alfred Werner on nitrogen compounds, and the whole is admirably presented in English by the translator—Arnold Eiloart.

The Year-Book of British Columbia. By R. E. Gosnell. (British Columbia Government Agency.) We have in this handy volume a multitude of facts respecting the material resources, and the historical, political, and sociological character of British Columbia, the whole forming a *vade mecum* of information concerning the province, so compiled as to anticipate all references of a practical nature. At the present time many people are anxious to obtain exact knowledge respecting mining in the great North-West, and it will, perhaps, be welcome news to those who contemplate enterprises of this kind when we say that here are to be found mining statistics up to date, mining laws—including the Yukon mining regulations—agriculture, trade and finance, outfitting and expenses, and so on, all well authenticated in every particular—explicit details, definite conditions, actual results.

Life Histories of American Insects. By Clarence Moores Weed. (Macmillan.) Illustrated. 6s. net. Consists of a series of able sketches of a few of the principal American insects, profusely illustrated with first-rate diagrams and plates. To entomologists this book will, we think, form a useful acquisition, and general readers who occasionally indulge in light science may hope for both information and amusement by a perusal of these bright and stimulating pages.

Nature Studies in Elementary Schools. By Mrs. Lucy Wilson, PH.D. (Macmillan.) Illustrated. 3s. 6d. Mrs. Wilson has designed a book which aims at imparting to teachers a method of conveying instruction in a way that must prove both amusing and interesting to all grades of children. The book is divided into months, and for each month full particulars are set down as to the subjects of instruction; the curriculum including weather, plants, animals, fruits and stones, varying according to the period of the year at which the lessons are supposed to be given.

BOOKS RECEIVED.

Practical Organic Chemistry. By Samuel Rideal, D.SC. Second Edition. (H. K. Lewis.) 2s. 6d.

The Birds of Montreal. By Ernest D. Wintle. (John Wheldon & Co.)

A Text-Book of Zoology. By H. G. Wells and A. M. Davies. (Clive.) Illustrated. 6s. 6d.

Financial Sketches. By Hélène Gingold and Dudley Hardy. (Columbus Printing, Publishing, and Advertising Co.) Illustrated. 1s.

Stepping Stones to Literature. By Sarah Louise Arnold and Chas. B. Gilbert. (Silver, Burdett, & Co.)

Directory (revised to June, 1898), with Regulations for establishing and conducting Science and Art Schools and Classes. (Spottiswoode.) 6d.

On Sea Beaches and Sandbanks. By Vaughan Cornish, M.SC. (Reprinted from the *Geographical Journal.*)

Archives of the Röntgen Ray. Edited by W. S. Hedley, M.D., and Sydney Rowland, M.A. Vol. II., No. 4. (The Rebman Publishing Co.) Illustrated. 4s. net.

Letters.

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

SUNSPOTS.

To the Editors of Knowledge.

Sirs,—In a letter of Mr. Shackleton's in the May issue of Knowledge (p. 113), he quotes the late R. A. Proctor as confirming a theory of refraction lately advanced by Mr. East, and illustrated by him by the familiar old experiment of a bowl of water with a penny at the bottom of it; and in the concluding paragraph of his letter he seems to consider that this theory is therefore a settled matter, which ought to have found its way into recent books treating on the subject as an accepted view of one of the phenomena of sunspots.

I cannot help thinking that Mr. Shackleton attributes rather too much importance to the few words said by Proctor in the passage alluded to in "Old and New Astronomy." He is not discussing the visibility of the umbra in a foreshortened spot; he does not mention it or allude to it in any way, here or anywhere else, except by a few words in a short note, after he had made his drawing for a totally different purpose. He is describing the manner in which he imagines a sunspot to be formed, and he gives a sketch of what he conceives would be the section of a spot according to this view. It must have struck him that, if this section was a true one, it would be impossible to see the umbra at all when a spot was foreshortened; and he then suggested the idea of refraction as a means of bringing the umbra into view. Surely this theory requires a little more discussion and explanation than a few words added casually in a note. It is hardly one to be accepted as if it was the most obvious thing in the world, which only had to be stated to be received without a shadow of doubt as to its truth.

Fig. 1.—Ideal Section of a Sunspot.

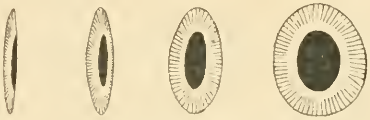


Fig. 2.—Changes in the Appearance of a Symmetrical Spot due to foreshortening.

Fig. 3.—A Group of Sunspots on the First Day after passing the East Limb. May 6th.

I do not therefore think that Proctor intended to lay down this theory for general acceptance upon his authority, as one thoroughly examined and deliberately adopted by him. However that may be, it is clear that this theory is only needed if the section of a spot drawn by Proctor is a true one. *Is* the umbra something at the bottom of a cavity, which requires, in a foreshortened spot, to be brought into view by refraction like the penny in the bowl of water? I maintain that it is not, but that, on the contrary, the umbra is more or less on a level with the outer edge of the penumbra. I did not adopt this view hastily, or merely as a way out of a difficulty, but only after having bestowed a good deal of attention to the matter. It was only after having spent some time on every available day for some months, carefully observing and drawing every spot that occurred, that the conclusion forced itself slowly and irresistibly upon me, in opposition to what I had before imagined to be the generally accepted view—that the umbra, instead of being a hole at the bottom of a depression, was in reality on a general level with the top of it. My idea is that at the edge of the penumbra there is at first a considerable depression, which continues for a certain distance towards the centre, and that the surface then rises gradually into a cone, the open top of which is the umbra. I take it to be impossible to draw any true section of a sunspot, and the outline I have drawn is only intended to show my meaning in the roughest and most general manner. If, then, the umbra is, as I imagine, the open summit of a cone, its circumference would form a ring with a dark centre (I am taking the case, of course, of an ordinary symmetrical spot), while the edge of the penumbra would form an outer ring; and as long as any portion of the inside of one ring was visible, the same amount would be visible of the other. It follows, then, from this view that there is no necessity to fish up the umbra by refraction from the bottom of a spot. As to its possibility, I am in no way competent to form an opinion; but as regards the illustration given in support of the theory, I fancy that a pair of bellows brought to bear upon the surface of the water in the bowl would obliterate the image of the penny at the bottom of it, just in the same way as a very slight ripple coming upon the surface of calm water instantly renders all objects invisible at the bottom; and, considering what the eruptive force must be which produces a sunspot, and the violence of the movements which must be going on among the gases and vapours within its area, the conditions do not seem favourable to the transmission of an image by refraction.

There is, however, another point which has always seemed to me to require some explanation, viz., the rapidity with which a spot opens out when still but a short distance from the limb—more observable in some cases than in others. I have often been surprised to find that a spot which was little more than a mere line on one day had opened out within twenty-four hours to a degree that I did not know how to account for. It has sometimes occurred to me whether refraction could have anything to do with it; not refraction, however, within the spot itself, but that of the sun's atmosphere, as we are, in this case, looking along the surface of the sun for an immense distance, and, consequently, through the greatest possible amount of his atmosphere. The two drawings are very rough copies of drawings of spots showing the extent to which a spot opened out from one day to another after its first appearance on the east limb. J. H. Jenkinson.

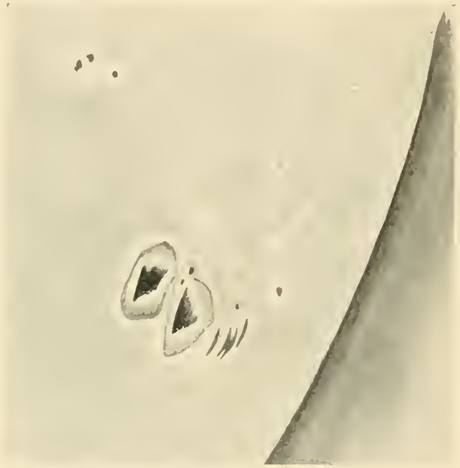


Fig. 4.—A Group of Sunspots on the Second Day after passing the East Limb. May 7th.

Ocklye, Crowborough, May 23rd, 1898.

[The context of the passage from Proctor's "Old and New Astronomy," quoted by Mr. Shackleton, fully supports Mr. Jenkinson's suggestion that Proctor's reference to refraction in sunspots was a mere casual incident in his argument. The point he is really discussing is whether sunspots have their origin from below or above, and he supports the former view with all his usual insight and masterly grasp of principles. On the other hand, as he works out his idea, he shows how slight was his personal observational experience. The sharp well-defined circular outline is far more characteristic of the western than of the eastern border of spots, and decay in spot groups, in the great majority of instances, begins to the eastward and works to the front. To my own mind a sunspot appears a region of upheaval—an upheaval which results in a breach in the glowing shell we call the photosphere, and a smaller breach in the less brilliant shell below it which forms the penumbræ of spots. I regard the photosphere in the neighbourhood of a spot, the penumbra, and the umbra, as probably all convex to the general level of the sun's surface; the amount of convexity probably varies immensely in different spots.—E. Walter Maunder.]

THE ECLIPSE THEORY OF VARIABLE STARS.

To the Editors of Knowledge.

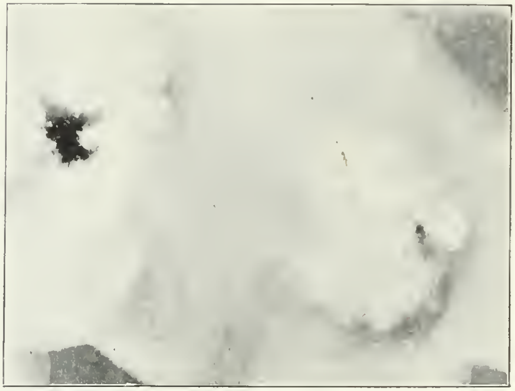
Sirs,—The title of Colonel Markwick's paper seems to me somewhat misleading. The theory referred to does not embrace all variable stars, but a class only.

My object in writing is, however, a different one. Your able contributor seems to assume that the surface-brightness of stars is uniform. In the case of the sun we know that this is not true. Near the edge the brightness is not more than one-seventh of what it is near the centre. This fact seems to be satisfactorily explained by the assumption of a solar atmosphere, which there are other grounds for believing. Assuming that Algol is similarly constituted and that the satellite (B) was quite dark, still the light would not be constant from the time that the whole of the satellite got in front of the bright star (A) until it began to move off again. The minimum would occur when the satellite occupied the most central position in front of the bright star. If the eclipse was central it would occur when the centres of both stars were in the line of sight.

I think it very probable that in these cases the eclipsing body is not quite dark. If the satellite of Sirius crossed the face of the bright star, the phenomena would probably be undistinguishable from those caused by the passage of a dark satellite. One thing, at all events, seems certain. We know of no instance in which the eclipse is total; but on the assumption of a dark companion, it would be natural to expect that its surface would be smaller than that of the bright star, and that therefore the eclipse would not in any event be total.

Further, the eclipsing body may not be a star, but a dense cloud of meteors. In many cases we are driven to the conclusion that, if it be a star, its density is very small in spite of its opacity and comparatively low temperature. The sun's motion in space must ultimately affect these eclipse stars, though our periods of observation may not hitherto have been long enough to detect the change. In almost every instance the eclipse must be becoming either greater or less. In the former case the duration of the change will become greater and the difference between the maximum and minimum will become greater also. In the latter case the eclipse will become less and less until it disappears altogether. Of course, where the eclipse is now increasing it will ultimately decrease again after becoming central; and no doubt eclipses will hereafter appear in the case of stars whose light is at present constant. Spica Virginis is very possibly such a star. Either it has been an eclipse variable in the past, or else it will become so in the future. W. H. S. Monck.

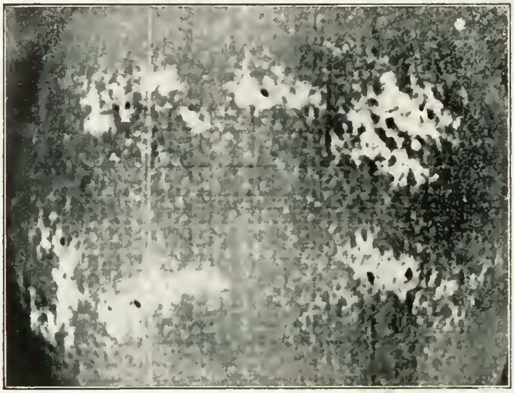
ARTIFICIAL AND NATURAL FACULÆ.



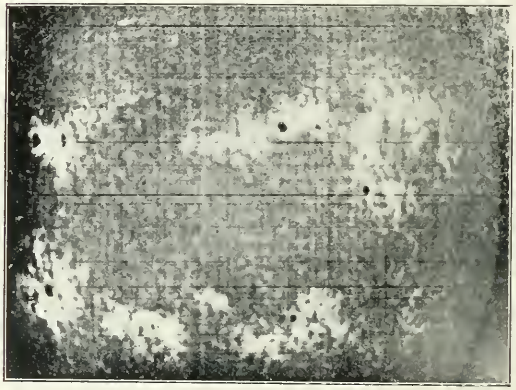
A.—Artificial Faculæ with part of Overhanging Pulp removed, showing an Ordinary Spot.

B.—Large Patch of Artificial Faculæ.

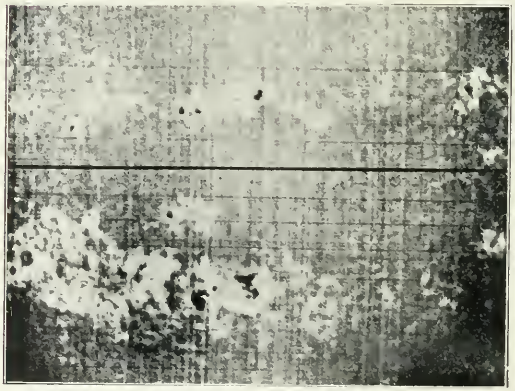
C.—The same as B, but with part uncovered, showing Spot below.



D.—Faculæ taken with Prof. Hale's Spectro-heliograph, at Kenwood Observatory, July 11th, 1893, at 10 a.m.



E.—Faculæ taken on July 13th, 1893, at 8 a.m.



F.—Faculæ taken August 7th, 1893, at noon.

To the Editors of Knowledge.

Sirs,—Colonel Markwick, in his interesting paper on variable stars, is at pains to reconcile his flat curves at minimum with the real ones. This would be easily explained by supposing the nearer star *not* to pass centrally over the other, but so that its upper or lower edge coincided or overlapped its primary. Then the slightest movement to left or right would reduce the occulting area. It would be interesting to calculate curves for bodies of equal size, but only partially occulting one another.

The whole subject suggests in the future a wonderful widening of the harvest of fact. Harold Whichello.

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HOOKED PROCESS ON BEES' MANDIBLES.

To the Editors of Knowledge.

Sirs,—In Knowledge, October, 1895, appeared a letter and sketch of a hooked process on the mandible of the bee (*Apis melifica*). In the succeeding number, Mr. T. A. Cowan wrote asserting that they were not hooks, but hairs, and pointing out that they were correctly figured in his book on the honey bee. This is rather ancient history, but my excuse for referring to the subject after so long an interval is that immediately after the publication of my letter I was laid on my back by a long illness, which for a long time after recovery prevented the use of my microscope. I have now taken up the subject again. I have asked the opinion of several gentlemen of authority as entomologists—among others, Mr. Fred. Enock, whose most interesting papers are now appearing in your columns—and they endorse my view that the objects under discussion are hooks and not hairs. I have carefully examined Mr. Cowan's book, and I find that they are *not figured* there, neither is any reference made to them, inclining me and others to think that Mr. Cowan has mistaken the hairs that fringe the mandible for the hooks that are placed on the buttress of chitine that bridges the concavity of the mandible. They are so specialized that Mr. Enock says that they must have some very practical use (I suggested in my letter that they might be used in clustering), but at present that use is a mystery. Sir John Lubbock was kind enough to inform me that he had not previously noticed them, and had no idea of their utility; so that perhaps I may, though with the humbleness of the tyro, be permitted to claim that I was the first to call attention to these interesting microscopic objects, all the more remarkable for having remained so long unnoticed on an insect so closely studied as the hive bee. Walter Wesché.

ARTIFICIAL FACULÆ.

By the Rev. Arthur East.

An article appeared in the December and April Numbers of Knowledge giving an account of some experiments made with paper pulp in order to illustrate a theory of the formation of sunspots. It is proposed in the present article to apply the same method to faculæ.

It had long been almost necessarily supposed that the faculæ, as the bright rifts and ridges seen on the edge of the sun are called, extended really over the whole spot-zone surface of the sun; but it was reserved for Prof. Hale actually to photograph them with his spectro-heliograph in localities extending across the whole disc, where, telescopically, faculæ are invisible.

A delightful account of this triumph of photography is given in Sir Robert Ball's "Story of the Sun"; and by the kindness of Prof. Hale, now at the Yerkes Observatory, I am enabled to illustrate this article with three of the remarkable pictures of the solar surface taken with the spectro-heliograph of the Kenwood Observatory in Chicago.

What will immediately strike anyone accustomed only to the telescopic appearance of spots is the *cloudy* aspect of the solar surface, and the absence of the clearly cut, crisp outline of the spots to which he is accustomed, but an aspect which the artificial spots (as may be seen) very faithfully reproduce; this cloudy appearance is not due, I believe, to any imperfection of the photograph, but to the faculæ being so much more evident. We seem to see here cloudy masses of vast extent lifted high above the surface of the photosphere, and bright because lifted beyond the "fog or smoke stratum" of the sun (an expression of Prof. Hastings, endorsed by Prof. Young, and most consoling to the Londoner).

There is one most instructive feature in the spectro-heliographs here given, viz., that there are several *pairs* of spots visible—not circular, but elliptical, and with the appearance of being, as it were, *back to back*, as if the spots were openings on opposite flanks of a vast tumulus; and looking as though, were the overlying mass to be removed, a single orifice would be disclosed underneath.

And it also very clearly appears from these pairs of spots that the penumbra being widest on the eastern edge of a spot which is passing off the limb, is no argument against the Wilsonian theory of depression, but may be due to the spot being crateriform, or an *elevated* depression, as suggested in a former article.

Now, this lifting of the photosphere into faculæ is precisely what we frequently get with the artificial spots, as Fig. B may help to show. When the heat is applied, often, instead of any spot appearing, flocculent masses rise, and are, moreover, remarkably permanent—a characteristic feature of faculæ according to Prof. Young: the heated water meanwhile escapes at the sides of the upheaved mass; but, if the mass be removed, an ordinary spot is found below (Figs. A and C).

There is probably no doubt now remaining that faculæ are very closely related to spots; spots are apparently always accompanied by faculæ, although faculæ often occur without spots, but the particular nature of the relationship is not known.

The behaviour of artificial faculæ—as Figs. A, B, and C will show—suggests that the faculæ are really masses of condensed vapour which *overhang and conceal* the spots, and that in many cases, if not in most, if the faculæ are dispersed an ordinary spot will be disclosed. Thus Fig. A shows two patches of faculæ, but one is uncovered to show the spot below; Fig. B, again, is a larger mass of artificial faculæ. After this photograph was taken, the overhanging mass was gently removed in one place, and Fig. C was taken, to show the ordinary spot below. The relationship between faculæ and spots would thus be exceedingly close, the suggestion being that wherever faculæ are seen there also are corresponding spots below, from which the vapours forming the faculæ are being, or have been, ejected; that in certain conditions of the solar atmosphere, as in our terrestrial atmosphere, these condensed vapours are reabsorbed or dispersed, and the *open* spot (if it may be so termed) disclosed; but that at other times the vapours are not so dispersed, and continue to overhang the spot from which they come, entirely concealing it, and appearing as part of the photosphere, except to the eye of the spectro-heliograph.

If this be so, and faculæ in all cases have spots below them, it would explain very simply the extreme rapidity with which large spots at times appear; they are, in fact, *uncovered*. The telescope shows, perhaps, a disc entirely plain and free from spots, ignoring faculæ which it is unable to show. Meanwhile the spots may be there concealed by faculæ, until some violent disturbance scatters the faculæ and the spot is suddenly revealed.

Faculæ would be, according to the view here expressed, identical with the photosphere, being only solar clouds at a higher level, but distinct from the prominences, although closely associated with them.

[Kindly allow me to say that, when writing the article on sunspots which appeared in the April Number of Knowledge, I was quite unaware of the passage from the late R. A. Proctor's "Old and New Astronomy," and of his ideal section of a sunspot, quoted by Mr. Wm. Shackleton, or I should certainly have referred to it; but I am grateful to Mr. Shackleton for drawing attention to the passage.—Arthur East.]

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THE OBJECTIVE PRISM, THE FLASH, AND THE REVERSING LAYER.

By E. Walter Maunder, F.R.A.S.

Within the last few years a special form of spectroscope has come largely into public notice. Readers of Knowledge need only refer back to the number for March, 1897, and they will there find, opposite page 78, six beautiful photographs of stellar spectra. These, as Mr. Fowler has fully explained in the article which accompanies the plate, were taken with what is now usually called a "prismatic camera"—that is to say, a photographic telescope before the object glass of which a prism or train of prisms had been placed. In effect this formed the posterior half of a giant spectroscope, the anterior—the slit and collimator—being absent. The slit was not needed, as the star is itself but a point of light, as minute as the narrowest slit; the collimator was not necessary, as the rays of light from the star were already parallel when they reached the prism. The prism and view-telescope, therefore, were all that in this case were required.

The spectrum of a star with such an instrument is a very narrow line; a broken line whose vacant spaces represent the dark Fraunhofer lines that we see in the solar spectrum. Such a broken line would be too narrow for useful work, but by causing the telescope to move at a slightly different rate from that of the star the latter can be made to "trail," and thus the spectrum may be broadened out to any required extent. As will be seen by reference to the plate in question, a star spectrum so obtained looks exactly like the spectrum given by an ordinary slit spectroscope.

But this instrument is quite suitable for other kinds of work, and its recent revival as an eclipse instrument, by Sir Norman Lockyer, has shown it to be, taken all round, our most powerful instrument for eclipse research.

But the appearance of the spectra of an eclipse with a prismatic camera is quite different from the spectra to which we are ordinarily accustomed. If we look through a prism at the young moon when she first sets her thinnest silver crescent in the western sky, we shall see a spectrum like that which an ordinary slit spectroscope will give us, but with one great difference: the dark lines would no longer be straight, but would be semicircles. All the chief lines so familiar to us in the ordinary Fraunhofer spectrum would be there, but instead of each being an image in negative of a straight narrow slit, each is an image in negative of the slender arch of the moon itself. Exactly in the same way, if we watch through a prism the coming on of an eclipse of the sun, we shall see, shortly before totality, when the encroaching dark disc of the moon has reduced what is left of the sun to a thin crescent-like arc, a spectrum with the Fraunhofer lines all circular arcs; images in negative, that is to say, of the little strip of sun still uneclipsed, instead of the straight lines with which the ordinary slit spectroscope has made us familiar. In other words, we shall see spectra precisely like the first and last of the splendid series of photographs which Mr. Evershed gave us in the June Number.

So far the matter is very plain, but just before second contact the state of affairs becomes much more complicated. It may appear a very obvious truism to say that, at any moment during the eclipse, the spectrum which we obtain is the spectrum of that bright object which is exposed to our view at that moment, but it is a fact which has to be very clearly kept in mind. In a slit spectroscope, the slit is the source of light, for no other light is admitted to the spectroscope except that which comes through the slit. The slit may not be fully illuminated, and, in such a case, it is only the lighted part of the slit which is the source of our spectrum. But here, with a prismatic camera directed towards an eclipse in progress, the source of light is the whole of the phenomena—sun, chromosphere, prominences, and corona—that at the moment of observation remain uncovered by the dark body of the moon.

The accompanying diagram (Fig. 1) may serve to show just what it is which forms our source of light at the instant before second contact. Let the arc C A B D represent the dark approaching limb of the moon. The arc A K B represents the limb of the sun, and, as we see, only a very narrow segment of sunlight remains still disclosed. Beyond the sun's limb, however, there is a gaseous envelope of which the chromosphere forms a part. For the sake of distinctness I have supposed this envelope to consist of two strata, an upper and a lower, and we may consider the former as representing the chromosphere, the latter as representing the "flash."

What is the appearance of the spectrum at this moment? The small arc of sunlight still remaining gives us, of course, a continuous spectrum, and it will be seen that this continuous spectrum must narrow very fast as the actual moment of totality comes on. This narrowing strip of continuous spectrum is of course crossed by the Fraunhofer lines, each of which is of the same general shape as the little arc of sunlight. But above and below this arc of sunlight we find the dark limb of the moon bordered only by the gaseous envelope. At the point of the cusps, and a little beyond, we have both strata, but the lower becomes narrower and narrower, and terminates at C and D. The upper stratum can be traced further still, until it, too, is cut off by the lunar limb at E and F.

These arcs, then, A C, C E, and B D, D F, being arcs simply of glowing gas, give us bright-line spectra. The elements contained in each region will each give its own spectrum of bright lines, and these bright lines will each supply an image of the region over which that particular element is found. Above and below the continuous spectrum, therefore, with its arched Fraunhofer lines, we find a bright-line spectrum of tapering horns of light of different lengths, and we see at once that the length of any arc is an index of the height above the sun to which that particular bright line can be traced.*

As the fateful instant approaches, the continuous spectrum narrows faster and faster; the bright horns above and

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* It does not, however, follow that the gas giving rise to the line extends right from the sun's surface up to this height. It may simply exist as a thin shell at the height thus determined. The different effects in the two cases are not considered here.

below multiply and extend; and just at the last moment before totality is accomplished the continuous spectrum is invaded by a number of dark longitudinal lines, resembling the "dust lines" in an ordinary slit spectroscope. The edge of the moon is of course somewhat rugged, and here and there a mountain peak or range will project right across the thread of sunlight which remains, and interrupt the continuous spectrum at that point. But the effect is not quite that of an ordinary "dust line," for if the mountain, as at G, cuts out the sunlight, it does not cut out the gaseous envelope above. This is free, therefore, to yield its own bright-line spectrum, and consequently we see our "dust line" sparkling out here and there into stars of coloured light. H is an instance where a lunar mountain hides the lower gaseous spectrum, and allows us only to see the upper. P, again, is the summit of a prominence which appears quite detached from the sun, since its base is hidden by the moon. It therefore shows itself in the spectrum by a row of tiny coloured images of itself, shining like stars, quite detached from the remainder of the spectrum. In most prominences these will be the lines of hydrogen, helium, and the celebrated H and K lines.

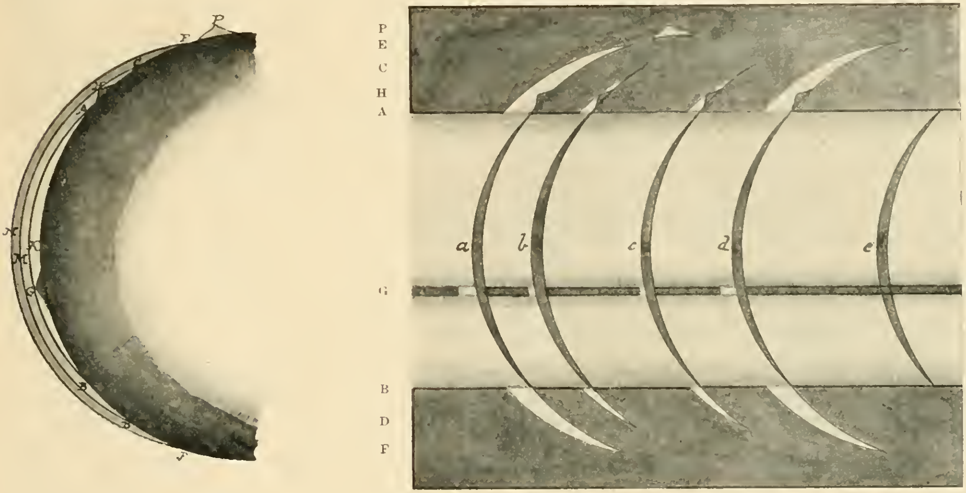

Fig. 1.—Diagram to illustrate the appearance and meaning of the Spectrum of an Eclipse, just before totality, as obtained with a Prismatic Camera. The left-hand figure represents the portion of the Sun and its Atmosphere still visible beyond the black disc of the advancing Moon; the right-hand figure the corresponding Spectrum. Lines *a* and *d* are supposed to be lines common to the Sun, the "Flash," and the Chromosphere; lines *b* and *c* are common to the Sun and the "Flash"; line *e* is seen only in the Solar Spectrum as a dark line.

The crisis is at hand; the interruptions, which I have likened to "dust lines," multiply and broaden. The intervening continuous spectra are worn down to thinnest threads, then snap and vanish, and totality has come. The tiny stars which broke up the "dust lines" flash out as a long sequence of little arcs of colour, and shine for a second, or perhaps two, ere the encroaching dark limb of the moon covers the stratum to which they belong and hides them from us. That brief, brilliant glimpse of little bright-line arcs is what is known as the "flash"—the "so-called flash," as certain over-cautious writers have termed it, in the spirit of him who censured the manners of this "so-called nineteenth century." "Flash" it is—a most wondrous and beautiful sight, be its explanation what it may.

The "flash" was first seen by Prof. C. A. Young in the eclipse of 1870, with a slit spectroscope attached to a telescope, the slit being placed as a tangent to the limb of the sun at the point of second contact. As he watched he saw the ordinary solar spectrum gradually fade away, and "all at once, as suddenly as a bursting rocket shoots out its stars, the whole field of view was filled with bright lines."

It will be seen, then, that this "bursting rocket" is but a stage in a process that has been going on for some time. It began at an early stage in the eclipse with the appearance at the cusps of the bright arcs of H and K, of hydrogen, and of helium, and these arcs have been multiplying right up to the moment of totality; but the final outburst is so instantaneous, and brings so great a number of lines into view, that it seems to stand out like a new phase in the phenomenon. To vary the image, hydrogen, helium, and calcium might be likened to the three performers in a trio, and now, as at the descent of the conductor's baton, they have been joined by the complete chorus.

The "flash," then, represents a shallow stratum of glowing gases immediately surrounding the sun. The height to which any particular gas can be traced can be determined in three ways. First, by the length of the bright-line arc beyond the cusp which it shows at any particular moment; next, by the length of time that the moon takes to hide the stratum; third, by the extent to which a given lunar mountain may interrupt the lines of the gas at a particular moment. In one way or another we find that, roughly speaking, the "flash" corresponds to a stratum of some seven hundred miles in depth.

When Prof. Young first saw the "flash" he considered that the bright lines seen by him corresponded with the ordinary Fraunhofer lines, and he remarks that though "it would be very rash, on the strength of such a glimpse, to assert with positiveness that these innumerable lines corresponded exactly with the dark lines of the spectrum," yet that the general appearance and grouping of the lines in the spectrum seemed perfectly familiar to him. Mr. Pye, who observed the same eclipse and also saw the "flash," says that the effect was "as if all the dark lines were converted into bright ones."

Spectroscopists have, as a rule, been content to accept the "flash" as in all probability practically a reversal of the Fraunhofer lines. Sir Norman Lockyer, whilst objecting to it, thus clearly states the ordinary view as to the "reversing layer":—

(1) We have terrestrial elements in the sun's atmosphere.

(2) They thin out in the order of vapour density, all being represented in the lower strata, since the temperature of the solar atmosphere at the lower levels is incompetent to dissociate them.

(3) In the lower strata we have especially those of higher atomic weight, all together forming a so-called "reversing layer," by which chiefly the Fraunhofer spectrum is produced. ("Chemistry of the Sun," p. 303.)

It follows that, on this view, the spectrum of the base of the solar atmosphere should most resemble the ordinary Fraunhofer spectrum (*ibid.*, p. 306). In 1873, however, Prof. Lockyer was led to take an entirely different view, and he was convinced "that the absorption took place at various levels above the photosphere." ("Recent and Coming Eclipses," p. 99.) "On this latter hypothesis, the different vapours exist normally at different distances above the photosphere, according to their powers of resisting the dissociating effects of heat." It follows that "the spectrum of the base should least resemble the Fraunhofer spectrum, because at the base we only get those molecules which can resist the highest temperatures."

The immense importance of the spectrum of the "flash" becomes at once apparent. Upon its characteristics and upon their interpretation stand or fall our whole conceptions of the chemical constitution of the sun. For the "flash" is the revelation of the spectrum of the base of the sun's atmosphere within the limits of the powers of our present instruments. A depth of seven hundred miles is an enormous one in any atmosphere, and especially in that of the sun, and must include a vast range of conditions, both of pressure and temperature; but we are at present compelled to treat it as an indivisible integer. Keeping this fact in view, that the seven hundred miles of depth of the "flash" stratum must include a great number of very distinct minor strata of which only the lowest can, on the old hypothesis, be in complete correspondence with the Fraunhofer spectrum, it is clear that we can test the rival claims by watching whether or no, as totality comes on, the ever-increasing bright horns which appear above and below the continuous spectrum are the reversals of the dark Fraunhofer arcs. On the old hypothesis, the multiplying bright lines should ever be approaching complete correspondence with the Fraunhofer spectrum up to the moment of commencement of full totality; on Lockyer's hypothesis, they should ever be diverging further from it. The conditions of observation preclude us at present from following out the process to its minutest and final detail. All we can do—and it is sufficient—is to mark in which direction the tendency lies.

It is this question of the direction of progress which is the crucial one—whether, as we get nearer the base of the solar atmosphere, the bright-line spectrum becomes more and more, or less and less, accordant with the Fraunhofer spectrum. It is not a question of establishing a complete and exact correspondence. That we could not expect. Nor is it a question of the relative intensities of the lines. With that question we are not yet competent to deal. It has been generally assumed (Sir Norman Lockyer asserts it nakedly*) that the relative intensity of the bright lines of the spectrum of any element in the laboratory ought to be the same as that of those same lines when dark in the Fraunhofer spectrum. Dr. Johnstone Stoney has recently reminded us how wholly unwarranted this assumption is; for if, as he puts it, we observe the spectrum of some source of white light through a sodium flame, and therefore see the D lines dark in a continuous spectrum, and then increase the brilliance of the sodium flame, we diminish the intensity of those dark lines.

Dr. Stoney also points out that a difference of intensity between the bright-line and the dark-line spectrum may be due to the gas being present in but very small quantities. Thus the D_3 line of helium is very brilliant as a bright line in the chromosphere, but is normally absent as a dark line from the spectrum of the disc. We cannot tell certainly whether this is due to the helium being so bright as to emit as much light as it absorbs from the sun, or whether it is so tenuous as practically to absorb nothing when we look at the sun through it, and only reveals itself at the limb in consequence of the vastly greater depth we look through; or a combination of the two factors may supply the complete explanation. For myself, believing as I do that any true solar atmosphere must be limited to a very few miles above the photosphere, and that chromosphere and prominences, however magnificent in appearance, are of the last degree of tenuity, I am disposed to put much stress upon the second suggestion. The phenomena of comets' tails might remind us how brilliant and far reaching a body may be without any real substance. Indeed, the corona itself is a case in point. We look down upon the sun day by day through millions of miles of depth of its strange, complicated structure, and are not able to recognize the faintest sign of its presence.

The "flash" past, the next stage of the phenomenon is one in which the prismatic camera still asserts its preeminent usefulness. The corona, prominences, and chromosphere, so far as these still lie outside the dark disc of the moon, are now our source of light. The two latter give us a bright-line spectrum only. The corona gives us a bright-line spectrum plus a faint continuous one. We have, then, still a number of bright arcs of different lengths in the spectrum, and of different shapes; for there is no prominence, there is no elevation of the chromosphere, however small, that does not give its own separate spectrum. We find the counterfeit presentment of each painted over and over again in each several tint that the lines of the gases which compose it yield. One such photograph, therefore, supplies us not with one spectrum, but with many; not with one representation of the chromosphere, but many. Thus in Mr. Evershed's beautiful photographs, taken during the total phase and reproduced in the June Number, there is no point of light that is not significant, no dot or line that has not its story to tell.

I trust that I have in the foregoing paper succeeded in impressing upon my readers some of the advantages of the prismatic camera. A further advantage is that by its extreme simplicity it is most economical of light. It is not, indeed, theoretically a suitable instrument for the determination of wave-lengths. Practically, so many of the lines seen in an eclipse being thoroughly well known,

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[*] "The line least intense in the photograph ought to be the least intense in Thalen's tables, and if it existed in the sun at all it ought to be the least intense among the Fraunhofer lines."—"Chemistry of the Sun," p. 231.

no great drawback attaches to it in this respect. In one point, however, it is inferior to the slit spectroscope. If the lines, say from a prominence, are broadened by increase of temperature or pressure, or distorted or displaced by motion in the line of sight, such change in the shape of the line is detected in the slit spectrum: it is confused, in the spectrum with the prismatic camera, with the shape of the prominence itself. Where both forms of instrument can be used, the slit form of spectroscope should therefore not be neglected. If, however, only one form can be employed, and a choice between the two is allowed, then it would be simple folly to prefer the form of the slit spectroscope—with its limited field of view, and the risk that a minute error of adjustment may shut out from it the most important stage of the phenomena (Fig. 2)—before that of the prismatic camera, with its instructive detail, and its grasp of the eclipse in its entirety.

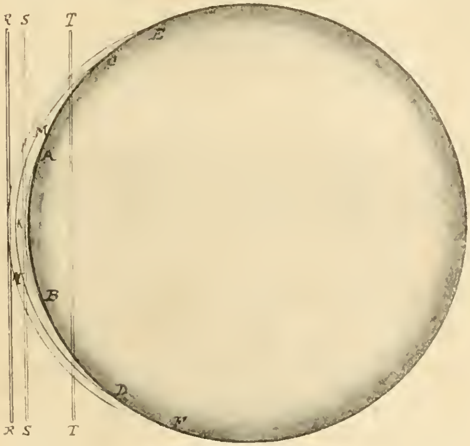

Fig. 2.—To illustrate the relative extents of the fields of view of a Slit Spectroscope and a Prismatic Camera during an Eclipse. The Prismatic Camera embraces the whole area of the phenomenon outside the dark disc of the moon. The Slit Spectroscope only the minute portion of it under the slit. For observation of the "Flash" the slit must be most exactly placed as at S S. If outside the limb of the Sun, as at R R, the "Flash" will be entirely missed; if within, as at T T, only a very small portion of it will be seen.

ALEXANDER GOODMAN MORE.

On the 22nd of March, 1896, Alexander Goodman More, F.R.S.E., F.L.S., M.R.I.A., etc., sometime Curator of the Science and Art Museum, Dublin, passed away, aged about sixty-five years. His life had been one of much suffering and disappointment, owing to constant ill health, but was and is most fruitful to others who can reap where he has sown by patient study in the world of nature. Friends have eagerly awaited the volume of More's "Life and Letters," which is now before the public,* and proves to be a perfect treasury of interesting facts and information about birds, beasts, and butterflies—such a book as every naturalist may be glad to possess, and will find himself constantly referring to. Of the man himself this biography will tell a stranger little; a fact to be regretted, as More's personality was singularly attractive and original. Those who knew him well will not soon forget his quaint dry humour, his royal disdain of "shams" and double dealing in every form, and his determination to secure accuracy in the minutest details. His kindness and forbearance towards young naturalists were unfailing, but he never allowed them to rejoice in the triumph of a new "find" until it was absolutely verified by careful examination. More's own name will be best preserved by the book "Cybele Hibernica," which he prepared in collaboration with the late Dr. Moore, of Glasnevin Botanic Gardens (Dublin). Prof. Babington wrote "Hints" towards such a work in 1859, and one of my friend's latest efforts was to correct the proofs of a revised edition in 1893. This is now a standard work upon Irish botany, but More also wrote a goodly number of important magazine articles: "Studies on the Birds and Flowers of the Isle of Wight," "On Migration, Distribution, and Habits of Birds," etc., while keeping up correspondence with Darwin, Babington, Dr. Günther (on fishes), De Candolle, Newton, and others. Yet he was never too busy to reply to the letters of old friends, and I well remember the patience with which he studied and triumphantly verified the lesser water lily (*Nuphar intermedium*), discovered in one of his rambles beside our lake. We grew tired at last of sending him so many specimens of the plant in different stages of growth; but he persisted with his usual caution: "Verify, verify. Better take trouble and be *quite* sure." In spite of ill health, and, in later years, lameness, More was an enthusiastic collector, and his discoveries added the names of many plants to the list of British flora. I think the little *Neotinia intacta* was among his most valued "finds," but *Chara alopecuroides*, identified by Prof. Babington in 1864, was also a special treasure. From 1867 to 1887 More worked in the Dublin Museum, first as Assistant, afterwards as Curator; and the improvements made during those years must have been very great. He had pre-eminently the power of drawing out what was useful in others, and had soon an earnest band of collectors labouring for him all over Ireland. As an example of the above we note that in 1885 a White's thrush, a wood sandpiper, and a spinous shark were secured for the Museum—all rare, and the second a first specimen found in Ireland. To record here even the most interesting of Mr. More's captures would be impossible. We must refer our readers to the biography for details. He never paraded his knowledge, never boasted of his success; but as years go on one feels that his patient accuracy will make his work permanent, when the memory of more brilliant men has faded away.

C. Maud Battersby.

HOW TO PHOTOGRAPH THROUGH A FLY'S EYE.

By Fred. W. Saxby.

In order to perform this delicate and interesting experiment a photomicrographic apparatus will be required, and the operator should have some experience in the mounting of microscopic specimens. The object of the experiment is to obtain a multiple photograph of the subject, the images of which are to be formed by the lenticular facettes of an insect's compound eye. With few exceptions insects possess two of these eyes, one on either side of the head. The outer covering, known as the cornea, no longer functions as a single lens, but is subdivided into a multitude of extremely small

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* Edited by C. B. Moffat, B.A. Pp. 644. Published by Hodges, Figgis, & Co., Dublin.

closely packed facettes, of usually hexagonal contour and convex surface. They are in some instances so numerous as to occupy nearly the whole of the head.

A section through the eye of the drone-fly, *Eristalis tenax*, gives a general idea of the structure of this organ. The cornea, hyaline in shape, is a modification of the tough exo-skeleton of the insect, and like it consists of chitine. Behind, and in the centre of each facette, is a cone of transparent gelatinous matter, with its base towards the cornea; this cone, which functions as a crystalline lens, terminates at its apex in a nervous filament. The filaments so produced converge as they proceed, and finally fuse into an optic nerve which connects them with the great nerve-ganglion or brain. Each lens with its nervous filament is isolated from those adjacent by the opaque pigment with which the intervening space is filled, so that no light passes into the eye except at that point directly under the centre of each facette. The pigment matter is variously coloured, and is the source of that sparkling appearance often seen in the eyes of living insects when viewed by reflected light.

We are at present concerned, however, with the cornea and its tiny lenses, through which we are to obtain our photograph. Each lens is a compound of two plano-convex lenses, united at their plane surfaces. The corneal mass does not follow any definite curve throughout, being considerably flatter in the middle than at the margin. In some of the larger dragon-flies parts of the eye may be found nearly flat, and on that account will serve our purpose the best. Having secured a specimen of the common dragon-fly, *Libellula depressa*, we can proceed to dissect off the cornea. First remove the head, and embed it in a cell of melted beeswax, so as to obtain a firm hold, leaving one eye exposed. Take a two-edged scalpel, and with the point of it make a series of stabs along the margin of the cornea, going all round. The entire mass, like a little dish with a quantity of pigment matter in it, can then be lifted off. Next melt the beeswax, remove the head, and float the separated cornea, with its contents uppermost, upon the still fluid wax and allow the latter to set. Pare a quill to the shape of a J pen, making the point slightly rounded and thin, and with it scrape out the contents of the eye; the cornea, being extremely tough, is not liable to injury from the point of the quill. Procure a small camelhair pencil, cut down the hairs until only an eighth of an inch long, and, having charged the stump with turpentine, proceed to twirl it about in the "dish," so as to remove the last trace of pigment. Examine under a pocket lens, and, if clean, melt out the cornea, and with a pair of fine scissors trim off the turned-up edge of the "dish," retaining only the flattest part of the bottom. Soak in turpentine until any wax that adheres is dissolved, and you have the lenses for your camera—but the disc is not flat. Select the thinnest cover-glass you can get, clean thoroughly, and place it upon the hot plate as for an ordinary balsam mount. Melt a quantity of the oldest and hardest Canada balsam obtainable, and upon the point of a needle apply a small bead of it, not larger than a pin's head, to the centre of the cover-glass. By the aid of the fine forceps and the warm air, drive off the turpentine from the piece of cornea, and then place it upon the cover-glass, concave side down, with its centre over the bead of balsam. Cut out a small disc of notepaper, rather less in diameter than the "object" you are mounting, and place it centrally over the disc of cornea. Have a three-by-one glass slip handy, support one end of it upon the hot-plate, and allow the other to press upon the object, with the disc of paper in between. Proceed to load the middle of the three-by-one slip with coins sufficient to flatten the piece of cornea. As soon as this takes place the bead of balsam under it will spread out and make its appearance round the margin of the object.

When this can be seen through the slip, remove the spirit lamp and allow the whole to cool. The under side of the flattened cornea will then be cemented to the cover-glass and the "facettes" will be simple plano-convex lenses, since their inner convexities, being embedded in the balsam, will cease to exert their optical properties to any appreciable extent. The mount, resting upon a three-by-one slip, can now be examined under the microscope. Put in a half-inch objective, and, if it has a screw collar, adjust for an "uncovered" object. Use a low power eyepiece of about three diameters and an Abbé condenser. Stop down the aperture and bring the cornea into sharp focus. By a solid cone of transmitted light an hexagonal figure will be seen forming the boundary of each facette. A number of hairs appear upon the eyes of some insects, and it is in the angles of these hexagons that the hairs have their origin. It will require some nicety of illumination, however, to disclose the "lens" in each of these divisions; the solid cone of light as usually transmitted by the condenser fails to reveal them. Remove the limiting diaphragm from the back of the condenser and insert in its place a patch-stop that will give dark-ground illumination with the objective employed, having previously stopped out half the annulus with a strip of black paper. Use the plane mirror, and, with the condenser in focus, this semi-annular beam of light will fall obliquely upon the object and the "eye-lenses" will appear in bold relief (Fig. 1).

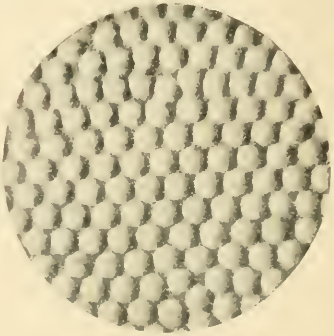

Fig. 1.—Group of "Eye-lenses" ready for the Camera. (× 200.)

To prepare the mount for the microscope, select a three-by-one slip of wood, through the centre of which a small hole has been bored. Lay the cover-glass with the object face downwards over the hole and fasten with a punched gummed label, after the manner of a French paper-mounted slide. Fix the slip firmly in the stage of the microscope. The cornea, being under the cover-glass, is protected from injury, and the facettes, facing the condenser, are in the right position for our experiment.

Next incline the microscope to a horizontal position, and fix it in its place upon the baseboard of the camera. Correct the objective to the thickness of the cover-glass, remove the mirror, and the diaphragms and stops from the substage condenser. Place a microscope lamp about ten inches from the condenser, with its flame in the optic axis of the apparatus and the bull's-eye turned aside. Withdraw the camera *pro tem.*, and proceed to focus up the middle of the object. When the field is full of sharply defined hexagons, and an image of the lamp-flame is seen in the middle of the field, the centreing may be regarded as correct. Upon the next move depends the success of the experiment. Rack down the substage condenser until its front is about half an inch from the object, and then proceed very slowly, by means of the coarse adjustment, to rack the body tube of the microscope back from the object. The hexagons will go out of focus, and nothing can be seen. Continue the backward movement a little farther, and a number of points of light will appear, disposed in rows across the field. Focus with the fine adjustment until sharply defined, and it will be seen these points of light are inverted images of the lamp-flame, each one formed by a "lens" in the cornea. By racking the Abbé a little nearer to the stage the image in each facette will be seen to increase in size, and *vice versâ*. The focus of the objective remains fairly constant for all positions of the condenser, provided this latter is not too near. Tracing the path of light (Fig. 2) we find an image of the radiant is formed in the principal focus of the condenser, at A, which, being at a considerable distance from the cornea, is practically in the indefinite (anterior) focus of the "eye-lenses," B. An image is again formed in the principal (posterior) focus of each "eye-lens," at C, and when this plane C is in the focus of the objective the observer at the microscope can see an image of the radiant through each facette in the field. The corneal convexities, however, are not all of the same diameter and radius, so that where a number will yield a sharp outline of the radiant, others will produce a blurred and indistinct image; but as the area covered by a half-inch objective is very small, there should be little difficulty in finding a group of facettes of similar focus. The subject to be photographed may now be considered; it should be either self-luminous or white. If the former, a window with open landscape beyond will answer, but on account of its large size must be relatively more distant from the instrument. By artificial light, opaque figures pasted on a ground-glass screen illuminated from behind may be tried, but the most satisfactory photographs are those of white subjects by reflected light, such as a bust or statuette. For the purpose of my experiment I have chosen a small chalk bust of Her Majesty the Queen, and is it not appropriate that the noblest and greatest monarch the world has ever seen should be the subject of a photograph through the most infinitesimal lens known to science? Remove the lamp, and in its stead place the object to be photographed in the optic axis of the apparatus, and, say, eighteen inches distant from the condenser; the exact distance will depend upon the amount of subject it is intended to include. It will now be necessary to bring to bear upon the subject all the available illuminating power at our disposal. Two Welsback gaslights, being easily obtained, will do. Place one on either side of the subject in such a manner that their combined rays shall play upon the surface to be photographed. Two curved pieces of new tinplate, placed between the burners and the camera, will improve the illumination and prevent any direct light from entering the condenser. Both burners and reflectors should be as near the object as possible, but must not trespass upon the subjective field. Examine through the microscope, using the substage pinion freely, until an image of suitable size and definition is seen in each facette. Attach the camera and fine focussing rod and see that all is light-tight; the bellows may be stretched twelve to eighteen inches. In spite of the large amount of light reflected from the subject the rays transmitted by the facettes will be extremely faint, owing to their minuteness. They rarely exceed one-thousandth part of an inch in diameter, and it will be found impossible to project through them an image visible upon the ground-glass screen, though the latter be most finely obscured. But the photomicrographer will have more refined methods at his disposal to meet the greater delicacy of his work. Having removed the obscured screen from the frame, insert in its place a piece of plain glass of the same size; a spoiled negative from which the film has been stripped will answer excellently. A focussing eyeglass will now be required, and it must be so adjusted that when resting upon the plain glass screen the furthermost surface of the latter is in focus; this is best accomplished by applying with the finger scales from a moth's wing, or other minute particles upon that surface. Having arranged the eyeglass to our satisfaction, we can return the plain screen to the camera and proceed to focus the subject. To do so the operator must retire a little from the eyeglass so that its lens is seen to be full of light; this will occur when his eye and the screen are equidistant from the lens and in its principal focus. The writer uses a glass in which both distances are determined by a tube. But the images which appeared to the observer at the eyepiece of the microscope will not be in focus at the screen. We have lengthened the major conjugate focus of our apparatus and must therefore shorten the minor. By means of the fine adjustment rod, cause the objective to approach the object, keeping a sharp look-out for images through the focussing glass. It is not by any means easy to determine the exact point at which the images are best defined, and probably many "ins and outs" will be tried before a satisfactory focus is established. Presuming the objective to be of the usual achromatic type corrected for an optical focus, an isochromatic plate—the most rapid obtainable—should be employed, as the plates so designated are extra sensitive to the yellow or visual rays within the C and E lines of the spectrum. Exposure will depend, among other things, upon the desired size of the images and consequent camera stretch, and may be as much as, or more than, three hours. I shall not here enter into details of development; that formula with which the operator has had most experience is the best. Although the first plate *may* prove a success, it is advisable not to remove any of the apparatus until a satisfactory negative has been obtained.

Fig. 2.—The "Eye-lenses," B, act as Telescopes. Aërial foci at A and C.

In the distribution of visual organs nature has been most lavish to the insects, and we are filled with astonishment when we reflect that from a dragon-fly's head we could obtain twenty-five thousand perfect lenses, so minute that a million of them would not cover a square inch of surface, and yet each be capable of yielding a recognizable photograph. Had nature provided man with eyes in similar profusion, how much more could he have seen of her wisdom!

> "I, like Samson, would have eyes at every pore.
> To see the light and learn of truth the more."

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NOTES ON COMETS AND METEORS.

By W. F. Denning, f.r.a.s.

The Discovery of Comets.—In the last number attention was drawn to the relative scarcity of new comets discovered during the eighteen months preceding June. The latter month, however, furnished a record, for three new comets were discovered, while two known comets were redetected. It will be found on searching through catalogues of comets that no other month has ever yielded such an abundant harvest of important observations in this branch of astronomy. This is the more remarkable from the circumstance that June, with its strong twilight, is unfavourable to the detection of comets. The summary of recent discoveries may be stated as follows :—

	Discoverer.	G. M. T.	Position of Comet.				Perihelion Passage. Berlin Mean Time.
			α		δ		
			°		°		
1.	Coddington	June 11·722	246	14	−25	14	Sept. 13 849
2	Tebbutt	June 11·844	103	22	+11	34	Mar. 25·0
3.	Perrine	June 14·974	52	15	+58	36	Aug. 16·338
4.	Hussey	June 16 967	34	5	+19	43	July 4 60
5.	Giacobini	June 18·526	309	7	−21	14	July 24·894

No. 2 is a reobservation of Encke's periodical comet, No. 4 of Wolf's comet. These, with Perrine's comet found on March 19th, represent a total of six comets visible, though they cannot all be seen on the northern hemisphere. Encke's and Coddington's comets have a southern declination of about forty-five degrees early in August. The latter is the second comet discovered accidentally on a photographic plate, the previous instance being that of 1892 V., which was similarly detected by Mr. Barnard. There can be no doubt that astronomical photography, when it comes to be more extensively practised, will afford the means of revealing many new comets.

Dr. Schorr has pointed out that the elements of Perrine's comet of June 14th exhibit a remarkable similarity of elements with those computed for Pons's comet of 1812 and 1884.

The following are ephemerides of three of the comets now visible :—

Comet Wolf.

Date. 1898.		R.A. h.	m.	s.	Declination. °	′	Distance in millions of miles.	Brightness.
August	6	4	42	28	+17	27·4	170	2·42
,,	10	4	52	59	+16	48·8	168	2·44
,,	14	5	3	13	+16	6·0	166	2·47
,,	18	5	13	12	+15	19·6	164	2·49
,,	22	5	22	52	+14	29·5	162	2·50
,,	26	5	32	13	+13	35·7	160	2·53
,,	30	5	41	13	+12	39·5	159	2·55

Comet Perrine (March 19th).

Date. 1898.		R.A. h.	m.	s.	Declination. °		″	Brightness.
August	2	5	58	10	+52	37	15	0 07
,,	6	6	3	44	+52	22	31	0·06
,,	10	6	8	51	+52	8	45	0 06
,,	14	6	13	30	+51	56	4	0·06
,,	18	6	17	40	+51	44	29	0·06
,,	22	6	21	22	+51	34	2	0·05
,,	26	6	24	35	+51	24	43	0·05
,,	30	6	27	21	+51	16	32	0 05

The distance from the earth varies very little from two hundred and seventy millions of miles during the month.

Comet Perrine (June 14th).

Date. 1898.		R.A. h.	m.	Declination. °	′	Distance in millions of miles.	Brightness.
August	14	8	9 0	+11	56	135	8·4
,,	30	9	17·2	− 9	14	134	7·0
September	15	10	36·0	−24	43	145	3·7
October	1	11	57·2	−37	44	166	1·8
,,	17	13	11·7	−43	29	193	0·9

At the middle of August this comet will be only about twenty-three degrees west of the sun, so the conditions affecting its visibility will be very unfavourable. It is moving rapidly southwards and will soon be lost to observers in our latitude.

In addition to the various comets mentioned, astronomers are expecting the return of Tempel's comet (1867 II.), but its detection has not yet been announced; and, in view of the fact that its distance is increasing, and that it escaped observation at the last three returns, there seems but a slender prospect that it will be observed during the present year.

August Meteors.—With the return of the Perseids, meteoric observers have plenty of attractive work in hand. Meteors are abundant, and the season is a convenient one for night work of this kind. This year the moon will be full on the morning of August 2nd, so that in the early part of the month the sky will be very light, and only the larger Perseids are likely to be observed. Moonlight will, in fact, prove rather a serious hindrance to observation during the first eight or nine nights, for our satellite moves so rapidly northwards that she rises very little later on successive evenings. Her age and times of rising, at the most important period, are as follows :—

1898.		Age at noon. d.	h.	Time of rising. h.	m.	
August	8	20	16·2	9	36	p.m.
,,	9	21	16·2	10	4	,,
,,	10	22	16·2	10	41	,,
,,	11	23	16·2	11	26	,,
,,	12	24	16·2	12	20	,,

The last quarter occurs on the evening of the 9th, so that on the night of the 10th, when the maximum of the shower is usually attained, the light of the moon will have declined so much as to be comparatively feeble. In the last number an ephemeris was given of the Perseid radiant to the end of July, and the following is a continuation of it to August 18th, when the display will be nearly exhausted:—

		°	°				°
August	1	35	+ 55	August	10	45	+ 57
,,	2	36	+ 55	,,	11	46	+ 57
,,	3	37	+ 56	,,	12	47	+ 57
,,	4	38	+ 56	,,	13	49	+ 58
,,	5	39	+ 56	,,	14	50	+ 58
,,	6	40	+ 56	,,	15	51	+ 58
,,	7	41	+ 57	,,	16	53	+ 59
,,	8	42	+ 57	,,	17	54	+ 59
,,	9	44	+ 57	,,	18	55	+ 59

It will be interesting to test the accuracy of this ephemeris by careful observations made on the individual nights mentioned. Notwithstanding the interference of the moon the Perseids are usually so active, even at the early part of August, that the radiant point may be readily derived.

Bright Meteors.—On June 5th, about 10h., a meteor brighter than Vega travelled from β Ophiuchi to β Lyræ. It was bluish white in colour, and left a trail of sparks. Observer : Mr. Albert Ashby, West Croydon.

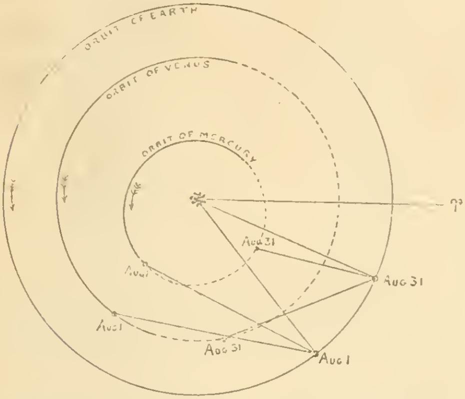
On June 26th, 11h. 24¼m., a meteor, about as bright as a first magnitude star, appeared in a barren part of the sky, eight degrees north of the star σ Sagittarii. It pursued an upward course, vanishing exactly one degree west of θ Serpentis, and during its flight increased so much in brilliancy that at the end it was equal to Venus at her best. The meteor was bluish white in colour, and moved slowly along its path in about five seconds. Observer : Rev. S. J. Johnson, Bridport, Dorset.

THE FACE OF THE SKY FOR AUGUST.

By A. Fowler, F.R.A.S.

Sunspot activity is apparently approaching a minimum, so that perhaps few spots of considerable magnitude may be expected. Still, abnormal conditions have been noted in the past, and careful observation may not go unrewarded. Bright faculæ and coarse granulation of the general surface have been recently noted.

Mercury will be an evening star, reaching its greatest easterly elongation of 27° 22′ at 3h. A.M. on the **9th**. On that day he sets at 8h. 13m. P.M.—that is, only forty minutes after sunset—so that the planet is not particularly well situated for observation in this country. The apparent diameter on the **1st** is 6·6″; on the **9th**, 7·4″; on the **15th**, 8·1″. At noon on the **1st** the horizontal parallax is 8·8″, the distance of the planet from the Earth thus being identical with that of the Sun.



Orbital Movements of Earth, Venus, and Mercury during August, 1898. (The dotted lines represent the parts below the ecliptic.)

Venus is an evening star throughout the month, but the southerly movement will render her appearance less striking to the naked eye than might be expected. During the month her declination changes from 4° 49′ N. to 10° 16′ S., and her apparent diameter increases from 15·6″ to 20 0″. On the **19th** at 6h. P.M. she will be in conjunction with Jupiter, 1° 51′ to the south; on the **21st** at 8h. A.M. she will be in conjunction with the Moon, the planet being 5° 3′ to the north. The planet will set at 8h. 52m. P.M. on the **9th**, seventy-nine minutes after sunset, and at 8h. 2m. P.M. on the **29th**, seventy minutes after sunset. At the middle of the month 0·65 of the disc will be illuminated.

Mars is still so distant that only large instruments are likely to reveal any detail. As a matter of comparison it may be of interest to note that at the favourable opposition of 1892 his horizontal parallax was 23·4″, corresponding to a distance from the Earth of 34,935,000 miles, while at the middle of August it will be 5·6″, corresponding to a distance of 145,980,000 miles. At the middle of August his apparent diameter is only 6·0″. On the **1st** he will be 5° north of Aldebaran, and will travel eastwards, until on the **23rd** he will be about 2° north of ζ Tauri. He will rise shortly before midnight in the earlier part of the month, and about 11h. P.M. towards the end.

Jupiter may be observed shortly after sunset during the early part of the month. He passes eastward from near η Virginis on the **1st**, through a point less than 2° south of γ Virginis on the **20th**. The polar diameter diminishes from 30·6″ to 29·0″.

Saturn, in Scorpio, may still be observed in the early evening. On the **9th** he sets at 11h. 21m. P.M., and on the **29th** at 10h. 3m. P.M. He will be stationary on the **9th** and in quadrature on the **29th**. The outer major and minor axes of the outer ring vary respectively from 40·02″ to 38·71″ and 17·37″ to 16·87″ from the **8th** to the **28th**; during the same period the corresponding dimensions of the inner bright ring vary from 25·47″ to 24·64″ and 11·06″ to 10·74″ respectively; and the apparent polar diameter of the planet diminishes from 16·0″ to 15·4″ between the same dates. The northern surface of the ring is visible.

Uranus remains a little east of λ Libræ, forming an almost equilateral triangle with β and δ Scorpii. The planet is very low in the sky, and even at the beginning of the month sets before midnight. The apparent diameter diminishes from 3·8″ to 3·6″ during the month.

Neptune describes a short eastward path in Taurus, from about 1° to 1½° north-east of ζ Tauri. At the beginning of the month he does not rise until after midnight, but towards the end he will rise shortly before 11 P.M.

The Moon will be full on the **2nd** at 4h. 29m. A.M.; she will enter the last quarter at 6h. 13m. A.M. on the **9th**; will be new at 10h. 35m. A.M. on the **17th**; enter the first quarter at 8h. 32m. P.M. on the **24th**; and will again be full at 12h. 51m. P.M. on the **31st**.

A conveniently observable minimum of Algol is due about 9h. 44m. P.M. on the **23rd**. Other minima, at less convenient times, will occur on the **3rd** at 8h. 2m. P.M., and on the **20th** at 12h. 55m. P.M.

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Chess Column.

By C. D. Locock, B.A.

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

Solutions of July Problems.

No. 1.

(By A. G. Fellows.)

1. Kt to Q7, and mates next move.

Correct Solutions received from Alpha, W. de P. Crousaz, H. S. Brandreth, J. M'Robert.

No. 2.

(By A. C. Challenger.)

Speaking from memory we believe that the author's intended solution was 1. R to B6. Our trustworthy correspondent "Alpha" claims that this attempt is frustrated by 1. . . . B×P. We must apologize for our inability to verify this, having unfortunately mislaid the current number of Knowledge. W. de P. Crousaz also claims "no solution."

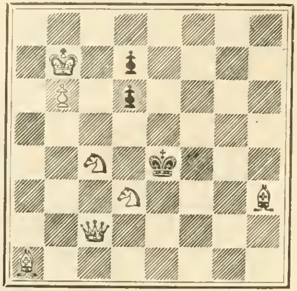
B. G. Laws.—Many thanks for the problem, a copy of which shall be sent you next month. We congratulate the problem department of the *British Chess Magazine*.

PROBLEMS.

By J. Nield (Crompton).

No. 1.

Black (3).

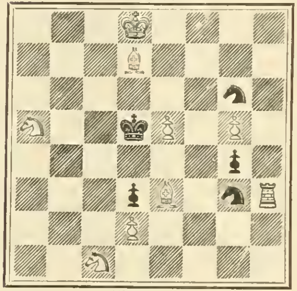


White (7).

White mates in two moves.

No. 2.

Black (5).



White (9).

White mates in three moves.

CHESS INTELLIGENCE.

We much regret to have to announce the death of Mr. James Rayner, the problem editor of the *British Chess Magazine*, and for many years one of the strongest players in the North of England. Mr. Rayner was also certainly one of the finest English problem composers, and his death at the early age of thirty-nine is a great loss to the chess world. He is succeeded in the problem department of the *British Chess Magazine* by Mr. B. C. Laws, who formerly conducted the problem department of the *Chess Monthly*.

The Vienna international tournament still continues. Messrs. Pillsbury, Tarrasch, Janowski, and Steinitz are leading at present. Of the English representatives, Mr. Burn is doing best. Herr Schwarz retired after playing eight games only, and his score was cancelled. The Congress of the German Chess Association begins at Cologne on July 31st.

There is little chess of importance in England at this season, but Messrs. Lee and Teichmann are engaged in a short match.

The amateur tournament of the Southern Counties Chess Union begins at Salisbury on Monday, September 5th, and will be continued, if necessary, till September 14th. All entries must reach Mr. C. J. Woodrow, 3, Castle Street, Salisbury, on or before August 31st, and must be accompanied by entrance fees. Further particulars may be had on application to the above address. Messrs. Bird and Blackburne will probably be present during the meeting.

Game played in the Vienna tournament:—

"Kisseritzky Gambit."

White. (C. A. Walbrodt.)	Black. (A. Burn.)
1. P to K4	1. P to K4
2. P to KB4	2. P×P
3. Kt to KB3	3. P to KKt4
4. P to KR4	4. P to Kt5
5. Kt to K5	5. B to Kt2
6. P to Q4	6. Kt to KB3
7. Kt×KtP	7. Kt×P
8. B×P	8. Q to K2
9. Q to K2	9. P to Q3
10. Kt to K3	10. B to K3
11. P to B3	11. Castles
12. Q to B3	12. P to Q4
13. B to Q3	13. P to QB4
14. B×Kt	14. P×B
15. Q to Kt3	15. P×P
16. B to Q6	16. Q to Qsq
17. P×P	17. R to Ksq
18. P to Q5	18. B to Q2
19. Kt to B3	19. Kt to R3
20. Castles (KR)	20. R to QBsq
21. R to B2	21. P to B3
22. QR to KBsq	22. K to Rsq
23. P to R5	23. Kt to B4
24. P to R6	24. B×P
25. R×P	25. B×Kt2
26. R to B7	26. B to Q5
27. R×Pch	27. Resigns.

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WHALE MODELS AT THE NATURAL HISTORY MUSEUM.

By R. Lydekker, B.A., F.R.S.

Although many of us have from time to time witnessed the evolutions of a shoal of porpoises from some seaside pier, or the deck of a coasting vessel, while more fortunate individuals have enjoyed the spectacle of a whale rising from the water by the side of an ocean steamer, or have seen a stranded specimen on the beach, to the majority of landsmen the larger members of the Cetacean order have hitherto been more or less mysterious creatures. Their proper form and size have been but vaguely realized, and their peculiarities of structure most imperfectly conceived. Not improbably there are still in existence persons whose knowledge of whales is mainly, if not exclusively, limited to "whalebone" and sperm-whale teeth, and who have some vague idea that the two are products of one and the same animal. A year or so ago anyone who visited even the most advanced and up-to-date museum would have come away with little more idea of the external form and dimensions of these mighty denizens of the deep than the misleading and unsatisfactory impressions that can be gathered from a study of their bare skeletons. It is true that in some Continental museums, like the one in Paris, casts of stranded examples of some of the smaller species have for some time been exhibited, but the distorted and "flabby" condition of the animals themselves when thrown ashore rendered the resulting plaster-casts very far indeed from affording a lifelike representative of the species, while their comparatively small size precluded the realization of the vast dimensions attained by the giants of the group.

This unsatisfactory condition of affairs has been totally changed by the opening on Whit Monday last of the new Whale Gallery in the Natural History Branch of the British Museum. Here, for the first time in the history of the world, may be seen some of the largest representatives of the Cetacean order modelled of the natural size, and as lifelike in appearance as the resources of modern skill and science can make them. The exhibition is indeed a truly marvellous one, and its conception and successful execution will remain as a permanent memorial of the administration of Sir W. H. Flower, whose great aim has been to make the great institution under his charge as popular and instructive as possible, and under whose immediate personal superintendence the present addition was carried out from first to last.

From an educational point of view the value of the new exhibition cannot be over estimated; from a purely popular standpoint, as a "show," it will be very hard indeed to beat; while even to the professed naturalist it is of the highest interest, and presents several problems still requiring elucidation as to details of form in one or two species. Mystery in regard to our conceptions of the form of these huge denizens of the deep is, however, practically at an end; and for the future there ought to be no misconception as to the nature and position in the body of the substances respectively known as whalebone and spermaceti, and the animals to which they severally belong. Much importance has been rightly attached by the Director to an adequate supply of carefully-written descriptive labels, and these have been placed in positions convenient for the study of the groups or species to which they refer. The labels are of two kinds—large and small; the former referring to groups and the latter to particular species. Of the large labels, all of which are affixed in conspicuous positions on the walls of the buildings, the first gives in popular form the leading distinctive features of the order Cetacea, which, it is almost needless to observe, includes not only the animals commonly known as whales, but likewise porpoises, grampuses, and dolphins. The first point necessary to a right comprehension of the mutual relations of these animals is to thoroughly realize the difference between the whalebone whales and the toothed whales, or those which produce whalebone, or baleen, and those whose mouths are simply armed with teeth, of larger or smaller size and number. To emphasize the distinction, the whalebone whales, whether models or skeletons, have all been set up with their heads pointing to the north end of the gallery, while all the toothed whales are turned in the opposite direction; the distinctive features of the two groups being likewise clearly set forth in large labels on the walls. Yet another set of similar sized labels enables the public to grasp the difference between right-whales and rorquals; while the characteristics of the individual species exhibited are displayed on smaller labels mounted on stands placed in front of the specimens to which they refer.

Those of our readers who have seen the gallery (and it may be hoped that those who have not will take the earliest opportunity of doing so) will not fail to realize how cleverly economy of space and material has been effected in the construction of the models. This has been done by taking the mounted skeleton of the specimen to be operated upon, and building upon one side of it a hollow half-model of the external form. As the right side of the body has been thus modelled in the whalebone whales, and the left side in the toothed whales, it results from this ingenious plan that whereas the visitor on entering the gallery sees the external form of the species that have been modelled, when he moves to the opposite side he is confronted with a view of the skeleton surrounded by the outline of the bodily contour. By this means not only are the skeletons as accessible as before for the purposes of anatomical study, but the relationship of their component portions to the bodily form is most clearly displayed. Accuracy in the modelling has been secured from the circumstance that the skeletons of most, if not all of the specimens, are those of stranded individuals, whose form and proportions have been recorded while in the flesh from measurements and drawings or photographs.

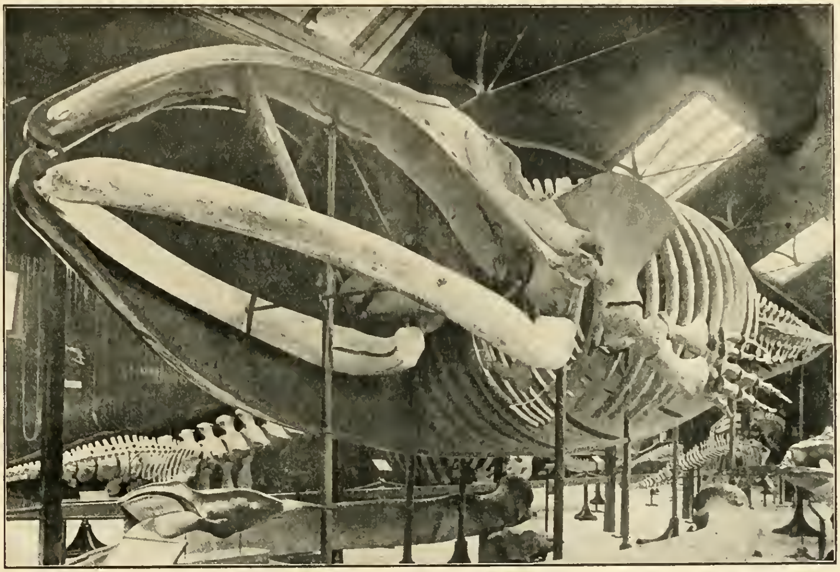
In its present condition the gallery contains models of six of the larger species, namely, the southern right whale (*Balæna australis*), Rudolphi's rorqual (*Balænoptera borealis*), and the common rorqual (*Balænoptera musculus*), among the whalebone whales; and the gigantic sperm whale (*Physeter macrocephalus*), the killer (*Orca gladiator*), and the white whale (*Delphinapterus leucas*), among the toothed whales. Of these, the killer differs from the others in that it is represented by a complete model, alongside of which is mounted the bare skeleton. The first of the four larger models attempted was that of Rudolphi's rorqual, which was undertaken somewhat as an experiment to see how the idea would work. As this is a comparatively small species (scarcely reaching fifty feet in length at its maximum) it obviously did not give an adequate idea of the huge dimensions attained by other members of the group, and, consequently, a model of the much larger common rorqual was subsequently executed. This accounts for the circumstance that while the rorquals are represented in the gallery by two species, there is at present no model of the allied but very different hump-backed whale (*Megaptera*), for which room does not now remain. But it may be hoped that an extension of the limits of the building may ere long admit of this very important species being added to the exhibition.

The finners, or rorquals, are noted among whalers for their extreme speed, and, consequently (especially as their short whalebone is of but little value), escaped persecution until the introduction of steam vessels and harpoon guns; and the models, in comparison with the one of the southern right-whale, clearly show how their long slender bodies are adapted for the attainment of such rapidity of movement. In these specimens the whalebone has been placed in its natural position in the skull, and thereby exhibits its characteristic shortness. Another feature shown almost for the first time in these models is the capacious distensible pouch occupying the throat of the rorquals, the flexible longitudinal bands in the pouch constituting the characteristic groovings seen in the skin of this part of these animals. On the skeletal aspect of the common rorqual the tiny bony nodule, which alone represents the thigh-bone, or femur of ordinary mammals, can scarcely fail to arrest attention, and affords a most interesting example of a rudimentary, or, rather, vestigiary organ. Although the common rorqual, which grows to sixty-five or seventy feet in length, is not the largest member of the group, being exceeded in this respect by the blue rorqual (*B. sibbaldi*), which reaches eighty or even eighty-five feet, yet the model in the gallery serves to show that very exaggerated ideas of the dimensions attained by these monsters formerly prevailed, and even yet do not appear wholly extinct. And it may be hoped that with the opening of this gallery to the public we shall hear the last of blue rorquals measuring a couple of hundred feet in length.

Passing on from the model of the common rorqual to that of the black or southern right-whale, the visitor will have impressed on his memory the essential difference between a rorqual and a right-whale in a manner never to be forgotten. The contrast between the comparatively short and thick body of the latter, its narrow and vaulted upper jaw, the highly convex border of the enormously deep lower lip, and, above all, the immense space left between the upper and lower jaws for reception of the huge plates of whalebone, and the corresponding proportions of the rorqual are apparent at a single glance, and appear more wonderful still on minute inspection. A few of the whalebone plates belonging to the skeleton of the model have fortunately been preserved, and are inserted in their approximate position in the upper jaw; and it is probable that this is the only idea that the public will ever gain of what the fully-armed mouth of a right-whale looks like in nature. Even if the present specimen possessed its full complement of whalebone, it would not come up to a Greenland right-whale similarly provided, for in that species the head is considerably larger and the whalebone plates are longer than in its southern relative. Plates of both species are exhibited on the wall adjacent; and an idea of the leading differences between the two forms may be gathered by comparing a small model, with the whalebone in position, of the Greenland species placed beneath the head of the southern kind. This small model was presented by Captain D. Gray, who, in the course of his numerous cruises, has done so much to acquaint us with the anatomy and habits of the Greenland right-whale. In addition to the features already mentioned, the small model shows the peculiar conformation of the lower lip, the marked constriction immediately in advance of the enormous "flukes," and the white areas on the lower lip, at the base of the flipper, at the root of the flukes, and round the eye, which form such striking marks of distinction between the northern and southern right-whales.

Beneath the head of the model of the southern right are placed the two halves of the lower jaw of a Greenland whale, which was evidently a much more gigantic animal than the specimen above. To this jaw a somewhat melancholy history attaches. Captain Gray had the laudable intention of procuring for the Museum the entire skull of the finest specimen of the fast-vanishing Greenland right-whale he could capture. In "Jubilee" year he had alongside his vessel the carcass of a splendid bull; after the whalebone and blubber had been removed, preparations for removing and hoisting on board the head were about to be taken, when, as ill-luck would have it, other whales hove in sight, and the boats' crews were of course in requisition. As a result of the interruption all that he saved of the skull was the lower jaw in the Museum. To make matters worse, neither of the whales which caused the diversion were secured. It was, I believe, the ambition of Captain Gray to see the skull exhibited with its whalebone in position in the Museum, but as the "bone" yielded by this particular specimen realized some two thousand pounds, financial considerations might have interfered with the accomplishment of his desire. There is, however, yet opportunity for some millionaire to present such a specimen to the Museum before the species becomes entirely extinct. And here I am reminded that those of my readers desirous of becoming acquainted with the migrations of the Greenland right-whale, and the localities where it is still likely to be found, cannot do better than read a very interesting paper on this subject recently communicated by my friend Mr. T. Southwell to *Natural Science.*

Having given so much space to the whalebone whales but little remains for the toothed group. In this section, by far the most striking exhibit is the model of a male sperm whale, built upon the skeleton of a specimen stranded upon the British coasts. In addition to its vast corporeal bulk, as great if not greater than that of the Greenland right-whale, the most remarkable peculiarities are the enormous truncated head, at the front extremity of which is situated the single blow-hole, the powerful teeth with which the lower jaw is armed, the absence of a back fin, and the peculiar tuberosities on the middle line of the back somewhat in advance of the flukes. On the skeletal side of the specimen the visitor will be at once struck by the enormous size of the cavity containing the fine oil, which, on removal, solidifies into spermaceti; and will also wonder at the use of such a receptacle and its contents. Probably the oil is merely the most convenient material for filling a cavity rendered necessary by the peculiar conformation of the animal's head. Those of my readers who are intimately acquainted with the natural history of the sperm-whale may perhaps notice that the muzzle is made somewhat less truncated than is the case in many of the pictures of the animal; and naturalists are somewhat at issue with regard to the exact conformation of this portion of its body. All the old whalers are, however, in accord in representing the muzzle as broad and truncate as the front of a railway engine; and this peculiar and characteristic contour is shown in a rude sketch of the creature made by a whaler on one of its own teeth exhibited in a table-case in the gallery. Although some modern observers have stated that the muzzle is much less truncated and more or less pointed, it seems impossible to traverse the general accuracy of the testimony of whalers, so far at least as old bulls are concerned. And if there be any departure from this type it remains to be proved whether it is not due to age. Another moot point connected with the sperm-whale is its power to raise the lower jaw into the horizontal position without turning over on its back. The mucous membrane of the mouth is of a glistening white colour, and it has long since been asserted that, when on the feed deep down below the surface of the sea, the creature is in the habit of dropping its lower jaw and thus attracting prey within its glistening mouth. Whatever may be the truth of the latter part of the story, there seems no doubt that these whales are very generally in the habit of dropping the long lower jaw into a nearly vertical position, and some modern observers say that such is from necessity its habitual practice. Such a position would, however, be extremely inconvenient to reproduce in a model, and therefore no fault can be found with the restoration on the conventional lines. Here it may be mentioned that although the sperm-whale has long been known to feed on cuttles and squids, it has only recently been ascertained that the species preyed upon were of gigantic size. When harpooned these whales invariably disgorge their last meal, and some of the matter thus ejected has included portions of the arms of cuttle-fish measuring fully six feet in cube.



View in the New Whale Gallery at the Natural History Museum, with the skeleton and restoration of the Southern Right-Whale in the foreground.

Near by the sperm-whale model stands a mounted skeleton of the lesser sperm-whale (*Cogia breviceps*), a species differing from its larger relative by the much shorter jaws and proportionately smaller spermaceti cavity. It is, in fact, in one sense, a sperm-whale in course of evolution, not the least remarkable feature in its anatomy being the marked dissimilarity in the size of the two nasal apertures in the skull. It may be hoped that means will be found for making models of the bottle-nose *Hyperöodon* and of one of the beaked whales, the latter of which are now represented in the gallery by a series of skulls.

Apart from a couple of porpoises, the models in the dolphin family include those of the killer and the white whale; the former species being remarkable for its bold alternation of light and dark colours, while the latter is unique on account of the pure creamy white hue of its glistening skin. Why the white whale should have a hide of this bridal hue, while its not very distant relation the pilot-whale (*Globicephalus*) is clad in deep sable, stands urgently in need of explanation. A model of the latter species is shortly to be added to the gallery; and, both on account of the spotted coloration of its skin and the peculiar conformation of the head, one of the narwhal would also prove an interesting addition to the series.

In the vestibule of the new gallery is a small case containing representatives of the small family of freshwater dolphins (*Platanistidæ*), the few living types of which are all creatures of comparatively small size. While the Indian susu (*Platanista*) is represented chiefly by skeletons and skulls, of the La Plata dolphin (*Pontoporia*) the plaster model of a specimen killed during my first visit to Argentina forms an attractive exhibit. Its peculiar light brown colour seems to have been produced to harmonize with the clear, but brown-stained waters of the River Plate.

Till the new gallery was opened the Cetacean collection of the Museum was exhibited in a low, ill-lighted, and crowded gallery, where the incautious visitor was only too likely to run the risk of cracking his own skull against that of a whale, and where skeletons alone formed by far the greater portion of the show. That gallery is now closed to the public, but the contrast between its dismal array of bones—almost unmeaning to all save the anatomist—and the present light and interesting exhibition will probably survive in the memory of some of my readers. In a word, while the old style was exactly what a museum ought not to be, the modern one is precisely what it should be.

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REPETITION AND EVOLUTION IN BIRD-SONG.

By Charles A. Witchell.

THROUGHOUT the animal world we may find numberless instances of acts being rapidly repeated, with apparently only one sustained effort for the series, which acts seem to have originally been performed much less speedily and with separate efforts. Repetition means facility. Facility generally implies rapidity of repetition, and a series of acts for one purpose.

In the cries and songs of birds, we not only find indications of a former progressive evolution through the medium of mere repetition, but we may observe this evolution in actual development. I have elsewhere suggested that some prolonged alarms and songs of birds may be considered to have been evolved from mere repetitions of one cry. We may suppose that in some species a long song was a desideratum, since it is unaccompanied by any considerable variation in pitch. In the night-jar and grasshopper warbler there is practically no variation, though the latter "drums" in about the interval of a minor third.

The cricket-like chirp of the chiff-chaff may be heard everywhere, and is occasionally given in autumn as well as in spring; but I have never heard it rendered in more than three syllables; and it almost invariably consists of two only. It would be interesting to know whether readers of Knowledge have ever heard this uttered with four or five syllables. If such a local variation were discovered it might be considered as a survival of an earlier form of cry, or as an advance upon the ordinary song. I incline to the former proposition.

The turtle dove has a tremulous purring note, reminding one of the croak of the common frog (not of the more commonly heard "work, work" of the toad). It seems to consist of a very rapid succession of little coos. If greatly prolonged it would remind one of the note of the night-jar. In the common pigeon, and some of the doves also, a succession of little coos constitutes the whole song, which is often somewhat elaborate—as in the common collared turtle dove.

There may, of course, be the change of retrogression or reversal, as well as changes due to elaboration. The great titmouse seems to afford an instance of the former. The young (out of the nest) have a repeated cry with a curious wryneck-like tone, which may be rendered "klee, klee, klee." It is generally repeated from three to five times. The old bird never repeats a cry of this tone, but it utters a long single note as a cry of distress when a hawk is in sight. The cry of the young is no doubt inherited, and it may seem that the note may formerly have been repeated often by adult birds where it is now given only in single long cries.

On the other hand, the adult great tit has an alarm (a rapid "shashashasha") which is absent from the young. This is the most frequent danger signal of the old birds, and it always contains many syllables, all given, however, at the same pitch. How long it takes a wild titmouse to develop a variation of an alarm cry I know not, but in Western Canada I heard the marsh tits giving precisely the same note as their British prototypes, though the birds of the two countries must have been wholly separated during an incalculable period of time.

At Montreal, also, the house-sparrows (which were said to have been introduced fifteen years earlier from the States and not from England), had exactly the same cry, as well as the same manners, as the British bird. The sparrow, when bred in a cage, proves itself to have a strong tendency towards mimicry; yet these Canadian birds, like the marsh tits in the Far West, and the sparrows that chirp on the Bank of England, retained the ancestral tones of their species.

An interesting instance of repetition, developed in one strain to completeness, and in another not advanced beyond an elementary stage. occurs in the wood-wren. This bird's song consists of the simple repetition of a not musical sound, slow at first, but gradually getting faster until the song ends in an ecstasy. The whole may be rendered "si-si-si-sisisisisi." The pitch varies only a little; but there is a beautifully even *accelerando* in the strain. The bird has another cry which might be taken for a song, but this seems to be really a signal of danger. It is a full brief whistle repeated two or three times at the same pitch, and at about the rate of two per second. It may be written "kew, kew, kew." I have listened, but in vain, for any sign that even one of these birds had any inclination to repeat this beautiful note more than four times in succession. If that sound were somewhat prolonged, and given a few more times, it would rival some of the sweetest strains of the nightingale. But the wood-wren neglects this pure tone, and throws all his effort into the sibilous strain which falls to us from the tree tops, even as it fell on the ear of Gilbert White long ago.

The cuckoo, like the wood-wren, has developed the repetition of a note into a strain—a full-toned bubbling cry which is uttered at least by the female—yet the well-known "cuckoo" is given with apparently no suggestion of a further development than the doubling of the first note.

The sedge warbler is much more inventive, for he frequently creates an original strain by associating two or three cries of other species, and repeating them in a certain order and with a definite accent many times successively in one song, thus proving what a single bird *can* do by means of repetition, and indicating what *may* be occurring much less quickly in other species.

In the thrush a few notes, often borrowed, are very generally repeated a few times, but never prolonged, as in the song of the sedge-warbler. The thrush, indeed, seems to repeat from lack of originality, and yet without sufficient persistence to produce striking strains.

The nightingale is, however, the master of repetition in song. The majority of his strains simply consist of one or two notes repeated with varying speed, the whole song including from two or three to twenty-five or thirty repetitions of one note. I have counted as many as thirty-three repetitions, given at about the rate of five per second, and this number is probably often exceeded, though not after the middle of May, when the song begins to wane. The charm of the bird may be partly due to its repetitions, for the ear is not so tired by them as by the rapid jerky songs of the blackcap, and some other quick singers, but may dwell on and enjoy each simple pure tone. The nightingale has acquired a magnificent *crescendo ;* and one cannot but surmise that human ideas of this grace in singing may have been borrowed from the bird. The sedge-warbler and blackcap, and perhaps the wood-wren also, have imperfectly acquired it.

The origin of some of the nightingale's strains may presumably be found in single cries—a history which, in the case of the well-known long notes of the bird, is occasionally traversed at the present time. A little call-note, "tewy," is sometimes produced several times in succession, each note more prolonged than the last, until the strain ends in the ordinary long notes in all their sweetness.

The origin of certain prolonged strains may also be indicated in the cries of young birds. The nightingale, for instance, has a harsh "sisisisisi" which is quite unlike its sweeter tones. The fledged young one, however, when being fed, utters a similar long rapid cry. The ordinary cry of the young is a croak similar to that of the parents.

The young greenfinch, ready to quit the nest, utters when being fed, a rattling cry so like the "didititit" rattle in the song of the parent that the only point of distinction is that the parent gives the strain in several keys, and interrupts it with other cries. The actual rattle is identical with that of the young.

The young fledged nuthatch, when being fed, utters a quick repetition of an almost toneless cry, with the same general character, however, as the full, bubbling song-rattle of the adult.

It would, therefore, seem that when some song birds are developing their strains by simple repetitions of cries, they may be less inventive than at first appears, and be merely returning to an infantile mode of expressing a want.

The following note may be of interest as indicating that a bird whose habitat is remote from the range of our nightingale has followed a similar method in developing a song. The British birds have a rather short strain consisting of three or four peeting notes given at the same pitch, and an ensuing full rattling sound at a lower pitch, the whole sounding something like a "pee pee pee bobloblobble." This is given throughout the season of song, though it is one of the least noticeable of the usual strains. It is varied in length of repetition very slightly, but is rendered in any interval of pitch between a third and an octave. Three years ago in Vancouver City, I was much struck with the song of a common bush-warbler, a bird with the general appearance and manners of our hedgesparrow. The bird gave this strain of our nightingale perfectly, except that the leading notes seemed to be very slightly inflected.

The strain was in all other respects the strain of our nightingale, pure and simple. It seemed never to be modulated by the Canadian bird ; and it was particularly noticeable as being almost the only bird-song to be heard. But so frequent was it that the canaries on the houses near vacant "lots" had all "caught" the song, and included it in their own strains, and so accurately, that often I should not have known which bird was singing had not the sound come from some lofty window and not from the low bushes. I doubt not but that many of the canaries in Vancouver still have this strain, and that any local observer who has noticed the song of the warbler could confirm my statement as to the canaries. Did the Canadian bird borrow it from our nightingale or *vice versâ?* Or did they, uninfluenced by each other, follow the same course in elaborating their strains from simple originals ?

THE KARKINOKOSM, OR WORLD OF CRUSTACEA.—V.

By the Rev. Thomas R. R. Stebbing, M.A., F.R.S., F.L.S.

There are many contrivances for moving through water, but, few if any, are more handy than rowing. Independently of any boat or implement the human swimmer rows with his front legs, commonly called his hands and arms. Birds, beasts, fishes, insects, and crustaceans use various appendages for the same purpose, and many of them might with more or less propriety be called oar-footed. Among crabs the genus *Remipes* has monopolized the title in its Latin form. In a Greek dress it falls to the Podocópa, a division of the bivalved Ostracóda. But more suitably, in another Greek derivative, it has been bestowed upon that extensive branch of the Entomostraca, which are therefore known as the Copépoda. These oar-footed crustaceans, individually considered, are a feeble folk, but in the mass much worthy of respect. Unlike their little boxed-up brethren the Ostracóda, they cannot produce an interminable list of fossils, or claim an unbroken record of representation throughout the entire series of stratified rocks, to prove the antiquity of their lineage. In this kind of documentary evidence they are singularly deficient. But when regard is paid to their extensive distribution, resourcefulness, variety of structure, beauty of form and colouring, and their indirect usefulness to mankind, they are found to occupy no undistinguished place in the realm of existing life.

Of some of this order there are said to be thirty generations in three weeks. Such prolific accumulation may seem incredible, but it harmonizes with the fact, repeatedly recorded, of ships traversing miles of ocean coloured in broad bands by dense masses of these small creatures. Dr. G. S. Brady says, "There can be no manner of doubt that the sea, from the Equator to the Poles, supports everywhere a profusion of Entomostracan life, chiefly of the order Copépoda," and Sir John Murray, of the *Challenger* Expedition, declares that "Copépoda were rarely, if ever, absent from the tow-net gatherings when examined on board ship," although the profusion was too great to admit of more than a selection being preserved. Dr. Giesbrecht describes a sort of fine drizzling rain that may sometimes be seen close to the smooth surface of the Mediterranean. It is a shrimpy shower, not from above, but from below. There are swarms of certain Copépoda at the surface, and the vivacious animals springing out of the water and falling into it again produce the strange effect.

Now, albeit that these creatures are so incalculably numerous, they had to wait long before attracting scientific attention. In 1770 there was published at Copenhagen, by J. E. Gunner, Doctor and Professor of Divinity, and Bishop of Trondhjem, an account of "Some small, rare, and mostly new, Norwegian sea-animals." Among these was one to which Dr. Giesbrecht awards the distinction of being the first of the marine free-swimming Copépoda that was ever described and figured. It is no little credit to the bishop, under these circumstances, that not only is his species clearly recognizable, but his description of it is almost entirely free from error. It should not be forgotten that "Cuf's magnifying glass," with which he examined his specimens, was not precisely the same kind of instrument which microscopists have at command in the present day. The species is now known as *Calanus finmarchicus* (Gunner), and is sometimes spoken of as "whale-food." That Gunner includes it among rare animals could only have been in regard to its novelty, for he himself says, that "Off Hammerfest, in West Finmark, the sea was teeming everywhere with these minute animalcules, and that a good number could be caught by merely letting the sea-water flow into a bottle." So far from being really rare, it happens that this is one of the four cosmopolitan species, ranging from north to south, indifferent to heat and cold. There are some four hundred* other species of marine free-swimming Copépoda, of which a comparatively few brace themselves exclusively with frigid waters, the majority preferring their bath decidedly warm or at least with the chill off. To the hardiest of the hardy must those belong, which are capable not only of existing, but of shining in the difficult situation which Nordenskiöld has described. "Very singular," he says, "is the impression experienced in walking on a cold, dark, winter's day (with the temperature nearly at the freezing point of mercury) on snow from which on all sides shoot at every step sparkles so vivid that sometimes one is almost afraid of seeing one's boots and clothes catch fire." The sparkles referred to in this passage emanate from living, though not, under the circumstances, free-swimming Copépoda.

Without, however, tempting the perils of the sea, or tramping over Arctic ice, the student, live where he may, can rely on being able to obtain a fresh-water *Cyclops* from the nearest pond. Little as it may seem to resemble crab or cumacean, lobster or woodlouse of the Malacostraca, upon careful comparison the relationship will become apparent. Examine the series of appendages. Observe that the head, just as in the Amphipoda and Isopoda, is supplied with two pairs of antennæ and four pairs of mouth organs. These latter are commonly spoken of as mandibles, maxillæ, first maxillipeds, second maxillipeds; whereas in the Malacostraca we are accustomed to the succession of mandibles, first maxillæ, second maxillæ, maxillipeds. The difference in naming came about in this way. The celebrated naturalist, Professor Carl Claus, in tracing the transformations experienced by young Copépoda, found reason to believe that there was a loss of one pair of maxillæ, and, on the other hand, a severance of the outer and inner branches of the maxillipeds to constitute two distinct organs. Like the traditional origin of Eve from Adam, this supposed making of two out of one has not commended itself to all investigators. Dr. Giesbrecht and Dr. H. J. Hansen agree in denying its validity, and, as Nature generally prefers the beaten track, there is a presumption that they are right. It is in the hinder part of the body, rather than in the front, that the Copépoda differ from the Malacostraca. Following the mouth organs are five, or occasionally only four, pairs of limbs, attached to as many segments. The first four pairs almost always, and the fifth pair often, are two branched. Then comes the pleon, or tail-part, without appendages, but like the trunk consisting of five segments (the first two usually coalescent in the female) and ending in the caudal fork with its apical setæ.

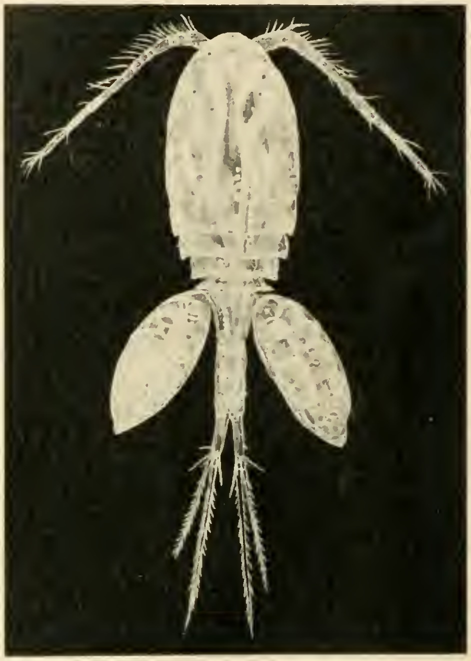

Figure of *Cyclops serrulatus* Fischer. From Uljanin.

In one division, comprising the families Calanidæ and Pontellidæ, there is a well-marked separation between the trunk and the pleon. This division Giesbrecht calls the Gymnoplea, Copépoda with footless pleon, as opposed to the Podoplea, comprising the Cyclopidæ, Harpacticidæ, Peltidiidæ and Corycæidæ. The Podoplea, meaning Copépoda with foot-bearing pleon, have indeed a footless pleon, like all the Copépoda, but here the constriction between trunk and tail occurs after the fourth pair of limbs, and by that means the fifth pair of trunk-limbs, such as it is, often a very small affair, lends its support to the pleon, or tail-part of the animal.

The Gymnoplea generally have a pulsating heart, almost always lead a pelagic life, and have the joints of the appendages in general more numerous and more variously plumed than is the case in the Podoplea. The latter scarcely ever have a pulsating dorsal vessel, and include, besides numerous marine species, almost all that live in fresh water.

As these papers have the insidious object of tempting

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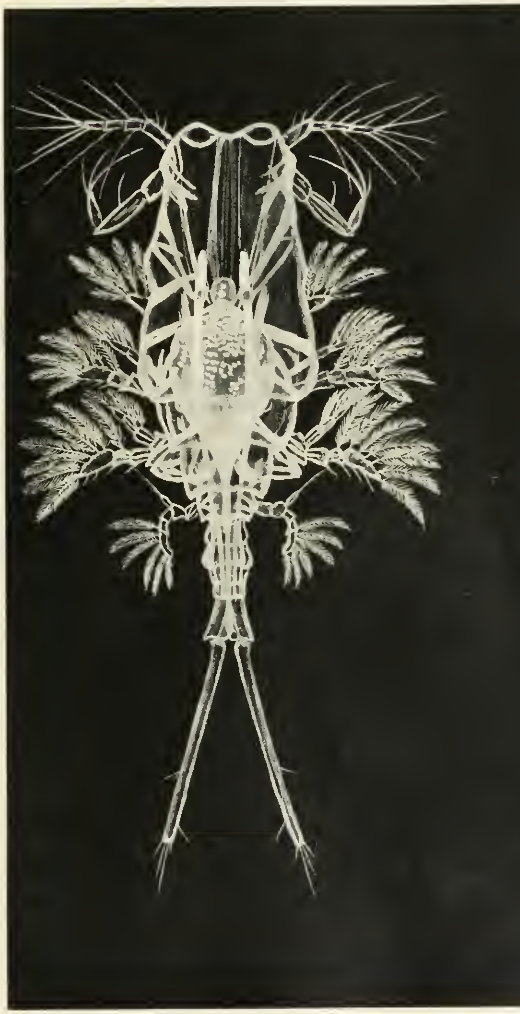
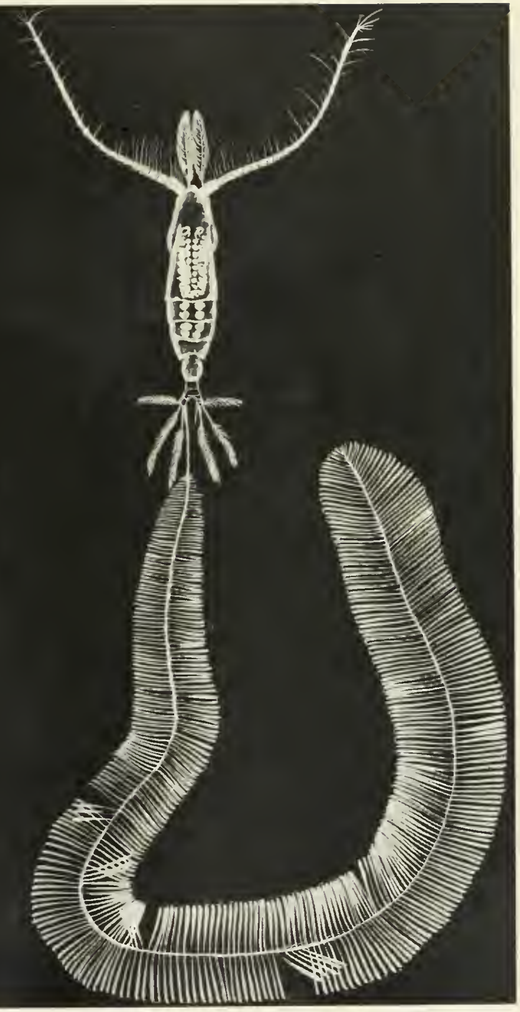
* More than forty of these were added in one batch from the Gulf of Guinea, by T. Scott, Esq., F.L.S., in 1891. *See Trans. Linn. Soc., London,* Zool. Ser. 2, Vol. 6, Part 1.



COPILIA VITREA (Haeckel).

From GIESBRECHT.



CALOCALANUS PLUMULOSUS (Claus).

From GIESBRECHT.

the unwary reader to become a student, it would be wrong to linger any longer on the dry and endless details which belong to anatomy and classification. In the first chapter mention was made of *Notopterophorus papilio*, to give a hint of the profundity of learning of which the subject was capable. The names of this truly remarkable Copepod species signify "a butterfly which carries wings on its back." Most butterflies have that privilege. But this is a crustacean, member of a class which climbs the mountain and fathoms the abyss, but which never made the least pretension to have wings to fly with. Yet this wonderful species indicates that Nature, if it chose, could even make a flying crab.

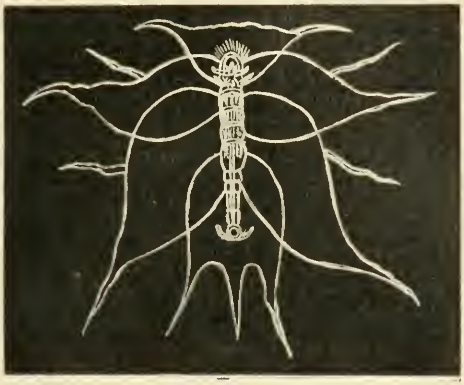


Figure of *Notopterophorus papilio* Hesse. From Brady.

Dr. Giesbrecht's name has been more than once mentioned. To his monograph of the pelagic Copépoda (*Fauna und Flora des Golfes von Neapel*, Mon. 19, 1892) those should turn who are willing to be entrapped by the fascinations of this branch of study. On seeing some of these "off-scourings of the sea," as the eye of the microscope and the eye of the artist have combined to reveal them, it is probable that the most contemptuous will be surprised into admiration. Dried specimens, and specimens preserved in spirit, as they are seen in collections, are commonly reduced to a uniformly pallid tint, so that few persons know or ever behold the richness and variety, the gaiety and even splendour of colouring, of which these tiny denizens of the sea are susceptible. Crustaceans brought up from the gloomiest depths are frequently gorgeous in orange and crimson. Of Copépoda which frequent the surface many, as already explained, are either transparently hyaline, brilliantly iridescent, or variously decked with points or bars or splashes of brightly harmonious colours. Some of them have ornaments which, when magnified to suit our dulness of sight, appear quite astonishingly graceful. In this respect the genus *Calocalanus* seems to deserve the palm, and within this genus the species *Calocalanus pavo* (Dana) may be held to compete in beauty with the bird after which it is named, if our minds can be brought to tolerate a comparison between the haughty fowl which condescends to adorn our pleasure grounds and a little ocean waif with a body the twentieth part of an inch long. It is not easy to explain in words the quality of distinction and the charm with which the marine organism is really invested, although on a scale so infinitesimal. The body is slenderly oval and colourless. Through the pellucid segments of the back can be seen the mass of orange-coloured eggs, for it is the female which is the more exuberantly beautiful. In front, on either side of the head, are extended with gracious sinuosity the twenty-five jointed first antennæ, nearly twice as long as the body, which they help to keep steadily balanced in the water. The bristles of various shapes, sizes, colours, and functions, with which the several joints of these antennæ are adorned, are important in the animal's economy, as well as very conspicuous features in its array. They shoot out in all directions like a shower of rockets. But this remarkable apparatus becomes almost commonplace by comparison with that of the caudal extremity. Each branch of the furca has four bristles. Such caudal bristles may be simple, serrated, or plumose, but, in any case, they are usually narrow and tapering. Here, on the contrary, from a slender stem the feathering gradually widens till it equals the breadth of the animal's body, passing from limpid clearness at its base to a magnificent orange and brick red, with a metallic gleam, over all its broadly-rounded distal portion. When the animal is in repose, the furcal arms are extended at right angles to the body, and then all its brilliant feathers are spread abroad in dazzling symmetry, like the train of a Court lady wrought in satin of "old gold."

Another species of this same genus, *Calocalanus plumulosus* (Claus), though inferior in charm, is even more wonderful in appearance. Like its congener, it has four caudal bristles on each furcal branch. These are bright orange in hue, all of very moderate length and breadth, with one exception. The exception is the innermost on the left side. This attains a truly colossal magnitude, being nearly twice the width of the animal's body and about six times its length. The feathering extends over almost the whole of this singular and very fragile ornament, which, if regard be had only to proportions, may vie with any single plume that the most wonderful bird can boast of.

In some genera the brilliance of adornment is shown rather at the middle of the body than at its extremities. *Copilia vitrea* (Haeckel), by the glassiness which its name implies, permits a facile study of its internal anatomy, and accordingly it is able to exhibit attractions in a part of the organism from which a display of beauty is not usually expected. The stomach is a magnificent orange-red. On either side, its four pairs of swimming-feet make a gorgeous show by means of their conspicuous feathered bristles, not exactly gleaming with purple and gold, but tipped with violet, and in other parts lustrous with a hue that matches the unwonted splendour gleaming from within the body.

Apart from the beauty of the Copépoda, there are many points of interest, such as the strange forms developed for special purposes in the antennæ and fifth pair of limbs, the peculiar eyes of *Copilia* and *Corycæus*, the problems of distribution, and others which remind us that, within the compass of a few columns, nothing more is possible than a little fluttering over the surface of so vast a subject. The parasitic Copépoda may claim a chapter to themselves.

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ECONOMIC BOTANY.

By John R. Jackson, a.l.s., etc., *Keeper of the Museums, Royal Gardens, Kew.*

MALVACEÆ.—This is a large and important economic order, marked by two distinct characters which pervade the plants constituting the order, namely, the fibrous inner barks and the mucilaginous or gummy substances found in the stems, roots, and fruits. None of the plants have any deleterious properties. Their geographical range is wide, though they are most abundant within the Tropics. The forms of the plants included in the order vary considerably, from small herbs, as in the marsh mallow, to the baobab (*Adansonia digitata*), or the giant silk cotton trees (*Eriodendron anfractuosum*).

The order is divided into four groups or tribes. Malveæ, which includes the mallows and the species of *Sida* and *Abutilon*, well-known fibre plants of India and China. Ureneæ, of which the principal products are fibres furnished by species of *Urena*, *Malachra*, and *Malvaviscus*. Hibisceæ, containing the several species of *Hibiscus*, *Gossypium*, and *Thespesia*; and Bombaceæ, which includes *Adansonia*, *Bombax*, *Eriodendron*, and others.

The following are the most important species of *Hibiscus* from an economic point of view:—*H. esculentus.* This is a large annual herb growing to a height of five or six feet, the native country of which is uncertain, though opinion inclines to some part of Africa. At the present time it is cultivated all over the tropical and warmer parts of the world, chiefly for the sake of the mucilaginous fruits which are known under the various names of okro, gombo, or bendikai. These fruits are narrowly oblong or fusiform, from three to ten inches long, and dehiscing, when ripe, by longitudinal sutures. In the young green state the fruits are extensively used as an article of food, particularly for the purpose of thickening soups. In the very young state they are sometimes pickled like capers. The seeds contain oil of good quality, and is expressed in some countries and used for culinary purposes. They are also roasted and used as a substitute for coffee. The fibre from the stem is used for ropes and cordage. Another annual largely cultivated in India, Ceylon, and in other tropical countries is the roselle (*Hibiscus sabdariffa*). This is grown both for the fibre, used like the last-named, and for the fleshy calyces of the fruit, which are of a reddish colour when fresh, and are made into a kind of preserve. Other species of *Hibiscus* yielding fibres of equal quality are *H. cannabinus*, *H. abelmoschus*, and *H. elatus.* The first named is an Indian species, while the two latter are West Indian. *H. abelmoschus* is known as the musk mallow, in consequence of its seeds possessing a strong, musky odour, for which reason they are frequently used in perfumery as a substitute for animal musk. *H. elatus* is the tree from which Cuba bast is procured, a substance better known twenty years ago than at the present time. It consists of the inner bark of the tree, and was at one time largely used in gardens for tying up plants as well as for tying bundles of Havanna cigars. In gardens, however, it has long been superseded by raffia, and in the Cuban cigar trade by ribbon. Even now Cuba bast occasionally finds a use in this country, and not long since it was adopted, after bleaching or dyeing, for the manufacture of ladies' hats in consequence of its lightness and lace-like appearance.

By far the most important plants in the whole family of Malvaceæ are those species of *Gossypium* which furnish cotton of commerce, the chief of which is *G. barbadense*, a large herbaceous or shrubby plant growing to a height of nine or ten feet, with numerous widely-spreading branches, and bearing capsular fruits dehiscing into three or five valves, and containing numerous closely-packed seeds entirely buried in a mass of long, very delicate white hairs, varying in length from a quarter to an inch or more. The commercial value of cotton is judged by the length and strength of the fibres, or staple, as it is termed in trade, and the clean separation of them from the seeds, and it is these two essential qualities that cause the cotton produced by *G. barbadense* to be of a much superior quality to that produced by other species, or indeed by some varieties of the same species. The separation of the fibre from the seed is so marked in the different qualities that in the Sea Island cotton of commerce the mass of fibres can be readily removed from the seed by the fingers without breaking the fibres and leaving the seed perfectly clean, while in others, and inferior qualities, the fibres break away, leaving the seeds thickly clothed with the woolly bases. *G. barbadense* is supposed to be a native of the West Indies, as its specific name would imply. Its culture at the present time is spread over a large portion of the warmer regions of the globe, and, as is commonly the case with plants so long and widely cultivated, it has numerous varieties, known in commerce under distinct names, such as Sea Island, Kidney, Peruvian, Bahia, Brazil, and others. These varieties are cultivated in the West Indies, the Southern United States, Central and South America, and other countries. *G. herbaceum* and *G. arboreum* also furnish some of the cotton of commerce.

In a brief *résumé* of the economic plants of the several natural orders like the present it is impossible to detail the processes employed in the preparation of cotton for the market; or even to speak of the numerous uses to which this most important product is put, but as a proof of the value of a single vegetable fibre we may quote the following returns of the imports and value of raw cotton into the United Kingdom during the year 1897:—

	Cwts.		£
From United States	12,323,090	value	24,557,513
„ Brazil ...	150,129	„	303,425
„ Egypt ...	2,447,616	„	6,484,450
„ British India ...	375,777	„	636,267
„ Other Countries	97,622	„	213,077
Totals ...	15,394,234		32,194,732

Besides the fibre another useful product is the seeds, which at one time were considered of no value, and were used as manure for the land; for some time past, however, they have been largely used for the expression of oil, which has been applied for illuminating purposes, oiling machines, and in the preparation of woollen cloth and morocco leather, also for soap making, and, when highly purified, for mixing with olive or almond oils, or as substitutes for them. After the expression of the oil the cake is much used for feeding cattle.

The baobab, or monkey bread-tree (*Adansonia digitata*), which belongs to the tribe Bombaceæ, is a tree of considerable interest, if not of high value, from an economic point of view. It is a native of west tropical Africa, but is found cultivated in many parts of India and Ceylon. It grows to a height of forty to sixty feet, with a diameter of trunk of thirty feet, and attains a great age. Humboldt speaks of it as "the oldest organic monument of our planet." The trunk is covered with a very thick fibrous bark, from which the natives make ropes and nets. It has been proposed as a material for paper making, and paper of good quality has been made from it; but as the supply must necessarily always be limited, its future as a paper material is very doubtful. On the other hand, where the quantity required would be less—such, for instance, as the plaiting for ladies' hats—it might, and indeed has been found an useful article, for a few years ago it was so used, after being bleached or dyed in various colours. The remarkably large fruit of the baobab (often two feet long and one foot diameter in the middle) contains a quantity of pulp which is of an agreeable acid taste, and is used by the people for making a refreshing cooling drink, besides which the fruits are used as floats for fishing nets. *Bombax malabaricum*, a large soft-wooded Indian tree, has a coarse fibrous bark, from which rough ropes are made in India.

The seeds are buried in silky floss, generally known as silk cotton, which, however, has little or no strength, and is not capable of being spun into fabrics. Another kind of silk cotton of very similar character is obtained from the capsules of *Eriodendron anfractuosum*, also a large, soft-wooded tree, native of the tropics of the old and new worlds. Under the name of "Kapok" this substance has been exported from Java to various parts of Europe for many years past in large and increasing quantities, for the purpose of stuffing mattresses, cushions, &c. Like the silk cotton of *Bombax*, it is quite unsuited for spinning. One of the most remarkable edible fruits of Malacca and the Malay Islands is that known as the durian, the produce of *Durio Zibethinus*. It is a large globular fruit, dehiscing when ripe, and covered with strong spines or prickles. The pulp is described by those who have become accustomed to it as one of the most delicious of tropical plants, but by those tasting it for the first time it is said to have a flavour of civet, turpentine, and garlic.

Sterculiaceæ.—The plants constituting this order are trees and shrubs, mostly of tropical countries. The woody stems, though soft, are for the most part stronger and somewhat harder than those of the silk cotton group, to the properties of which, in many respects, they are similar. Thus, the inner barks are mostly fibrous, and ropes and cordage are made from them in the countries where the plants grow. More particularly is this the case in the species of *Sterculia* itself; in three of the best known Indian species, namely, *Sterculia urens*, *S. villosa* and *S. fœtida*, the barks are used for cordage. The sterculias also yield a quantity of gum of a light colour, very much resembling, both in appearance and in their properties, gum tragacanth, inasmuch as they absorb a quantity of water, and swell before dissolving. The sterculia gums are much used in India as substitutes for tragacanth, and are known as Kuteera. Similar gums are produced in tropical Africa, as well as in Australia from allied species of *Sterculia*.

The Kola Nut, which in a comparatively few years has established itself as a regular and an important article of trade, is the seed of *Cola acuminato*, a tree of about forty feet high, native of the West Coast of Africa. Amongst the natives the kola nut has been long used as a remedy for satisfying the cravings of hunger, and enabling those who have to endure great fatigue to do without actual food for a long period. During the last twenty years kola has attracted considerable attention in this country, and the plants have been introduced into most of the British Colonies possessing a suitable climate for its success, and in the West Indies it has become quite established. Kola contains a large proportion of caffeine, and is much used in the preparation of certain kinds of cocoa, as well as for other purposes.

Another very important plant in the order is the cocoa (*Theobroma cacao*), a moderate-sized tree, a native of Brazil and other northern parts of South America, extending into Central America and Mexico. Under cultivation the tree is found in the tropics of both hemispheres, but especially in Trinidad, Venezuela, New Grenada, Jamaica, and more recently in Ceylon. As might be expected with a plant so long and extensively cultivated, a large number of varieties are known, distinguished by the size, shape, and colour of the fruits and the quality of the seeds. For the preparation of the seeds for the market they are first removed from the pulp of the fruit in which they are embedded, washed and slightly fermented, and when dry are ready for the market. For the preparation of cocoa and chocolate they are slightly washed and the outer husk removed, when they readily break up into small, irregular pieces, and in this state are known as cocoa nibs—the only state, indeed, in which they were known in Europe forty or fifty years ago. To prepare the soluble cocoas of the shops they are ground into a fine powder, and often mixed with starch, sugar, and other ingredients. Chocolate consists of the same seeds very carefully pounded or ground in powerful mills, and sweetened and flavoured with vanilla and various other spices. In the preparation of pure cocoa nothing, of course, but the seed is used, and a certain proportion of the oil, or natural fat, which is contained in the seed, is first extracted and forms what is known as cocoa butter. The seed contains about half its weight of oil. This cocoa butter is much used in pharmacy for suppositories, as well as an ingredient in ointments and for coating pills for all purposes, for which it is strongly recommended on account of its agreeable bland taste and freedom from rancidity. The uses of cocoa and chocolate in this country have greatly increased of late years, the quantity of raw cocoa entered for home consumption last year amounted to twenty-seven millions, eight hundred and fifty-two thousand, one hundred and fifty-two pounds against twenty-four millions, five hundred and twenty-three thousand, four hundred and twenty-eight pounds in 1896.

Tiliaceæ.—An order of trees and shrubs, and very rarely herbs, the species of which are most abundant within the tropics, though some are natives of the more temperate regions of both hemispheres. The trees are noted for their even and close grained, yet soft and easily cut wood, which is well represented in the common lime (*Tilia europea*) and the American bass wood (*T. americana*). The durability of the wood of the former and its adaptability for carving is further exemplified in the lime wood carvings by Grinling Gibbons in Hampton Court Palace, St. Paul's Cathedral, and other public buildings. Another character of the tiliaceæ is the fibrous barks found in most of the species, notably in the lime tree, which forms Russian bast from which mats are made, used for covering plants, and by upholsterers for packing furniture. From the fibrous point of view, however, by far the most important plant in the whole order is that furnishing jute (*Corchorus capsularis*). It is an Indian plant, cultivated to a large extent in Bengal for the sake of the fibre which is contained in the inner bark. For the purpose of increasing the length of the fibre the seeds are sown thickly to cause the plants to run up without branching. The stems, which seldom exceed in thickness that of the finger, are steeped to soften the fibrous bark, which is afterwards removed and the fibres combed out and cleaned. The rapid development of the trade in this fibre is remarkable; fifty years ago it was scarcely known out of India, where it was, and is still used for making rice and sugar bags. In 1846 the imports of the fibre to this country amounted to about nine thousand tons, which in 1897 had increased to three hundred and thirty-six thousand, nine hundred and nineteen tons. Jute fibre is now used for various purposes, such as carpets, tapestries for curtains, sacking, twines, and even for adulterating cheap silks.

Lineæ.—This is a small order of trees, shrubs, and annuals well known for their bright but fugitive flowers. Many of them, like the plants in the last-named order, are marked by the presence of a fibrous bark, the most important being the common flax (*Linum usitatissimum*), a stiff-growing slender stemmed annual, the native country of which is not known, the cultivation of the plant dating from the remotest periods of history. It readily escapes from cultivation, and is found in a half-wild state in almost every country where it is grown. Its cultivation at the present time is widely extended in both temperate and tropical climates, as, for instance, in Russia, Egypt, India, Holland, England, and the United States. Enormous quantities of linseed are imported from Russia and India.

In this country the flax culture has been declining for many years, though English-grown linseed is usually considered the best quality. The principal constituents of linseed is a fixed oil, which it contains to the extent of one-third of its weight, and a quantity of mucilage which is contained in the testa. The oil is expressed and forms the well-known linseed oil of commerce, so largely used for mixing with paints, as well as for various other purposes, and the mucilage causes the seeds to be valuable in the preparation of linseed tea—a well-known demulcent drink used in inflammatory conditions of the mucous membrane. The imports of linseed during the year 1897 amounted to one million, nine hundred and eight thousand, six hundred and twenty-eight quarters, the value of which was two million, nine hundred and eighty-eight thousand, five hundred and three pounds. Though this is a considerable sum derived from one species of plant, it is not the largest item in the total value of the flax plant, for besides linseed, the flax fibre obtained from the stem shows a still greater money value; for during the same year, 1897, flax in its various stages of preparation was imported to the extent of ninety-eight thousand, eight hundred and two tons, of the value of three millions, two hundred and three thousand, one hundred and eighty-four pounds. Flax is so well known that it is unnecessary to say more of it than that it is the cleaned fibre of this slender-stemmed plant, the value of which as a textile has been known from the very earliest periods, and continues to the present day, for it is the strongest and best vegetable fibre known capable of adaptation for the finest fabrics, as delicate muslins, and the coarsest, as tarpaulins, and, notwithstanding the introduction and adaptation of numerous vegetable fibres in recent years, flax still maintains its superiority.

Another important plant of the Linaceæ which has come much to the fore in recent years is *Erythroxylon Coca*, from the leaves of which is prepared the well-known *Cocaine* of the medical profession. The plant is a small shrub, two to four feet high, cultivated to a very large extent in the Andes of Peru, and in Bolivia and Columbia, also in parts of Brazil, Argentina, etc. It is considered to be a native of some of these countries, though it is unknown in an actual wild state. It has long been in use by the natives, who chew the leaves with a little unslaked lime for the purpose of lessening the desire for food, and enabling the chewer to undergo a large amount of bodily exertion without fatigue. For this reason it is a common practice to carry the coca leaves about with them, together with a small gourd for holding the lime. In gathering the leaves much care is exercised by the people so as to ensure their absolute dryness, and not to break them. In Peru, the plants begin to yield the first crop of leaves in three years after planting, and in some favoured localities two or three crops are obtained in one year. The largest and most mature leaves are said to contain the largest amount of cocaine. The leaves have an agreeable and somewhat aromatic smell. Cocaine is now very largely used as a local anæsthetic, and in the preparation of coca wine. Under cultivation, several variations from the specific type have arisen.

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The announcement of the retirement of Sir William Flower from the Directorship of the Natural History Museum at South Kensington was received with great regret. We learn that Prof. E. Ray Lankester has been appointed to succeed Sir William Flower.

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

Late Arrival of Spring Migrants near Exeter.—The current year has, so far, proved a most uninteresting one from an ornithological point of view in this neighbourhood. It has been distinguished by the great scarcity of most of our summer migrants, and the very late appearance of some of them. Although daily on the look-out for Chiff-chaffs and Willow Warblers, I did not see any till the 7th June, when Blackcaps, Willow Warblers, Chiff-chaffs, Garden Warblers and Spotted Flycatchers all suddenly appeared here, and were seen for a few days. Since then I have noticed very few of them. No Blackcaps visited the ripe berries of the ivy in April, as usual, and very few have frequented the currant bushes. Whitethroats were first seen on June 8th and 9th. Redstarts did not show until June 15th, but at the end of the month they were numerous at Chagford. Only one Sedge Warbler has been seen amongst the reeds here, and that was on the 10th of June. Common Sandpipers were first seen on April 15th, when two were on the river, and many on 21st of the month. At the end of June, I saw a great many on Dartmoor about the upper part of the North Teign, where they nest. The first return from the breeding grounds was on July 29th. The Cuckoo was heard on the 14th and 19th April, and afterwards became very numerous. Swallows have been scarce. The first was reported from the north of the county, near Barnstaple, about the 10th April, but I saw none until the 21st of the month, when I observed some in the streets of Topsham. A few Sand Martins were seen flying over the Exe on April 25th. Although the Rev. M. A. Mathew observed a House Martin at Buckland Dinham, in Somersetshire, on April 26th, I failed to see any here until June 19th, and there were very few at Chagford (where this species is usually very numerous) at the end of the month. It is certainly much less abundant in South Devon than it has been in most years. I noticed two Swifts on May 2nd, apparently coming from the north-east, but there were very few about until the 20th of the month, when numbers arrived from a southerly direction. On June the 9th Mr. Mathew saw four Turtle Doves on the foreshore of the Exe estuary below Lympstone. None now visit our marsh, where a small flock used formerly to feed, in July and August, on the seeds of the plants growing on the salt mud. We also saw a Red-backed Shrike near Budleigh Salterton. I imagine that the cold at the end of March and beginning of April, and the prevalence of cold blustering westerly winds at the migration time, prevented the arrival of our spring migrants by the ordinary route across the Channel, and those that reached us probably mostly came across England from the East. Hence they were noticed earlier in Somersetshire than about Exeter. —W. S. M. D'Urban, Newport House, near Exeter.

Lesser Black-backed Gulls on the Exe.—On April 13th I watched a small flock of Lesser Black-backed Gulls resting on the shingle outside our lawn wall at low water. They were mostly immature birds of last year, but there were a few adults among them. This gull is by no means common on the Exe, and this is the first time I have ever observed a flock of this species on the river.—W. S. M. D'Urban.

Peregrines and Herring Gulls.—On March 12th, while watching the Peregrine Falcons at Beachy Head, I was surprised to see these birds chased by Herring Gulls; yet immediately afterwards I found the body of a Herring Gull which had evidently been struck down by a Peregrine.—C. J. Wilson, 21, Earlsfield Road, S.W.

On a Hybrid Thrush found in Norway (*Turdus iliacus* × *Turdus pilaris*). By R. Collett (*Ibis*, July, 1898, pp. 317-319).—Prof. Collett here describes a specimen of a bird which he believes to be a hybrid between a Redwing and a Fieldfare. The bird was snared in Faaberg, Norway, on December 11th, 1897, together with some examples of the Fieldfare. Prof. Collett diagnoses the specimen as follows:—"Size, halfway between those of *T. pilaris* and *T. iliacus*; eye-stripe broad, of a buffy white; upper parts most like those of *T. pilaris*; rump, greyish brown, somewhat lighter than the back. Lower parts most like those of *T. iliacus*; the side spots somewhat triangular; under wing-coverts, rusty red mixed with pale red." A similar specimen was caught near Stockholm on February 12th, 1859, and is still preserved in the Riks Museum, Stockholm.

Iceland Gull in County Sligo in Summer (*Irish Naturalist*, August, 1898, p. 209).—Mr. Robert Warren observed a bird of this species on July 18th feeding in company with some Herring Gulls in a field. At about a distance of ten yards, and with the aid of field glasses Mr. Warren made the bird out to be an immature one. This is only the second time the Iceland Gull has been observed in Ireland in summer.

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.*

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Letters.

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

THE "QUAGGA."

To the Editors of Knowledge.

Sirs,—In your May number, on page 138, Mr. R. Lydekker calls the quagga an extinct animal. He says: Zebras "and the now extinct quagga." He is mistaken. At the moment of writing, the skin of a quagga is in the backyard being salted and preserved. The quagga was shot one month ago between Zwazieland and the Portuguese territory from a troop of four. Signs of larger troops were seen then and there. Hunters report still larger herds more to the north.

H. W. M. Lagerwey, ll.d.

Johannesburg, June 29th, 1898.

[In reference to the above, it is a well-known fact that the name "quagga" is now commonly applied in South Africa to Burchell's zebra (*Equus burchelli*), although it properly belongs to the apparently extinct *E. quagga*, which is a very different animal.—R. L.]

PHOTOGRAPHING THROUGH A FLY'S EYE.

To the Editors of Knowledge.

Sirs,—If any readers of Knowledge wish to try Mr. F. W. Saxby's interesting experiment, but are unable to get "eye-lenses" (and dragon flies do not flourish in towns), I have a good number of the cast nymph skins of the dragon fly, *Anax formosus*, which I will very gladly send to anyone who cares to send an address. The cornea is facetted, hyaline, and, moreover, has the advantage of being already almost perfectly clear. Arthur East.

Southleigh Vicarage, Witney, Oxon.

U ORIONIS AND S AND U CORONÆ.

To the Editors of Knowledge.

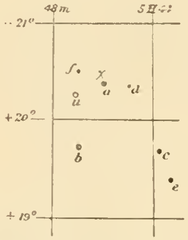
Sirs,—A maximum of U Orionis was computed for March 28th, 1898. It is an interesting star, and the past apparition increased the desire to know more about it. Being near the zenith most of the time, the opportunities were more favourable for its observation than for other stars.

It appeared to be on February 11th at about ninth magnitude, and from that day forward as follows:—

Feb.	22	7·8
,,	24	7·6
,,	27	7·4
Feb.	28	7·3
Mar.	2, 4, 5 ...	7·2
,,	8	6·8
,,	13, 15, 16	6·5
,,	19	5·9
,,	20 (max.)	5·9
,,	24	6·1
,,	26	6·3
,,	31	6·4
April	1, 2	6·5
,,	6, 7, 9 ...	6·6
,,	14, 16, 19	6·8
,,	24	7·1
,,	26	6·7
,,	27	6·8
,,	28	6·7
,,	28, 29 ...	6·6
May	1	6·8
,,	7	7·15

Lost behind trees.

U Orionis.



D.M.	19°	1106	6·8	mag.	e.
	,,	1110	6·00	,,	c.
	,,	1126	6·30	,,	b.
	,,	1156	7·20	,,	d.
	,,	1162	5·00	,,	a.
			7·90	,,	f.

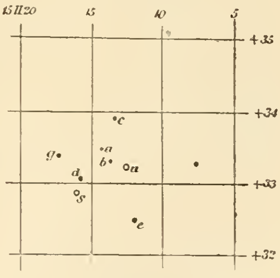
Except on a few nights the seeing was unsteady, and the light-curve irregular.

Comparisons were made with the D.M. stars in the field or close by.

When S Coronæ rose clear of the eastern city vapour and smoke on March 13th it seemed to be at its brightest, 6·7 magnitude; this apparition was four days after the computed maximum, and, as usual, it remained on a level until the middle of the following month. The first and subsequent changes were noted as follows:—

April	14 ...	6·8
,,	15 ...	6·9
,,	16 ..	6·8
,,	19, 24	6·9
,,	25, 26	7·0
,,	27, 28	7·1
,,	30 ...	7·2
May	8 ...	7·5
,,	10 ...	7·4
,,	11, 15	7·7
,,	17 ..	7·8
,,	19 ...	7·9
,,	22 ...	8·1

S and U Coronæ.



D.M.	31°	2719	7·0	mag.	e.
	,,	2724	7·3	,,	d.
	32°	2561	6·5	,,	f.
	,,	2569	U var.		
	,,	2577	7·8	,,	g.
	33°	2572	9·0	,,	b.
	,,	2573	8·9	,,	a.
	,,	2574	6·8	,,	c.

Comparisons were made with the D.M. stars in the field and close by. The star was regular in its movements, but the seeing was only occasionally good. The maximum, which evidently was a bright one, seems to have been passed on or about the computed date for that phase, March 8th. David Flanery.

Memphis, Tenn., U.S.A.,
23rd May, 1898.

◆

A THEORY OF REFRACTION IN SUN-SPOTS.

To the Editors of Knowledge.

Sirs,—I do not find that Mr. Jenkinson's objection, that the refraction (illustrated in the August number of Knowledge) would be destroyed by a blast from a pair of bellows, has any foundation in fact. I enclose a photograph which will show that a current of air has but little effect on the refracted bottom.

I have intentionally removed the "penny," as this has but little to do with the discussion.

It is, of course, true that a very slight ripple will often destroy refraction, but this is from a cause that we can hardly expect to find reproduced on the solar surface. In rippled water the refraction is often destroyed by the reflection of the sky or of bright objects; but if the surface be shielded from bright *reflections*, refraction will suffer but little. Arthur East.

Science Notes.

The report of the Select Committee on Museums of the Science and Art Department has furnished abundance of material for those who make it their business to criticise the responsible agents of our State-aided institutions. "The South Kensington Ring," the "Brompton Boilers," the "Poor Relations' Benevolent Institution," and such like sly insinuations have for many years been the only encouragement which the heads of departments at South Kensington have received from some quarters. "The work has in innumerable instances," says one of our contemporaries, "been bad to the extent of dishonesty, and a gross waste of public money. Indeed, so extravagant are the faults proved against the department, that one can hardly credit the truth of them." Even if all this be true, the fact remains that the Department has accomplished an incalculable amount of useful work, the mature fruit of which still remains to be gathered in.

◆

A number of the cases of birds and their nests at the Natural History Museum have been photographed by Messrs. Newton & Co., and a series of coloured lantern slides have thus been produced. Stuffed birds usually look stiff and unnatural in a photograph, but the natural surroundings in the cases photograph well, and the slides are on the whole accurately coloured.

◆

Mental fatigue—the most characteristic of the ills that flesh, or at all events civilised flesh, is heir to—has during recent years been made the subject of careful scientific observation. Though there is still much to be learnt respecting the factors influencing it, a very great deal has been added to our knowledge of the conditions attending its occurrence, and the means necessary for its dissipation. The investigations regarding mental fatigue naturally fall into two divisions. There is, first, the effect of intellectual effort upon the physiological activities of the body; and, second, the result upon the mental powers themselves. It has been fairly proved that all intellectual work has an immediate effect upon the physiological state of the various bodily organs. Thus, the earliest result of the mind's activity is to quicken the heart beat, though after half-an-hour a distinct slackening follows. This is naturally accompanied by an increased blood pressure on the brain. Similarly, respiration is quickened, though the inspirations and expirations of air are not, individually, as vigorous. The amount of tissue used up in the body increases, too, as is shown by the larger absorption of oxygen from the air, and the increased expiration of waste product in the form of carbon dioxide. Such increased wasting away of the material of the body has been found, as one would have expected, to carry with it an increase in bodily temperature. A particularly important relation has been made out between intellectual and muscular effort. While a brief mental exercise of fifteen minutes or less seems to increase the momentarily available muscular energy, a longer mental exertion distinctly decreases it, though when it is accompanied by emotional excitement this mind work may not be followed by the enfeebling of the muscles until much later. Observations made in a French school show that the amount of bread consumed by the pupils, who were always allowed to have just as much as they wanted, decreased with fair regularity until the minimum was reached in July. This is interpreted to mean that there is a gradual decrease in vitality as the result of continued school work. Many other results of less popular interest have been obtained and will be found described in an excellent volume on mental fatigue, by Professors Binet and Henri, recently published in Paris.

◆

Many people believe that soon after death a peculiar smell arises from the body. "There is death in the house," old women will say. So, too, it is well known that in some countries ravens appear, oftentimes in large numbers, almost immediately animals have expired. It is easy to explain all such phenomena by changes due to decay of the body; but the smell before death, which is referred to as *odor mortis*, is not so easily understood. This "death smell" attracts several species of flies to the dying in certain seasons, and the approach of death in a human being or animal, if it occurs at a time of the year when these insects are in active life, is said by some to be unmistakably heralded by the determined manner in which such flies settle on the skin, especially in the region of the nostrils. According to many authorities the smell is unappreciable to average nasal organs, though not a few trained observers are without doubt of its existence. Of numerous cases which have recently been put on record in the *British Medical Journal*, one or two may be referred to here, as they provide sufficient ground for further investigation. An apparently strong, healthy nurse was suffering from a severe attack of typhoid, and towards the end of the first week a peculiarly heavy odour was noticed about the patient by the doctor in attendance, and since he had noticed a similar smell in previous fatal cases he felt anxious. Shortly after the odour had been detected the nurse developed other symptoms and died. Another physician records that having remarked the smell in the case of a child, who otherwise did not appear to be seriously ill, he regarded it as a sign of most unfavourable import, and sought a consultation. The consultant thought there was no cause for anxiety, yet the child died within forty-eight hours. These, and other cases described by medical men, certainly give ground for the belief that, in some cases at least, the approach of death is heralded by a strange odour, though it is difficult to understand exactly the cause of its occurrence.

VARIABLE STARS OF SHORT PERIOD.

Whoever will make a careful examination of the brightness of a large number of stars, either in the sky, or, better, as photographed upon different plates, will be impressed with the vast number which show no perceptible variation. The discovery of variable stars is greatly aided when we are able to make a suitable selection for examination, either from their spectra or from their presence in clusters. Visually, we can never be sure that all the variables in a given region have been found, however carefully we may study them. Photography brings this problem more nearly within our reach, and a partial solution of it is illustrated in the accompanying figure. A photographic telescope was constructed having as an objective a Cooke anastigmatic lens with an aperture of 2·6 cm. and a focal length of 33·3 cm. This telescope was mounted equatorially, and the lens was alternately exposed and covered for intervals of exactly ten and fifty minutes by an electrical attachment. The polar axis of the mounting was displaced and the rate of the driving clock was increased, so that the successive images should be slightly separated. An eight-by-ten photographic plate was exposed in this instrument on April 21st, 1898, and eight successive images were obtained, the Greenwich mean times of the middle of the exposures being 13h. 49m., 14h. 49m., 15h. 49m., 16h. 49m., 17h. 49m., 18h. 48m., 19h. 48m., and 20h. 48m. The plate covered a region about thirty-three degrees square, whose centre was R.A.=1h. 2m., Dec.=+76·6°. The images of the stars in the corners of the plate were sufficiently good when visible to show very slight variations in light, but owing to their increased size the faintest stars were not shown. The greatest loss amounted to about one magnitude. If, now, any variable star having a period of less than fourteen hours was contained in this region, it is probable that at least one maximum and one minimum would be photographed. The figure represents a portion of the plate described above, enlarged ten times to a scale of 60″=0·1 cm., and covers about one square degree. It therefore represents one-thousandth of the entire plate, the size of which on this scale would be two mètres, or nearly seven feet square. The entire sky, from the north to the south pole, could be covered by forty such plates, and it is proposed to do this as soon as the best method of taking the plates has been determined. The arrow indicates the variable star U Cephei, and its photometric magnitudes at the times the eight images were taken were 7·5, 8·1, 8·9, 9·1, 9·1, 8·3, 7·6, and 7·2. The three stars above it are +81° 30′, +81° 27′, and +81° 29′, which have the photometric magnitudes 7·9, 8·5, and 8·6. To separate the successive images various methods have been tried. The best of these seems to be stopping the driving clock for a few seconds every hour. By the above plan we hope to secure a complete list of all variable stars of short period brighter than the ninth magnitude at maximum whose variation exceeds half a magnitude and whose period is less than a day. Doubtless, many other variable stars of longer period, and stars of the Algol type, may also be incidentally found.

Edward C. Pickering.

Harvard College Observatory.

THE ASTRONOMY OF THE "CANTERBURY TALES."

By E. Walter Maunder, F.R.A.S.

There is one subject of which men never tire. They are always willing to be told of the way in which other men in different circumstances, in other lands, or in past ages, lived; of their habits and thoughts. Those who can tell us with certainty and vividness these things about other men will always claim our attention, and because of all such narrators he is one of the freshest and most natural, old "Dan Chaucer, the first warbler," as Tennyson so aptly calls him, will never lack an audience.

There are other reasons for his popularity.

> "Oh to be in England,
> Now that April's there,"

was Browning's wish, and Chaucer ever takes us to England in the freshest, fairest blossom of a spring-time, always young. A free-hearted contentment possesses him at all times:—

> "Sufficë thee, thy good, though it be small."

But more frequently this broadens out into a frank joyousness that refreshes us still, five hundred years after he has gone to sleep.

> "Unto this day it doth mine hertë boote,
> That I have had my world as in my time."

It is not, however, with Chaucer as a poet, or as a shrewd, observant kindly man of the world, that I am now concerned. Like one of his friars whom he scathes so sharply, yet so amusingly, I have to keep within my "lymytatioun," and to ask him, not for the sweet scent of the hawthorn, nor for the joyous notes of the woodland birds, but for any information which he may have to give as to the astronomy of his time.

From a poet so natural, so absolutely unpedantic, living long before the invention of the telescope and the revival of learning, and in a poem, the subject of which is the wayside talk, and free blunt banter of ordinary folk, one would not naturally expect to find a single astronomical allusion, nor, if we found any, that they should be accurate. Yet even in Tennyson, by far the most scientific of our modern poets, there are scarcely more astronomical allusions than there are in Chaucer.

On the first day of the month just past—"Saint Lubbock's Day"—a far greater pilgrimage than that which was "personally conducted" by the stout host of the Tabard Inn, set out from London and spread itself through Kent, in much the same direction as their forefathers, half a millenium before. But it may well be doubted if any of the modern company—nearer nine-and-twenty thousand than nine-and-twenty—brought any astronomy into their holiday talk, or, if perchance a little science did leak out in conversation here and there, that it was anything but vague, uncertain, and at second-hand.

In spite of Board schools and University Extension lectures, we are not in all things the unquestionable superiors of our forefathers in the days of the Plantagenets. The men who deal in Chaucer's trade to-day—the writers of short stories—have multiplied as abundantly as our Bank Holiday makers have increased over the Canterbury pilgrims; but astronomy is carefully avoided by them unless perchance the hero has to be delivered from a tight corner by a total solar eclipse lasting an hour and a half, or the heroine to be treated to a sight of Venus between the horns of the crescent moon.

Chaucer's astronomy is of course of quite a different kind from any that would come into popular tales or conversation to-day. He knows nothing whatsoever of the spots on the sun, of Jupiter's belts, or Saturn's ring. His mind is vexed by no controversies as to whether the "gemination" of the canals of Mars is a real phenomenon, or a mere function of imperfect focussing, and the nebular hypothesis, either in its gaseous or "meteoritic" phase, passes him by untouched.

Still, astronomy, real astronomy, enters into his verse; the astronomy of the day and year; it is familiar and actual both to the poet and to his characters.

Never did any poem open with a fuller, fresher breath of spring than the Prologue to the Canterbury Tales:

"Whanne that April with his shoures sote
The droughte of March hath perced to the rote,
And bathed every veine in swiche licour,
Of whiche vertue engendred is the flour;
Whan Zephirus eke with his sote brethe
Enspired hath in every holt and hethe
The tendre croppes, and the yonge sonne
Hath in the Ram his halfe cours yronne,
And smale foules maken melodie."

It is Chaucer's habit to give his notes of time, sometimes by reference to the calendar, sometimes, as in the present passage, by the position of the heavenly bodies, the sun in particular. The eighth line in the above quotation has given rise to some unnecessary discussion. For in Chaucer's day the sun entered the sign Aries—not the constellation—about March 12th. By the first of April, therefore, the sun would have passed through more than half of the sign of the Ram. But the first two lines seem to point to April being far advanced, since its "sweet showers" have "pierced to the root," the "drought of March." Later on Chaucer expressly tells us in the Prologue to the "Man of Lawe's Tale," that it was then the 28th of April when the pilgrimage had nearly come to its close. We may therefore suppose that it is quite the middle of April when the poem opens, and that by the sun's "half course" in the Ram is meant the latter half of the sign, the half he passed through in the first fortnight of April, not the former half, which he passed in the last fortnight of March.

For it is clear from other passages that Chaucer quite understood when the sun entered Aries, for in the "Squier's Tale" we are told that Cambuscan—

"He let the feste of his nativitee
Don crien, thurghout Sarra, his citee,
The last Idus of March, after the yere.
Phebus the sonne ful jolif was and clere,
For he was nigh his exaltation
In Martes face, and in his mansion
In Aries, the colerike hote signe:
Ful lusty was the wether and benigne,
For which the foules again the sonne shene.
What for the seson, and the yonge grene,
Ful loude songen hir affections:
Hem semed han getten hem protections
Again the swerd of winter kene and cold."

The Ides of March fell on the 15th. For the following day we have a further note of time. The sun has entered Aries four degrees, that is four days.

"Up riseth freshe Canace herselve,
As rody and bright, as the yonge sonne,
That in the Ram is foure degrees yronne
No higher was be, whan she redy was,
And forth she walketh esily a pas,
Arrayed after the lusty seson sote."

So again in the "Nonne Preste's Tale" we have a day in May marked out for us in two ways, first by the calendar, next by the position of the sun in Taurus—

"Whan that the month in which the world began
That highte March, whan God first maked man,
Was complete, and ypassed were also,
Sithen March ended, thritty dayes and two.

* * * *

Cast up his eyen to the bright sonne,
That in the signe of Taurus had yronne
Twenty degrees and on, and somewhat more:
He knew by kind, and by non other lore,
That it was prime, and crew with blisful steven,
The sonne, he sayd, is clomben up on heven
Twenty degrees and on, and more ywis.
Madame Pertelote, my worldes blis,
Herkeneth thise blisful briddes how they sing.
And see the freshe floures how they spring."

Chaucer here evidently means that the sun entered Taurus about April 11th; hence it would enter Aries March 12th; but the exact day would vary of course with the position of the year with regard to leap year.

The knowledge of the sun's longitude day by day throughout the year strikes us as strange and unusual. But the above quotations, especially from a work so entirely natural and descriptive as the "Canterbury Tales," shows us how very general was the knowledge at the time, and is a clear indication that the sun's movements were both followed observationally with considerable diligence, and were published freely up and down the country in works to which many had access. Probably the great popularity of the Universities at the time, the attendance at which was, relatively to the entire population, something like fifty times what it is at present, had much to do with the wide diffusion of knowledge of this kind.

Another relation in which astronomy is introduced is a more practical one. The need to be able to tell the time of day has caused men in countries, and in times when clocks and watches are unknown or little used, to pay much more attention to the daily movements of the sun than we do. He still, of course, remains our great timekeeper; but there are so few who now resort to him directly for the information that his service in this connection is quite forgotten by the great majority.

It was not so in Chaucer's day. Then the sun dial, or, failing that, a rough estimation of the sun's altitude, was the means for telling the hour. In the Prologue to the "Persone's Tale," Chaucer gives us the method by which he concluded that it was four o'clock, and a little calculation shows that he was sufficiently correct.

"By that the Manciple had his tale ended,
The sonne fro the south line[*] was descended
So lowe, that it ne was not to my sight
Degrees nine and twenty as of hight.
Foure of the clok it was tho, as I guess,
For enleven foot, a litel more or lesse,
My shadow was at thilke time, as there
Of swiche feet as my lengthe parted were
In six feet equal of proportion."

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[*] The meridian, that is to say.

Nor was Chaucer alone able to make such a calculation. The host of the Tabard, though “not depe expert in lore,” could work out a similar but simpler problem.

“Our hoste saw wel that the brighte sonne
The ark of his artificial[*] day had ronne
The fourthe part, and half an houre and more;
And though he was not depe expert in lore,
He wiste it was the eighte and twenty day
Of April, that is messager to May;
And saw wel that the shadow of every tree
Was as in lengthe of the same quantitee
That was the body erect, that caused it;
And therfore by the shadow he toke his wit,
That Phebus, which that shone so clere and bright,
Degrees was five and fourty clombe on hight;
And for that day, as in that latitude,
It was ten of the clok,[†] he gan conclude.”

It is in these two particulars, the apparent progress of the sun along the ecliptic during the year, and his course across the sky during the day, that astronomy entered chiefly into men's lives in Chaucer's day. There was as yet no suspicion that the earth was not the fixed centre of the solar system, or that the apparent motion of the sun along the ecliptic was due to the real motion of the earth. Ptolemy was still the master-mind of astronomy.

“Of alle men y blessed mote he be,
The wise astrologien Dan Ptholomee,
That sayth this proverbe in his Almageste:”

As with Dante, the planets revolved for Chaucer in successive crystalline spheres, for Europe had still two centuries to wait for Copernicus.

“And by his eighte speres in his working,
He knew ful wel how far Alnath was shove
Fro the hed of thilke fix Aries above,
That in the ninthe spere considered is.”[‡]

But though he gives us evidence enough that the commonality believed in astrology more or less, he himself and the better classes had quite broken off from it. The “Chanones Yemanne” tell us—

“Sol gold is, and Luna silver we threpe;
Mars iren, Mercurie quicksilver we clepe:
Saturnus led, and Jupiter is tin,
And Venus coper by my fader kin.”

But this is only the trade jargon of a confessed charlatan. The wife of Bath gives astrological reasons why learned men have little estimation for women, but is scarcely more serious in her argument than in her quotations from St. Paul.

“The children of Mercury and of Venus,
Ben in hir werking ful contrarious.
Mercury loveth wisdom and science,
And Venus loveth riot and dispence,
And for hir divers disposition
Eche falleth in others exaltation.
As thus, God wote, Mercury is desolat
In Pisces, wher Venus is exaltat,
And Venus falleth wher Mercury is reised.
Therfore no woman of no clerk is preised.”

But the Frankeleine disposes of astrology or “magike naturel” in a very off-hand manner, though he describes the work of an astrologer in much detail.

“Which book spake moche of operations
Touching the eight and twenty mansions[*]
That longen to the Mone, and swiche folie,
As in our dayes n'is not worth a flie.

* * * *

“His tables Tolctanes[†] forth ho brought
Ful wel corrected, that ther lacked nought,
Nother his collect, ne his expans yeres,
Nother his rotes, ne his other geres,
As ben his centres, and his argumentes.
And his proportional convenientes
For his equations in everything.

* * * *

“Whan he had found his firste mansion,
He knew the remenant by proportion;
And knew the rising of his mone wel,
And in whos face, and terme and every del;
And knew ful wel the mones mansion.”

Such was astronomy in Chaucer's day, very narrow and confined, without a hint of those wonderful revelations which the telescope and the spectroscope have brought to us, without a guess at that majestic order of which Copernicus had the first faint vision, which unfolded itself in three-fold stages to Kepler, and gave itself in the fulness of its completeness to Newton.

Yet, narrow as it was, hampered as it further was by its connection with the bastard science of astrology, already falling into merited contempt, astronomy had a real existence in Chaucer's time; real because a science of actual observation. Englishmen of that time lived out of doors, they were cooped up in no great cities, the sun himself was their great almanac and clock, and they were obliged to learn how to read him. That which they were able to learn from Nature may not have been much, but, at least, they learned it first hand.

Exactly the opposite condition of things prevails to-day. Immense volumes of knowledge have been opened to us of which our forefathers never dreamed; and the Press secures the ready and wide diffusion of every fresh advance. Yet there can be no doubt that in some respects a practical personal acquaintance with Nature is less general now than then. We may be quite sure that in Chaucer's day the veriest clodpole knew that the stars rose and set. There are probably millions in England who do not know it to-day; Sir George Airy thought it not safe to assume that even Cambridge undergraduates knew it.

There is a knowledge of science, of a sort, very widely spread to-day, but the utter nonsense which is often calmly printed in newspapers, and far more often inserted in popular stories, proves how thoroughly second hand it is. Such knowledge as that possessed by Tomlinson, of Berkeley Square,

“This I have read in a book, he said;
And this was told to me;
And this I have thought that another man thought.”

is indeed better than nothing; but far better still is it to base one's knowledge upon one's own observations, one's own experiments, however crude, and to learn not from books alone, but from the lips of Nature herself.

Notices of Books.

A Sketch of the Natural History (Vertebrates) of the British Islands. By F. G. Aflalo, F.R.G.S., F.Z.S. Blackwood. Illustrated. 6s. net. The “unambitious” aim of this book is that it shall serve as an “introduction to the many excellent handbooks to county fauna.” For one man to attempt this task seems to us very ambitious, and to endeavour to write such an introduction in the space of

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[*] “His *artificial* day,” *i.e.*, his *mean* day, from six in the morning to six in the evening, as contrasted with his *natural* day, from sunrise to sunset.

[†] It would be nearly a quarter to ten, apparent time, corresponding to the “fourth part” of the daily arc, “and half an hour and more.”

[‡] In other words, he knew the distance of the first star in Aries, the actual constellation, from the first point of Aries, the zero point of celestial longitudes. The actual stars and constellations are considered to be in the eighth sphere; the equal signs of the zodiac, the divisions of celestial longitude, in the ninth; the different planets occupying the first seven.

[*] Of the lunar zodiac.

[†] The Alphonsine Tables.

five hundred small pages seems an insult to our fauna, which, if not very large, has been very closely studied. In our opinion anyone would be bound to fail in such an attempt, and certainly Mr. Aflalo has failed. It is not our intention to criticise each portion of the book. As a sample of the whole, let us take the largest division—the birds, to which two hundred pages are devoted. We have first to complain that, notwithstanding his acknowledged want of space, the author fills many valuable lines with assertions such as the following :—" The wood-wren used to nest in great abundance near Doberan, Mecklenburg, in May, 1890." Of what interest is it to those for whom this book is intended to know that the wood-wren nested near Doberan ? Unless the book is intended to be nothing but a mere list, we presume that it would have for one of its chief objects the means of identifying species. The author's aim in this direction has been to enable the observer to recognize the live bird rather than the dead one. If it were possible to give sufficient information to be of any value for this purpose in a few words, the author's want of care—or is it want of knowledge—would prevent him from attaining his end. We are told, for instance, that the fire-crest may be distinguished from the gold-crest by the deeper orange of its crest. We venture to affirm that no one could distinguish the two birds by this means. The chief distinguishing feature of the fire-crest is that it has a black line through the eye. Again; we have to distinguish the turtle dove from other British doves merely by the " somewhat larger tail, which is edged with white, and by the black and white patches on the neck." From this we have to conclude that the turtle dove is, in general colouring, the same as the woodpigeon, stock dove, and rock dove. Of the statements that the common tern has the bill and tail orange-coloured, and that the Arctic tern is apparently *resident* on the east side of Scotland, we can make nothing. The many instances of this sort of slip-shod description render the book practically valueless for purposes of identification, and there is so little space for anything but the very briefest description of species that we cannot see on what grounds any value can be claimed for the book.

Birds in London. By W. H. Hudson, F.Z.S. (Longmans.) Illustrated. The birds of London have attracted a considerable amount of attention during the last few years, and Mr. Hudson's book is very opportune. The author's first idea was to write a handbook, giving lists of all the birds that are to be found in London, but this idea was subsequently discarded, and wisely, for what are the boundaries of London now, and who can tell what they will be in a few years to come ? If we judge Mr. Hudson rightly, his chief objects in writing this book have been, first to show how badly wild birds are looked after in a great number of the parks and open spaces, and secondly, what a great delight and pleasure the birds are to the Londoner. In describing the bird life in the parks and open spaces, the author gives a great deal of sound advice as to how these places could easily, and often with little expense, be made enticing to birds, not only as visitors, but as permanent residents. We agree with Mr. Hudson in general on this point, but his arguments are sometimes a little one-sided. The Londoner no doubt is very fond of wild birds, and greatly enjoys seeing them in the parks, but the author would apparently have all the rhododendrons pulled up, and hollies and gorse planted in their stead, and a portion of the money that is spent on the flowers expended in providing for the accommodation of the birds. From an ornithologist's point of view this is only right and proper, but we should not care to say with the author, that " a gorgeous bed of tulips that has cost a lot of money is regarded by a majority of visitors with a very tepid feeling of admiration compared with that which they experience at the sight or sound, whether musical or not, of any wild bird." Mr. Hudson deals at length with "the cat question." It appears that cats, chiefly stray ones, swarm into the parks at night, and do incalculable damage to small birds, which roost in low bushes. On this subject again the author gives some good advice, and it is a subject into which he has evidently entered thoroughly. There are a number of amusing anecdotes about birds in the book, but we think one or two of them which bear the marks of imagination, or exaggeration, might have been omitted. It is always a pleasure to read Mr. Hudson's well-written books, and we feel sure that the present one will be found interesting, as well as instructive, by Londoners and those who take an interest in London birds.

Das Weltgebaude : a Popular Treatise on the Heavens. By Dr. M. Wilhelm Meyer. (Leipzig and Vienna : Bibliographical Institute. 1898.) The earth at present appears to be passing through the nucleus of a swarm of text-books of general astronomy. Now, a really magnificent specimen has come to hand from Germany, and though it labours under the disadvantage of being written in German, and printed in black letter, even an Englishman can enjoy the lucidness of Dr. Meyer's style, and the impartiality with which he discusses the theories that are not yet proven.

Assuredly the book is not of the dogmatic type. Dr. Meyer has perfectly realized that it is not the function of a text-book to formulate an astronomical creed, or to say the last word on any point of doubtful doctrine. He does not say, for instance, " I believe that Venus rotates on her axis in two hundred and twenty-five days, and I count all who believe not, schismatics " ; neither does he assert that she rotates in some twenty-four hours. The same spirit of reasonableness attends him when he treats of the lunar surface, and leads him to supplement his actual description of the objects, by descriptions of terrestrial objects seen under similar conditions, and which they resemble or from which they differ. Thus, in the case of the lunar Apennines, he gives, beside it, a bird's-eye view of the Island of Corsica to emphasize the fact that moon mountains as a rule consist of single peaks arranged in a ring form, but that earth mountains are ranges which radiate in roughly parallel directions.

The arrangement of the matter is perhaps somewhat unusual, but there is much to be said for it. In the introduction there is a very full account of the optics of the telescope, with which is incorporated a description of some of the great telescopes of the world, others being left until Part II. The introduction also includes a full description of the photography and photometry of the stars and heavenly bodies, and of their spectral analysis. The rest of the book is divided into two parts, which deal with the heavenly bodies. Ordinarily in text-books these two sections are not distinct, but practically we believe that Dr. Meyer's arrangement will be at once more interesting and more intelligible to the general reader. But it presents the historical anomaly of the discussion of the results obtained from photographic and spectroscopic observations of the sun and heavenly bodies in the beginning of the first section, and the Ptolemaic theory towards the end of the second ; the theories of the Milky Way, of double stars, of comets' tails, and the meteoritic hypothesis, some three hundred pages before the discovery of the law of gravitation.

But, even more than with the text, the reader is struck with the illustrations. These may be divided into three classes. There are those which are beautiful reproductions of drawings or photographs of the planets, sunspots and rice grains, corona, prominences, comets, stars, and nebulæ, and of many other notable objects of interest. For such a collection of illustrations, exquisitely reproduced, too much praise cannot be accorded. There are, again, drawings or photographs of what may be called the terrestrial or laboratory analogies of celestial objects. Of such, we may mention a bird's-eye view of the Colorado Cañon and the Yosemite Valley, to illustrate lunar rills; of the volcano Kilauea, to compare with Jupiter's great red spot; and of some artificial electrical coronæ which bear a remarkably strong resemblance to the solar ones. The third class of illustration is most peculiar: it consists of highly coloured landscapes in some of which the artist purports to be situated on the planet Mars or Saturn, whence he views the setting sun or the globe shadow thrown on the rings. In others he views the giant Jupiter from one of its moons, or from our satellite observes an eclipse of the sun. We are not prepared to criticize the scientific accuracy of these observations, never having occupied these standpoints, though we have grave doubts as to whether the sun appears so large to an inhabitant of Mars, or whether Jupiter is so very like a Dutch cheese cut in two, in the eyes of its satellites. Certainly it does not seem obvious why the scenery on the moon, viewed in the light of its eclipsed sun, should present such delicacies of shade and colour, even in its shadows, when the moon in full sunlight is but black and white. There are also two landscapes of the earth seen under the illumination of the eclipsed sun and of the eclipsed moon. Here, indeed, there is a grave error, for in both cases the diameter of the luminary is made to measure fully ten degrees, and thus an utterly false idea of the magnitude of the corona is given.

A Text-Book of Botany. By Dr. E. Strasburger, Dr. Fritz Noll, Dr. H. Schenck, and Dr. A. F. W. Schimper. Translated from the German by H. C. Porter, Ph.D. (London: Macmillan & Co.) 18s. net. This handsome volume is a complete treatise on botany, including as it does sections on external morphology, histology, physiology, and systematic botany. The translator has had the good fortune to see his work undergo a general revision at the hands of Mr. A. C. Seward, M.A., the Cambridge University Lecturer in Botany, so that its suitability for English students is quite assured. The whole style of the book is admirable; the type, illustrations, and general arrangement leave nothing to be desired, while the coloured pictures of typical cryptogams and phanerogams, which are scattered throughout the text, are lifelike in their beauty. Such plates, which are, we believe, a new feature in ordinary text-books of botany, do more than any amount of verbal explanation to supply the reader with information which makes the recognition of the species in the field quite easy. Though it is perhaps too much to hope, yet we cannot but wish that somehow the introduction to the volume could get into the hands of that omnivorous person, the general reader. Showing as it does the relation which exists between animal and plant life; and making clear that as the line of development of animals and plants is traced back, through lowly and more lowly forms, the points of difference between them gradually vanish, until eventually it is found that they assimilate to one another's characteristics, and it becomes impossible to say whether the primitive organism is plant or animal; it is difficult to imagine a more fascinating piece of reading. In the same interesting way the work of Darwin, Müller, Schwann, and Pasteur is briefly reviewed, the part they each took in the elaboration of the whole subject being made quite simple and clear. We have not the slightest doubt that this text-book, like the German *Lehrbuch* from which it has been translated, will be long regarded as a standard work, and we wish it all the popularity it deserves.

SHORT NOTICES.

On Laboratory Arts. By Richard Threlfall, M.A. (Macmillan.) Illustrated. 6s. The student who desires to gain a practical knowledge of mechanical work in the chemical and physical laboratory will find in Mr. Threlfall's book a valuable auxiliary. The author aptly remarks: "It often happens that young physicists are to be found whose mathematical attainments are adequate, whose observational powers are correctly trained, and whose general capacity is unquestioned, but who are quite unable to design or construct the simplest apparatus with due regard to the facility with which it ought to be constructed." To such, this book forms a plank, so to speak, which will carry them safely across the difficulties generally encountered by the indifferent manipulator. Glass blowing, the making of vacuum tubes, glass grinding, and many other indispensable operations are described in detail, and helpful diagrams are interpolated here and there to illumine the text.

General Elementary Science. Edited by Wm. Briggs, M.A. (Clive.) Illustrated. 3s. 6d. Designed to meet the requirements of the modified syllabus of the University of London, this book is intended as a guide to general elementary science for the matriculation course. All aspirants for University honours, whether scientific or not, should at least acquire a knowledge of the fundamental principles of natural philosophy. Cramming, however, has attained the culminating meridian, when an editor endeavours to compress the sciences of mechanics, heat, light, electricity, and chemistry within the compass of a single volume scarcely large enough to convey a fair notion of any one of these sciences; and, keeping in view this flimsy groundwork, a smile might be tolerated when one reads that this meagre introduction is "to provide them (the matriculation candidates) with the means of recording observations with some degree of exactness." "*Some*," of course, is one of those elastic words which may represent any magnitude between zero and the infinitely great.

The Story of Life in the Seas. By Sydney J. Hickson, F.R.S. (Newnes.) Illustrated. 1s. With a thoughtful endeavour to instruct those who have not been trained in the alphabet of zoological technicalities, Prof. Hickson has, in this little book, avoided all the more intricate branches of marine zoology which, though of the highest importance to some, would not tend to encourage the general reader. Never losing sight of the goal he has set himself to reach, he conducts the reader through the trackless sea, so to speak, and by the help of a rich vocabulary—very slightly afflicted with unavoidable long words—conjures up a wonderful picture of the inhabitants of the great deep, including shallow-water fauna, surface-swimming fauna, and deep-sea fauna, as well as chapters on oceanography, commensalism and parasitism, and the origin of the marine fauna.

A Simple Guide to the Choice of a Photographic Lens. 1s. T. R. Dallmeyer, F.R.A.S. This booklet, written as it is in a clear and concise style, forms, with its explanatory diagrams, an excellent and trustworthy guide to photographers who wish to buy and use their lenses with greatest satisfaction.

The Story of Photography, by Alfred T. Story, is one of Messrs. Newnes' series of "Useful Stories." It answers its purposes very satisfactorily. The information given is plentiful and accurate.

BOOKS RECEIVED.

Astronomy for the Young. By W. T. Lynn, B.A., F.R.A.S. (Stoneman.) Illustrated. 6d. net.

A Dictionary of Bird Notes. By Chas. Louis Hett. (Jacksons', Market Place, Brigg.) 2s. 6d.

A Classification of Vertebrata, Recent and Extinct. By Dr. Hans Gadow. (Black.) 3s. 6d. net.

The Play of Animals. By Prof. Karl Gross. Translated by E. L. Baldwin. (Chapman & Hall.) 10s. 6d.

Outlines of Vertebrate Palæontology. By Arthur Smith Woodward. (Cambridge University Press.) Illustrated. 14s.

Forty-fifth Report of the Department of Science and Art of the Committee of Council on Education. (Spottiswoode.) 1s. 10d.

Chemical Analysis. By W. Briggs and R. W. Stewart. (Clive.) 3s. 6d.

"INSECT MINERS."—II.

By Fred. Enock, F.L.S., F.E.S., etc.

A NUMBER of very interesting miners, together with their parasites, may be observed in leaves of sunflowers, carnations, columbine, etc., etc.; and in the shoots of black currant bushes, the larva of the pretty currant clear-wing moth, *Sesia tipuliformis*, is found, but more frequently by the blue tits than by gardeners, who attribute the broken twigs to these useful birds. I know that the majority of gardeners look upon anyone as insane who would say a good word for the sparrow, but I am proud to own them as friends, though they do pinch the crocuses and other things. In my insect diary I have many records for good as well as for evil deeds. I have frequently watched sparrows examining the lime trees in search of the brindled beauty moth, *Biston hirtaria*, and seen them kill and eat a number of females—each of which would lay over six hundred eggs. Again, that great miner the wood leopard moth, *Zeuzera æsculi* (whose larvæ work such havoc among trees of all kinds in our parks and gardens), is a favourite morsel of the sparrow. I turn to my diary for 1873, and find an entry to the effect that every ash tree (over thirty) on the right side of Hanley Road, N., was infested with wood leopards, which emerged about five o'clock in the afternoon. On some trees over a dozen were to be seen drying their wings. Further observation showed dozens of sparrows "collecting" and eating these savoury insects. I noted the same thing going on at Finsbury Park, where I pointed out several infested trees to the late Mr. Thomas Cochran, Superintendent, who had them immediately cut down and opened, much to the wonder of the staff, who had no idea such "miners" could bore through and through the solid ash trunks. Where the wood leopard failed the huge larva of the goat moth (*Cossus liquiperda*) took up the work of destruction. In the year 1878, when living near Finsbury Park, I noted a small willow tree in my next-door neighbour's garden which appeared to be infested with these caterpillars. Soon after we were astonished to find a large larva in the kitchen one morning, but though, according to Pliny, the Romans used to consider this stinking goat moth larva a luxury of the table, I did not feel disposed to prove it, though I could not understand the visit. However, others continued to arrive almost daily in various parts of the house, until I obtained permission from my neighbour to examine the willow before mentioned. It was not more than five inches in diameter, and, when broken up, I found it full of larvæ of *C. liquiperda*, varying from an inch and a half to four inches long! These, added to those which had visited us, all told, totalled up to one hundred and nine! But how many beside went over the walls the other side it is impossible to say. What a feast for anyone so inclined! I have seen a sparrow attack and destroy one of these large moths. Only last week I found the mutilated remains of a wood leopard in my own garden, where from a small pear tree I cut out one of these larvæ, but the damage had gone too far, as the "miner" had bored right up the central stem and the tree died.

FIG. 9.—Holly Leaf mined by Larva of *Phytomyza aquifolii*. (Natural size.)

We must not forget that sparrows kill great numbers of "daddy longlegs" before most people are awake. We all know how plentiful "green fly" has been on every plant this dry season; I, for one, have been much indebted to the sparrows for their persistence in picking off immense numbers of this pest.

"Seeing is believing," and I only write of the things which I have seen, and feel it to be a duty to say a kind word on behalf of the much-abused sparrow.

The holly leaves are sometimes sorely affected by the larva of *Phytomyza aquifolii* (Fig. 9), a miner which, for obvious reasons, has things pretty much its own way, except for the industrious parasite (Fig. 10) which does its best to check the advance of this disfiguring larva.

FIG. 10.—Parasite of Holly Fly. (× 12 Diameters.)

To those who grow raspberries "the maggot" ought to be familiar, but it is astonishing how seldom the cause of a bad crop is detected. This is owing to the fact that inquiry is generally made too late, and should "opportunity be neglected" sorrow is sure to follow.

The month of May is the best—I might say the only time when any steps can be taken to destroy this miner, which is, when full grown, a little over a quarter of an inch long—a chubby little pink maggot—which has during the winter been securely protected in a tiny covering among the earth at the foot of the canes. In the spring it ascends until it reaches the buds just breaking into growth. Into the bud it bores a minute hole (Fig. 12), which is frequently hidden away by the scale. When once inside it is safe from observation, and it quietly goes on with its mining right up the centre of the fruit-bearing shoot, the only outward indication of its presence being an

FIG. 11.—Raspberry Shoot affected with "the Maggot" of *Lampronia rubiella*.

occasional darkening of portions of the leaves (Fig. 11), and always the presence of minute pellets of frass, which are forced out at the aperture at the tip of the shoot, and, falling, rest in the axils of the leaves (Fig. 11). Directly these signs are noted any of the shoots so affected, on being split up, reveals "the miner"—plump and fat—with plenty of room to move up and down. All shoots containing a maggot have (as shown at Fig. 12) the centre eaten clear away, and all chance of fruit-bearing is gone. The larva sometimes leaves its burrow and pupates among the dead leaves at the base of the shoot, but it generally remains inside to undergo its change. The pupa has rings of minute spines around the margins of the segments, by the aid of which it can lever itself up to the top of the shoot, from which the raspberry moth emerges in the course of a week or two.

The great point to bear in mind in connection with this raspberry pest is that it remains but a few weeks in the shoot, and that it is there the latter part of May. This, then, is the time to destroy it, which must be done at the sacrifice of many canes, or even the whole crop. When the moths have escaped—in early June—it is impossible to prevent eggs being laid by them for the next season's brood. Catching the moths (in exactly the same manner as by entomologists) would materially lessen them if carried out in a systematic manner, and until some such work is carried out these insect miners will go on increasing.

Fig. 12.—Section of Raspberry Shoot showing larva of *Lampronia rubiella*.

Fruit and flower growing has now been brought up to great perfection, but we are still far behind in systematic work for coping with insect pests.

BOTANICAL STUDIES.—V.

ASPLENIUM.

By A. Vaughan Jennings, f.l.s., f.g.s.

In the moss plant which formed the subject of our last study* we found that, as in *Jungermannia*,† the life-history consisted of two distinct stages. It was observed that the leafy moss-stems of *Mnium* carried more or less evident "flowers" at their tips, containing either the egg-bearing Archegonia or the fertilizing Antheridia; and that from the former there arose the slender stalk and drooping capsule which we know as the "moss-fruit." In other words, that there was a green, leafy *Oöphyte*, or egg-bearing plant, from which grew a distinct type of plant, the *Sporophyte*, whose spores in turn developed the form of the parent Oöphyte.

Bearing this in mind, and looking among the higher flowerless plants, such as the ferns and their relatives, for a type to study in continuation of our series, we should come to the subject with preliminary expectations that will cause us some trouble. Naturally enough we shall expect that a fern, say the little spleenwort here figured (common in the crevices of stone walls), may be regarded as a plant comparable to a moss-plant, though of much higher development and greater complexity of internal structure. We shall look at the fronds expecting to find something equivalent to the moss "flowers," and showing under the microscope more or less similar groups of Archegonia and Antheridia.

It will be found that the only structures on a normal frond which suggest a fructification, are the oblique lines on the under surface of its pinnæ; light coloured in the young plant, but larger, browner, and dust-like on the older parts. If we cut a thin section with a razor across one of the younger pinnæ, we shall find something similar to the central figure in the illustration. A number of oval bodies borne on longer or shorter stalks, rising from superficial cells of the leaf, though partly covered by a thin irregular membrane rising from one side. The oval bodies have evidently a distinct cellular wall, and the older ones enclose a mass of dark granular cells in a condition of active division. There is evidently nothing that can be compared to an archegonium. What, then, are these structures? Are they antheridia? It seems not improbable from their appearance when young, but an examination of the older ones will not confirm the idea. If we take one of the older pinnæ and scrape off the brown material from the under side, we find the structures shown in Figs. M and N. They are stalked, thin-walled cases, with a dark layer of thick cells running round some two-thirds of the margin; in the interior is a dark mass which, when a ripe case bursts, resolves itself into a number of brown bodies with thick, rough walls. There is, evidently, nothing here like the minute, free-swimming bodies we saw discharged from the moss antheridium; but, on the other hand, these bodies have a strong resemblance to the spores of the moss and the liverwort.

It is, in fact, evident that the oval cases are *Sporangia*: but are they equivalent to the spore-capsule of *Mnium* or *Jungermannia*? If so, they are very minute and simple in structure; and, further, should be found to arise from fertilized archegonia. Referring again to the section, or making new preparations, no trace of archegonia can be found, and it is evident that some different line of study must be adopted. Suppose we "plant" the spores and see what becomes of them.

If a number of the spores are scattered over a layer of mould or on the side of a flower pot, and kept moist, it will soon be seen that the surface is acquiring a green colour, and a pocket-lens will show that this is due to the growth of a number of separate little green discs. Under the microscope these may be seen distinctly to originate from the germinating fern-spores. At first they are merely narrow plates of chlorophyll-containing cells, but by the continued division of a triangular cell at the tip, and by the rapid growth and division of cells at the side of it, a heart-shaped or bi-lobed structure is ultimately

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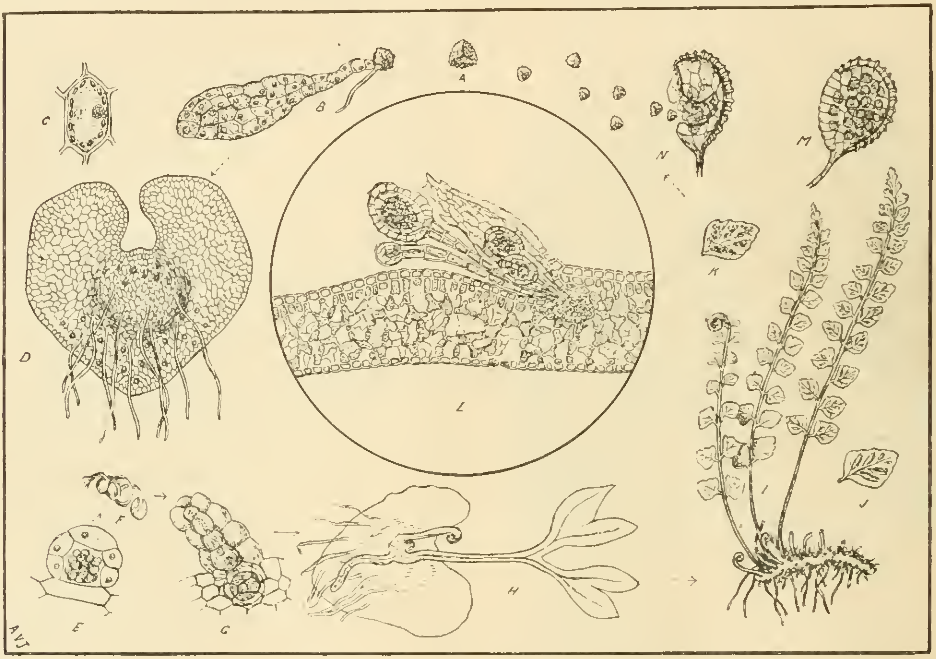
* Knowledge, July, 1898. † Knowledge, May, 1898.

produced. This becomes thicker in the centre owing to division of cells in a horizontal direction; and from the under side are developed slender root-hairs or rhizoids, which serve both to anchor the plant to the soil and to collect food material therefrom.

Thus the cell-plate is able to lead an independent existence, feeding itself from the air and the soil like other green land plants. Yet it shows no tendency to differentiate into root, stem, and leaf, or to acquire any of the characteristics of a fern. Longer observation will show also that it does not continue to increase in size; many will dry up and disappear, but from some of them new green shoots will be seen to rise growing upward from their surface. These are evidently new structures, not further growths, since the heart-shaped cell-plate still remains, though shrinking and withering round their base.



A.—The Fern Spore. B.—Germination of the same, producing the young Oöphyte or Prothallus. C.—One of the Cells of the Prothallus, showing the Protoplasmic Contents, with Nucleus, Vacuoles, and Chlorophyll bodies. D.—The Prothallus, seen from the under side. The small round bodies among the root-hairs toward the apex are *Antheridia;* those below the notch are the *Archegonia.* E.—An *Antheridium* as seen in Section, with the mass of developing Antherozoids within. F.—One of the Antherozoids (or Spermatozoids) set free. (Highly magnified.) G.—An *Archegonium* ready for Fertilization. H.—A withered Prothallus, with a young *Fern Plant* (*Sporophyte*) growing from it. I.—*Sporophyte* of Asplenium trichomanes, showing the creeping Stem (Rhizome) and young Fronds rising behind its apical growing point. J, K.—Younger and older Pinnæ of the Frond, showing the Sori on their under surface. L.—Section through a Pinna and *Sorus,* showing the *Sporangia* in different stages of development, partly covered by the *Indusium.* M.—A ripe Sporangium with enclosed Spores. N.—A burst Sporangium discharging the Spores.

The explanation of these phenomena can only be arrived at by a closer study under the microscope.

If a medium-sized disc, one about a quarter of an inch across, is mounted in water and examined with a moderate magnifying power, it will be seen that the regularity of the cell arrangement is sometimes broken by dark spots distributed more especially over two regions. The more conspicuous are small round bodies scattered among the bases of the root-hairs; while another group occurs above, round the indentation at the apex.

It will be found quite possible to get a good idea of the form and nature of these structures by carefully focussing the microscope, or even by dissecting them out with needles; but it is far preferable to harden some of the plants in spirit and then cut thin sections through them. The latter group referred to will be found to have all the essential characteristics of Archegonia, a typical egg cell lying in a rounded cavity, and above it a "neck" composed of several rows of cells surrounding a central passage. The wall of the chamber round the egg cell is not so distinct as in the moss, since the whole base of the structure is here embedded in surrounding tissues; the neck is also much shorter and wider, but these are mere details, the organ is evidently an *Archegonium.*

That the round bodies occurring among the rhizoids are similarly true *Antheridia* may be readily proved if one of the darker-coloured riper ones is selected and burst by light pressure on the cover glass. A mass of small cells will escape into the surrounding water, and shortly each will be seen to take the form of a spirally coiled spermatozoid with a more or less defined disc at one end and a tuft of cilia at the other.

It thus becomes evident that these little bodies, which can be found in any greenhouse round growing ferns, though not so easy to distinguish out of doors, are true egg-bearing plants. They are, in fact, the real oöphyte stage in the fern-plant's life-history, and we are forced to the conclusion that we must look on them as the equivalent of the moss-plant with its stem and leaves, and regard the familiar fern as the representative only of the stalked capsule or sporophyte of *Mnium* and *Jungermannia*.

The two generations have, as it were, changed places in respect of size, conspicuousness, and elaboration of structure.

While it is impossible to exaggerate the importance of this "alternation" in the life-history, it remains difficult to decide whether we should regard the two stages as fundamentally different, or look on them as extreme specializations on distinct lines of a type with double potentiality. Thus, we cannot overlook the facts that in a few exceptional cases the formation of Archegonia can be dispensed with, and the prothallus may grow out vegetatively into a sporophyte ("*Apogamy*"); while, on the other hand, the tissues of a frond may, in rare cases, develop prothalli without the intervention of spores ("*Apospory*").

We have, in fact, crossed a wide gap in the continuity of vegetable life. We have passed from a type in which the sporophyte grows from, and is physiologically dependent on, the parent egg-bearing plant, to one in which the oöphyte generation is small, inconspicuous, transitory, and of simple structure. The sporophyte has become a highly specialized growth, with complicated systems of tissues like those of flowering plants; ranging through an infinite variety of forms, from the moss-like fronds of the filmy ferns to the rigid tree trunks of the Cyatheas and Alsophilas of the Tropics.

With the detailed structure of this sporophyte we are not here concerned; but to complete our summary of the life-history the cycle of reproduction may be summarized as follows:—

Division of the fertilized egg-cell produces a fern-embryo which develops a primary root, leaf, and stem growing-point long before the final decay of the Oöphyte or Prothallus. When the latter has dried up and disappeared the stem of the fern-sporophyte is in active growth; producing successive leaves or fronds behind the progressive apex, and establishing firm connection with the soil by its numerous roots. The fronds from the first perform all the functions of leaves in the vital economy of the organism, and in their older stages take their part in the reproductive cycle by developing Sporangia. These, in the case of the true ferns, are formed each from an epidermal cell, though as numbers of such cells are active together the result is usually a group or *Sorus* of sporangia. The form of the sporangium varies, and special forms characterize particular groups, but in all our common ferns the type is that shown in the figure. The position and shape of the *sori*, and the form of their membranous covering or *indusium* when present are characters of great importance to the systematic botanist. Through the whole series of true ferns, however, whatever their variety of appearance, the spores are of *one kind only*, and when they germinate produce a free green prothallus such as we have observed.

Having thus got some idea of the life-history of a fern, it only remains to see if we can get any glimpse from this standpoint, either backward or forward, along the lines of plant evolution.

Looking downward, it is very remarkable that we can see no evident links connecting the fern-type and the moss-type. It is possible to imagine a moss in which leaves might be formed on the seta, or in which the sporophyte might root itself and live after the oöphyte had perished, but as a matter of fact we do not know of any such types. It is also possible to imagine a moss-capsule becoming complicated in structure by internal division into chambers, owing to certain cell layers not forming spores; and later by the separation of these layers so that the whole sporophore became a compound structure. Prof. Bower has shown how the various types of "fructification" in the vascular cryptogams may in this way be compared with one another, and with some relatively simple ancestral type. It is, of course, neither necessary nor reasonable to suppose the fern derived from a specialized moss-type, but it is probable that the whole series of the vascular cryptogams—ferns and their relatives—might, if the intermediate links were still existing, be traced back to some form having relationship with both mosses and liverworts.

Looking in the other direction, the question arises, what is likely to be the next stage in the series if the subordination of the Oöphyte generation continues? It will be some plant in which the prothallus is still smaller, more ephemeral, and less independent. In our next study we may find that this link in the chain between the lower and higher plants is also easily obtainable, and almost equally easy to observe.

◆

NOTES ON COMETS AND METEORS.

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

Comets.—Though we have recently had a numerous display of comets they do not seem to have furnished any special instance of brilliancy or peculiarity of appearance. The positions of the objects referred to are, in the majority of cases, unfavourable. Perrine's comet of March 19th is now exceedingly faint, and during September will be almost stationary in about R.A. 6h. 32m. Dec. fifty-one degrees north. The comets of Coddington, Encke, and Perrine (June 14th) are too far south to be favourably seen. Giacobini's comet is becoming very faint. Wolf's periodical comet, is still visible in the morning hours, but it requires a good telescope to show it, as it is by no means a conspicuous object. The following is an ephemeris by Thraen for Berlin mean midnight:—

Comet Wolf.

Date.		R.A.			Declination.		Distance in millions of miles.
1898.		h.	m.	s.	°	′	
September	11	6	6	7	+9	31·8	153
,,	15	6	13	38	+8	24·2	151
,,	19	6	20	45	+7	14·2	150
,,	23	6	27	26	+6	2·2	148
,,	27	6	33	41	+4	48·4	147

During September its brightness remains practically constant at 2·6. From the ephemeris it will be seen that the comet moves slowly to south-east passing from the north-easterly limits of Orion into the head of Monoceros. On September 23rd the comet will be in conjunction with the 6th mag. star 12 Monocerotis, and about one and a-quarter degrees north of the star.

Meteors.—Fireball of July 14th.—A brilliant fireball, apparently as large as the moon, was seen on July 14th at 9h. 50m. by Mr. Murrell Dawnay from a position about two miles off Beachy Head. The path of the fireball was roughly estimated as from 280° – 14° to 310° + 8°, but no other descriptions of it have come to hand.

Fireball of July 26th.—Mr. F. C. Dennett, of Dalston, E., writes: "There was a remarkable meteor on July 26th, at about 9h. 12m. It appeared from behind houses and disappeared behind clouds about twenty degrees N.N.E. of the zenith. Size a-quarter to a-third that of the moon. The colour was green, very decided, and its trail, perhaps four degrees in length, was red. Its motion was fairly rapid, and its path was nearly south to north, perhaps ten degrees east of the meridian." Mr. C. Grover at Lyme Regis describes the time as 9h. 10m., and says: "The fireball started from a point a little south of east at an altitude of about fifteen degrees, and vanished in about north-east, at a height of about ten degrees. At first it appeared like a small star, but rapidly increased until it was far brighter than Venus, and finally disappeared in a shower of sparks. The colour was most remarkable—a brilliant, dazzling green—so intense as to be quite startling. The sky was very hazy at the time." Mr. W. Lucking, of Berden, Herts, reports, in a letter to Prof. Herschel, that on July 26th, 9h. 10m., a magnificent detonating fireball passed over that village. There was a vivid illumination of the landscape, and, on looking upwards to ascertain the cause, a fireball with a red train was observed moving northwards nearly from the zenith. The fireball burst with a loud report, which was compared to that of a cannon fired at a short distance. At Albury, Herts, a loud detonation occurred, and is described as being simultaneous with the disruption of the meteor. People indoors thought there must have been an explosion at the Waltham Powder Mills, and were much alarmed. The fireball was also seen at Maldon and other places. From a comparison of the various accounts the approximate real path of the object appears to have been from above a point twenty-five miles west of Dieppe, France, to March, Cambridge. The height was seventy-three miles at first, and twenty-seven miles at the end. The meteor had a long flight of about one hundred and ninety-one miles from south to north, and a probable radiant at 269° – 23°. It must have passed over the zenith of Berden at a height of thirty-eight miles, so that a detonation of the meteor would have taken three minutes to reach observers there. This is, however, a relatively short interval, and quickly passes when people have been surprised by an unexpected phenomenon, so the statement that the sound came simultaneously with the meteor's explosion may not be quite correct.

Fireball of August 1st.—Mr. W. Lascelles-Scott, of Romford, reports that just before 10h. 9m. p.m. he saw a magnificent meteor about eight times the brilliancy of Jupiter: "It passed directly overhead, and apparently describing a curve upon a vertical plane in the direction S.S.W. by S. to N.N.E. by N., descended until it quietly disappeared, after traversing more than one-third of the heavenly dome."

The Perseids.—This long-continued shower commences about the middle of July, and the sky being almost free from moonlight at this epoch, an attempt was recently made to observe a few of the earlier members of the display, Prof. Herschel, at Slough, watched the north-west portion of the firmament on July 13th, 14th, and 15th, and noted nineteen meteors, which included two Perseids, one seen on July 14th at 11h. 25m., and the other on July 15th at 10h. 59½m. At Bristol observations were commenced on July 16th, when three small Perseids were recorded amongst fifteen meteors seen during a watch of three hours. On later nights of July a few other Perseids were registered, both at Slough and Bristol, but they were not sufficiently numerous on any particular date to indicate a good radiant.

On July 30th a fine Perseid appeared in the moonlit sky at 10h. 43m., and was fortunately observed by Prof. Herschel and the writer. The real path of the meteor extended over fifty-seven miles, from Northampton to Burford, and it fell from a height of eighty-one to forty-seven miles. Its velocity was thirty-six miles per second, and the radiant point, from the combined paths, was at 23° + 53°, which is several degrees west of the normal place of the Perseid centre on July 30th. At Slough the meteor was observed at a considerable distance from its radiant, and a slight inaccuracy in recording the direction of flight would throw the radiant some degrees away from its correct position. At Bristol the meteor was much foreshortened close to its radiant, and it left a dense streak, broken in the middle, just south of α Cassiopeiæ.

Among the minor showers observed in July, there was a prominent display of Cygnids from a radiant at 315° + 47°. This is a well-known position, and furnishes quite a distinct stream to that of the August Cygnids, which were very active in 1893, from a radiant at 292° + 53°.

There was also a well pronounced radiant in Hercules at about 249° + 37°, and very few Aquarids were recorded, but there was a display of long-pathed meteors from a centre at 338° – 25°, near Fornalhaut.

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THE FACE OF THE SKY FOR SEPTEMBER.

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

The Sun has been free from spots for several days together during the last two months, but several spots of moderate size have been observed. Bright faculæ have been frequently seen. It is, of course, impossible to say what may happen during the present month.

Mercury will be at inferior conjunction on the **5th**, and will reach his greatest elongation of 17° 51′ W. on the **21st**. He will, therefore, be a morning star during the latter part of the month. On the **21st** he will cross the meridian 1h. 12m. before the Sun, his declination being 8° 20′ N., while that of the Sun will be 0° 36′ N.

Venus is an evening star, and will be at greatest eastern elongation on September **21st**, 46° 27′ E. of the Sun. She is, however, so far south, and sets so soon after the Sun, that her appearance is not very striking. On the **21st** she will set about an hour after the Sun. At the middle of the month, a little more than half of the disc will be illuminated. On the **19th** it will be interesting to observe the planet in close proximity to the Moon, the two being in actual conjunction about 7 p.m., shortly before they set. At the time of conjunction the Moon's age will be 3d. 19h., and Venus will be 1° 28′ north of the Moon.

Mars does not rise until between 10 p.m. and 11 p.m. during the month, and he is too far distant for profitable observation with small telescopes. It is, however, always interesting to follow the apparent movement of this planet. During the month he pursues a direct path in Gemini, along a line running a little north of the star η, south of ε, to a little north of δ. His apparent diameter increases from 6·4″ to 7·2″. There will be a daylight occultation of this planet on the **9th**, the disappearance taking place at 1.31 p.m., at a point 95° from the vertex, and the reappearance at 2.19 p.m. at 215° from the vertex. The Moon will be twenty-three days old, so that the disappearance will take place at the bright limb. A telescope will, of course, be necessary to observe the occultation, but as the Moon will probably be visible to the naked eye, an equatorial will not be essential.

Jupiter will be an evening star during the month, but he is too near the Sun for useful observation. He will be in actual conjunction with the Sun on October **13th**, and the satellites will not be observable from September **15th** to November **12th**.

Saturn is still an evening star, at the middle of the month remaining above the horizon for about two and a half hours after the Sun has set. He is in the constellation Ophiuchus, but may perhaps be better recognized from his position of about six degrees north of Antares.

Uranus passes from Libra into Scorpio, but is too far south and too near the Sun for convenient observation. His path is from about one-third to one-half the distance from λ Libræ to ω Scorpii.

Neptune, still in Taurus, rises about 11 P.M. at the beginning of the month, and about 9 P.M. at the end. He is a little to the north-east of ζ Tauri.

The Moon will enter her last quarter on the **7th** at 10.51 P.M.; will be new on the **16th** at 12.10 A.M.; will enter her first quarter on the **23rd** at 2.39. A.M.; and will be full on the **29th** at 11.11 P.M. At the full the phenomena of the Harvest Moon will be presented to us; that is, she will rise almost full at about the same time on several successive evenings. This is illustrated in Fig. 1, showing the Moon's position on the celestial sphere at the times of rising, from September **27th** to October **1st**, as seen from outside. The direction of the diurnal motion being indicated by the arrow, it is at once evident why the times of rising vary so little. At the time of setting, the ecliptic is no longer nearly coincident with the horizon, as will appear from Fig. 2, and the intervals between the times of setting on successive days are longer than the average. The following are the times of rising and setting of the Harvest Moon at Greenwich :—

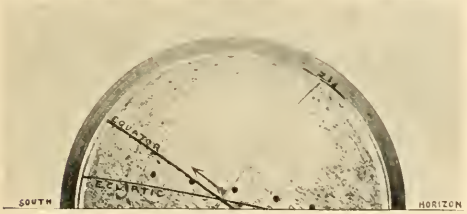


Fig. 1.—Illustrating the Rising of the Harvest Moon.

Fig. 2.—Illustrating the Setting of the Harvest Moon.

	Rises.	Sets.
September **27th**	4.29 P.M.	2.38 A.M.
,, **28th**	4.47 ,,	4.1 ,,
,, **29th**	5.4 ,,	5.21 ,,
,, **30th**	5.22 ,,	6.41 ,,
October **1st**	5.42 ,,	7.59 ,,

Conveniently observable minima of Algol will occur on the **12th** at 11.27 P.M., and on the **15th** at 8.16 P.M.

Observers interested in variable stars may be reminded that a maximum of Mira Ceti is probably not far distant.

◆

Chess Column.

By C. D. Locock, B.A.

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

Solutions of August Problems.

(By J. Nield.)

No. 1.

1. Q to QR2, and mates next move.

No. 2.

As pointed out by W. de P. Crousaz only, Kt to R2 will not solve this problem, on account of the reply Kt to K7.

Correct Solutions of No. 1 received from Alpha, W. Clugston, H. Le Jeune, G. G. Beazley, J. M'Robert.

Mr. A. C. Challenger writes to say that the unsoundness of his problem in the July number was due to the absence of a White Pawn at KB2.

W. J. Bearne.—After 1. QK2ch, K to Q5, 2. Kt Kt4 is not mate.

W. Clugston.—July solution correct, as you will have seen.

F. W. Andrew.—Thanks for the problem; it is marked to appear next month, and a copy shall be sent to you.

J. Nield.—Have posted copy as requested. Can you account for the difficulty in No. 2?

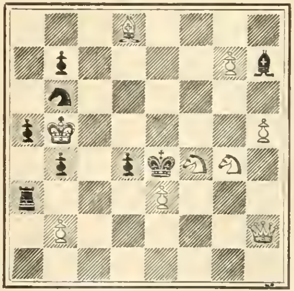
A. C. Challenger.—Many thanks for the explanation. The original being no longer available, it is impossible to say whether the omission was there or not. Judging by the number of pieces, it seems perhaps probable that the omission was made as you suggest. We shall be glad to receive the substitutes.

PROBLEMS.

No. 1.

By B. G. Laws.

Black (8).



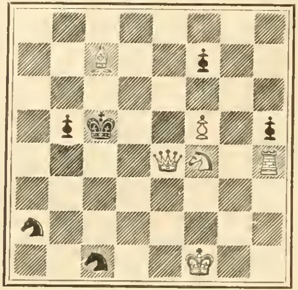
White (9).

White mates in three moves.

No. 2.

By A. C. Challenger.

Black (6).



White (6).

White mates in two moves.

CHESS INTELLIGENCE.

The Lee-Teichmann match resulted in a victory for Mr. Teichmann by three games to one, with five draws. Such a score does not show any marked superiority on either side.

The final score in the Vienna tournament was as follows, Herr Schwarz's score being cancelled:—

H. N. Pillsbury	28½	tie for first and second prizes.
S. Tarrasch	28½	
M. Janowski	26½	third prize.
W. Steinitz	24½	fourth prize.
C. Schlechter	22½	fifth prize.
A. Burn...	21	tie sixth prize.
M. Tchigorin	21	seventh prize.
G. Maroczy	20½	tie eighth prize.
P. Lipke	20½	ninth prize.
S. Alapin	19	tenth prize.
E. Schiffers	18	special Chess Club prize.
G. Marco	17½	
J. H. Blackburne	17	special prize.
J. W. Showalter	16	
C. Walbrodt	15½	special prize.
E. Halprin	15	special prize.
H. Caro...	13½	
D. G. Baird	9	
H. W. Trenchard	6	

On playing off the tie for first and second prizes, Dr. Tarrasch won the first prize (£250) by two games to one, with one draw; Mr. Pillsbury taking the second prize (£166).

Dr. Tarrasch lost only three games out of thirty-six played, a very fine performance; Mr. Pillsbury lost five, but drew considerably fewer games, this result being in accordance with the styles of the two players. M. Janowski lost both games against Lipke and Halprin. Mr. Steinitz's only double defeat was at the hands of Janowski, but he drew more games than usual, as also did Burn. Herr Schlechter, as usual, drew about half his games, losing only six. He was the only player to beat Mr. Burn in both rounds. Probably the latter had resolved not to draw at all costs, with the usual result. Tchigorin, like his old rival Steinitz, lost both games to Janowski, and to him only. Maroczy hardly fulfilled expectations. He drew more games than even Schlechter. Lipke also was insatiable in the matter of draws, but he could not get one against Steinitz. Alapin had an excellent score at the end of the first round, but he failed in the second. Schiffers, on the contrary, started badly, and altogether failed to do himself justice, while Marco hardly played as well as he has lately. Blackburne drew no less than twenty games. When playing his last game (against Caro) he found himself in the anomalous position of standing to lose £4 if he won the game. Naturally he lost it, thereby winning the £12 prize for the best score against the prize-winners. Showalter again disappointed his admirers, while Walbrodt has his own carelessness to thank for his low position. He forfeited two games through arriving late. The last three are representatives of London and New York; evidently the Anglo-American cable match is not quite up to the standard of a first-class international tournament. Altogether, the present tournament is one of the strongest ever known, the players on the whole being superior to their predecessors in the Vienna tourney of 1882, though Lasker and Charousek were needed to make it complete. The winner enhanced his already great reputation; of the others, the chief honour rests with Schlechter and Burn.

Several of the Vienna competitors are now playing in the tournament of the German Chess Association at Cologne. Herr Cohn, the well-known Berlin amateur, was leading at the end of the tenth round, closely followed by Mr. Burn. Of the remainder, Steinitz, Charousek, Tchigorin, and Schlechter were making the best scores, and Herr Schallopp the worst.

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CONTENTS.

AN ESKER IN THE PLAIN.

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

THE gravel ridges of the Irish plain have been already mentioned* as a welcome feature in its landscapes. These "green hills," with their pleasant grassy slopes, have often given a name to groups of houses clustered near them; and here and there they were seized on long ago as sites for commanding forts. The Irish word *eiscir* means "a ridge," and there is a hamlet called "Esker" to this day on a gravel bank near Lucan. The term has, however, become a scientific one, through the interest roused among geologists by the characters of many of these ridges; and General Portlock,† Mr. G. H. Kinahan, and, finally, Mr. Maxwell Close,‡ have distinguished between *eskers* proper and the fairly parallel banks of drift, or *drumlins*, which are found so abundantly in glaciated countries.

We need not go far from Dublin to find a typical little esker. Four miles south-west of the city, out in the limestone plain, the main road to Tallaght makes a sudden rise, and reaches the crest of a green ridge on which the hamlet of Balrothery stands (Fig. 1). Gravel pits have been opened on either hand, and a by-road turns off along the ridge, which it follows for some three miles to Crumlin. Such a road is in itself a feature of an esker; these dry raised causeways offered themselves to the ancients ready-made; and the fact that they seldom ran in a straight line was not in those days of much importance. If we start from Balrothery, we at once note that the esker is formed of irregular beds of pebbles, with occasional yellow sands. At the summit it is little wider than the road, and falls with a slope of twenty degrees on either hand; from its base there is a gentler slope to the ordinary level of the fields, doubtless due to the washing down of detritus from the ridge. Before us, planted on the crest, rises the tower of Tymon Castle, one of the defences of Norman Dublin against the Irish; and the road has to give way and descend round about it. The west slope has here an angle of nearly thirty degrees (Fig. 2). Soon we reach Green Hills, where the inhabitants are engaged in quarrying, and where large sections have been opened in the esker. Here the ridge broadens and becomes less defined, and finally breaks up into a number of mere mounds of gravel.

When once recognised, such a feature will be picked out again and again in a traverse of the Irish plain. Gravels are common on its surface, largely composed of limestone pebbles, with a sprinkling of other rocks, which can generally be traced to the highlands of the country along one or other line of ice-drift. The pebbles of the plain are ground and striated on their surfaces, and clearly were at one time under solid ice, or embedded in its moving layers. When, however, we examine the material of the eskers, we find the same pebbles, but with subsequent signs of water-action. Here and there the old striæ remain; but in most cases further rounding and abrasion have gone on. The bedding, whether in the rough layers of the gravel, which are seen to dovetail into one another in the sections, or in the delicate stratification of the brown and yellow sands, reminds us at once of the river-deposits that are laid bare by Alpine streams. But in the esker the form of a stream-deposit is reversed; instead of an alluvial mass, filling up the groove of a valley-floor, and widening from below upwards, we have the narrower part at the top, and a pebbly ridge has been heaped up without visible retaining walls.

The sharp ridges formed by the lateral moraines, as a glacier shrinks in its own bed, will come to the mind of any traveller. But these occur in pairs, or series of pairs, marking successive halting-points in the transverse shrinkage of the glacier. They curve round, moreover, towards the terminal moraine at the nose of the glacier, and are altogether more systematically disposed than these eskers of the Irish plain. Further, their materials are just dropped off the edges of the ice, and are not specially waterworn.

Rivers, again, do not form isolated ridges of detritus, although they may raise their courses above a plain on broad strips of pebbly land, which they themselves have formed. For a long time, the movements of currents in a shallow sea was invoked to account for the building of eskers, and their various curvings and bays were held to mark swirls of water along which the pebbles had become accumulated. Marine shells, however, could not be found in the esker-gravels, though they are plentiful in some

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* Knowledge, Vol. XXI., p. 75. (April, 1898.)

† "Report on Geology of Londonderry, Tyrone, etc.," 1843, p. 639.

‡ "General Glaciation of Ireland," *Jour. R. Geol. Soc., Ireland*, Vol. I. (1867), p. 211 and p. 212, footnote.

other deposits of the Ice Age. Nothing like a true esker could be quoted, moreover, from the sea-banks now forming off our shores. The North Sea, at any rate, should have given us some clue to their formation; in the absence of such evidence, the marine theory was adopted with considerable reserve.

Prof. Sollas,[*] in his valuable review of the history of the subject, points out that Mr. N. H. Winchell and Mr. Warren Upham in America were among the first to show how mounds and ridges of gravel could accumulate at the base of crevasses in a glacier, and how they would come to light on the final melting of the ice. But Mr. J. G. Goodchild, on our side of the Atlantic, was at the same time elaborating his views as to the distribution of materials carried in the body of the ice—such materials as we now call "englacial" or "intraglacial." In a paper on the Eden Valley,[†] read in 1874, Mr. Goodchild gives the gist of the matter in this sentence:—"The angular moraine-like drift occasionally found in parts of the dales, the upper and lower tills and the intercalated beds, the deposits of sand and gravel that form the eskers, and, finally, the numerous boulders that are left at nearly all elevations, are each and all the results of the melting of a great sheet of land ice that was charged throughout with rock-fragments of all sizes and of all kinds occurring within the area wherein the ice originated." Mr. Goodchild held that eskers were formed where materials in the lower part of a melting ice-sheet were arrested by some underlying ridge of rock. The water would run on either side, and would leave a long bank of pebbles to mark the line where scouring action was least, *i.e.*, the line between two adjacent subglacial streams. Simultaneously, Dr. Hummel in Sweden was putting forward his view that the eskers accumulated *in the channels* of such streams, and that they are casts, in fact, of the grooves worn in the bottom of a glacier by the streams that issue from it.

FIG. 1.—View from the road along the Esker at Balrothery, showing the low Gravel Ridge, and the Dublin Mountains in the distance.

Good accounts of Hummel's paper are given by Prof. Jas. Geikie[*] and Prof. Sollas, and the former practically introduced it to English readers. Dr. Holst, in 1876, urged that pebble-accumulations in the beds of rivers on the surface of melting ice may in time be lowered, by melting and excavation, until they are left as ridges on the glacier-floor, when this finally comes to be exposed. Like Goodchild, Holst lays stress on the amount of intraglacial material, which would fall out into the stream-channels as they cut more deeply into the ice.

In the last twenty years, as may be seen from Prof. Sollas's review, opinion has favoured the explanation given by Hummel rather than that of Holst. Prof. I. C. Russell has, moreover, seen eskers in course of formation in Alaska,[†] and to his account of the Malaspina glacier we shall have occasion to return. His remark that such deposits are typically associated with stagnant ice-sheets which are wasting away, may account for the disappointment felt by those observers who have failed to find modern eskers under more normal types of glacier. One might surely, however, have expected to meet with sub-glacial eskers in Spitzbergen; yet Messrs. Garwood and Gregory[‡] are obliged to report that evidence regarding them is absent.

These two authors, in their crisp, condensed, and unspeculative record, give strong support to Mr. Goodchild's theory of the importance of intraglacial drift. The waste material of the highlands round about a great glacier-basin falls upon the ice, and is gradually incorporated in the mass. It is transported laterally as well as vertically in the body of the ice, and becomes spread out into sheets, forming intraglacial strata. Here and there, by internal surging movements, it may become mingled with detritus that has already been ground against the floor. Ultimately it is extruded to form part of the copious clays, or sands, or gravels of the terminal moraine. The stones have generally been rounded, and are now attacked by the outflowing waters, and are re-arranged by their action at the glacier-foot. In periods of shrinkage of the ice, when melting has thoroughly set in, the intraglacial drift comes rapidly into prominence. "Stratified sands and gravels" are left behind in all the hollows; valleys are choked, and the striated floor and the *roches moutonnées* are concealed as quickly as they are deserted by the ice. In steeply falling valleys, it is unlikely that an esker-ridge would escape destruction during this final period of flood and flow. In open plains, however, the case is very different.

Let us picture Ireland in the Ice Age—a time of moderate coldness and abundant precipitation. The cold was sufficient to cause all the moisture to be deposited as snow; the precipitation was aided, moreover, by the greater height of the mountain-rim of the country, particularly on the western side. Above the town of Sligo at the present day, the Carboniferous Limestone rises in bold cliffs and plateaux; and the enormous quantity of limestone pebbles in the gravels of the plain shows that such high masses must have been common at the opening of the Glacial epoch. The plain itself was, however, determined by the synclinals of the Hercynian folding[§]; it had already assumed the character of a lowland, and was no doubt covered in part by swamps and pools, on

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[*] "A Map to show the Distribution of Eskers in Ireland," *Sci. Trans. R. Dublin Soc.*, Vol. V. (1896), pp. 788 and 794.

[†] *Quart. Journ. Geol. Soc.*, Vol. XXXI. (1875), p. 99. *See* also "On Drift," *Geol. Mag.*, 1874, pp. 509 and 510.

[*] "The Great Ice Age," 3rd edition (1894), p. 170. *See* also 2nd edition (1877).

[†] *Thirteenth Ann. Report, U.S. Geol. Survey* (1892), pp. 65 and 81.

[‡] "Glacial Geology of Spitzbergen," *Quart. Jour. Geol. Soc.*, Vol. LIV. (1898), pp. 211 and 222.

[§] KNOWLEDGE, Vol. XXI., p. 78.

which little icebergs began to float. Here and there, the sea may have encroached upon it, bringing in marine shells, which became broken up and mingled with terrestrial gravels poured down from the glaciated hills.

The precipitation continued in excess. The lakes and pools froze over throughout the year, and were lost beneath the mantle of freshly-falling snow. On all sides, from the slopes of the Kerry ranges, from the broad back of Leinster, from the high cirques of Mayo and Connemara, and from limestone uplands now altogether lost to us, glaciers crept down, spreading out in terminal fan-like forms, and finally coalescing in the plain. When the plain itself became full of ice, minor details of surface would cease to exert an influence, and the great lines of ice-movement asked for by Mr. Close in his memorable paper* may have been set up across the lowlands. The old extension of land southward and westward, of which we have so much evidence, may easily have provided nooks and corners, particularly on its seaward border, in which the early elements of the Irish fauna and flora could find refuge from these rigours for a time.†

We are not now concerned with the climax of the Glacial epoch, about which so much has been written, and about which we know so little. It is of small moment, moreover, in considering our eskers, whether part of the striation of our rock-surfaces was due to the movement of floating ice,‡ or whether it must be ascribed to ice-sheets of the magnitude demanded by Prof. Jas. Geikie and Mr. Close. The eskers belong to the latest phase, and overlie the boulder-clays and gravels, about which controversy is so often raised. It is now almost impossible, at any rate, to suggest a marine origin for the eskers.

Prof. Sollas's map of the Irish plain, from Galway to Dublin, shows the distribution of eskers over a wide area; and he reasons carefully, from their knots and confluences, as to their resemblance to river-courses beneath ice. Similar evidence has been gathered, both from North America and Scandinavia; and Prof. Russell's* description of the Malaspina glacier supplies exactly what the followers of Hutton and of Lyell demand—an example of "causes now in action," capable of explaining the phenomena left us from the past.

Fig. 2.—The south-west slope of the Esker at Tymon Castle.

The Malaspina glacier lies in south-east Alaska, between the watershed that forms the Canadian frontier and the Pacific. It is seventy miles wide, and twenty to twenty-five miles long from front to back—*i.e.*, its length, like that of so many "hanging glaciers" in the Alps, is considerably less than its breadth. But it is not a hanging glacier, cut off in front along a line of cliffs; it results from the accumulation of snow and the confluence of normal glaciers, which slip from the mountain-ranges to the north; and it lies, with a fairly level surface, on "the flat lands between the base of the mountains and the sea." Hence it has been styled a "piedmont" glacier—an unfortunate term, when one thinks of the glaciers of Piedmont proper.

Fig. 3.—Section in the Esker at Green Hills, Co. Dublin, showing irregularly stratified gravels and purer sand below.

The moraine-material borne by it is covered with snow in the higher regions, and hence becomes "intraglacial." But it shows itself along the melting border of the ice, as a dark band some four to five miles wide. Forests of spruce firs and other vegetation, as shown in Prof. Russell's photographs, grow on this exposed material, which itself rests on the lower layers of glacier-ice. This dense woodland, rising from the surface of the glacier, is a fine example of the contemporaneous occurrence of a north-temperate flora and of continental ice. Animals similarly find a home on the ice, and their remains must become embedded in strata belonging to this local glacial epoch.

The area of the Malaspina glacier is one thousand five hundred square miles; but it is only fair to remember that it is fed by some of the highest ground in North America. Mount St. Elias, itself eighteen thousand feet in height, supplies it on the north-west through the Libby and the Newton glaciers.† The latitude of the district is sixty

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* *Op. cit.*, pp. 231, 238, and Plate VIII.

† *See* Scharff, "Origin of European Fauna," *Proc. R. Irish Acad.*, 3rd Ser., Vol. IV. (1897); and comments by G. C. Carpenter, *Natural Science*, Vol. XI., pp. 382 and 385; and G. Cole, *Irish Naturalist*, 1897, p. 240.

‡ Garwood and Gregory, *op. cit.*, pp. 215 to 217; Scharff, *op. cit.*, p. 494.

* *Op. cit.*, p. 67.

† *See* Russell's Map *op. cit.*, Pl. IV.; and also Pls. V., VII., XV., etc.

degrees north, about that of the Shetlands and Christiania. Could we procure a similar climate, *and similar means of precipitation*, along the west side of the Leinster Chain, a glacier as large as the Malaspina would cover all the lowland area of Kildare, Carlow, and Queen's County. Indeed, our highlands, as they now exist, would have gone far, at the close of the Glacial epoch, to keep the plain of Ireland full of ice.

Whatever the cause, the means of precipitation were actually provided; but at last the modern epoch opened. The sun shone on the ring of snow-peaks from Lough Foyle to Galtymore, on the long moor of Leinster, and on the white plateaux of the north; but centuries may have elapsed before the lowlands were free from the cold burden thrust upon them. The ice of the plain was full of intraglacial drift, shot into it by avalanches and landslides, or slowly incorporated with it by the glaciers descending from the hills. As melting began, this gravelly detritus would appear, capping, for instance, the islands of Clew Bay, or streaming down as delta-formations far out into the Irish Sea. Broad stratified deposits might be formed by a union of marine and river action; but in the interior of the country the deposits would be more hummocky and isolated, and would often represent the courses of the last subglacial streams. The plain of ice might in time become reduced to separate patches, each with its fringe of hillocks, piled up from intraglacial drift; and, where melting was slow and steady, true eskers might remain, sinuous and steep-sided, as casts of the more permanent waterways. For a long time, the torrential flow would have kept such channels open; so that the eskers represent the final accumulations, due to failure of the water-supply, and are younger than many of the distributed gravels, which originated equally from the intraglacial drift.

Fig. 4.—Stratification of Sand at base of the Green Hills Esker, Co. Dublin.

Such appears at present to be the logical history of eskers, like that of Balrothery and Crumlin. The stratification in the Green Hills of Co. Dublin is marked in the basal sands, but is highly irregular in the gravels of the summit (Figs. 3 and 4), and this is what might be expected from the suggested conditions of formation, the material having been washed down, at different times, with very different rates of flow. The freshness of the esker slopes, and the preservation of the ridge-like form, may be paralleled by the undisturbed outlines of the extinct scoria-cones of Auvergne. In both cases, the porosity of the material allows the water to sink through it, and a few channels here and there alone mark the attack of exceptional storms.*

We have, in conclusion, to go to the uplands of Tyrone to see what a part the "esker-drift" may play in the present conformation of the surface. Near Dunnamore, for instance, we may see a giant esker running across country, descending one side of the valley and climbing up the opposite slope, with all the persistent air of the Great Wall of China. In the hollow below us, the trend of which is scorned by it, the esker is breached by the existing stream. Clearly, its central part must have formed at one time the barrier of a temporary lake. When we ascend to the moorland over against us, we find the gravel ridge lost in a plexus of curving mounds, in the bays of which lakelets lie gleaming in the western light. As the sun sinks, the shafts pick out the soft green flanks of gravel domes, sometimes isolated, sometimes clustered in all manner of strange positions on the far hill-sides. Even on the high spurs of Slieve Gallion, Lough Fea is bordered by them, as if by the *débris* of a landslide. We look back along our grass-grown wall, the one side of which is now cold and purple-grey, the other golden in the sunset. It stands out before us more sharply than ever, still more strange and fascinating; and we feel that we have a good deal yet to learn with regard to the origin of eskers.

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THE SEA-SQUIRT.

By E. Stenhouse, A.R.C.S., B.Sc.

The sea-squirt has such a curious organisation, and passes through so strange a series of changes in its development, that it and its allies have long been regarded with more than usual interest by naturalists. For the sea-squirt is a living example of degeneracy, of structural degradation so complete that until recently it was universally supposed to be a mollusc. Its shape is roughly cylindrical or ovoid; its colour a dingy grey; and it lives attached by its base to a rock on the sea-shore. At its free end there is a hole, commonly surrounded by eight small lobes, and a little less than half-way down the side of the body is another opening, with six encircling lobes. The upper aperture is the mouth, and it leads to the digestive tube, which consists of a spacious pharynx immediately following the mouth, a gullet, a stomach, and an intestine. Completely surrounding the digestive tube, except along one line, where the pharynx is fused with the body-wall, is a chamber called the atrium. The atrium opens to the exterior at the lower of the two external apertures, which is hence called the atrial opening.

If the Ascidian be carefully watched under natural conditions, a current of water will be seen to continually enter the mouth and leave by the atrial opening. If it be touched the creature will suddenly send out a stream of water from each opening, and its common name is derived from this habit of squirting when irritated. The inflowing current of water is doubly useful to the Ascidian. It not only washes into the digestive canal the microscopic organisms which constitute its food, but it also carries in solution a store of fresh oxygen, which is just as necessary for the healthy life of the animal as it is for our own well-being. The region of the pharynx which is fused with

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* *See* Judd, "Volcanoes," p. 155; Lyell. "Principles of Geology," Vol. II. (1833), p. 205.

the body-wall forms a mucous secretion, by which the food-particles are arrested and guided into the gullet, to undergo digestion in the stomach. The water, on the other hand, does not take this course, but passes through the tiny slits of the delicate basket-work composing the walls of the pharynx. The edges of these slits are beset by little lashing threads, known to biologists as cilia, and the result of their rhythmic motion is that a continuous current of water is driven from the cavity of the pharynx to the surrounding atrium. The slits in the pharynx-wall, arranged in transverse rows, are very numerous. Now, between each row of slits runs a little blood-vessel, and tiny branches also follow the delicate partitions between the slits themselves. The walls of the blood-vessels are excessively thin, and the oxygen contained in the sea-water is thus able to diffuse through the walls into the blood as the water swills through the slits. Waste carbon dioxide passes out from the blood into the water at the same time. Hence we have here all the essentials of a breathing-process.

The blood is constantly renewed by the beating of a little heart placed on one side of the stomach. The heart works in a somewhat peculiar fashion. The contractions are for some time in one direction, and then the motion is suddenly reversed, the blood being propelled in the opposite direction. In this manner does the adult creature live, if such an uneventful existence can be called living. It spends its days sedately rooted to the spot where, on abandoning the wayward habits of youth, it first settled down, and its obvious movements are limited to occasional contractions of the outer coat or "tunic." If the animal has any intelligence at all it is of the most rudimentary character, and it is even problematical whether it possesses any special sense-organs. There is a mass of nervous matter just at the beginning of the pharynx, and this and some neighbouring structures may be of use for testing the quality of the water flowing in at the mouth, but organs of sight and hearing are quite absent. The life of an oyster is in comparison one of pleasing variety.

It is one of the greatest triumphs of the still young science of embryology to have shown conclusively that this creature—little more than an automaton, and possessing no obvious trace of vertebrate structure—is yet a member of the great sub-kingdom to which all birds, mammals, reptiles, amphibians, and fishes belong, and of which we are pleased to consider ourselves the crowning pinnacle and glory. A brief *résumé* of the features which biologists consider to be essential characters of vertebrate animals may assist the reader to a better appreciation of the masterly piece of research by which Kowalewsky showed the Ascidian to be a fallen vertebrate, and gave to it a position of quite unique interest.

In the first place, all vertebrates possess a supporting skeletal rod running along the main axis of the body. This is usually the "backbone," but it may be represented by a spinal column of cartilage or gristle, as is the case with the sharks and their allies. In the lowest vertebrates, and in the embryos of all the higher ones, the skeletal axis consists of a simple continuous rod called the *notochord*, which is of the consistency of stiff jelly. Secondly, the central nervous system of all vertebrates arises as a groove along the middle line of the back or "dorsal" surface of the developing animal. The edges of the groove arch over and meet, converting it into a tube, which becomes the spinal cord and brain. Moreover—and this is a fact of very great interest to the evolutionist—every member of our great sub-kingdom passes through a stage in which the pharynx (already defined as the part of the digestive tube immediately following the mouth) has its side-walls perforated by slits. These gill-slits are present throughout the whole life of fishes. The water taken in at the mouth escapes through the slits, aërating the blood flowing through the gills on the margins of the slits as it does so. Amphibians, which nearly all spend their infancy in water, breathe during the greater part of their aquatic life exactly as do the fishes. When, however, the tadpole attains his froghood and leaves the water, his gill-slits close, and he breathes by lungs. This early habit of water-breathing probably indicates that frogs are descended from fish-like ancestors, and that the tadpole repeats, to some extent, his ancestral history in his own development, or, as Marshall happily expressed it, climbs up his own genealogical tree. Again, every bird and reptile, whilst in the egg, passes through a stage with gill-slits piercing the sides of the neck, slits which are of no conceivable use to it as organs of respiration, and which are only explicable as ancestral features which have persisted through countless ages.

It is clear, then, that no animal can justly claim the proud title of vertebrate unless it possess at some period of its existence (*a*) a notochord, (*b*) a dorsal tubular nervous system, (*c*) gill-slits in the wall of the pharynx; and Kowalewsky's famous research showed that the sea-squirt passes through a stage in which all three are present.

As he watched the tiny egg develop, he saw the single cell divide up until a hollow two-layered ball of cells was formed. The cavity of the ball, the primitive digestive sac, communicated with the exterior by a small pore. Next one side of the ball became flattened and then grooved. The groove was bounded by right and left folds, which soon began to arch over and unite at the hinder end. The union extended farther and farther forward on the dorsal surface until a tube was formed, the rudiment of the spinal cord and brain.

That a mollusc, as the sea-squirt was supposed to be, should develop a hollow nervous system in this manner was a very remarkable circumstance, and we can imagine with what breathless interest the observer must have watched the further growth of the little embryo. For what followed was stranger still. A rod of cells between the nerve-tube and the digestive sac became more and more prominent, and soon acquired all the characteristics of a veritable notochord. Then the hinder part of the embryo began to grow out as a tail, carrying both spinal cord and notochord with it. At the opposite end a mouth opened into the digestive tube, and the enlarged front end of the spinal cord developed an eye and an organ of hearing. The embryo was now a free-swimming larva, which was in appearance and structure curiously suggestive of a tadpole, but it was of very minute size. Openings soon perforated the walls of the pharynx-region, but the growth of an atrium round the pharynx shortly afterwards shut off these gill-slits from communicating directly with the exterior.

The tiny larva, which thus conformed completely with vertebrate requirements, swam about vigorously for a few hours by means of its fish-like tail-fin, and then—"O! what a fall was there!"—it fixed itself by some little suckers which had appeared under the mouth, the tail grew less and less, and eventually vanished altogether, taking notochord and spinal cord with it; the eye and the organ of hearing disappeared; and the front end of the nerve tube, too, so hopefully suggestive of a brain, dwindled until nothing remained but a little shapeless mass. Gone, "like the baseless fabric of a vision," were all vertebrate characters save a few poor gill-slits. These slits increased in number, various changes in the relative size of other organs occurred, and the animal stood revealed, a prosaic and phlegmatic sea-squirt.

THE AFFINITIES OF FLOWERS.

THE BLADDERWORT AND ITS RELATIVES.

By Felix Oswald, b.a., b.sc.

In wandering over some desolate moor in July or August, we may perchance find a peaty pool aglow with strange yellow flowers, somewhat like snapdragon, on slender stalks which rise from a green feathery mass floating just beneath the surface of the water. Let us lift out the whole plant and examine it more closely; we can then clearly see why it has been named the bladderwort, for we find numbers of minute pale-green bladders interspersed among the branching feathery leaves. Observation alone will lead us to infer that these little bladders are merely modified leaflets, for they are set on stalks arising from the much divided leaves, generally from a point of bifurcation. Moreover, they still bear branching bristles at the apex, similar to the leaf filaments. Some species indeed, (*e.g.*, *Utricularia intermedia* and *U. grafiana*), reach a further stage of specialization in having the bladders restricted to separate branches.

There is a total absence of roots, just as in many other floating plants, such as the water-fern (*Salvinia*). Indeed, the rootless condition has become so deeply impressed on the constitution of the bladderwort that not even a primary root is developed when the embryo germinates. The hair-like character of the leaves may perhaps be due to their having to adopt the function of roots in absorbing the nutrient salts contained in solution in the water. But it may be also due (as Grant Allen has suggested in regard to the submerged leaves of the water crowfoot) to the necessity for searching out, so to speak, for the scanty amount of carbonic acid in the still waters frequented by these plants.

The bladders, however, form the chief interest of this strange plant, for they have become differentiated into the most efficient traps for catching small water animals. The entrance to the bladder is firstly protected, by means of branched bristles, from larger creatures, which might damage the apparatus. When once past this *chevaux de frise*, an entrance is easily effected by pushing inwards the elastic valve or upper lip, which closes tightly upon the lower lip—a thickened cushion of tissue. But no return is possible when the door has closed, and all hope of freedom must be abandoned. Here the prisoners remain in their dungeon until they die from suffocation or inanition, victims to their own curiosity. Death usually overtakes them in about twenty-four hours, although they sometimes linger on for as long as six days. A close scrutiny of the bladders will usually reveal a variety of small crustaceans such as water fleas (*Daphnia*, *Cypris*, and *Cyclops*), larvæ of gnats and midges, innumerable infusoria and diatoms, and even small worms. The bladderwort, however, is not always left in undisputed possession of its prey, for a water spider sometimes finds it a profitable undertaking to spin its silken silvery bell among the branches of the plant, and to rifle the contents of the bladders.

No digestive ferment is secreted in these traps as on the leaves of the carnivorous sundew and butterwort, but we find special absorbent hairs arranged in groups of four, studded at intervals all over the inner surface of the bladder. A gradual transition may be observed between these peculiar hairs and those outside,* which secrete a kind of mucilage, perhaps attractive to the deluded visitors. It is considered probable that the nitrogenous products of decomposition are taken up by the internal hairs into the system of the plant for assimilation—a distinct advantage for the species, since peaty soils are well known to be deficient in nitrogen, which is so important an element of animal and plant life. It is also possible that the carbon dioxide exhaled by the animals during their imprisonment may be of considerable service to the plant.

On the approach of winter the whole plant decays, with the exception of the terminal bud, which is wrapped up and protected by leaves closely crowded together, but without any bladders. This resting bud eventually sinks to the bottom of the pool, just as the frog-bit (*Hydrocharis*) and many other water plants. The warmth of spring rouses the dormant bud into activity, the leaves expand, the stem grows, bladders are again developed in place of leaflets, and the plant rises to the surface of the water. Formerly it was considered that the sole reason for the existence of the bladders was to raise the plant from the bottom of the pool after the long winter rest, and to buoy it up so as to float in the most suitable position. It is possible, indeed, that their primary function was hydrostatic, and that the habit of catching animals is secondary, and has induced several modifications in structure; yet it is clear that at the present time the bladders cannot act merely as buoys, in view of the fact that the small British *Utricularia intermedia* does not float at all, but creeps along the bottom of pools, anchored to the soft mud by the bladders, which, in this case, are borne on separate branches of the stem. Moreover, there are many purely terrestrial species of bladderwort in the tropics which possess bladders essentially similar to those of our aquatic species, although very much smaller. They frequent, however, damp places, in association with mosses and liverworts. A strange instance of dependence of one plant upon another is afforded by a Brazilian species (*Utricularia nelumbifolia*); it lives in the reservoirs of water formed by the leaf rosettes of *Tillandsia* plants (allies of the pineapple). This bladderwort spreads abundantly, sending out long runners which grope their way to another water receptacle of a *Tillandsia*, and even to those of neighbouring plants.

Bladderwort plant in flower, one-third less than natural size.

The bladderwort belongs to the small family Lentibulariaceæ, represented in Britain by only one other genus, viz., the insect-catching butterwort, which is not, however, a very close relative. The characteristics which they possess in common show a considerable degree of specialization; for instance, both calyx and corolla are irregular, with two broad lips, somewhat like a flattened snapdragon. The corolla is produced into a honey-containing spur; the stamens have become reduced to two; the ovary is unilocular (*i.e.*, it consists of a single chamber), with the ovules arranged on a central pillar; the fruit is a capsule

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* Chodat has shown that these hairs arise from cells which in land-plants would have become stomata; a change of habitat necessitating a change of function.

opening by two valves; and the seeds contain no reserve material or endosperm.

The flower of the bladderwort is particularly remarkable for the extreme irritability and sensitiveness of its stigma; the two lobes close together immediately on being touched, but open again after two or three minutes if no pollen grains happen to be enclosed in their embrace. A precisely similar device is to be found in the yellow monkey-flower (*Mimulus luteus*) which is sometimes found floating in golden masses on still and silent pools. A flower-haunting fly, such as one of the hovering *Syrphidæ*, will alight on the lower lip of the corolla, and in thrusting his proboscis down the tube in order to reach the honey in the spur, will first of all rub his back against the stigmatic lobes which project beyond the anthers. Directly afterwards he will be dusted with fresh pollen and will be ready to carry it to the next flower he visits. The sensitive folding together of the stigmatic lobes is thus a safeguard against self-fertilization, for when the insect, laden with pollen, withdraws from the flower, the lobes will have their receptive surfaces in close contact with each other. Yet, if the flower is not fortunate enough to secure the advantages of cross-fertilization by insect agency, it will take to self-fertilization as a last resource, the stigma curling round backwards so as to receive the pollen which at first it was so careful to avoid.

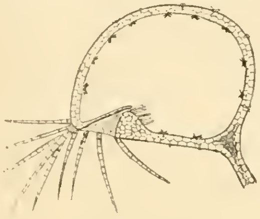
The butterwort (*Pinguicula*) is in some respects more highly specialized than its cousin the bladderwort—at least from a physiological point of view—for its leaves can not only catch insects with a greasy sticky secretion, but can also digest them (just as in the sundew) by means of the ferment pepsin. Moreover, the flowers of the butterwort reach a higher note in the scale of colour; *Pinguicula alpina*, indeed, is yellow, and is fertilized by flies (*Syrphidæ*), but *P. vulgaris* and *P. grandiflora* are deep blue and adapted for bees.*

The butterwort on the other hand is provided with roots, and still shows the primitive characteristic of a rosette of simple undivided leaves, of which only a trace exists in the youngest stage of the bladderwort, although this rosette is more noticeable in the terrestrial species. The stigma of the butterwort does not show any sensitiveness to the touch; its lower lobe merely hangs down like a curtain in front of the anthers so as to intercept any pollen which may be brought by a winged visitor. Self-fertilization, however, may likewise occur if no pollen has been transferred by insects from other flowers. Finally, the embryo of the butterwort has not reached quite so low a state of degeneracy as in the bladderwort, because it is still provided with a seed leaf.

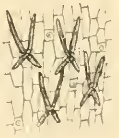
We have to turn to the tropics in order to find another member of the order, which will show intermediate characteristics between our bladderwort and butterwort. This is the genus *Genlisea* of Brazil, which retains the primary rosette of leaves; the stem is, however, thickly covered not only with unmodified spatulate leaves, but with others metamorphosed into curious insect traps, long-necked bladders with a kind of spiral entrance, thickly beset with hairs, pointing backwards and preventing any escape. *Genlisea* is a land plant, but agrees with the bladderwort in being destitute of roots.

The tropics, again, are the home of the Gesneriaceæ, the order with which the Lentibulariaceæ show the closest genetic relationship, for although the flowers possess external resemblances to some of the more distant Scrophulariaceæ, such as snapdragon and calceolaria, yet these similarities are no more than what all three orders possess in common.

The Gesneriaceæ form a family well known to gardeners for the handsome and showy flowers comprised within its limits, such as *Gesnera*, *Gloxinia*, *Achimenes*, *Æschynanthus*, etc.



1. Bladder of Bladderwort, in diagrammatic section, magnified.

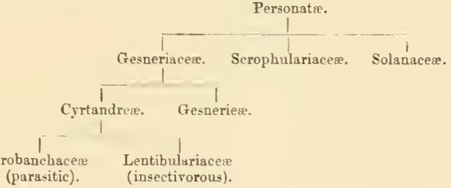


2. Internal absorptive hairs, still further magnified.

The Lentibulariaceæ possess so many points in common with the Gesneriaceæ, especially with the subdivision Cyrtandreæ that they might almost be classed with the latter; thus, in both cases the ovary is unilocular and the seeds are without endosperm. Moreover, many of the Cyrtandreæ have only two stamens, and the genus *Streptocarpus* agrees with *Utricularia* in the absence of even a primary root.

It may be added that the parasitic family of broomrapes (Orobanchaceæ) is also closely allied to the Gesneriaceæ, and agree, too, with the bladderwort in the embryo being totally undifferentiated, consisting merely of an oval cellular mass.

In conclusion, the different relationships may be graphically represented thus:—



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ETHNOLOGY AT THE BRITISH MUSEUM.

By R. Lydekker.

Since, so far at least as his bodily structure is concerned, man evidently forms but the highest development of the mammalian type, it is evident in every well-arranged museum he should take his proper position at the head of the series, adjacent to the man-like apes. And it is therefore in the highest degree satisfactory that this has at length been recognized by the authorities of the natural history branch of the British Museum, where an ethnological series is now in process of formation and arrangement in the upper mammalian gallery. It is not, indeed, that this is an entirely new departure, for ever since the transference of the natural history collections from Bloomsbury to South Kensington, human skulls and skeletons were arranged in serial position in the gallery of osteology, which formerly occupied the whole of what is now the upper mammalian

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* The small Lusitanian butterwort is, however, pale lilac in colour, and depends only on self-fertilization. This is, perhaps, a case of reversion from the blue flower fertilized by bees.

gallery. But no attempt was made to exhibit man's external bodily form in its numerous racial modifications; and the specimens of his bony skeleton, like most of those of his fellow mammals, were widely separated from the mounted skins of the apes and monkeys.

In the new arrangement, now drawing to approximate completion, of the mammalian galleries such skulls and skeletons as are exhibited to the public are placed in proper position among the mounted skins of ordinary mammals, and man accordingly heads the series of exhibits. Although the amount of case room devoted to illustrate the bodily structure of the numerous varieties of mankind is comparatively small when contrasted with that in the new ethnological gallery in the Paris Museum, it will probably prove sufficient to exhibit examples of all the leading types which are likely to prove of general public interest, and is not disproportionate to the space given to other groups of mammals. In Paris it appears to be the practice to exhibit every skull and skeleton in the collection to the public, whereas in the British Museum the rule is to show only a limited number of examples, most of which ought to illustrate some particular point or feature. And, although to the specialist the former plan may be, and probably is far more preferable, yet to the general public there can be little doubt that the latter arrangement is the more advantageous, since the exhibition of a large series of duplicates is much more likely to confuse than to instruct.

Bushman. From a Photograph of a Life-like Model in the British Museum.

That such an ethnographical series as is contemplated in the Natural History Museum will do much to educate the public on matters anthropological cannot for one moment be doubted, seeing that there is no other institution in London where a similar exhibition is displayed; and that, as a general rule, English people display a remarkable lack of information concerning the relationships and peculiarities of their fellow human races. With our vast colonial empire, we, of all people, ought to make mankind our especial study; and we ought to be in a position to make the national gallery of ethnology almost unique in its completeness, so far as the allotted limits of space permits.

In considering man from a purely zoological standpoint, as it is necessary to do in an exhibition of this nature, it is obviously imperative to take into consideration only his bodily form and structure, putting entirely on one side arts and manufactures of every description. To study the weapons and dress of modern aboriginal tribes, and the various implements of our prehistoric ancestors, the student may visit the British Museum at Bloomsbury, while he will find no inconsiderable series of specimens of prehistoric implements in the palæontological gallery of the branch establishment in the Cromwell Road. But, as has been well remarked, to form a complete anthropological series it is illogical in the extreme to stop at the implements, manufactures, and arts of savage and prehistoric tribes. Such a series ought to commence with the rudest drawings on mammoth ivory, and the most primitive stone weapons, and to conclude with a selection from the last Academy exhibition, and examples of Krupp and Maxim guns. But whether such a splendid collection will ever be realised or no, it does not really concern us here, and we may accordingly revert to the gallery in the museum.

For such a gallery the selection and proper arrangement of suitable objects is a matter of much greater difficulty than might at first be thought to be the case; while even when the nature of such exhibits has been decided, there is often immense difficulty in procuring the requisite specimens. In a gallery open to the general public of both sexes and all ages there are obvious objections to exhibiting models of the entire human form, and it has accordingly been decided that busts are the kind of model best adapted for display. At present the series of these is very small, but we believe that steps are being taken to augment it as rapidly as possible. Already several of these busts attract general public interest. Among these attention may specially be directed to those of a male and female Bushman and a Tasmanian man and woman, as exhibiting two very characteristic types of the inferior races of mankind. By kind permission of Sir W. H. Flower we are enabled to present our readers with photographic representations of two of these life-like models. To those of the Tasmanians an especial and mournful interest attaches, since they are taken from two of the last survivors of a very remarkable pure-bred race whose extermination was brought about by means reflecting but little credit on our own character as a nation. Unfortunately, the extermination of the Tasmanians took place before sufficient care had been taken to secure abundant examples of their skulls and skeletons, which are now of excessive rarity in collections; and the Museum is therefore to be congratulated on having lately secured a perfect male skeleton. It may be added that the extermination of the Tasmanian serves as a warning that no efforts should be spared to obtain specimens illustrating the bodily structure of other primitive aboriginal tribes while there is yet time, since it is but too apparent that many of these, even in spite of strenuous efforts for their preservation, are doomed ere long to pass away for ever. Possibly, too, in the years to come, when education has advanced its sway over a still wider circle, the survival of such races in their primitive form may even be regarded as a blot upon the world's civilization, so that efforts may be made to "improve" the survivors out of existence.

After models, the next best method of showing the racial variations of man's external form is by photographs. For the most part those exhibited in the Museum comprise only the head and neck, and, where practicable, these are enlarged to the natural size. These large-sized photographs have been executed in platinotype under the immediate superintendence of Mr. H. O. Forbes, the Director of the Museum at Liverpool. At present the series is richest in North American Indians and African Negroes, but there are also numerous examples of Melanesians and Papuans. As an example, a reduced reproduction of the photograph of a Papuan girl, exhibiting in great perfection the artificial frizzing-out of the hair, is herewith given. And it may be mentioned that in the case of tribes who are in the habit of thus dressing their locks, photographs have a decided advantage over busts, in which it is impossible to reproduce the peculiar style of capillary adornment.

As regards the exhibition of human skulls and skeletons, it must be freely confessed that in a public museum these have, at least at first sight, a somewhat gruesome and ghastly effect. Nevertheless, this is to a very great extent undoubtedly due to early associations and prejudices; and if we can but disabuse ourselves of these, such objects are really very far from being repulsive, especially if artistically arranged among the busts and photographs, and not occupying the whole of the shelves to themselves. Apart from all such considerations, the exhibition of parts of man's anatomy is, however, of primary importance in the formation of an ethnological gallery, seeing that many of the most important racial characteristics are displayed solely by the skull and skeleton. Moreover, in order rightly to appreciate the marked cranial peculiarities distinguishing even the lowest representatives of the human race so broadly from the highest of the man-like apes, it is essential that a large series of the skulls of both should be on view.

Tasmanian Woman. From a Photograph of a Life-like Model in the British Museum.

Although there is still some difference of opinion among anthropologists as to the number of primary branches into which the existing members of the human race should be divided, in the arrangement adopted in the Museum only three such branches are recognised. These are (1) the Negroid, or black branch; (2) the Mongolian, or yellow and red branch; and (3) the Caucasian, or white branch. Wherever and whenever these three branches first originated, they are now so intermixed in many parts of the world by crossing, that it is frequently difficult to decide to which certain races belong, and it is consequently in some instances impossible to draw a hard and fast line between them. Nevertheless, the typical representatives of each show very distinct modifications. Although the colour of the skin forms one of the most marked points of distinction between such typical representatives, it must not be inferred that this character will hold good for all the races included under each. The Sudanis, for instance, many of whom are included in the Caucasian branch, are often as black as the Negroes, partly no doubt owing to a large infusion of Negro blood.

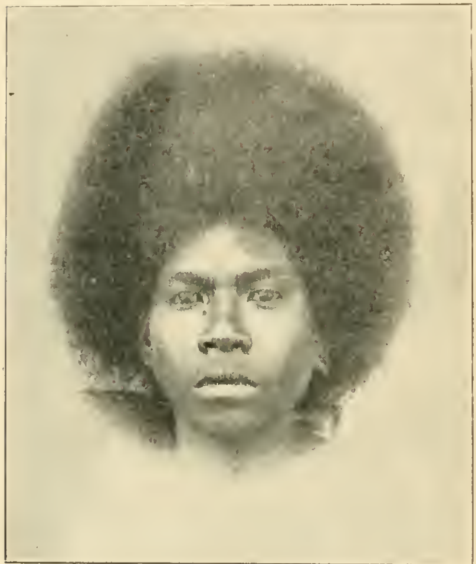
To give all the characteristics of each of the three primary existing branches of mankind, and to enumerate all the different races included in each, would obviously be far beyond the scope of an article like the present, and only a few of such points can be touched upon.

The Negroid branch is obviously the lowest of the three, as is exemplified by the projecting jaws, everted lips, and the flat and broad nose, supported by flattened nasal bones quite unlike the arched form which they assume in the Caucasian branch. It is in this branch alone that the so-called "woolly," or more correctly, "frizzly" hair is met with; the frizzly nature being due to each individual hair being elliptical instead of circular in cross section, and thus tending to twist on its own axis. But this frizzly character of the hair is not common to all members of the Negroid branch, being absent, for example, in the Australians, although present in their near neighbours the Tasmanians. And it is an interesting question to determine whether the frizzly or the ordinary cylindrical hair is the more primitive type; a question closely connected with the primitive coloration of the skin in the human race—whether black, yellow, or red. Some authorities, Monsieur de Salles for example, have attributed red hair to the earliest representatives of the human race; which would apparently imply also a light-coloured skin, although red hair and a leaden skin are associated in the Orang-utau. Again, M. de Quatrefages urges that nothing authorizes us to regard the Negroid branch as having preceded either of the other two, and further suggests that the ancestors of the modern Negro were of a much lighter colour than their present representatives.

Of course this is just one of those questions about which reams of paper might be written over without hope of a definite conclusion. But it may be mentioned that all anthropologists without exception recognize the projecting jaws of Negroes as a primitive feature, and, secondly, that the chimpanzee and gorilla, which come nearest of all the apes to the human race, have black hair and skin. Consequently, the onus of proving that the projecting jaws and other primitive features met with in modern negroes were ever associated with light-coloured skins and fair hair rests with those who are objectors to what may be termed the black theory of the human race. With regard to the frizzly hair of so many representatives of the Negroid stock, it is quite possible that this may be an acquired feature, seeing that it is much more probable the hair of primitive man was cylindrical, like that of apes, rather than elliptical. And if this be so, the Australians would seem to indicate a more primitive race than the Tasmanians.

The Negroid branch includes the typical Negroes of Africa south of the northern tropic, the pygmy Negrillos of equatorial Africa, the somewhat larger but equally primitive Negritos of the Andaman Islands and certain other parts of Asia, and also the great group of Melanesian or Oceanic Negroes, among which are comprised the Papuans of New Guinea, and most of the inhabitants of the smaller islands of the western Pacific, such as New Zealand, New Britain, New Caledonia, the Solomons, the New Hebrides, Fiji, etc. The native Australians and Tasmanians likewise pertain to this branch.

The true Negroes of Africa are the typical representatives of this branch, and present its most characteristic features, including the frizzly hair. All such Negroes are characterized by the elongated form of the skull, and the slight development of the ridges above the eyes, so that the lower part of the forehead is comparatively flat and smooth. The Negrillos of equatorial Africa are best known by the pygmy Akkas, so well described by Schweinfurth and Emin Pasha ; one of the most valuable objects in the ethnological series of the Museum being the skeleton of an Akka woman, collected by the explorer last named. These Negrillos, like the Negritos of Asia, differ from the typical African Negroes, not only by their greatly inferior stature, but likewise by the shorter and more rounded form of their skulls.



Head of Papuan Girl, showing the artificial frizzing out of the hair. From a Photograph in the British Museum.

The Oceanic or Melanesian Negroes chiefly differ from their African cousins by the much greater development of the ridges on the forehead of the skull above the sockets of the eyes in the male sex. The nose also is less wide and depressed, this feature displaying itself more distinctly as we approach New Guinea and the neighbouring islands. The culmination of this is displayed by the Maories of New Zealand, whose features are so Caucasian-like that some authorities have not hesitated to pronounce these people, to a large extent at least, of Caucasian origin. Their traditions, however, all point to a Melanesian origin. The custom of preserving heads with the skin attached among the Maories, renders specimens readily procurable for exhibition ; although, for purely zoological purposes the tatooing is a sad disfigurement, the examples in which this so-called ornamentation is of the simplest character being consequently the most valuable in a series like that of the Museum.

The other two branches can receive but very brief mention here. In the Mongolian, or yellow and red branch, are comprised the typical Mongols of Asia, such as the Chinese, Tibetans, Tartars, Japanese, etc. ; but to the same great branch belong also most of the inhabitants of Siberia, the Eskimo, the Malays, and the so-called brown Polynesians of the eastern Pacific, although, among both the two latter, there are often more or less pronounced indications of an admixture of Negro blood.

The Finns and Lapps derive their peculiar characters from a cross of Mongol blood with that of the dark Caucasian type. Although by some writers the aboriginal inhabitants of America previous to the immigration of white races from Europe have been regarded as indicating a fourth primitive branch of mankind, the general concensus of opinion points to the propriety of including them in the Mongolian group. And it is especially noteworthy that, as we pass eastwards in Northern Asia in the direction of Bering Sea, the native tribes assume a more and more marked approximation to the native American type. The general Mongolian type of countenance is too well known to require particular description ; the yellow leathery skin, the prominent cheek-bones, oblique eyes, long straight hair on the scalp, and the slight development of hair elsewhere, being among the most conspicuous. American Indians have a redder tint of skin. Curiously enough, the Ainos, or primitive inhabitants of Japan, many of whom still remain in Yezo, differ from this type by their excessive hairiness, in consequence of which it has been thought that they are of Caucasian rather than Mongolian origin.

Of the Caucasians, or inhabitants of Europe, South-western Asia, and Northern Africa, it must suffice to say that they may be divided into a blonde, or xanthochroic, and a dark, or melanochroic type ; the former being found in Scotland, Scandinavia, Northern Germany and Afghanistan ; while the latter embraces the inhabitants of Southern Europe, the higher races of India, and many of those of North Africa, where, however, there is a large infusion of Negro blood. The Semitic (Arab) and Hamitic (Egyptian and Jews) races are wholly Melanochroi, but the Aryans belong in part to the Xanthochroi and in part to the Melanochroi.

Did space permit, this article might be extended to an indefinite length ; but it is hoped that what has been written may suffice to awaken an interest among the readers of Knowledge in the efforts now being made by the British Museum to establish an ethnological series worthy of the nation to which it belongs.

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THE FOURTH INTERNATIONAL CONGRESS OF ZOOLOGY.

CAMBRIDGE, 1898.

The First International Congress of Zoology was held at Paris in 1889, under the presidency of Prof. Milne-Edwards. The second, which was held at Moscow in 1892, was presided over by Count Kapnist. The third took place at Leyden in 1895, Dr. Jentink being the president.

The Fourth Congress opened on August 23rd, 1898, under the presidency of the Right Hon. Sir John Lubbock, Bart., M.P., at Cambridge, a place eminently suited for such a Congress, both on account of its historical associations, and as the seat of a great zoological school.

The University and the Corporation gave the members of the Congress a most hospitable reception, and every comfort and convenience was provided for the large and representative gathering.

Tuesday, August 23rd.

In his Presidential Address, Sir John Lubbock expressed his profound regret at the absence of Sir William Flower, who had been nominated President, but had found himself unable to accept the post owing to continued ill-health.

In the afternoon, in Section A (General Zoology), among others Prof. Mitsukuri, of Tokyo, read a paper "On some zoological matters in Japan." He traced the gradual rise of science in Japan from beginnings which could be traced back as far as the ninth century. He then gave a sketch of the present condition of zoological science in Japan, referring amongst other points of interest to the beautiful new marine zoological station at Misaki, near Tokyo, and to the great richness of the marine fauna of the neighbourhood.

Mr. Stanley Gardiner read a paper on "The building of atolls," suggesting that the depths at which corals and nullipores live is due to the extent to which light can penetrate sea water, the food of corals being derived entirely from the commensal algæ. The atoll-reef was then shown to have arisen from a pinnacle on the top of a dome-shaped mound, formed on an elevation of the ocean floor, which had been built up by the remains of deep sea animals. It was then urged that these pinnacles broaden by the addition to their edges of buttresses, etc., on a talus slope supplemented by the solution of their interior parts.

Wednesday, August 24th.

A general meeting of the Congress was held in the morning (Prof. Dr. F. E. Schulze in the chair), when Prof. Yves Delage opened a discussion on the position of sponges in the animal kingdom. The discussion was continued by Mr. E. A. Minchin, who remarked that there was no group of organisms whose systematic position is so much disputed, at all periods as well as at the present day. Up to the end of the first half of the nineteenth century it was still a matter of dispute if sponges were plants or animals; this controversy was laid to rest by the discovery of cilia by Dujardin (1841), and Dobie (1850), as well as by the subsequent researches of Lieberkühn and Carter. The animal nature of sponges was thus established, but their position in the animal kingdom was still uncertain. In conclusion, Mr. Minchin said that the larval development showed that sponges could not be considered Cœlenterates. Such a comparison must start either from the larvæ or the adults. If based on the larvæ, then neither the architecture nor the composition of the adults were in any way comparable. If based on the adult structure, then the larval development of sponges was altogether anomalous, and not similar to any other known development, since the ectoderm assumed an internal position, and became surrounded by the endoderm. The most probable view was that sponges were descended from Choano-flagellate Protozoa, since collar cells were not known to exist except in these groups.

The discussion was continued by Prof. Haeckel, who was in favour of the Cœlenterate theory; Dr. Vosmaer, who believed that "we cannot yet answer the question about the position of sponges," but suggested that "if we have to classify, we must either bring them to a separate group of the same value as the Metazoa, or consider them as Metazoa, but forming a separate class, like Cœlenterates, Echinoderms, etc."; Mr. Saville Kent, who urged that "this vexed problem of sponge affinities should be fairly approached and examined from a protozoic as well as from a cœlenterate basis, and that those undertaking the task should familiarise themselves with both the collar-bearing flagellates and the corresponding sponge elements in their living state."

In the afternoon Prof. Ewart exhibited and made remarks upon a very interesting series of slides, showing photographs of Hybrids between the Horse and the Somali Zebra.

Mr. Durham, for Prof. Kanthack and himself, read a paper on Tsetse Disease.

Tsetse disease, or N'gana, is one of the many scourges of South Africa. Bruce discovered that the cause of the disease is a parasite belonging to the flagellated protozoa and the genus *Trypanosoma*. According to Bruce's observation, the fly merely acts as a carrier. If it feeds on the blood of an infected animal, and again feeds within two or three days upon a healthy susceptible animal, it communicates the disease. A fact of importance in the dissemination of the disease is Bruce's discovery that the fly is viviparous; the mother flies have to feed frequently in order to nourish their young. Bruce has further shown that the blood of certain of the wild animals of the "fly districts" may contain the parasite (*e.g.*, the Koodoo).

At the instance of the Royal Society, the living parasite was brought over to this country, where a large number of experiments have been made.

The inoculation with the parasite not only gives rise to a fatal issue in the horse, ass, ox, goat, dog, and such domesticated animals, but is also fatal to mice, rats, etc., including the hedgehog. The guinea-pig is able to withstand the infection for several months in some cases.

So far we have no means of curing the disease when it has once begun, nor have we any means of preventive inoculation or salting. Some drugs, like arsenic, help to prolong the life of the animals, but the end is always fatal. Prof. Cossar Ewart has, with the true scientific spirit, allowed certain of his valuable zebra hybrids to be inoculated with the tsetse disease in order to see whether they will show a degree of refractoriness which the zebra must possess, in that it is capable of living in the fly-infested districts. It is too early to make any statement with regard to these animals, since they have only been recently inoculated. They have all shown signs of illness, and the parasite has been found in their blood. Whether they recover eventually must be left to the future to decide.

A question was asked as to whether man was refractory, in reply to which Mr. Durham said that all the evidence that we have in regard to the susceptibility of man is entirely negative. Man is bitten by the fly, and accidental scratches and cuts have been incurred during experimental investigation, which would have been sufficient to have communicated disease had man been susceptible.

Prof. Pelseneer, of the University of Ghent, expressed his views on uniform orientation of the figures in zoological papers, showing of what great advantage it would be if, in papers treating on the same objects, all the figures could be arranged in the same way, the left side of the animal, for instance, being always on the left side of the figure, and the same abbreviations being used for the same organs.

Thursday, August 25th.

An interesting discussion was held in the morning on the "Origin of Mammals." The debate was opened by Prof. Seeley (London) and Prof. Osborn (New York).

Prof. Seeley showed that the Theriodont division of the Anomodonts approached the mammalia in the characters of the teeth and the very small size of the quadrate bone; while, on the other hand, they suggested affinities with the Labyrinthodont reptiles in the presence of such cranial bones as the supratemporal, and of intercentra in the vertebræ. Although the parts of the pectoral and pelvic girdles bore a close comparison with those of the Monotremes, and although in many Theriodonts the skull was typically mammalian in form, the mandibular ramus never consisted of a single piece as in mammals. The Anomodonts were not the parents of mammals, but a collateral and closely related group; and the common parent of both might be sought in rocks older than the Permian, perhaps in Silurian or Devonian strata.

Prof. Osborn said that in order to clear the way for a successful attack upon the difficult problem of the origin of mammals, it was necessary first to reject the hypothesis, brilliantly formulated by Huxley in 1880, of a genetic succession between Monotreme, Marsupial, and Placental types, since neither palæontology nor comparative anatomy supported this view. He concluded by saying that for further developments of the problem we must probably look to the rich fauna of the Karoo beds of South Africa.

A discussion followed, in which Profs. Marsh, Haeckel, Adam Sedgwick, Hubrecht, and Newton took part.

In the afternoon in the Senate House, the honorary degree of Doctor of Science was conferred on the following:—H. P. Bowditch, A. Dohrn, A. Milne-Edwards, C. Golgi, E. Haeckel, A. A. W. Hubrecht, H. Kronecker, W. Kühne, and S. J. Marey.

Dr. Sandys, the Public Orator, in the speeches in which he introduced the above-named, adopted the reformed pronunciation of Latin, which was greatly appreciated by the large number of International visitors in the Senate House. We have not space here to print the speeches *in extenso*.

Dr. Sandys referred, amongst the zoologists, to Prof. Milne-Edwards as not only the first president of such gatherings as these, but even their instigator and parent.

Prof. Haeckel was referred to as not only an indefatigable investigator of the minute forms of marine animal life, but also as a daring propounder of an imposing theory, throughout which he had endeavoured to trace the origin of animal life from its remotest source.

Prof. Hubrecht was introduced as a man who, born among the Batavian fields, and gifted with the happiest of dispositions, has won the hearts of all. There is scarcely a nation in Europe whose language he has not claimed for his own; added to this, he has collected for accurate investigation those most minute and microscopic sea monsters (if I may use the expression) which are designated Nemertea. If we may believe the Greek poets, those great beasts are, at all events, sufficiently ancient in origin and worthy of notice. I need hardly say, that Nereus himself was *νημερτής τε καὶ ἤπιος* (truthful and gentle), while Proteus, *γέρων ἅλιος νημερτής*, "The old man of the sea who never told a lie." However this may be, in extolling a man by whom those marine monsters in all the various forms they assume have been most veraciously described, nothing is easier than to speak the truth, nothing pleasanter than (to quote Homer) *νημερτέα μυθήσασθαι.*

Friday, August 26th.

Prof. Haeckel read an extremely interesting paper on "The Descent of Man." He said that the monophyletic origin of all mammalia from the Monotremata upwards to Man is at present no more a vague hypothesis, but a positively established fact. All the living and extinct mammalia which we know are descended from one single ancestral form, which lived in the Triassic or Permian period; and this form must be derived from some Permian, or perhaps Carboniferous, reptile (allied to the Progonosauria and Theriodontia), and the latter from a Carboniferous amphibian (Stegocephalia). These latter are descended from Devonian fishes, and these again from lower vertebrates. Much more difficult is the question of the origin of the great vertebrate-stem, and its descent from invertebrates. But these questions are not so important as the fact that Man is a member of the primate-order (Linné), and that all primates descend from one common stem (Huxley). Zoology may be proud to have proved this fact, based on the theories of Lamarck (1809) and of Darwin (1859).

Several other papers were read during the day, amongst which was one by Sir Herbert Maxwell on "Recent Legislation on Protection of Wild Birds in Great Britain," in the course of which he pointed out the necessity of international protection as the only efficient safeguard against the diminution of a great many of our migratory birds.

On Saturday morning, August 27th, a general meeting was held, at which it was decided that the fifth Congress should be held in Germany in 1901. The members of the Congress then adjourned to London, to attend a reception by the President and Council of the Zoological Society at the gardens in the afternoon and a reception by Sir John Lubbock at the Natural History Museum in the evening.

On Monday a good number availed themselves of the Hon. Walter Rothschild's invitation, and spent an enjoyable and profitable day at Tring.

On Tuesday about forty members of the Congress journeyed to Woburn Abbey, at the invitation of His Grace the Duke of Bedford, and spent a delightful day in inspecting his magnificent collection of deer, yaks, zebras, and other wild animals.

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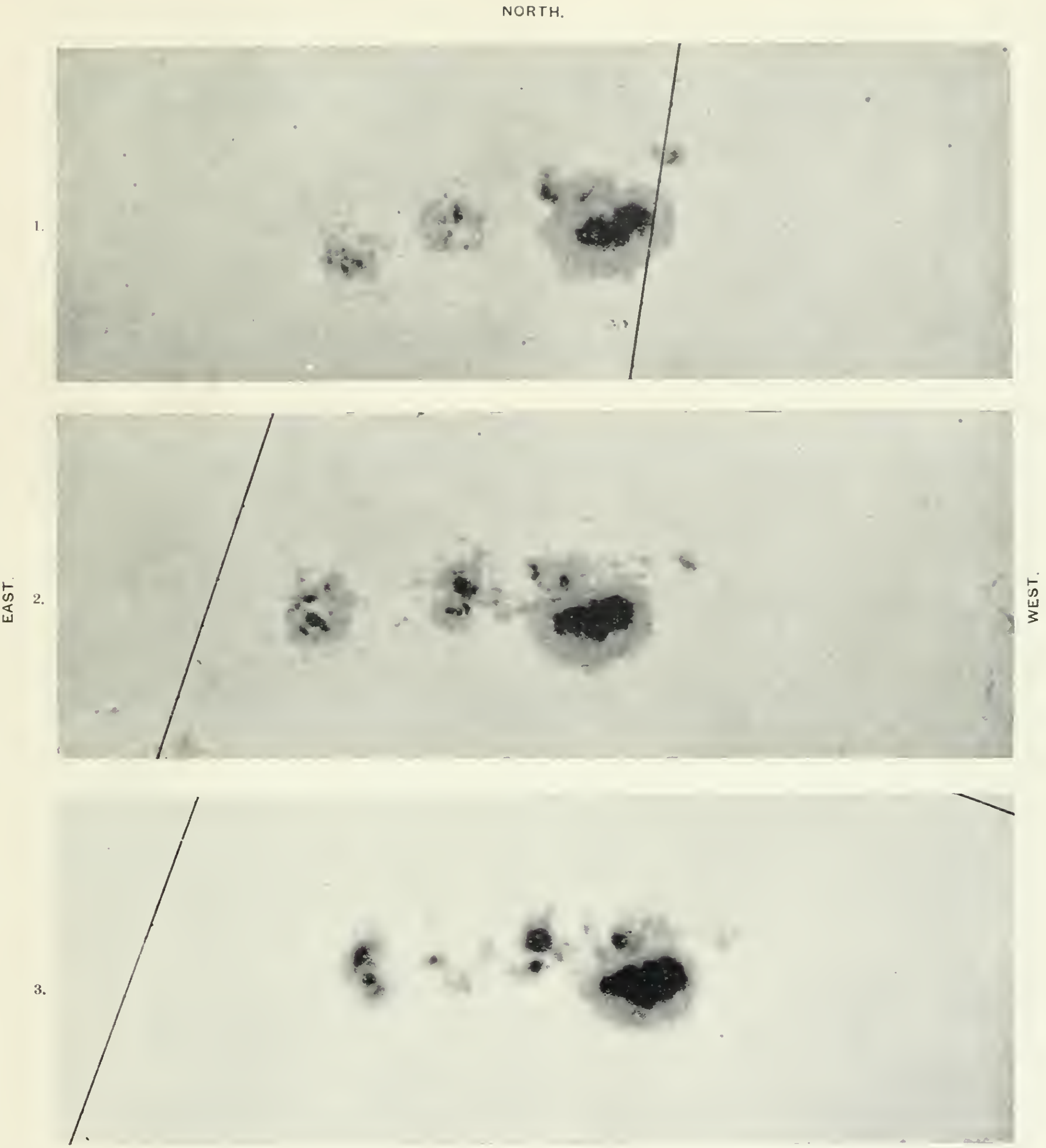
THE GREAT SUNSPOT AND THE AURORA.

By E. Walter Maunder, F.R.A.S.

It is almost two years since the occurrence of a most remarkable sunspot, a series of photographs of which were published as the astronomical plate in Knowledge for November, 1896. That group was remarkable as being the longest connected stream of spots observed on the sun during the present quarter of a century. It was no less remarkable that so great an outburst should take place at a time when the mean solar activity had already much declined. Three years had passed since the maximum, and in the ordinary course the minimum was expected in four years more. Since then the further decline in the solar activity has been marked enough. The number of days on which the sun has been wholly free from spots has increased rapidly, and yet now, as if on purpose to entirely upset all our conceptions, we have a fresh solar storm on a scale that would be noteworthy even at the time of full maximum, two years after the group we have just referred to, five years after the maximum, and when, according to rule, we have barely two more years to wait for the minimum.

Our present group was one of an entirely different order to that of two years ago. It probably might have been observed as a notch on the limb of the sun on the afternoon of Friday, September 2nd. By the following morning it was well within the limb, a single large spot, of area of nearly one thousand four hundred millions of square miles, with dark nucleus, and lying amongst long ridges of bright faculæ. By Sunday, September 4th, it was sufficiently advanced on the disc to show some of its peculiar beauties with distinctness. The details which perhaps drew most attention were the long tongues of bright matter which invaded the spot from without. The northern edge of the principal umbra, which was very dark, was fringed with such tongues, and a brilliant one invaded it on the south preceding side. This latter tongue had adopted a most curious form by the following day. A double spear of light pierced the darkness of the umbra to its centre, and was then bent obliquely backwards. On this day, Monday, the first elements of a following stream of spots were seen, which increased rapidly day by day up to the 10th, grouping themselves on the 8th and 9th, principally in two very complex clusters. Wednesday, September 7th, showed a great increase in the following spots, and the bright photospheric matter appeared mixed



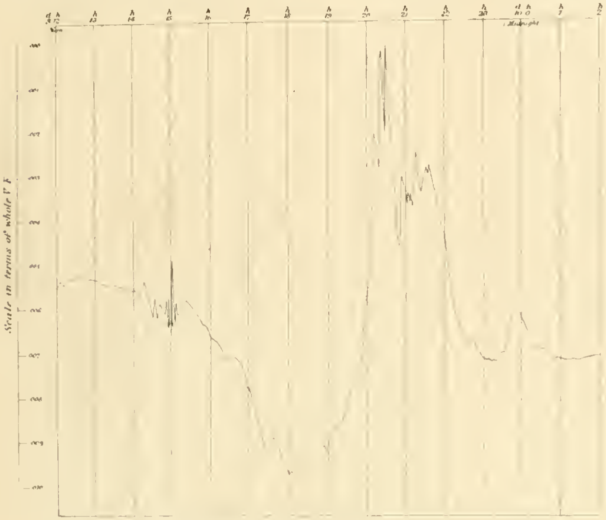
THE GREAT GROUP OF SUNSPOTS of September 3rd—15th, 1898.

As Photographed at the Royal Observatory, Greenwich.

1. Taken 1898, September, 3d. 10h. 29m. 19s. Greenwich Civil Time.
2. „ „ 9d. 14h. 59m. 2s. „ „ „
3. „ „ 10d. 10h. 40m. 6s. „ „ „

(Reproduced by permission of the Astronomer Royal.)

with the northern portion of the great spot, in an intricate lacework of light on the two next days. By the 11th the middle spots in the following stream had begun to disappear, and by the 13th only one small dot remained in that part of the group, the rearward spot being then separated from its leader by a broad belt of photosphere. By this day a very fine bright bridge, which was in process of formation on the previous day, had forced its way across the great umbra from north to south. The northern portion of the great spot was still full of complicated detail. On the following day the bright tongues which invaded the spot lay mostly on the east. By September 15th the great spot was seen only as a notch on the limb, and one spot alone followed it.



Tracing of Vertical Force Photographic Register during the Magnetic Disturbance of 1898, September 9—10.

The accompanying plate shows the group at its fullest presentation, namely on September 8th, before it had reached the central meridian, and September 9th and 10th, immediately after passing it. These were the days, too, on which it attained its greatest area and extent; the total area of the group being then some two thousand seven hundred millions of square miles, its greatest length nearly one hundred and forty thousand miles, and its breadth forty-four thousand miles. They are reproduced, by the kind permission of the Astronomer Royal, from photographs taken in the ordinary routine at the Royal Observatory, Greenwich, with the photoheliograph presented by Sir Henry Thompson. This instrument has an aperture of nine inches, stopped down to four inches on the present occasion, and a focal length of eight and a-half feet. The image in the primary focus is about one inch in diameter, and is enlarged by a secondary magnifier seven and a-quarter times. The resulting photograph has been further enlarged some two and a-half diameters, so that the present plate gives the spot on a scale of eighteen inches to the sun's diameter.

A special interest attaches to a great disturbance like the present when it occurs at a normally quiet time, for it brings out into clearer relief the peculiarities of the connection between these solar displays and the related phenomena on this planet of magnetic storms and auroræ. The accompanying trace, reproduced from the photographic sheet of the vertical force magnet at Greenwich, shows that some fourteen hours after the great spot crossed the central meridian of the sun, a sharp magnetic disturbance set in, which was at its height from eight to eleven o'clock on Friday evening, September 9th.

During these three hours an aurora of a specially brilliant and beautiful character was observed generally throughout the British Isles, the official report of the Greenwich observer, Mr. Beadle, running as follows:—"At 20h. 45m. a bright light was observed in the northern sky from which issued several white streamers. These became especially distinct at 21h. (when they attained an altitude of about 45 degrees), and remained visible, more or less brightly, till about 21½h.

"By 22h. an arch had formed. This was of bright yellow light and the ends were separated by a distance of about 90 degrees; it was most decided in form and colour at about 23h. 15m. At this time the summit of the arch was fifteen degrees to twenty degrees above the horizon. By 23¾h. the phenomenon had quite disappeared."

A fainter display was noticed also the following night, and in more northern latitudes, as in Norway, the auroræ were most brilliant for several successive nights.

It will be noticed that we have here, again, a striking case of the quick answer of the earth to a really great solar disturbance, of which I gave several instances in my paper on "The great Sunspot and its influence," in Knowledge for May, 1892, and that the terrestrial disturbance was at its height about twenty or twenty-one hours after the sunspot had reached the centre of the disc. My own experience fully confirms that of Signor Ricco, the great Italian solar observer, that this is the relationship that most generally prevails. Dr. Veeder, on the other hand, considers that the influential position for a sunspot is when it is on the east limb, a view in which I am not able to coincide. A spot like the present occurring at a comparatively quiet time is even more useful for settling such a point than one at maximum.

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Letters.

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

THE AURORA BOREALIS.

To the Editors of Knowledge.

Sirs,—As I was particularly well placed for watching the very fine Aurora Borealis on the evening of the 9th inst., I think you may possibly find some interest in comparing my observations with those of others.

I went out in the garden just after 8 o'clock, and was immediately struck by curious flecks of light in the south, suggesting luminous clouds, and on going out on to Bramshott Common, where there is an uninterrupted view for many miles, I saw that in the north there was a pale yellowish-white light, which gradually increased in brilliancy. Meanwhile little gauze-like clouds in the south and south-west caught gleams of light, flickered, and quickly faded again.

About 8.30 bright shafts of light began to shoot up from the northern horizon, and from then until past 9 o'clock there was an almost continuous display, increasing and diminishing in brilliancy alternately.

Magnificent great rays, like columns of light, shot up far into the sky, some reaching as high as the pole star or even higher. There were three, four, five, and at one time, seven of these shafts, extending westward nearly to Arcturus and eastward occasionally as far as Capella. Those near the centre were of a pure, clear, white, while those on either side took a decidedly rosy-pink shade, and were not so clearly defined at the edges. A friend who was with me saw exactly the same difference in colour which I noticed.

After 9 o'clock the display gradually ceased, but the light was still lingering in the north-eastern sky at 11.30.

I may mention that at 8.40 I could see the time by my watch easily and distinctly, but at 9 o'clock I could only with difficulty distinguish the position of the hands.

Bramshott Common, Surrey, J. M-R.
Sept. 12th, 1898.

Erratum.—In Mr. Saxby's article, in the August number, on "How to Photograph through a Fly's Eye," at page 188, column 1, line 6, for "The cornea, hyaline in shape," read "The cornea is hyaline."

Science Notes.

Sir William Crookes may possibly have sounded the alarm a little prematurely with respect to a pending universal wheat famine, and that "starvation must be averted by the laboratory." While it is a fact that at present the United Kingdom grows only twenty-five per cent. and imports seventy-five per cent. of its annual consumption of wheat, it is also true that ours is one of the best wheat producing countries in the world—the yield per acre for the United Kingdom being 29·1 bushels, whereas in the United States it is 12 bushels, in Russia 8·6 bushels, and in Australasia only 6·8 bushels, the average of the whole world being 12·7 bushels. Anent the argument that by increasing the present average wheat crop per acre from 12·7 to 20 bushels in order that the world's supply may keep pace with the demand, we refer our readers to the results of the Rothamsted agricultural experiments.[*] There it will be seen that in 1863, with the aid of mixed mineral manure and nitrate of soda, $55\frac{5}{8}$ bushels per acre were grown on land which is not better than the average as regards natural fertility. Sir William's presentiment of coming evil, though well-founded, need not therefore alarm us if the cultivators of the soil will only follow the example of those pioneers who have elicited so much from the economy of Nature.

Professor Japp, in his Presidential Address on "Stereochemistry and Vitalism" before the Chemical Section of the British Association, attacks the question whether the phenomena of life are wholly explicable in terms of physics and chemistry. The frank admission which he makes, coming as it does from so great an authority on organic chemistry, will be received with satisfaction by those who do not regard science as the *alpha* and *omega* of opinion on this much controverted question. He says: "I see no escape from the conclusion that at the moment when life first arose a directive force came into play—a force of precisely the same character as that which enables the intelligent operator, by the exercise of his will, to select one crystallized enantimorph and reject its asymmetric opposite. I would emphasize the fact that the operation of a directive force does not involve a violation of the conservation of energy."

M. de Rougemont's ordeal before the British Association is reminiscent of other travellers who have brought home strange stories of adventure in unknown lands. Bruce was for some time regarded as a romancer, M. du Chaillu was suspected as a perverter of the truth when he disclosed his story of the gorillas, and even Mr. Stanley was, like Joseph, believed by many to be a dreamer when news came of the finding of Livingstone. Certainly the desirable credentials to establish the truth of the traveller's story are still wanting, but the ready, straightforward and ungarnished narrative goes a good way to dispel doubts as to the veracity of the forced exile. Much that M. de Rougemont had to tell is merely confirmatory of other travellers' narratives, but, taken as a whole, his story conjures up in the mind, we think, a more vivid picture of life among the aborigines of Australia than anything which has as yet appeared in print. At the same time it is difficult to understand why so responsible a body as the British Association should have permitted the reading of a paper of this character, without first clearing up *all* doubts as to its veracity.

Monium (from the Greek *μόνος*—alone), the new element announced by Sir Wm. Crookes in his presidential address, affords another instance of the application necessary in order to make headway in scientific research, the veteran chemist having persisted for eighteen years in his investigations since first suspecting a new member of the rare earths, and only within the last few weeks has this suspicion emerged into absolute certainty. Monium has a well-marked individuality, enters readily into any number of chemical alliances, and has an atomic weight not far from one hundred and eighteen. The wave-lengths of the principal lines are three thousand one hundred and twenty and three thousand one hundred and seventeen.

According to Prof. Flinders Petrie's paper in the anthropological section of the British Association, the starting point of known history must be put backwards at least a thousand years, a decision arrived at by the study of remains excavated during the last five years. Some of the objects found at Nagada were once attributed to a new race, but they can now be safely assigned to the predynastic stock, about 5000 B.C., and even earlier. It is alleged that we have now before us the development of the art of writing and the civilization of Egypt. The population of the pre-dynastic age was different in type from that of historical lines, and in the early monuments the presence of diverse types is very clear.

A high-class microscope for the amateur, the student, and the bacteriologist, at a sufficiently moderate cost to come within the reach of all, or nearly all, would-be microscopists, has long been a desideratum, and we are pleased to find that the "Fram"—a newly-designed microscope by Messrs. W. Watson & Sons—seems to us destined to meet the requirements of the most fastidious. The instrument is strong, solid, and rigid, steady at every angle, and therefore well adapted for micro-photography. In the coarse adjustment provision is made for avoiding backlash, and in the fine adjustment compensating screws are employed for eliminating slackness after prolonged use. Indeed, the entire microscope is designed to yield the advantages that have hitherto been associated only with the most expensive instruments.

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[*] Knowledge, p. 140, June, 1898, and p. 148, July, 1898.

Notices of Books.

Audubon and His Journals. By Maria R. Audubon. With Zoological and other Notes by Elliott Coues. 2 Vols. (Nimmo.) Illustrated. Although nearly fifty years have passed since the death of Audubon, this is the first published account of his life, with the exception of that edited by Robert Buchanan, which was both inaccurate and incomplete. Audubon will be chiefly known by his great folio work on the "Birds of America," the publication of which was commenced in 1827. The author's drawings (in the original edition the text to the plates appeared separately as the "Ornithological Biography") in this magnificent work formed its chief feature, and, as has been remarked, "it is one of the few illustrated books, if not the only one, that steadily increases in price as the years go on." With the many advances that have been made of late years in the drawing of birds, as well, of course, in the process of reproducing drawings, this is very high testimony for the accuracy and beauty of Audubon's plates.

AUDUBON.

From the Portrait by Henry Inman. Now in the possession of the family.

When we look into his methods, as revealed in his own journals here published, we can better understand why Audubon's drawings have stood the test of time and criticism. His work was always first hand. Days and nights were spent in the wilds of America, alone, in the company of savages, or with a few fellow spirits watching, hunting, and procuring wild creatures, and especially birds. When he ultimately knew the habits and attitudes of a creature he would procure it, and as soon as possible, by means of wires, set it up in the flesh, and draw it, adding a few leaves or flowers which would be found growing in its habitat. It was thus that Audubon made his drawings, the like of which the world had never before seen, and it is exceedingly interesting to find in this book the history of many of these drawings written by himself. But this is not the only interest we have in reading these simple pages. They reveal the nature of the man—open-hearted, generous, forbearing, good natured, and hard working as he undoubtedly was. Although often depressed and in very poor circumstances himself, he was always ready to assist the needy and comfort the distressed. Every great character has his enemies, and Audubon was no exception, yet he never had a bitter word for them. It is surprising that he lived to such a great age, considering the amount of hard and rough work that he underwent. He would often work seventeen hours a day. Above everything, Audubon was a man of the open air. In the words of his grand-daughter (Vol. I., p. 48): "With them (the Osage Indians) he delighted to track the birds and quadrupeds as only an Indian, or one of like gifts, can; from them he learned much woodcraft; with them he strengthened his already iron constitution; and in fearlessness, endurance, patience, and marvellously keen vision, no Indian surpassed him." He was called the "American Back-woodsman," and was an ideal field naturalist.

The first of these volumes contains an account of the life of Audubon by the authoress, the European journals, the Labrador journal, and part of the Missouri River journals; while in the second we have the completion of these journals, and a number of Episodes. The "life" is an excellent and unvarnished biography. The European journals deal with Audubon's visit to Great Britain and France for the purpose of publishing his "Birds of America." This was by no means an easy task. The expense involved in the reproduction of the drawings was enormous, and the price of the book therefore very high. There were no means in those days such as we have now to get a book subscribed, and Audubon had to travel by coach all over England to obtain subscribers for his work. Besides the account of the immense labour he went through in connection with the publishing of his great work, the European journals are of intense interest for the descriptions they contain of the meetings and conversations he had with many notable men of the period.

The Labrador and Missouri journals will be chiefly valuable to naturalists, and especially, of course, to Americans, but there is so much of general interest in them that everyone who takes up the volumes will find them excellent reading. The Episodes are varied, all are interesting, and many very amusing. That entitled "The Eccentric Naturalist" is a most clever sketch, and we cannot refrain from extracting a few lines—

> "We had all retired to rest. Every person I imagined was in deep slumber save myself, when of a sudden I heard a great uproar in the naturalist's room. I got up, reached the place in a few moments, and opened the door, when, to my astonishment, I saw my guest running about the room naked, holding the handle of my favourite violin, the body of which he had battered to pieces against the walls in attempting to kill the bats which had entered by the open window, probably attracted by the insects flying around his candle. I stood amazed, but he continued jumping and running round and round until he was fairly exhausted, when he begged me to procure one of the animals for him, as he felt convinced they belonged to 'a new species.'"

The author goes on to say how he knocked down some of the bats with the bow of his "demolished Cremona," and so satisfied the naturalist. He does not, however, tell us how he must have mourned for the loss of his violin, on which instrument he was an accomplished performer.

The volumes are enriched by many valuable notes by Dr. Elliott Coues. By way of illustrations there are many portraits of Audubon and his sons, as well as three hitherto unpublished drawings of birds. The authoress has produced an estimable and lasting memorial to her grandfather Audubon, naturalist, woodsman, artist, and author.

With Peary near the Pole. By Eivind Astrup, translated by H. J. Bull. (Pearson, Ltd.) Illustrated. Although M. Astrup died some time ago, no mention of the fact is made in this translation, nor is the author's original preface dated. These omissions are strange enough, but that a translation of this book should be published a month or two before the appearance of a full account of the expeditions by their leader is still more remarkable. Eivind Astrup accompanied Mr. Peary on his two Greenland expeditions in 1891-2 and 1893-4, and this book is a short account of these two expeditions. By far the most interesting portion of the book is that dealing with the remarkable and successful sledge journey of 1892. Although by no means a practised writer, the author describes this journey exceedingly well, the great charm of the narrative being its simplicity. It will be well to remind our readers of this journey, which was quite as remarkable in its way as the crossing of the south of Greenland by Nansen, in 1885. Peary, Astrup, Gibson and Cook, started on their journey across the inland ice from MacCormick Bay, on the north-west of Greenland, on May 14th, 1892. On May 24th they reached Humboldt Glacier, and here the party divided, Peary and Astrup continuing the journey, and the other two returning to winter quarters. On June 27th the two intrepid explorers reached the eighty-second degree of latitude, and found themselves at the edge of the inland ice, while on July 4th they arrived at the north-east coast, and so practically proved that Greenland is an island and not a continent stretching to the Pole as some have thought. It was not until August 5th that, after innumerable hardships and incessant toil, Peary and Astrup gained winter quarters and comparative civilization. Besides the descriptions of the expeditions and their equipments, the book contains some valuable information on the customs, dress, and language of the Esquimaux, and the manner in which they live. This information is especially interesting, since it refers to tribes about which very little is known. The information, however, is scattered through the book, and not being systematically arranged loses much of its value. The translator has done his work well, and the book well deserves reading.

Cantor Lectures on Gutta-Percha. By Dr. Eugene Obach. (Wm. Trounce.) Illustrated. Gutta-percha is not, some may think, a very entertaining subject for a course of lectures, but a different opinion may be formed by a perusal of the Society of Arts' course of three lectures delivered by Dr. Obach nearly a year ago. The plant was subordinated to useful purposes by Sir Wm. Hooker and Dr. Siemens in the year 1847, and the Society of Arts deemed it fitting to celebrate the jubilee of its introduction into commerce by a course of lectures, which are embodied here, and suitably illustrated with photographs and diagrams of the processes employed in preparing the raw material for the market and its subsequent manufacture into various useful articles. The history, geographical distribution, botanical structure, and cultivation of the gutta-percha tree form the subject of the first lecture, while the second and third deal with the processes for cleaning, hardening, and so on. Among the many uses to which gutta-percha has been put, that for making ice-boats, as in the case of Lady Franklin when in search of her husband in 1850, seems to us most curious. A useful series of tables is appended at the end of the volume, giving analyses, imports and exports, and so on; indeed, we know of no work where so much and varied information, in an equivalent space, may be found on gutta-percha as in Dr. Obach's lectures here reproduced in convenient form for reference.

The Wonderful Century: Its Successes and its Failures. By Alfred Russel Wallace. (London: Swan, Sonnenschein & Co.) 7s. 6d. That this book is from Dr. Wallace's pen is guarantee sufficient that it is interesting and well worth reading. In the hands of such an author we expect that the subject will be dealt with in a fascinating and invigorating style, and we are not disappointed. As Dr. Wallace himself says, he has produced an appreciation of the century rather than its history. But the book is by no means full of jubilant expressions relating to the many wonderful successes of the last hundred years; more than half the volume is concerned with what the author regards as its failures. Among these the questions of vaccination, phrenology and spiritualism are discussed, the first named occupying a very considerable portion of the entire volume. The author has strong views on these subjects, and does not hesitate to express his opinions in vigorous language. This makes it advisable to offer a word or two of caution to readers who propose to study the book under notice. It by no means follows that because an author has attained pre-eminence in any one department of scientific knowledge, as Dr. Wallace has done in the realm of natural history, he is thereby qualified to give a final opinion on every controversial question which may arise out of the advances that science has made. There are many who are not prepared to accept Dr. Wallace as a judge upon such matters as the value of vaccination, or the claims of phrenology to be regarded as a science; and while admiring his manly English and his clear expression of what he thinks, we must point out that his conclusions are considered erroneous by numbers of equally eminent men of science. Doubtless many of Dr. Wallace's sentences will find their way into phrenologists' advertisements and the pamphlets of anti-vaccinators, but that does not constitute them deliberate expressions of the present state of scientific opinion. Dr. Wallace himself must recognize that he has no more right to decide these questions than an eminent chemist would have to pass judgment in matters of pure biology. If this is borne in mind the reader will derive both pleasure and profit from the perusal of Dr. Wallace's work.

Essays on Museums and other Subjects connected with Natural History. By Sir William Henry Flower, K.C.B., etc. (Macmillan.) Illustrated. 12s. net. We have to thank Sir William Flower for republishing these essays in book form. The earliest of them was written in 1870, and notwithstanding the great advance in scientific knowledge since that date, all these essays, with the exception of a few minor details, have stood the test of time, and are as interesting and instructive to-day as they were when first penned. The book opens with seven chapters on museums, a subject with which the author is, of course, eminently fitted to deal. If anyone requires advice as to how to build, plan, and fill a museum to the best advantage, or should anyone be at all hazy as to the true value of a museum, let him read these chapters. The last forms a brief history of Hunter's wonderful collection, now the museum of the Royal College of Surgeons. The next section of the book, devoted to biology, contains eight essays on various subjects. The chapter on whales, past and present, and their probable origin, is especially interesting. The chapters in the section dealing with anthropology, that much neglected science, should be read by everyone. The concluding chapters are biographical sketches of Prof. Rolleston, Sir Richard Owen, and Prof. Huxley, and an eulogium on Charles Darwin. The book is a mine of information of a very varied character conveyed in simple but eloquent language, and our only criticism is that an index would have rendered it more useful.

Elements of Descriptive Astronomy. A text-book by Herbert A. Howe, A.M., SC.D. (London: George Philip & Son.) This is a delightful text-book, intended not only for students at college, but for those also who attend the more comprehensive school of Nature herself. Dr. Howe touches upon each of the widely varying subjects which make what is to-day called the "new astronomy," and he discusses reasonably and without prejudice the hard questions that come up for answer on every side. Indeed, when he comes to the nebular hypothesis he deprecates, by a well-turned parable, the necessity of formulating any answer, of making any prophecy as to what will be the ending of the earth and sun.

But the "text-book" of the student should be his reference book when he has become a working astronomer. We once heard of a computer who could repeat Bottomley's logarithmic tables, in whole or in part, from memory, but unfortunately this power was exceptional, or rather unique, among the astronomers of his day. We ourselves cannot trust our memory to recall accurately the simplest trigonometrical rule or formula, and it is a question of time to work all problems out from first principles. Therefore, since the author says in his preface that he will welcome any suggestions for a second edition, we believe that it would still further add to the usefulness of this already valuable work if he furnished appendices not only of the "names of stars," the "astronomical constants," and of the "planetary data," but also of the formulæ most commonly used, say for the conversion of the altitude and azimuth of a star into its longitude and latitude, or right ascension and declination.

SHORT NOTICES.

Industrial Electricity. Edited by A. G. Elliott, B.SC. (Whittaker & Co.) Illustrated. 2s. 6d. This volume is one of a series of books on electro-mechanics. Apparently recognizing the fact that we have yet to learn a great deal from the French on matters scientific, Mr. Elliott has planned his book from a treatise by Henry de Graffigny. The principal applications of electricity in everyday life are popularly explained, that is to say, the non-mathematical reader may peruse it with profit, but the small size of the work does not admit of much detail. However, the other volumes of the series—some of which, by the way, have already appeared, whilst others are in preparation—are intended to enter more minutely into the various branches of applied electricity.

Notes on Observations. By Sydney Lupton, M.A. (Macmillan.) 3s. 6d. An attempt is here put forth to make clear to the scientific student the reasons for adopting the present system of mathematical nomenclature. The introductory chapters are devoted to philosophic reasoning, and the rest of the book is given up to rather abstruse problems, which will appeal more to the higher mathematical student rather than to physicists and chemists, for whom the book is really intended. References are given at the end of each chapter for those students who wish for fuller information. We think that there is room for more books of this kind—books which in a sense control a student's thinking powers somewhat after the manner in which the governor-balls of a steam-engine regulate the action of that useful mechanism.

Elementary General Science. By A. T. Simmons, B.SC., and L. M. Jones, B.SC. (Macmillan.) Illustrated. 3s. 6d. As an introduction to natural philosophy this book will be found very useful. Its chief merits rest upon the fact that all the fundamental principles of the sciences are presented with exceptional clearness, and the whole of the information is so thoroughly up to date as to form a solid basis for more advanced work.

Practical Radiography. By A. W. Isenthal and H. Snowden Ward. Second Edition. (Dawbarn & Ward.) Illustrated. 2s. 6d. Although only in its second edition, this work has been so thoroughly revised that it may be almost regarded as new. All the recent innovations in the infant science have been interpolated in their proper places and minutely explained, more particularly as regards the practical aspects of the subject. Some very good photographs illuminate the text here and there. As a handy guide to practical work of this kind there is, as far as we know, no better book available.

Elementary Chemistry. First Year. By T. A. Cheetham. (Blackie.) Illustrated. 1s. 6d. By way of supplementing elementary lectures on chemistry with practical work in the laboratory, Mr Cheetham's book is admirable. The so-called "test-tubing" is replaced by simple experiments which have for their object the development of the student's reasoning powers, ample scope for which is to be found in the resolution of chemical compounds into their elements, or *vice versâ*, and so on.

Scientific Method in Biology. By Dr. Elizabeth Blackwell. (Elliot Stock.) The main theme of this book is the necessity for practising more humane methods of medical research. It is maintained that truth, not curiosity, is the real aim of all scientific investigation, and therefore medical research should be pursued on strictly humanitarian lines. Many students can extract rare sport out of the sufferings of dumb creatures, and this morbid passion may retain its hold on the professional man in after years, when as a surgeon he is called upon to minister to afflicted humanity. All those who desire to maintain medical science at its highest level from a purely moral aspect will find much here to sustain and encourage them in their efforts to minimise human woe.

First Stage Magnetism and Electricity. By Dr. R. H. Jude, M.A. (Clive.) Illustrated. 2s. Dr. Jude follows the syllabus of the Science and Art Department, but it is not by any means a cram-book—a result which too frequently obtains in books written for examination purposes. The only other important points to notice are the useful summaries at the end of each chapter, and the careful attention bestowed on the all-important subject of potential—a slough in which most students flounder hopelessly.

The Barometrical Determination of Heights. By F. J. B. Cordeirs. (Spon.) 4s. 6d. An essay originally entered for the Hodgkin Prize Competition at the Smithsonian Institute, and mentioned as being *good*. Various formulæ are tabulated which, according to the author's idea, are more accurate than the old tables, these being faulty in the formulæ rather than in the method. But why a pamphlet of about thirty pages should cost four shillings and sixpence is beyond our comprehension!

The Adventures of Robinson Crusoe. (London: *Review of Reviews* Office.) 6d. This is still another edition of the famous novel, retold from Defoe's original, and edited by W. T. Stead. It is printed in large clear type, and illustrated throughout with a number of new drawings. Some of these new renderings of old friends are quite unintentionally humorous, notably that on page 89, representing the reunion of Friday with his old father. Mr. Stead has done well to reproduce a story which must always appeal to Englishmen all the world over as reminiscent of the days when all the world was young, and we first made the acquaintance of Robinson Crusoe.

We have received from the *Review of Reviews* office a selection of the Penny Poets series, and we gladly direct the attention of teachers in elementary schools to these most admirable books.

BOOKS RECEIVED.

Zoological Results based on Material from New Britain, New Guinea, &c., 1895, 1896, and 1897.—Part I. By Arthur Willey, D.SC. (Cambridge University Press.) Illustrated. 12s. 6d.

Catalogue of Scientific Periodicals. Vol. XL. (Smithsonian Miscellaneous Collections.)

The Rutherford Photographic Measures of Stars. By Herman S. Davis, PH.D. (Reprinted from the Annals of the New York Academy of Sciences.)

Birds of the British Empire. By Dr. W. T. Greene. (Imperial Press.) Illustrated. 5s. net.

The Fern World. By Francis George Heath. (Imperial Press.) Illustrated. 5s. net.

Applied Geology.—Part I. By J. V. Elsden, B.SC. (Quarry Publishing Co., Ltd.) Illustrated. 5s.

Geology for Beginners. By W. W. Watts. (Macmillan.) Illustrated. 2s. 6d.

Tylar's Catalogue of Photographic Appliances. (High Street, Aston, Birmingham.) Illustrated. 6d.

Stories of Starland. By Mary Proctor. (G. W. Bacon & Co., Ltd.) Illustrated.

The Unconscious Mind. By Dr. Alfred T. Schofield. (Hodder & Stoughton.) 7s. 6d.

Outlines of the Earth's History. By Nathaniel Southgate Shaler. (Heinemann.) Illustrated. 7s. 6d.

Meteorological Observations for the Year 1897. (Rousdon Observatory, Devon.) By Cuthbert E. Peek, M.A.

Wireless Telegraphy. By Richard Kerr, F.G.S.; with Preface by W H. Preece, C.B., F.R.S. (London: Seeley & Co., Ltd.) 1s.

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

Change of Nesting Sites of Common Tern and Ringed Plover.—Both the Common Tern and Ringed Plover breed commonly in the sands and bents to the north of Peterhead. The former bird is ever shifting its breeding grounds, perhaps through annoyance from fisher boys, who are persistent harriers of their nests. In former years I have always come across small breeding colonies within five miles of the town, either immediately above high water mark or on the bents. This year I found none, but inland I came across two colonies, one in the middle of a field of rye grass, and the other in the middle of a turnip field, where they certainly had more chance of raising their young. Is this reasoning on their part, or what? The same change of breeding grounds I observed on the part of the Ringed Plover. There were certain furrowed spots on the sand or back a little on the bents where you could always find their eggs, and where their piping was incessant, but this year there were hardly a pair in these parts. Nor had they mingled with the Terns in the fields, but they were piping commonly all along where the bent adjoins the cultivated land. Had two or three pairs been there it had not been noticeable, but they seemed all to be there. I wonder if they were going near the town so as to get their protection when Crows were hovering about?—William Scole, Peterhead.

Migrating Wagtails at Peterhead.—In years past, during September, I used to notice Pied Wagtails numerously, some nights in hundreds, near Fettes College in Edinburgh. They are every year very noticeable birds all over this region during the latter three weeks of August. In the spring they are very numerous as they push northwards, but nothing to what they are in August. They are just now in family parties, though later you would think that three or four families combine. They are in no hurry to travel southwards, perhaps because they have abundance of flies here during the herring season. There is always a fair sprinkling of the Grey Wagtail, but they are a little later in migrating.—William Scole, Peterhead.

Squirrels and Birds.—Squirrels are becoming very common in the woods and plantations of Ireland, and certainly form a charming addition to our somewhat slender list of wild fauna. The price which we must pay for the pleasure of watching them is, however, scarcely understood. Not only do they rob our gardens and orchards, but they are proving formidable adversaries to the increase of bird life. Nests are robbed without scruple, eggs and young devoured; and a squirrel was lately seen leaping triumphantly on the garden wall with a full-fledged Robin in his mouth. A neighbour of ours has proclaimed a war of extermination against the marauders, which, not content with stealing the food prepared for his young Pheasants, proceeded to eat the precious chicks themselves. It seems that we cannot allow Squirrels to increase at their own sweet will without making sacrifice for their sakes of the birds which are equally valued.—C. Maud Battersby, Cromlyn, Rathowen, Ireland.

Moorhen Chasing Stoat.—On August 16th I was in a canoe on the River Derwent, floating down stream and hardly making a sound, when I saw on the bank a Moorhen hunting a stoat. The stoat was galloping along, and the Moorhen kept making short swift runs at it, but each time striking distance was reached the bird stopped short. I kept the canoe still and watched till pursued and pursuer disappeared among some bushes. The Moorhen may have had young ones—a second brood—and the stoat have tried to rob her nest. The Moorhen uttered an alarm note incessantly, and the stoat seemed to me to utter every now and then a low short squeal, whether in anger or terror I cannot say.—Basil W. Martin, Darley Abbey, Derby.

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.*

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SUNSPOTS AND LIFE.

By Alex. B. MacDowall, M.A.

Is there any connection between the sunspot cycle and physical phenomena around us? We may reply with a confident affirmative, for the proof that magnetic variations are related to that cycle is clear and cogent. The same may be said about frequency of auroras.

There can be little doubt that the electrical condition of our globe with its atmosphere touches life at many points. (A familiar example is the susceptibility of some people to the influence of an approaching thunderstorm.) The subject, however, is largely a *terra incognita* at present.

Does the sun give out more heat when spotted, or when (comparatively) spotless? And does our atmosphere manifest such difference, if it exists? Have we more severe winters, hotter summers, etc., during one phase of the sunspot cycle than during the opposite phase? and, if so, what is the nature of the relation? Such questions are still (in the opinion of many) *sub judice.*

There is reason to believe, I think, that we have more winter cold about the time when there are few spots than when there are many. Some months ago I gave, in these pages,* two curves in illustration of this view; one, of frost days at Greenwich in the first quarter of the year, the other, of days of northerly wind in the winter half of the year. It would seem that the sun is hottest when spotted. The cold of winter is mitigated. Some say that the spotted sun gives us hot summers as well as mild winters.

Now we know how a great deal of cold in the late winter and early spring affects the life of plants, retarding their growth, and the life of migratory animals, delaying their return. If, then, this cold varies periodically in a cycle of about eleven years, should there not be a corresponding variation in the data of phenology?

This branch of science, *phenology*, has not yet come within the ken of "the man in the street." I hardly need say here, however, that the practical phenologist notes, year by year, the dates at which given plants come into leaf or flower (or other phase), the dates at which certain animals are first seen.

Do we, then, find that the variations in those dates show any correspondence with the variations of temperature and of the sun-spots in a period of eleven years? To this

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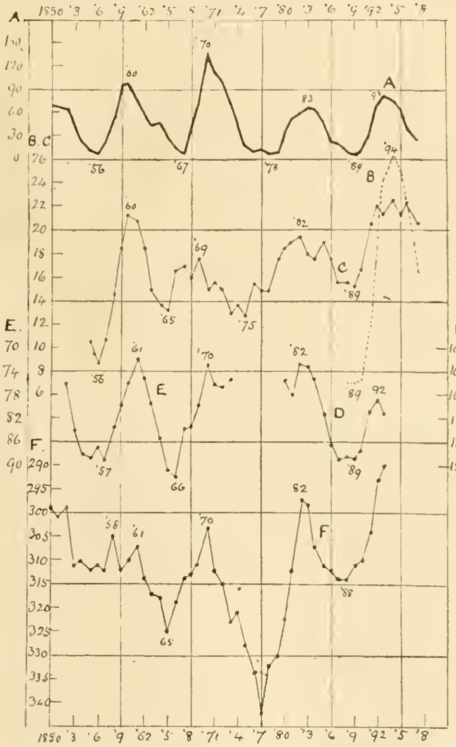
* Knowledge, October, 1897. "Coming Cold."

an affirmative reply has been given recently by the eminent French astronomer, M. Camille Flammarion.*

Some time ago he commenced observing the chestnuts at Juvisy Observatory, near Paris, recording the days on which leaves and flowers were first seen. He has now a uniform series of thirteen years of such records (1886—1898). He draws a curve to represent (say) the date of first flowering of the chestnut, in this way: The dates, ranging from 4th April to 9th May, are first changed into numbers, calling the latest No. 1, the second latest No. 2, etc. Then the thirteen years series of these numbers is smoothed with averages of four (averaging the first four, then the second to the fifth, and so on). These smoothed values yield the curve B in our diagram.† The thing to be noted is, that high points in it represent early dates, and low points late ones; and there is good agreement with the last sunspot wave (curve A), the earliest dates being near sunspot maxima and the latest near minima.



A.—Sunspot Curve. B.—Smoothed Curve of first flowering of chestnuts, near Paris. C.—Smoothed Curve of return of Swallow to Central France. D.—Smoothed Curve of average first flowering of five plants in Hants. E.—Smoothed Curve of first flowering of *Ribes Sanguineum*, Edinburgh. F.—Smoothed Curve of death-rate of male persons, eighty-five and upwards, in England. (D, E, and F are inverted curves.)

These data are obviously too meagre, however, to base much upon, and M. Flammarion has recourse to several longer records, showing the dates of return of some migratory birds (the swallow, the cuckoo, the nightingale) at a place near Moulins, in the centre of France (the Parc de Baleine). The longest record is that of the swallow, and the smoothed curve for it (drawn on the same principle) is that marked C. A correspondence of the same kind, not, indeed, absolutely perfect, is here apparent. The swallow returns later, on the whole, near minimum sunspots than near maximum. The dates here range from 19th March to 11th April. Curves of the two other birds are given by the author as pointing to the same influence.

With regard to temperature, M. Flammarion finds that a smoothed curve of the mean temperature of March and April (months of great importance to vegetation) corresponds with the sunspot curve, and also fairly represents the temperature variation of the whole year.

Coming to our own country, we may, if I mistake not, find the same influence at work; and I may be permitted to recall, in this connection, some curves which have appeared elsewhere.

D is a curve drawn from data in the Annual Reports on phenological phenomena presented to the Royal Meteorological Society. It represents the flowering of plants in a district of Hants. The five annual dates of first flowering of five plants (viz., coltsfoot, wood-anemone, blackthorn, white oxeye, and dogrose) from 1878 to 1895, translated each into the number of the day in the year, are added together and an average taken. Then the series is smoothed with averages of five (to get rid of minor waves of variation). Here a high number represents the opposite of what it does in M. Flammarion's curves, viz., a late date, while a low number represents an earlier date. The curve is an inverted one, the numbers increasing downwards. E is a curve got similarly from a record of the first flowering of *Ribes Sanguineum* (or flowering currant), at Edinburgh, 1850-75.

Both of these curves appear to indicate late flowering about the time of sunspot minima, and early about the time of maxima.

Cold retards the beginnings, the first signs of life; it often accelerates the end of life. We know that a sharp snap is fatal to many of the aged and the weak. The Registrar-General's reports give us an opportunity of seeing how the death rate of old people varies from year to year. If we take the series for males eighty-five and upwards, and make a smooth (inverted) curve of it (F),* we find it has considerable suggestions of a relation to that variation in winter cold whose effects we have been tracing, and the origin of which, as of much else, may probably be found where—

> "The very source and fount of day
> Is dashed with wandering isles of night."

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ECONOMIC BOTANY.

By John R. Jackson, a.l.s., etc., *Keeper of the Museums, Royal Gardens, Kew.*

ZYGOPHYLLEÆ.—A family usually known as the Guaiacum order, consisting of trees, shrubs, and herbs, found abundantly and widely dispersed in the tropical and warmer parts of the globe, the spiny species being characteristic of the desert vegetation of Egypt and Western Asia. Many of the

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* See *Bulletin de la Société Astronomique*, for June, 1898.

† I should perhaps state that these two curves, B and C, are not an exact copy of M. Flammarion's diagrams, but are drawn from his figures. The four year average is in each case put down to the *third* year of the group (with slight want of symmetry). These two curves should be considered independently; they are drawn with the same vertical scale for convenience.

* See *Lancet*, January 1st, 1898.

species are characterised by the presence of resin, and the woody species by their extreme hardness. The most important economic species of the order are *Guaiacum officinale* and *G. sanctum*, both of which furnish the well-known hard wood, Lignum vitæ, of commerce. The first is a tree of twenty or thirty feet high, crowded with numerous, spreading, jointed branches, covered with long green leaves and numerous bright pale blue flowers, which give the tree a very handsome appearance. It grows in most of the West Indian Islands, more particularly in Hayti, Jamaica, and Cuba, and is found also in Columbia and Venezuela. The second species, *G. sanctum*, grows in Cuba and the Bahamas, but is not found in South America, though it occurs at Key West, in Florida. Guaiacum wood or Lignum vitæ is imported in large logs or billets, weighing sometimes as much as a hundredweight. The bark is removed before exportation. The wood is often as much as a foot in diameter, and shows on a cross section a marked distinction between heartwood and sapwood, the former being of a dark greenish colour, owing to the presence of resin, which is known commercially as gum guaiacum, and the sapwood being of a light yellow, containing no resin. The heartwood is one of the darkest and hardest woods known, and is valued for these qualities as well as for its great durability, for which reason it is used largely for making ships' blocks, pulleys, skittle balls and bowling balls, rules, pestles, etc., and medicinally as a stimulant, diaphoretic, and alterative. It was formerly much used in syphilitic and cutaneous affections, chronic rheumatism, gout, scrofula, and similar diseases. For these purposes it was seen in chemists' shops in the forms of chips, shavings or coarse powder. It is, however, seldom used medicinally at the present time. The best kind of Lignum vitæ comes from San Domingo; other qualities are imported from Hayti, Bahamas, and Jamaica.

Guaiacum resin occurs either in lumps or small round pieces known as tears. Externally it is of a brownish-green colour, breaking with a clean, glassy green fracture. It has no smell, except when warmed or rubbed, when it emits an aromatic odour. It possesses the same properties as the wood, and is used in medicine for similar purposes.

A curious plant belonging to this order is that known as the creosote plant (*Larrea mexicana*), a shrubby plant of North America. A resinous substance or lac covers the twigs, which is scraped off by the Indians and melted into balls. It is considered by them as efficacious in the case of rheumatism.

GERANIACEÆ.—A group of herbs or shrubs distributed over the globe, the Pelargoniums being found abundantly at the Cape of Good Hope. The characteristic properties of the plants are astringent, aromatic and fragrant. They are, however, more valued, horticulturally, for the beauty of their flowers than for their economic properties. From this point of view the most important is, perhaps, the rose leaf geranium (*Pelargonium capitatum*), which is largely cultivated in the South of France, Turkey, Algeria, and Spain, for the fragrant oil which is distilled from its leaves, and is used as a perfume, both by itself and for adulterating attar of rose. *Sarcocaulon Heritieri*, a fleshy plant of the Cape, is peculiar in having a cylindrical stem which, in its older stages of growth, becomes so highly charged with a hard wax that all traces of vegetable tissue are lost, and the stem breaks with a short brittle fracture. It burns freely, and is sometimes used as a torch or candle.

The acid character of the plants of this order is well developed in the Blimbing of India (*Averrhoa Bilimbi*), belonging to the tribe Oxalideæ. It is a small tree, much cultivated in India for the sake of the fruit, which is cylindrical in shape, about three inches long and one inch in diameter, somewhat resembling a gherkin. It is extremely acid in its fresh state, but is often preserved in syrup, or candied, or used as a pickle. The carambola is a closely allied fruit, native also of the East; it differs, however, in shape from the Blimbing as it is distinctly marked with prominent ribs or wings running parallel down the sides of the fruit. It is the produce of *Averrhoa Carambola*. From the wood sorrel (*Oxalis acetosella*) oxalic acid is prepared, while the tubers of several other species of *Oxalis* are edible; such, for instance, as *O. crenata*, a native of Peru, but much cultivated about Lima. The tubers are about the size and shape of large walnuts, but are not unlike small potatoes in general appearance. Their naturally acid flavour is dissipated by cooking when they are eaten by the people, and are occasionally seen in the markets of this country. At the time of the early potato murrains it was thought that the tubers of this oxalis might under cultivation become a regular substitute for the better known tuber, but this has never been realized. Other species, the tubers of which are eaten in Bolivia and Mexico, are *O. tuberosa* and *O. Deppei* respectively, both of which were recommended for cultivation with us along with *O. crenata*.

RUTACEÆ.—This large and very important order consists chiefly of trees and shrubs, widely scattered over the warmer temperate regions of the globe, being especially numerous in Australia, South Africa, and tropical America. The order is characterized by the presence of bitter, aromatic, or fragrant oils, found abundantly in glands covering the leaves or fruits, as in the rue and the orange tribe, and in wart-like protuberances in the species of *Zanthoxylum*. The order is of much value from an economic point of view in consequence of its including the several species of *Citrus*, furnishing the oranges, lemons, and citrons of commerce. These fruits are far and away the most important products of the order, notwithstanding there are many others of very varied interest and value.

The sweet orange, which is also known as the Chinese or Portugal orange, is the fruit of *Citrus Aurantium*, a small, much branched tree of about twenty feet in height, which is scarcely known at the present time in a wild state, but which seems to have been originally a native of Northern India or Southern China, and not introduced into Europe till the middle of the fifteenth century. At the present time the sweet orange is cultivated very extensively in many parts of the Mediterranean district, as well as in Spain, Portugal, Madeira, the Azores, and many other countries possessing a suitable climate. In the South of Europe the trees flower in April and May, and the fruits ripen about a year after. A very large number of varieties of the orange have been described, the most important being those affecting the size, form or quality of the fruit. The more important varieties are those known as the China orange, the St. Michaels, the Blood or Malta, in which the pulp and juice are of a blood-red colour, the Mandarin and Tangerine. Orange trees are remarkably prolific fruit bearers, and it has been stated on good authority that one tree has been known to yield twenty thousand fruits fit for exportation. Enormous quantities of fruits, which are ever increasing in bulk, find their way into the English market, and when it is borne in mind that each fruit has to be gathered separately, wrapped in paper and packed, together with the cost of the boxes, freight and labour throughout, and after all this the fruits can often be sold in the retail market at twenty for a shilling, it seems very remarkable that the crops are made to pay even for the ground upon which they are grown. The orange is one of the most wholesome fruits known, and a truly valuable refrigerant, and it is remarkable that very few people dislike the orange. Besides the use of the pulp as an edible, the rind of the fruit, known as sweet orange peel, is valued for its aromatic, stimulant, and slightly tonic properties. The essential oil contained in such large quantities in the glands of the rind is extracted in the South of France and at Messina both by the sponge and ecuelle processes, which will be more fully described when considering the lemon. Large quantities of oil of orange peel are used in Germany in the preparation of perfumes and liqueurs.

From the flowers a volatile oil is distilled, known as oil of neroli, which is one of the ingredients in Eau de Cologne, and is also used in perfumery and liqueurs. Besides this, the leaves and young shoots of the orange plant yield by distillation another kind of oil known as *Essence de petit grain*. The bitter or Seville orange, which is a variety of the last named, is rather a smaller tree, and does not seem to be cultivated in India except in gardens, but it is extensively grown in the same countries as the sweet orange. The chief distinction is that the rind of the fruit has a bitter aromatic taste. It is used in making candied orange peel. The flowers are also used in distilling for oil of neroli. This variety, which is now classified as *Citrus Aurantium*, var. *Bigaradia*, was at one time considered a distinct species under the name of *C. vulgaris*. The Bergamotte orange is another variety (*C. Aurantium*, var. *Bergamia*). Its chief distinctions from the sweet orange are its smaller flowers, which are known by their delicate and peculiar odour, and the paler colour of the fruit. The Bergamotte orange is grown chiefly near Reggio, in Southern Calabria, and more sparingly in Sicily, Southern France, and elsewhere. The volatile oil obtained from the rind of the fruit forms the Essence of Bergamot of the chemist, the principal use of which is in perfumery, while from the pulp is obtained, by expression, the acid juice which forms a portion of the commercial lime-juice.

Citrus medica is the tree that produces the citron fruits. The plant does not exceed ten or twelve feet in height, and, like the species before mentioned, is not known in a truly wild state. It is, however, to Northern India that it is supposed to belong, and to have spread westward at a very early period, being cultivated in Syria in the time of Josephus, and probably introduced into Italy in the third century, from whence it spread through the Mediterranean regions. Its cultivation at the present time is chiefly carried on in the neighbourhood of Florence, in Sicily, Corsica, and the Riviera, and to a smaller extent in the Azores, Madeira, India, and China. Citron fruits are mostly of very large size, sometimes weighing several pounds, and measuring eight or nine inches in length, and four or five in diameter. It has a thick rind and a very small proportion of pulp. The rind is much used for making candied citron peel for dessert or confectionery purposes. Like all the orange tribe the rind is filled with oil glands, which is extracted in the same way as is lemon oil or essence, next to be described. Citron essence or oil, usually known as essence of cedrat, is much valued in perfumery on account of its agreeable odour. *C. medica*, var. *Limonum*, is the lemon, which is a straggling bush or small tree, ten to twelve feet high. Under cultivation it is now found throughout the Mediterranean region, and in all tropical and sub-tropical countries. It seems to have made its first appearance in Europe about the latter part of the fifteenth century. Lemons come to this country from Southern Europe, principally from Sicily, but also from Spain, packed in boxes or chests, and, like oranges, wrapped separately in paper. Lemon peel is candied in the same way as citron when it is used in confectionery and for culinary purposes. The dried peel is used in medicine. In its fresh state lemon peel is studded with numerous receptacles filled with a very fragrant volatile oil, which, when expressed and purified, is known as oil or essence of lemon. For expression two processes are employed, one known as the ecuelle and the other as the sponge process. For the purpose of expressing, or distillation—for some oil of an inferior quality is obtained in this manner—only the small or irregular fruits are used, the best shaped being selected for exportation. The fruits are gathered before they are quite ripe, as the oil is of a better quality than when they are fully matured. The peel is first cut off by the workman in three longitudinal pieces, and the portion containing the pulp is placed on one side. On the following day the pieces of peel are operated upon in the following manner: the workman takes the ecnelle, which consists of a shallow basin-like funnel, the spout portion of which is closed at the bottom, the inside of the basin is studded with sharp points against which the rind is pressed by the workman, this ruptures the oil vessels, and the oil trickles into the closed spout, which, when full, is emptied into another vessel. The sponge process is practically the same, except that in place of an ecuelle a sponge is used, which becomes saturated with the oil and when full is squeezed out. Prepared by either process, oil of lemon is of a light yellow colour, and has a very fragrant odour. It is mostly exported in small cylindrical coppers. Lemon juice is the concentrated acid juice of the pulp, which, together with that of the bergamot and lime, are the bases from which citric acid is made.

The acid lime, from which the bulk of the lime juice is now obtained in the West Indies, is the fruit of *Citrus medica*, var. *acida*, while the sweet lime is from *C. medica*, var. *Limetta.*

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NOTES ON COMETS AND METEORS.

By W. F. Denning, f.r.a.s.

Perrine's Comet (1898. I.).—Elliptical elements have been computed for this object by Herr K. Pokrowskij from observations between March 21 and May 21, and he finds the period three hundred and twenty-two and a-half years. This comet is possibly still perceptible in powerful telescopes, and is moving very slowly westwards, in the western part of the Lynx, its place on October 11th being R.A. 6h. 24m. 59s., Dec. +50° 24·8′, and on October 19th, R.A. 6h. 16m. 53s., Dec. +50° 17·4′.

Wolf's Comet continues visible, though it is a decidedly faint object. It is situated in Monoceros, and at the beginning of October will be at a distance of about one hundred and forty-five millions of miles from the earth. Its position on October 1st will be R.A. 6h. 39m. 28s., Dec. +3° 33·2′.

Encke's Comet, and the comets of Perrine and Coddington discovered in June are too far south for observations in this country. Giacobini's comet is probably too faint to be seen in ordinary instruments.

The Perseids of 1898 certainly formed a stronger shower than usual, and appear to have been very generally observed. M. C. Flammarion reports that on August 10th from 10h. to 14h. 30m. they were watched from the observatory at Juvisy, and that five hundred meteors were registered and marked down on a map of the heavens. At the Paris observatory Mlle. Klumpe observed two hundred, and it was estimated that altogether six hundred shooting stars were seen here. In England the sky was not so clear on August 10th as on August 11th, but many meteors were seen on both nights. The very exceptional clearness of the atmosphere on the latter date enabled the best view to be obtained, and the progress of the shower was watched by Prof. Herschel at Slough, Mr. Corder, Bridgwater, Mr. Blakeley, Dewsbury, Rev. S. J. Johnson, Bridport, Rev. T. E. R. Phillips, Yeovil, Mr. Besley, Exeter, Mr. Townshend, Paignton, Mr. King, Leicester, the writer at Bristol, and many others.

The display was sufficiently marked to attract the notice of many people, who, though quite unaware that such an event was expected, had their attention accidentally called to it by the surprising frequency and occasional brilliancy of the meteors. Though the maximum of the shower must have probably occurred before the night of August 11th, a single observer watching the sky interruptedly might have counted about fifty meteors per hour, and of these about forty would have been Perseids. They were characterized by the usual swiftness of motion, and almost invariably left green streaks. In several cases the streak would brighten up in a very perceptible manner after the nucleus had vanished; some of the meteors were, in fact, only observed in the form of streaks, the nuclei having been so faint as to elude observation. The whole duration of the shower appears to have been from July 14th to August 17th, but it was very feebly manifested at the opening and closing stages. The centre from whence the meteors diverged was variously fixed by several observers as under:—

Date.		Radiant.		Meteors.	Observer.
July	20	21°	+51°	4	W. E. Besley.
,,	28	32	+55	5	,,
,,	29	31	+54	6	E. R. Blakeley.
August	10	45	+58	4	A. King.
,,	11	45	+58	25	E. R. Blakeley.
,,	11	45	+58	40	W. E. Besley.
,,	11	46·4	+57·6	81	W. F. D.
,,	11	46	+58	28	A. King.
,,	11	39 45 46	+60 +57¼ +53	—	T. E. R. Phillips.
,,	11	46	+56	20	H. J. Townshend.
,,	14	54	+59	4	A. King.

Fireballs.—In twilight, on August 11th, and before observers had commenced watching for the Perseids, a beautiful meteor, rivalling Venus at her best, and slowly pursuing a long horizontal path in the southern sky, was seen by many persons. Amongst these were, fortunately, several astronomical amateurs who recorded the apparent path very accurately. Descriptions were received from Bridgwater, Slough, Bristol, London, Henley-on-Thames, Stroud, Gloucester, Wimbledon, Clevedon, South Croydon, Bengeo, Herts, Birmingham, Eastbourne, the English Channel, and other places. The nucleus of the meteor was white, and as it slowly travelled from east to west it threw off a shower of yellowish sparks, and finally broke up into fragments. A mere remnant of the meteor pursued its course with an exceedingly slow motion about eight degrees further; it looked like a spark sailing along on the wind and vanished suddenly without any train. On examining the observations the meteor was found to be an Aquarid, with a radiant at 339° – 10°. When first seen its height was sixty-six miles over the mouth of the Seine, France, and at disappearance its height was forty-one miles over a point three miles south-west of Okehampton, Devon. The length of its observed flight was one hundred and ninety-six miles, and computed velocity twenty-two miles per second.

On August 21st, at 9h. 16m., during a thunderstorm and frequently vivid lightning in the West of England (when, however, a part of the sky remained clear), a very fine meteor was noticed at several places. An excellent view of it was obtained by Prof. Herschel at Slough, who says that at first the nucleus was yellowish and as bright as Jupiter, then it expanded pretty rapidly until it equalled Venus, and became of a splendid, light emerald green colour, finally increasing to 1½ × Venus after going a little further. The course may have begun one and a half degrees below η Aquarii, but it must have been thirty degrees long from 330° – 6½° to 303° – 20°. Duration of flight five seconds. When as bright as Venus the nucleus appeared to be globular, but afterwards assumed a crescent shape with a tail of yellow sparks about two or three degrees long, and some six or eight minutes wide. The same meteor was observed by Mr. A. R. Schutz at Worthing, sailing slowly from 345° + 10° to 318¾° + 5°, when it disappeared suddenly. He describes the colour as pale bluish-green—the tail was red. At Cirencester the meteor was observed by Miss E. Brown, who estimated the nucleus as more brilliant than Venus. The direction was from the square of Pegasus, north to south, below γ Aquarii. The colour was white changing to greenish-blue. The meteor was directed from a radiant point at 5° + 13°, close to γ Pegasi. It began over France, about fifteen miles south-east of Cressy, at a height of sixty miles, and its flight being directed westwards, it crossed over a portion of the English Channel, and disappeared over a point about thirty-six miles south of Brighton. Whole length of path ninety-five miles, and velocity about nineteen miles per second. The meteor belonged to a tolerably well-known minor shower, and it seems highly probable that the splendid fireballs observed in Austria on August 25th, 1884, and in Germany on August 26th, 1858, were members of the same stream, as their radiants, determined by Von Niessl, were in the same region.

During recent observations of the Perseids, a number of the same meteors were observed at two or more stations. The real paths of these have been computed, and the average heights, etc., of fifteen of these were as follow:—

Height at First Appearance.	Height at Disappearance.	Length of Path.
74½ miles.	54 miles.	47½ miles.

The late somewhat brilliant return of the Perseids and the success which attended the observations encourage the hope that the year 1898 will prove a memorable one as regards the exhibition of meteoric showers. In November next, on the morning of the 15th, and on about the 23rd, we have the prospect of witnessing two brilliant showers if the weather should prove favourable. In October many meteors are often seen from about the 18th to the 20th, from a radiant at 91° + 15°, but the display is usually at its best in the morning hours.

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THE FACE OF THE SKY FOR OCTOBER.

By A. Fowler, F.R.A.S.

The state of solar activity about the present time is very uncertain, but large spots can scarcely be expected, and one need not be surprised to find occasional spotless days. Nevertheless, the appearance of the great spot of last month warns us not to imagine that the actual sun-spot minimum is close at hand.

Mercury is a morning star during the early part of the month, reaching the point of superior conjunction on the **19th**.

Venus is an evening star, and will reach her greatest brilliancy on October **27th**. Throughout the month she sets about an hour after the Sun. On the **15th** only one-third of the disc will be illuminated, and as the apparent diameter will then be 34·0″, very small telescopes will suffice to show the crescent phase. The apparent diameter increases from 28·0″ to 43·8″ during the month.

Mars is gradually coming into a more favourable position for observation, but the approaching opposition is by no means a good one for telescopic work. His apparent movement during the next few months, however, will be well worth the attention of young observers, and as a companion to such observations we give a diagram illustrating his path. He will rise shortly after ten on the **1st**, and about half-past nine towards the end of the month. The planet will be in quadrature on the **17th**, and 0·88″ of the disc will then be illuminated, while the apparent diameter will be 8·0″. As will be seen from the diagram, his path is in Gemini during October.

Apparent Path of Mars, October 1st, 1898—June 1st, 1899.

Jupiter is in conjunction with the Sun on the **13th**, and will not be observable.

Saturn is still an evening star, but is getting too near the Sun to be well observed. At the beginning of the month he sets about two hours after the Sun, and at the end about one and a half hours after. The apparent minor axis of the ring is still greater than that of the planet, the respective values at the middle of the month being 16″ and 14·4″, while the major axis of the ring is 36″. He may be found about 6° north of Antares at the beginning of the month, and afterwards a little to the east of that point.

Uranus also remains an evening star, but is still nearer the Sun than Saturn, and may be considered as not observable.

Neptune, in Taurus, rises about 9 p.m. at the beginning, and about 7 p.m. at the end of the month, his apparent diameter being 2.6″. He is a little more than 1½° north-east of ζ Tauri.

The Moon enters her last quarter on the **7th** at 6.5 p.m.; is new on the **15th** thirty-seven minutes after noon; enters the first quarter on the **22nd** at 9.9 a.m.; and is full on the **29th** eighteen minutes after noon. On the **19th** she will occult the star B.A.C. 5878, Mag. 6½. The disappearance will take place at 4.50 p.m., 73° from the vertex, and the reappearance at 6.1 p.m., 239° from the vertex, the Moon's age being 4d. 4h., and the time of sunset 4.57 p.m. On the **22nd**, ρ Capricorni, Mag. 5, will be occulted; disappearance at 5.5 p.m., 28° from the vertex, and reappearance at 5.51 p.m., 303° from the vertex. The Moon's age will be 7 days, and the time of sunset 4.50 p.m.

Conveniently observable minima of Algol will occur on the **5th** at 9.58 p.m.; on the **25th** at 11.40 p.m.; and on the **28th** at 8.29 p.m.

Mira Ceti is near a maximum.

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 September Problems.

No. 1.

(By B. G. Laws.)

Key-move—1. Kt to K6.
If 1 . . . K to B4, 2. Kt to Kt5, etc.
1 . . . R × P, 2. Kt to B2ch, etc.
1 . . . K to B6, 2. Kt to Kt5ch, etc.
1 . . . K to Q6, 2. Kt mates.
1 . . . K to Q4, 2. Q mates.
1 . . . Kt to B5, 2. Q to Kt2ch, etc.
1 . . . R to Q6, 2. Q to B4ch, etc.
1 . . . P × P, 2. Kt to B5ch, etc.

No. 2.

(By A. C. Challenger.)

1. Q to B3, and mates next move.

Correct Solutions of both problems received from Alpha, J. T. Blakemore, H. S. Brandreth, H. Le Jeune.

Of No. 2 only, from G. G. Beazley, J. M'Robert, W. de P. Crousaz, W. Clugston.

Mr. J. Nield, the composer of the August problems, points out that No. 2 is rendered sound by the addition of a Black Pawn at K7.

W. Clugston.—Thanks for your problem, which is marked to appear next month.

Notice.—Will contributors kindly observe the permanent change of address notified at the head of this column.

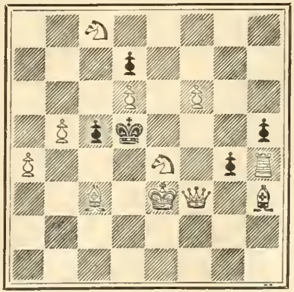
The following problems obtained first prizes in the recent *Brighton Society* tourney.

PROBLEMS.

No. 1.

By Rev. J. Jespersen (Denmark).

Black (5).



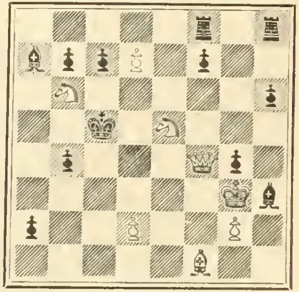
White (11).

White mates in two moves.

No. 2.

By Dr. C. Planck (Haywards Heath).

Black (12).



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"Falkbeer's Counter Gambit."

White. (R. Charousek)	Black. (J. Berger.)
1. P to K4	1. P to K4
2. P to KB4	2. P to Q4
3. KP × P	3. P to K5
4. P to Q3 (*a*)	4. Kt to KB3
5. Q to K2	5. Q × P
6. Kt to Q2	6. B to KB4
7. P × P	7. B × P
8. P to KKt4!	8. Q to K3 (*b*)
9. P to B5	9. Q to K2
10. Kt × B	10. Q × Kt
11. Q × Qch	11. Kt × Q
12. B to Kt2	12. Kt to Q3
13. B to B4	13. Kt to Q2
14. Castles	14. Castles
15. Kt to B3	15. P to KR4?
16. Kt to Kt5!	16. P to KB3 (*c*)
17. Kt to K6	17. R to Ksq
18. P to KR3	18. Kt to K4
19. B × Kt	19. P × B
20. KR to Ksq	20. P × P
21. P × P	21. R to R5
22. B to B3	22. P to KKt3 (*d*)
23. Kt × B	23. R × Kt
24. P × P (*e*)	24. R × B
25. P to B4 (*f*)	25. P to Kt3 (*g*)
26. P to B5	26. P × P
27. P to Kt5	27. R to Bsq
28. R × P	28. R to Ktsq
29. R × P	29. R × P
30. R to Q3	30. R to B5ch
31. R × R	31. Kt × R
32. R to Q5	32. Kt to Q3
33. Resigns.	

(*a*) This and the next move constitute the most fashionable modern defence. 5. Kt to QB3, on the next move, would allow Black to pin the Knight, with opportunities sometimes for P to K6 later on, if the White Bishop goes to Q2.

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(*g*) 25. . . R × P should be fairly safe here; if then, 26. P to B5, R checks; 27. K to Ktsq, R × P; 28. R to Ktsq, R to Bsq. The remainder is plain sailing.

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"AN equal appreciation of all parts of knowledge," says Humboldt, "is an especial requirement of the present epoch, in which the material wealth and the increasing prosperity of nations are, in a great measure, based on a more enlightened employment of natural products and forces." This truth, uttered half a century ago, is still applicable to our own times, in face of the many innovations which scientific men have introduced into everyday life. Obviously, if large areas of land in England were devoted to sugar-beet, in the localities most suitable, as to climate and other circumstances, for its growth, and factories were established for the manufacture of sugar from it, there would be greatly increased employment for the population. With regard to the suitability of the climate of the British Isles for the growth of beetroot in sufficient quantity, and, at the same time, of adequate richness in sugar, Mr. Sigmund Stein says: "The sugar contained in the home-grown beetroot is not only equal to, but even surpasses that contained in the beetroot grown on the continent of Europe." Referring to the beet-sugar industry of France, the United States Consul at Havre said, in a report last year, that "the crop pays the farmer better than wheat or any other agricultural product." England is often accused of being the only European State which is blind to its own interests, and certainly the sanguine supporters of the scheme for initiating a British sugar-beet industry are fortified with statistics and other evidence which, on the surface at any rate, seem to indicate that we are, in this respect, under the curse which ever clings to those who stand still. While other nations are thriving on a comparatively meagre production of beetroot, England is starving, so to speak, in the lap of luxury. Some idea of this state of things may be gleaned by an inspection of the following tables of results from the official statistics relating to Germany and France :—

GERMANY.

Years.	Number of Sugar Factories.	Area under Sugar-beet.	Produce of Roots per Acre.	Roots submitted to Manufacture.	Raw Sugar produced.	Raw Sugar per Cent. on the Roots.
		Acres.	Tons.	Tons.	Tons.	
1890-1	401	824,825	13·0	10,623,319	1,336,221	12·09
1891-2	406	861,583	11·4	9,488,002	1,198,025	12·06
1892-3	403	869,829	11·3	9,811,939	1,230,834	11·94
1893-4	401	954,995	11·1	10,644,351	1,366,001	12·34
1894-5	405	1,090,801	13·3	14,521,029	1,827,973	12·15
1895-6	397	930,749	12·5	11,672,816	1,637,057	13·11
1896-7	399	1,049,881	13·0	13,721,601	1,821,223	12·66
Mean	—	—	(12·1)	—	—	12·06

FRANCE.

1890-1	377	547,808	11·8	6,499,906	683,602	10·52
1891-2	368	551,955	10·2	5,628,804	642,023	11·41
1892-3	368	528,156	10·3	5,472,891	581,517	10·63
1893-4	370	543,645	9·6	5,250,192	571,987	10·89
1894-5	367	596,806	12·0	7,137,736	782,726	10·97
1895-6	356	505,858	10·7	5,411,484	659,607	12·19
1896-7	358	608,370	11·1	6,705,000	742,829	11·08
Mean	—	—	11·2	—	—	10·46

It will be noted that in Germany over a million acres were in cultivation in 1894-5, yielding an average of 13·3 tons of beetroot per acre, the mean produce for the seven years given being about twelve tons per acre, while the raw sugar obtained therefrom amounted to twelve per cent. The results relating to France indicate a poorer yield of roots, and a lower percentage of sugar, and while the factories in Germany remain practically constant there is a gradual reduction in their number in France. Now let us glance at the results of sugar-beet grown at Rothamsted, as set forth in the accompanying table, showing the quantity of the produce of sugar-beet per acre, with different descriptions and varying amounts of manure :—

			Standard Manures and Cross-dressings each Year as under.							
Standard Manures.	Series 1. Standard manures only.		Series 2. 550 lb. nitrate of soda = 86 lb. nitrogen.		Series 3. 400 lb. salts of ammonia = 86 lb. nitrogen.		Series 4. 400 lb. salts of ammonia & 2000 lb. rape-cake = 184 lb. nitrogen.		Series 5. 2000 lb. rape-cake = 98 lb. nitrogen.	
	tons	cwt.	tons	cwt.	tons	cwt.	tons	cwt.	tons	cwt.
14 tons farmyard manure	16	6	23	16	22	6	25	2	24	18
Superphosphate ..	5	18	19	11	13	9	17	15	16	5
Superphosphate and potash	5	18	18	17	14	19	22	3	17	17

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No. 2.

By Dr. C. Planck (Haywards Heath).

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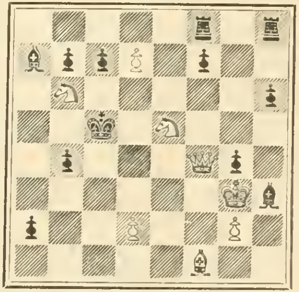

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1894-5	405	1,080,801	13·3	14,521,029	1,827[illegible]
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14 tons farmyard manure	16	6	23	16	22	6	25	2	24	18
Superphosphate	5	18	19	11	13	9	17	15	16	5
Superphosphate and potash	5	18	18	17	14	19	22	3	17	17

Proceeding from left to right it should be observed that, as indicated in the first column, farmyard manure alone gave an average of sixteen tons six hundredweight of roots; and the amount was raised to twenty-three tons sixteen hundredweight by the addition of five hundred and fifty pounds of nitrate of soda; to twenty-two tons six hundredweight by four hundred pounds of salts of ammonia; to twenty-four tons eighteen hundredweight by two thousand pounds of rape cake; and to twenty-five tons two hundredweight by rape cake and salts of ammonia together. Thus it is clear that by artificial means, as regards quantity, acre for acre, our own farmers could produce double the amount that either France or Germany have done in the past. When we point out that the crops at Rothamsted were not grown with the purpose of using them in sugar-making, the remarkable results given will appear still more worthy of attention to those who hope to make the sugar industry in England a means of resuscitating agricultural prosperity. For direct application to practice in the growth of the crop for sugar-making the amount of nitrogenous manures used were too large, and the distances apart from plant to plant were too great—conditions leading to over-luxuriance, and to imperfect maturing of the individual plants. In the face of all this it seems strange that the immense quantity of sugar consumed in the British Isles should reach us from abroad. Here are some figures relating to sugar-producing colonies:—

——	1891.	1892.	1893.	1894.
	cwts.	cwts.	cwts.	cwts.
Barbados...	994,960	1,186,960	1,336,160	1,304,640
British Guiana ...	2,339,360	2,257,600	2,155,420	2,050,040
British Honduras	3,696	1,759	1,810	83 lbs.
Fiji	409,412	377,656	307,789	545,307
Jamaica ...	304,918	452,889	396,270	453,886
Leeward Islands—				
Antigua	241,820	306,040	291,240	304,840
Dominica	32,720	44,300	29,480	24,400
Montserrat	20,620	50,000	23,210	33,880
St. Kitts—Nevis	257.810	357,380	340,840	337,920
Virgin Islands	*nil*	160	80	60
Mauritius	2,442,734	1,831,176	1,693,020	2,723,057
Natal	52,272	210,769	240,713	265,680
Queensland	647,620	840,380	1,102,520	1,349,020
Trinidad	907,160	987,340	903,040	937,380
Windward Islands—				
Grenada	1,440	170	1,170	2,031
St. Lucia	70,762	114,928	88,746	89,698
St. Vincent	80,280	62,700	58,460	48,940

The value of sugar-beet roots depends not alone on the percentage of sugar they contain, but also on what is called the "co-efficient of purity" of the juice. If the percentage of dry matter in the juice were found to be sixteen, and that of the sugar twelve, as indicated by the polariscope, then the sugar would represent three-quarters, or seventy-five per cent., of the dry substance. In the following table is given Dr. Carl Stammer's data, in English terms, as to the value per ton of roots of the different percentages of sugar as shown at the head of the columns, each at the six different degrees of purity of juice.

Quotient of Purity.	Sugar in the Roots.						
	10·0 per cent.	11·0 per cent.	12·0 per cent.	13·0 per cent.	14·0 per cent.	15·0 per cent.	16·0 per cent.
	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.
70	11 11	13 0	14 2	15 5	16 7	17 9	19 0
75	12 8	13 10	15 3	16 5	17 9	19 0	20 4
80	13 6	15 0	16 3	17 7	19 0	20 4	21 8
85	14 6	15 9	17 3	18 6	20 2	21 6	23 1
90	15 3	16 9	18 3	19 10	21 4	22 11	24 5
95	16 1	17 7	19 4	20 10	22 7	24 1	25 8

And so the lesson to be learnt from this table is, How great may be the difference in the value of the roots according to their composition!

Here is a table by M. Georges, showing the value per ton of roots for each percentage of sugar in the roots from thirteen down to seven:—

Sugar in the Roots.	Yield of Sugar in the Roots.	Proportion of the Total Sugar yielded	Price per Ton of Roots.
per cent.	per cent.	per cent.	s. d.
13	8·53	65·6	19 3
12	7·82	65·1	17 7
11	6·99	63·5	15 9
10	6·22	62 2	14 1
9	5·38	59·7	12 2
8	4·61	57·6	10 5
7	3·88	55·5	8 9

A noticeable point in this table is the small proportion of the total sugar in the roots that is obtained in the manufacture; the amount being only 65·6 per cent., with thirteen per cent. of sugar in the roots, and as little as 55·5 per cent., with only seven per cent. in the roots.

One of the vital questions to consider in forming a judgment as to whether success would attend an extended growth of sugar-beet, and the establishment of factories for the manufacture of sugar in this country is, at what price of sugar is it probable that such an enterprise would be profitable? Mr. Stein estimates that four hundred factories, each costing about fifty thousand pounds, would supply all the sugar required for consumption in the British Isles. Going into more detail he says: "A sugar factory working forty thousand tons of roots, the crop of, say, three thousand acres, would produce about five thousand (five thousand two hundred) tons of sugar, and would cost to erect about sixty thousand pounds." Giving a summary balance sheet, he reckons there would be a profit of over six per cent. on the sixty thousand pounds capital, if the price of sugar were nine pounds per ton, of fourteen and three-quarters per cent. if ten pounds, of 23·4 per cent. if eleven pounds, and of thirty-two per cent. if twelve pounds per ton. The same authority reckons the cost per acre of growing sugar-beet at ten pounds, in return for which he will be able to turn out fifteen tons of roots at eighteen shillings per ton delivered to the factory, the roots themselves being estimated to produce 13·3 per cent. of sugar at a cost price of nine pounds per ton.

In any undertaking of this kind, a serious warning is afforded by the fate of Mr. James Duncan, who attempted this branch of industry between the years 1869 and 1873, at Lavenham, in Suffolk. It is said that with a requirement of at least thirty thousand tons of roots to work his factory profitably, Mr. Duncan finally could only obtain about seven thousand tons, due probably to the farmers not sufficiently modifying their rotations to secure an adequate supply of roots. Sir John Lawes and Sir Henry Gilbert[*] point out that it would require about six thousand acres, or more, according to the rotation adopted, to ensure the necessary supply to the factory in Mr. Stein's scheme, and "certainly not a step should be taken towards the establishment of a factory until the necessary supply of roots had been assured." Also for climatic and other reasons these observers think that, so far as the production of the roots is concerned, it could only be a success over limited areas, not Great Britain generally. Great caution should be exercised in the choice of the localities, Norfolk and Suffolk, it is alleged, having the most suitable climate, and the soils should be of a medium character—neither too heavy nor too light.

---

[*] A Pamphlet—"The Growth of Sugar Beet and the Manufacture of Sugar in the United Kingdom."

THE KARKINOKOSM, OR WORLD OF CRUSTACEA.—VI.

By the Rev. Thomas R. R. Stebbing, M.A., F.R.S., F.L.S.

In the preceding chapter the Copépoda were spoken of as a resourceful group. No stories of preternatural ingenuity on the part of individuals can be told in support of this character. Seeing that they must be welcome and easily obtainable food to almost every kind of aquatic animal, and that they are massacred wholesale to fill the maw alike of sardine and cetacean, no humane person could wish them to be very highly endowed with sense and sensibility. But their individual helplessness is pretty solidly compensated by qualities which safeguard the existence of the community. They share with many other animals, higher and lower, larger and smaller than themselves, a surprising fecundity. But they are not content with this sort of mildly domestic defence against extinction. They turn upon their devourers. They take up their lodgings in the enemy's camp. They infest his skin. They invade his eyes and his very mouth. They enter joyfully into the spirit of Samson's riddle, "out of the eater came forth meat, and out of the strong came forth sweetness." They avenge the wrongs of their ancestors and their cousins by sucking the blood of almost every fish that swims.

In correspondence with the extraordinary variety of their dwelling-places, the parasitic and semi-parasitic Copépoda present a marvellously varied array of forms, ranging from those which nearly or altogether resemble the independent species, through countless gradations, to the eccentric, the abnormal, the shapeless, the unrecognizable. The recognition of the unrecognizable may sound mysterious. The key to the mystery is this, that of father, mother, and children, it is usually only the mother that is absolutely self-sacrificing in her indifference to any thought of personal vanity when the welfare of the race is concerned. In return for this it is the mother that chiefly attracts the attention of science by quaint peculiarities of form. The mother, too, is distinguished by her respectable proportions, being in some instances no less than thirteen times as long as her diminutive husband.

Sphyrion lævigatum (Quoy and Gaimard). M.A.S.

According to the Danish writers, Steenstrup and Lütken, the mode in which the eggs are carried furnishes a useful classificatory character. There is one series of genera in which the two egg-sacks are filiform, thread-like, and the eggs in each are flattened and packed one over the other like a long roll of minute coins. In the other series the egg-sacks are much more sack-like, the eggs are more or less globular, and, though the packing is always as neat as possible, it is not limited to a single line.

Among the free-living Copépoda, the Gymnoplea (noticed in the preceding chapter) as a rule do without an egg-sack or are content with only one, while the Podoplea, to which the parasitic forms may be affiliated, generally have a pair of these so-called sacks. The semi-parasites of the family Notodelphyidæ present a curious exception. There is here no external ovisac, the ova being matured in a pouch formed by the integument of the enlarged fourth segment of the thorax.* Sometimes, it should be added, the fifth segment of the trunk is utilized for this purpose. These animals, which, as the family name implies, have the matrix on the back, are found unattached and moving freely about in the branchial vesicles or body cavities of Ascidians. For this reason one of the genera has been named *Ascidicola*. The Ascidians are an accommodating set of creatures. They take in lodgers of many kinds, and especially they are an important hunting ground for those in search of Copépoda. Even species capable of living in freedom, and carrying free ovisacs, are not unfrequently found in Ascidians. They also shelter the Enteropsidæ, which are not free living, but yet have free ovisacs. Dr. C. Aurivillius, who established the family, found that in every case the full-grown mother of his *Enteropsis sphinx* was, along with its egg-bags, encapsuled, as it were, in folds of the branchial sack of the Ascidian. Thus the eggs are protected by the host itself, just as well as they are in *Notodelphys* by transfer to the mother's back. As Aurivillius points out, this is but one more instance of Nature's inventive genius applying to a single purpose manifold means. *Enterócola erúca*, Norman, actually condescends to live in an Ascidian's intestine, which seems to be carrying condescension rather far, and to be beneath the dignity of a crustacean. But odd things happen in the competition for a livelihood. Other species live in Mollusca. One, which abides in the common cockle, is specifically known as "agile," though

Notodelphys agilis, Thorell. From Brady.

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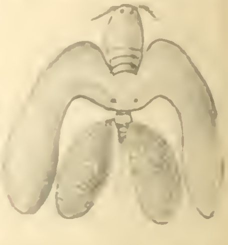
* G. S. Brady, "British Copépoda," Vol. I., p. 123.

the sphere of its activity is so limited.* Another,† which is at home with the horse mussel, is said to have both body and ovisacs coloured of a brilliant red, thus pleasingly harmonizing with the orange-coloured body of its red-footed host, like a polite lady choosing her costume to match the furniture of a friend. A species described by Messrs. T. and A. Scott as residing in a nudibranch mollusc is branded by them with the specific name of *insolens.*‡ It certainly takes liberties with its host far beyond those which the commensal and semi-parasitic forms allow themselves. In this case the authors tell us that they found the parasite "entirely buried in the body of the mollusc, with the exception of the last abdominal segment and the ovisacs." Even when it was dug out, no antennæ or mouth-organs could be discerned. The clasping organs of the embedded trunk are shown by the figure to be of a quite unexceptionable tenacity, as little likely to let go when once fixed as the teeth of any bulldog. Echinoderms, annelids, sea-feathers and various other zoophytes, give lodgings to the Copépoda. The latter also readily take up with other crustaceans, not on any terms of friendship, but merely to suit their own convenience. One species lives with a hermit crab, and is difficult to capture from the wiliness with which it conceals itself within or underneath the shell occupied by the hermit.


Lomanoticola insolens. From A. Scott.

One of the most frequently described species is the little *Nicothoë astaci*, Milne-Edwards and Audouin, so commonly found on the gills of the common lobster. This, when magnified, is seen to have the ordinary *Cyclops*-like form, only disguised at first glance by the enormous pair of lateral expansions at the fourth segment of the trunk. Its residence makes it more accessible to an inland observer than most of the marvels in this branch of study. Its size alone should endear it to the possessor of a good microscope. Within a total length of two or three millimètres he will find a series of appendages almost in all respects comparable with those of the large fish-parasites presently to be described. But while all this regular apparatus needs skill and care and a good instrument for making out its details, the most remarkable features of the animal are tolerably plain even to unaided vision. Attached to the front segment of the tail-part are two relatively enormous bags of eggs. It is with these that the monstrous lateral expansions of the trunk are deeply and doubly concerned. Not only do they form a protecting arch over the ovisacs, but it is from them that the rosy eggs as well as the bags that contain them are derived. Inside each of the great cylindrical outgrowths can be seen a faintly rose-coloured structure which is the ovary, and below this a whitish gland, the source of the cement which forms the ovisacs. The great carcinologists, Henri Milne Edwards, Henrik Kröyer, and Heinrich Rathke, have all studied with admiring care this minute but remarkable organism.

Far more difficult to find and difficult to examine are the Choniostomatidæ, which like Nicothoë are parasitic on Malacostracan crustacea. Their name signifies that they have a funnel shaped mouth. Eyes they need not. With antennæ they are provided, though the second pair is sometimes missing. They have mandibles, two pairs of maxillæ, and one of maxillipeds. In the matter of trunk-legs Nature has here been thrifty, giving them in some instances none at all, in others two pairs with occasional indication of a third. The body shows no segmentation. Trunk and tail-part are compounded into a sort of globular mass, from which even the head is not always very precisely distinguished. There are females in this family capable of laying as many as twenty-eight packets of eggs, and of becoming a thousand times as big as their amiable spouses. The female herself, in giant species, is never known to be fully a quarter of an inch long, and in species that are not gigantic, can dwindle to about a twentieth part of an inch. When such creatures have to be looked for in the branchial cavities of small Cumacea, or among the eggs of Amphipoda, the patience and discernment of the naturalist are put to a high test, and the chief encouragement to a beginner for tackling the Choniostomatidæ lies in the luminous English work on the subject by the Danish writer, H. J. Hansen. Some idea of the general form and the comparative sizes of male and female may be gathered from the subjoined illustrations, though they do not pretend to reproduce the delicate finish of the originals.


Nicothoë astaci, Milne-Edwards and Audouin.

Sp[illegible] H[illegible]. A, [illegible] [illegible] H[illegible]. From H[illegible].

Lest the reader should feel his imagination cramped by too long dealing with objects inordinately small, he may now be invited to explore a larger field, and, for that purpose, to provide himself with a few freshly-caught sturgeon, thunnies, sharks, sword-fishes, conger eels, sun-fishes, and fishing frogs. Of the so-called fish-lice the

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Diocus gobinus (Fabricius). From Steenstrup and Lutken.

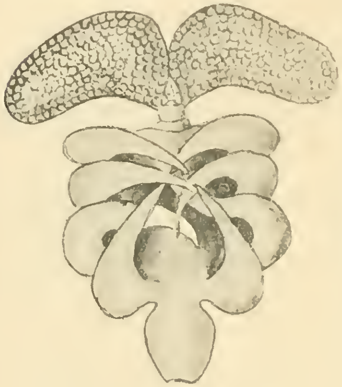
SELF-IRRIGATION IN PLANTS.—III.

By the Rev. Alex. S. Wilson, m.a., b.sc.

Rain in its passage through the air dissolves small quantities of ammonia, nitric acid, and other substances, and this is no doubt an additional gain to plants which collect and accumulate rainwater in proximity to their roots and other parts where absorption occurs. The water that gathers in leafcups especially is likely to contain materials useful to plants, since it is often quite brown with the remains of insects that have fallen in and been drowned.

To creeping ants and beetles water presents an impassable barrier. For this reason, when a gardener wishes to protect a plant from their attacks he puts it on the top of an inverted flower-pot and places this in the middle of a flat dish containing water, where it stands, as it were, on an island inaccessible to the ants, many of which perish in their ineffectual attempts to reach it. Similarly, the water in the leaf-cups of the teasle surrounds and isolates the stem; the leaves and flowers are protected as by a moat from the attacks of creeping insects.

Although such protection is perhaps their original use, leaf-cups in many instances appear to have assumed an additional function. Mr. F. Darwin has observed that certain hairs in the leaf-cups of the teasle emit protoplasmic threads into the water; this also occurs in the case of Silphium. As filaments exactly similar are emitted from certain cells in the little traps of the toothwort, now regarded as a carnivorous plant, there can be little doubt that leaf-cups serve to some extent like the pitchers of Nepenthes and Sarracenia for capturing insects, and that they consequently furnish the plant with an important source of nitrogen. This view is confirmed by the frequent presence of putrefactive bacteria in the water of leaf-cups. It has been found that when a drop of water containing carbonate of ammonia in solution is placed on a leaf, after a time both water and salt disappear. Leaves as well as roots therefore take up ammonia, and this explains why the sphere of its activity is so limited.* Another,† which is at home with the horse mussel, is said to have both body and ovisacs coloured of a brilliant red, thus pleasingly harmonizing with the orange-coloured body of its red-footed host, like a polite lady choosing her costume to match the furniture of a friend. A species described by Messrs. T. and A. Scott as residing in a nudibranch mollusc is branded by them with the specific name of *insolens*.‡ It certainly takes liberties with its host far beyond those which the commensal and semi-parasitic forms allow themselves. In this case the authors tell us that they found the parasite "entirely buried in the body of the mollusc, with the exception of the last abdominal segment and the ovisacs." Even when it was dug out, no antennæ or mouth-organs could be discerned. The clasping organs of the embedded trunk are shown by the figure to be of a quite unexceptionable tenacity, as little likely to let go when once fixed as the teeth of any bulldog. Echinoderms, annelids, sea-feathers and various other zoophytes, give lodgings to the Copépoda. The latter also readily take up with other crustaceans, not on any terms of friendship, but merely to suit their own convenience. One species lives with a hermit crab, and is difficult to capture from the wiliness with which it conceals itself within or underneath the shell occupied by the hermit.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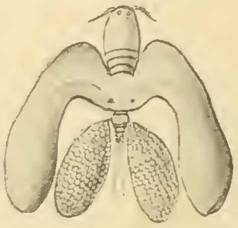
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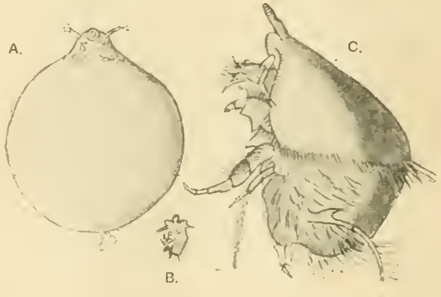

Sphæronella elegantula, Hansen. A. Female, × 27; B, Male, × 27; C, Another male, × 143. From Hansen.

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The water-vessels of the Bromelias and allied epiphytes, which often contain half a pint or more of water, are particularly interesting. The hollow leaf-base in some of this group of plants is a veritable aquarium. The water which accumulates in these curious receptacles Fritz Müller found to be inhabited by caddis-flies, entomostracans, and aquatic beetles belonging to species not occurring elsewhere. A small frog even takes up its abode among the bromelian leaves. Species of Utricularia also occur—small aquatic plants which capture in their curious little bladders the tiny crustaceans inhabiting the water in the bromelia leaves where they grow! *U. nelumbifolia* in this way grows in the leaves of Tillandsias, which are themselves epiphytes on the branches of other plants.

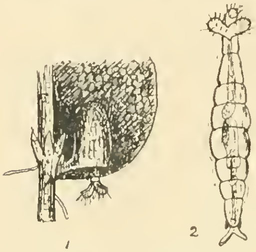

Fig. 1.—Rotifer inhabiting the hood of a Scale-Moss. (After Kerner.)

The term symbiosis is applied to those curious relationships in which we find two organisms of different kinds living together in partnership for mutual benefit and protection. A remarkable example of such symbiotic association is afforded by certain rotifers which take up their abode in the pitcher-like leaflets of some Jungermannias. One of these liverworts (*Frullania dilatata*) growing on the bark of species of Acer has hollow appendages of this description in which the water is retained by capillary attraction. In each of these pitchers a rotifer (*Callidina symbiotica*) takes up its quarters, finding in this retreat food and shelter. The association in all probability is one of mutual advantage; the rotifer is supposed to make a return to the plant for its entertainment in the shape of excrementitious products.

The case of these liverworts and rotifers is particularly interesting in connection with some recent observations made by the writer. In making sections of the chickweed stem to examine the origin of the lateral rootlets referred to in the preceding article, it was noticed that there frequently appeared on the slide specimens of the slipper-animalcule, Paramœcium, for whose presence it was difficult to account. So frequently did this infusorian put in an appearance that at last the idea suggested itself of its being a regular inhabitant of the water that gathers in the leaf axils of the chickweed. The examination of a number of specimens left little doubt as to the fact of this organism as well as several others frequenting the leaf axils of the plant in question. On submitting water from the leaves of a number of other plants it became apparent that leaf axils are rather favourite resorts for the minuter forms of life. Rotifers or wheel-animalcules, infusorians, monads, desmids, diatoms, micrococci and bacteria are of common occurrence. Paramœcium appeared to be rather characteristic of the chickweed, but was also present in the leaves of the sow thistle. In the leaves of the latter we also found that beautiful, lily-like infusorian the bell-animalcule, Vorticella cyathnia. Rotifer vulgaris occurs more or less frequently in the axils of the self-heal and ox-eye daisy. In none of the leaves examined could entomostracans be detected, although Cypris and other copeopods abounded in pools close to where the plants grew. The absence of the latter may be due to their size, entomostracans being very much larger than rotifers.

Although most of these organisms are to be found in all sorts of places where rain-water collects, their abundance in the tiny droplets that lurk in the leaf-axils of the plants just mentioned affords an interesting illustration of how Nature crowds her canvas, striving to utilize every nook and cranny that offers to living things the least coign of vantage.

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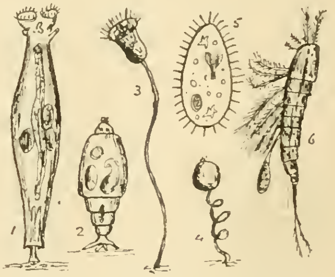

Fig. 2.—Animals inhabiting the axils of leaves. 1 and 2, Rotifer vulgaris; 3 and 4, Vorticella; 5, Paramœcium; 6, Entomostracan.

The prevalence of micro-organisms in leaf-axils suggests a probable origin of the carnivorous character; and though it may be difficult or impossible to establish a truly symbiotic relationship between any of them and the plants on which they live, these observations, nevertheless, touch the threshold of a large, inviting subject, practically unexplored.

PROGRESS IN RADIOGRAPHY.

By James Quick.

When, at the end of 1895, Röntgen reported the results of his experiments upon the photographic action of those invisible rays he was then working with, he could hardly, perhaps, have anticipated the widespread interest that was evinced upon the subject, or the extensive work that has been done and is now being carried on, throughout the world.

Probably few discoveries have been of so much service to scientific workers in general, or have claimed such universal attention, as that of the properties of the Röntgen rays.

The selective transmission of the rays being their prominent feature, the most powerful aid was, of course, given to the medical practitioner—especially to the surgeon—in localizing accurately, and without the slightest pain or inconvenience to the patient, any foreign body in the system, especially if that body be of a dense nature, such as lead or steel.

Radiography has, therefore, become quite a recognized addition to hospital work and to surgeons, and in some cases where the hospital has not been so equipped, systematic work of diagnosis has been undertaken for its physicians by the college or other scientific institution in the same town. Two sets of Röntgen ray apparatus were also provided for the Sudan expeditionary force.

The benefit derived by Röntgen's discovery, both to the doctor and to the patient, cannot be over-estimated. Many a patient, having had a foreign body somewhere in his system, or sustained a bone fracture, has afterwards left the hospital showering blessings upon the surgeon for having utilized the radioscopical or radiographical method for extraction or coaptation.

Every part of the human skeleton has now been successfully dealt with radiographically, the amount of definition obtainable depending upon the proximity of the part in question to the skin, and therefore to the plate. As the thickness of the tissues through which the rays have to pass increases, so their transparency diminishes, but, according to Batelli, not at an equal or uniform rate, while Vandevyver has shown that the necessary exposure varies as the cube of the thickness of the object, and also depends on the distance (and not on the square of the distance) between the focus tube and the sensitive plate.

Not only have X-ray pictures of the various portions of the body been taken at successive exposures and fitted together, but Dr. W. J. Morton has succeeded in obtaining, at one exposure, a life-size radiograph of the entire skeleton of a full-grown living woman—a most remarkable achievement and a striking picture—even the heart and other soft tissue organs being visible. The apparatus employed was a twelve-inch coil, worked from a one hundred and seventeen volt circuit. The distance of the focus tube from the plate was four feet six inches, and the time of exposure, including stoppages, thirty minutes.

In reviewing the work done by medical practitioners in this important and fruitful field for X-ray work, the number of successful cases would make by far too long a list to be adequately dealt with now. It is in the treatment of fractures and luxations, and in the detection and removal of the various calculi and other foreign growths and deposits that the most useful work has been done. Under the best adapted working conditions of apparatus for any particular case, the surgeon can examine with ease the exact condition of a fracture, or can ascertain how far reduction and fixation have been satisfactorily performed—even without disturbing any necessary splints or bandages. No difficulty is experienced with the former if they are made of wood or aluminium, or with the latter provided they are not soaked with lead lotion, or dusted with iodoform, both of which are impervious to the rays.

Until some twelve months ago, the accurate localization of different foreign bodies in the system was a difficult matter. This question, however, has been taken up—particularly by Mr. Payne and Dr. Mackenzie Davidson—and methods have been devised whereby the examination of any case by the surgeon has been much simplified. That of Dr. Davidson deserves attention as it is so simple and ingenious. With the necessary apparatus the exact position, to one hundredth of an inch, of an object can at once be found, the complicated geometry required by some other methods being simplified down by the apparatus itself and reduced to the application of callipers and a divided scale. Two exposures are made with the focus tube shifted through a certain distance, and the mechanical factors are reconstructed by the employment of fine threads, the position of which corresponds to the path of the X-rays. Fortified with this beautiful method the surgeon can now deal with many cases in much shorter time than was hitherto possible, and interesting reports have come to hand of the localization of bullets in the brain and eye, besides many other results.

With regard to the various calcareous deposits in the system, localizing the vesical calculi has been from the first a comparatively easy matter. Owing, however, to the position of the kidneys—close to the vertebral column—the depth of the cavity, and the thickness of overlying tissue, it was thought, at the earlier stages of the work, impracticable to obtain a radiograph of renal calculi, although, in the *Lancet* for 11th July, 1896, a case is reported by Dr. J. Macintyre of his having found, radiographically, a deposit in the position of the kidneys which, upon operation, proved to be a calcareous mass. A more interesting case, however, of renal calculi is reported by Dr. C. L. Leonard, the age of the patient being nineteen years. The radiograph was made with a twenty minutes' exposure, with the anti-cathode of the vacuum tube placed at a distance of twenty inches from the plate. An eight-inch spark coil was used. The successful operation performed proved the correctness and value of the diagnosis.

Amongst the many advances that have been made in radiographing the soft tissues, MM. Remy and Contremoulin report having devised a process, based on the deposition of chromate of silver within the tissues of anatomical preparations, which gives striking results in respect of mapping out the structure of the soft parts, while at the same time the bones are more distinctly marked out than they previously have been, so that sesamoid bones hitherto unknown have been discovered.

The action of Röntgen rays, however, is not only manifested in such cases as instanced above. Experiments show that they exert an influence upon the epidermis of the skin if exposed to them, sometimes causing local inflammation, and this action may occur even deep-seated within the tissues. The heart also, in some cases, appears to be affected when exposed to the action of the rays, insupportable palpitations and violent and irregular heart beats being produced, necessitating the complete sheltering of the heart by a thick metal shield.

In chemistry, botany, mineralogy, and other departments their properties have been discovered and applied. Their application to the detection of false gems is now well known, and a good deal about other allied results are obtained which open up interesting fields for investigation.

plants which have no true power of digestion are yet benefitted by capturing insects; from the decomposing bodies of their victims products are evolved which the plants are able to assimilate.

The water-vessels of the Bromelias and allied epiphytes, which often contain half a pint or more of water, are particularly interesting. The hollow leaf-base in some of this group of plants is a veritable aquarium. The water which accumulates in these curious receptacles Fritz Müller found to be inhabited by caddis-flies, entomostracans, and aquatic beetles belonging to species not occurring elsewhere. A small frog even takes up its abode among the bromelian leaves. Species of Utricularia also occur—small aquatic plants which capture in their curious little bladders the tiny crustaceans inhabiting the water in the bromelia leaves where they grow! *U. nelumbifolia* in this way grows in the leaves of Tillandsias, which are themselves epiphytes on the branches of other plants.

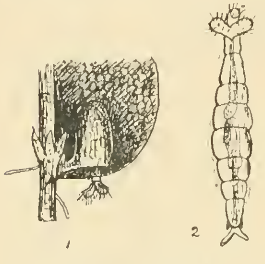

Fig. 1.—Rotifer inhabiting the hood of a Scale-Moss. (After Kerner.)

The term symbiosis is applied to those curious relationships in which we find two organisms of different kinds living together in partnership for mutual benefit and protection. A remarkable example of such symbiotic association is afforded by certain rotifers which take up their abode in the pitcher-like leaflets of some Jungermannias. One of these liverworts (*Frullania dilatata*) growing on the bark of species of Acer has hollow appendages of this description in which the water is retained by capillary attraction. In each of these pitchers a rotifer (*Callidina symbiotica*) takes up its quarters, finding in this retreat food and shelter. The association in all probability is one of mutual advantage; the rotifer is supposed to make a return to the plant for its entertainment in the shape of excrementitious products.

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Although most of these organisms are to be found in all sorts of places where rain-water collects, their abundance in the tiny droplets that lurk in the leaf-axils of the plants just mentioned affords an interesting illustration of how Nature crowds her canvas, striving to utilize every nook and cranny that offers to living things the least coign of vantage.

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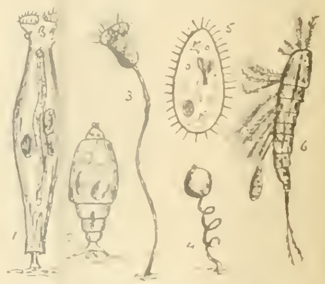

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Turning to the practical methods of working, one finds that, in the main, apparatus of the same principle as that used at the first stages of the work is used now. The improvements and modifications have been made principally in the domain of constructive detail rather than by employing different methods. The induction coil method of exciting the X-ray tube is still used by the majority of workers—some of whom use coils giving as much as eighteen or twenty-inch length sparks in air, although this by no means infers that successful work has not been done or cannot be done with coils of far smaller magnitude. Coils giving three or four-inch sparks in air are quite sufficiently large for obtaining perfect radiographs of the extremities of the body, such as the hand, the ulna and radius, or the tibia, while the writer has produced several good pictures of the adult chest with only a three-inch spark. In general hospital work and practice, however, the average size coil used is an eight or ten-inch one, and with this available spark length all the necessary radiographic and radioscopic work is done, and pictures of most of the deep-seated hard and soft tissues are obtained. For photographic work a small frequency of interruption at the contact breaker is best, while high frequency is more advantageous for direct fluorescent screen work. The question of adapting the contact breaker of a coil to give the rates of frequency required under different conditions of working has, therefore, occupied much time. Mercury contact breakers of different forms have been devised, and with arrangements to vary the rate of frequency of the make and break. Undoubtedly this form of break possesses a great advantage over the ordinary spring form, as with it there is no danger of what is known as "jamming" between the two connecting surfaces, which takes place sometimes in the ordinary break, and which is so fatal to the primary of the induction coil. Mercury breaks, however, are troublesome to work, and the resulting vapour very poisonous, of course. A great point is to have the mercury and the connecting platinum point perfectly clean, and to assure that the latter enters and leaves the former with a perfectly vertical motion. Sparking is much decreased by so doing.

The form of induction coil made by Apps or Apps-Newton has probably up to the present been the most efficient one in use, but it bids fair to be surpassed by a coil recently patented by Mr. A. L. Davis, and which is now about to be put on the market. By a special ebonite disc plan for the insulation of the secondary coil, the spark is considerably increased for the same amount of wire. In an experimental coil there were from thirty to forty sections, each about three-sixteenths of an inch thick, making a total width of just over six inches. With this coil, and using only three accumulators giving six volts in all, a continuous thick spark of ten inches was obtained. One advance with the above arrangement of insulation is that the secondary can be wound right down upon the tube insulating the primary.

When working with an induction coil great care has to be taken, of course, not to pierce the insulation, as that would be fatal; moreover the recharging of the necessary batteries is always a trouble unless one is near a charging station, or can get over the difficulty at home, and these drawbacks are increased very considerably when military field work or other expedition work is being undertaken, and there is no possible chance of getting things rectified once they go wrong.

The Wimshurst machine, as an exciter for X-ray tubes, possesses many advantages over the coil in some respects, and will probably be utilised much more in certain cases and localities. That Wimshurst machines are quite efficient for working X-ray tubes under all conditions and for all purposes has been proved by several investigators. Through the courtesy of Mr. Wimshurst, the writer has had the opportunity of testing the capabilities of the many sized machines in the inventor's possession. These results have shown that, provided the diameter of the plates is not less than twenty inches, very excellent and uniform fluorescent screen illumination is obtained, the rays emitted from the tube in use being of good penetrating value. A tube which previously had been found to be best adapted for a six-inch coil, worked admirably on a machine with four plates of twenty inches diameter. Using higher resistance tubes upon larger machines, and inserting in the circuit a small spark gap suitable to the exhaustion of the tube (the gap varying from one-half inch to one and a-half inches) much better results still were obtained. Further, the work with a Wimshurst machine proceeds noiselessly and without the flickering in the tube so often noticed with coils. The working also entails no more trouble than the mechanical turning of the plates.

At first sight the Wimshurst machine does not seem so portable as the induction coil, but when one takes into consideration the necessary important accessory of the latter, viz.:—the battery and the trouble it incurs—the relative portability of the machine is much increased. Furthermore, the Wimshurst with ebonite plates gives better fluorescent screen results than glass, and ebonite is practically unbreakable; the prime conductors can also be much reduced in size and capacity without affecting the efficiency for X-ray work. Considering, then, that rapid radioscopic work upon the field of battle is of much more importance than radiography, there is no doubt that, so long as the minimum size of plates is attained, and the machine made as compact as possible, it should prove of very great value to the army surgeon.

There only remains one more important practical item to be considered, namely, the vacuum tube for exciting the X-Rays. In principle this remains the same as the "focus" form originally introduced by Professor Jackson, of King's College, in which the cathode rays, emanating from the cathode, impinge upon the anode or anti-cathode and are scattered out through the glass as Röntgen rays. Two difficulties, however, presented themselves. Firstly, under different conditions of working and different spark lengths, the one tube with its one degree of exhaustion and one value of resistance could not be adapted. Secondly, upon continued working it was found that the exhaustion and therefore the penetrating value of the tube increased, so that, finally, in spite of repeated heatings by a flame so as to increase the pressure inside, the resistance of the tube was so high that discharge could not take place under the same conditions it was originally selected for.

These difficulties have been overcome chiefly owing to the persistent, patient work of Mr. A. A. C. Swinton, whose results upon the *modus operandi* in the interior of the tube and also upon the conditions affecting the emission of X-rays have proved of very great importance in the work. Among other things, Mr. Swinton found, with experimental tubes made in his laboratory, that if the anode of the tube be so arranged that the distance between it and the cathode could be adjusted, then a ready and very simple means was at hand whereby the resistance and penetration could be altered to suit the varied conditions imposed. The nearer the anode is placed to the cathode the higher the resistance and consequently the higher the penetration of the tube, and *vice versâ*. In moving the anode of a tube, however, the point of origin of the X-rays is also moved for each adjustment, which is certainly a disadvantage, especially when a difficult radiograph, requiring a lengthy exposure, is being taken. While, therefore, taking advantage of Mr. Swinton's very useful principle of varying the distance between anode and cathode, Dr. Dawson Turner, in conjunction with the writer, has reversed the arrangement by making the cathode moveable and keeping the anode fixed; and has added a further modification in that the cathode is adjusted by magnetic means, so that movement may be made easily, without disturbing the tube at all, while it is in any desired position. If the tube is constructed so that the cathode, in its movement slides in and out of the side annex blown in the bulb, so as to keep it in proximity to the glass throughout its movement, it is found that the latter has a greater influence upon the resistance of the tube than mere movement to and fro when the cathode is quite out into the bulb space, and affects it in the reverse way; that is, the nearer the cathode is to the anode the lower the resistance, and this increases as the cathode is gradually drawn back inside the annex. The above modifications for the variation in the penetration in the tube are certainly an advance over the older, uncertain methods of potash tubes, &c.

Taking advantage of the fact, first suggested by Prof. S. P. Thompson, that the higher the atomic weight of the anode the higher the penetration of the tube, a further advance has been made by Dr. Mackenzie Davidson, in the use of osmium as an anode. The scarcity of the metal, however, is the one great drawback to its use.

Little has to be said in regard to the fluorescent screen. Potassium-platino-cyanide and barium-platino-cyanide are almost the only salts used, as nothing has yet been found to approach them in efficiency. The latter is preferred on account of the ease in working it. The salt now obtainable is by far purer than that of two years ago, consequently screens are made with much more uniform and brilliant surfaces.

Mention must be made, however, of the great assistance screens offer in shortening the time of exposure, especially of the more inaccessible parts of the body. The salts fluorescing green, however, such as barium-platino-cyanide, are by no means so active as calcium tungstate, which fluoresces blue, and which has, therefore, a greater photographic activity. Placing the fluorescing surface of the screen in contact with the film of the plate, the exposure is, in some cases, reduced to one-fifth of the time otherwise required. Special plates, however, give the best results, and it is difficult to eliminate the granulation of the screen.

What, now, is the mechanism producing Röntgen rays? Do they consist of molecular streams, or are they of the nature of vibrations—transverse or longitudinal? Here we are confronted with a host of hypotheses and theories that would demand much more space than is here possible, to discuss adequately.

Experiments by Röntgen, Battelli, and others, have tended to show that Röntgen and cathode rays are of the same nature, but that the former constitute only part of the latter. The clear distinction, however, between actual similarity is expressed by the absolute non-deviation of Röntgen rays in a magnetic field, while this phenomenon is a strong characteristic of cathode rays. The numerous researches by Swinton and others seem to place beyond doubt the molecular nature of cathode rays, and to prove that they consist of electrified atoms or ions in rapid progressive motion, while the general opinion of physicists seems to be settling towards a wave or ether theory for the Röntgen rays. The difficulty of formulating a perfectly satisfactory theory is great, however, when one has to contend with the fact that there is no direct proof of reflection, refraction, or even polarization of the rays. If polarization could be proved it would simplify matters, as it would show the vibrations to be transversal. The three principal hypotheses under discussion at the present time are:—Firstly, the ultra-corpuscular theory, by Prof. J. J. Thomson; secondly, that the rays are transverse ether waves, and of such excessively short wave lengths that they are an extreme case of ultra violet light; thirdly, the hypothesis of Sir G. Stokes, that they consist of transverse waves in the same manner as light waves, but that they differ from the latter in that they do not form regular trains of wavelets—half a million or more, on the average, in each train—but are solitary waves, each "train" consisting of but one or two wavelets at the most.

The first of these theories is truly a startling one, for it assumes that the atoms of ordinary matter can be pulverized into still finer particles, and that even solid bodies may be penetrated by the flight of such subatoms travelling with enormous velocity. It also opens up the question of the divisibility of the atom, which, to say the least of it, is an amazing one to face.

Stokes' theory amounts to this:—That cathode rays consist of negatively charged missiles, shot in showers like hedge-firing, from the negative electrode against a target (the anti-cathode), which receives and suddenly arrests them; and that the Röntgen rays are due to the independent pulses propagated through the ether when the advances of their negative charges are thus abruptly stopped or altered. The radiation from the target reaches the object which is being skiagraphed as an undulation consisting of irregular pulses.

This view has been advanced by Johnston Stoney in analysing these irregular undulations and resolving them into trains of waves of different wave-lengths, among which waves of short wave-length are abundant if the hedge-firing has been sufficiently violent and irregular. The object will then be opaque to the longer waves but transparent to the short ones, and the Röntgen effects follow. This explanation tends to bring Stokes' theory into agreement with the above theory of Sagnac and others, that the rays are of the nature of light waves, but with excessively short, ultra-violet wave-lengths.

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HANDICRAFT IN THE LABORATORY.*

GIVEN—a piece of lead glass tubing, two inches in diameter; to hermetically seal in the tube a specimen of chlorine gas in order to display the yellowish green colour: how many chemists or physicists could do it so as to make the specimen presentable on a lecture table or for exhibition in a museum? Such a task demands more skill in craftsmanship than most students are ever able to command. Either traces of the reduced lead, through imperfect management of the oxidizing and reducing flames, will be left in the glass to mar the specimen, or lack of symmetry will appear in the two ends of the sealed tube due to inefficient control of the various forces which tend to alter the shape of the glass while in the plastic condition. A somewhat simpler (though by no means easy) task in the manipulation of the blowpipe is to seal up a specimen of sodium or potassium in vacuo, or in an atmosphere free from oxygen, so as to exhibit and retain the brilliant silvery lustre of these metals when their inordinate propensity for appropriating the vital element is thus held in check. True it is that some

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* "Glass Blowing and Working." By Thomas Bolas, F.C.S., F.I.C., etc. (Dawbarn & Ward.) Illustrated. 2s. net.

arts, as far as literary presentation is concerned, are extremely difficult to communicate, and glass blowing is an art of that class; it is, nevertheless, an art of the highest importance to scientific students—more particularly research students—and yet not more than about one in a hundred becomes really proficient in this auxiliary handicraft in the chemical and physical laboratory, while only a very moderate percentage attain tolerable dexterity. Glass working at the lamp, we take it, is, as Mr. Bolas says in the handy treatise before us, "specially calculated to lead to an intelligent study of the reasons for and against various modes of manipulation, and to an appreciation of the importance of economy in effort. . . . To surgical and dental students, as also all students of the more delicate handicrafts, a preliminary training in glass working should be specially useful, especially from the point of view of early acquiring ambidexterity." Practical work in all the sciences rests ultimately on accurate mechanical operations; and however ingenious one may be in original suggestion, he must also be able to execute the needful manipulative work, or somebody must do it for him. That Mr. Bolas is fully conscious of the magnitude of the task he has undertaken may be gathered from a passage on page 10, where he says: "The harmony of action between the two hands of an expert glass worker is probably beyond everything in technology; as, for example, when a longish tube, unequal in diameter at the two ends, is softened in the middle and then operated on, say by blowing in at one end. Not only must the two hands rotate the piece at the same angular rate while before the blowpipe, but each half must be balanced on the hands. When taken from the flame for blowing, the rotation must be maintained, and both hands must move in such exact correspondence as to put no unintentional strain on the soft part." All through the book the author thus indicates difficulties in every detail of the art and suggests means of overcoming them. It is, therefore, very gratifying to come across a work sufficiently practical to make not only a laboratory and workshop guide to the various phases of glass working at the blowpipe, but also, to some extent, technically educational in the real sense of the term—"as leading towards an understanding why each particular operation is done, and as facilitating that interdrift of method from craft to craft which is so conducive to progress." Those who desire to acquire artistic skill in the use of the blowpipe as a modelling tool—a tool acting with equal facility for relief or intaglio—will find ample suggestions in this book, suggestions and instructions which will enable them to model figures, faces, and expressions, as Venetian artists did in days gone by.

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We see from the above that the longitude of the descending node, or point where the planet crosses the plane of the ecliptic from north to south, is 123° 48′ 53″, which is distant only 1½° from the perihelion point; in other words, the planet when nearest to the sun is, at the same time, very near the plane of the earth's orbit, and thus approaches our earth more nearly than it would otherwise do. The following little table gives the least distance of DQ from the earth as compared with those of our other neighbour worlds:—

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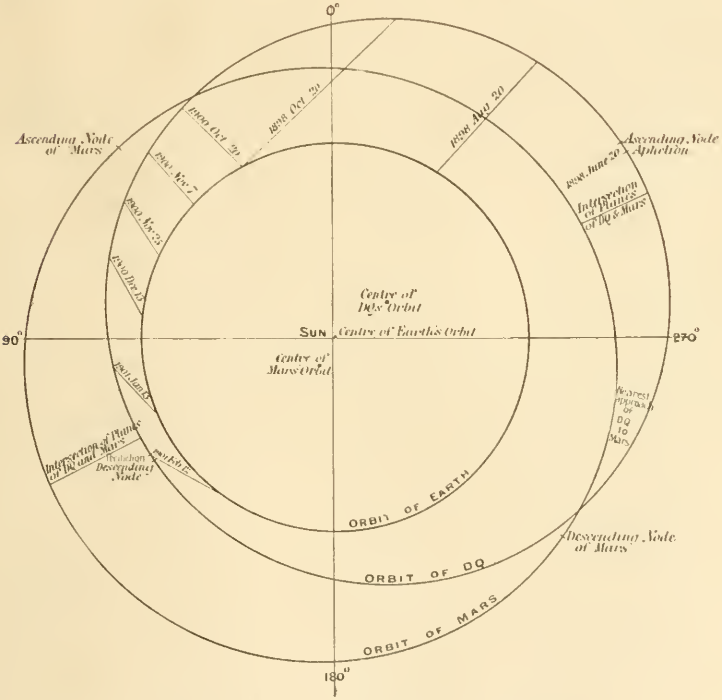

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The great value to astronomers of such a near approach lies in the means it gives for improving our knowledge of the sun's distance, the fundamental unit of the solar system. It has already been recognized that the minor planets which approach us most closely afford a better means of determining this than does Mars, in spite of its smaller distance. The method adopted consists of measuring with a heliometer the distances of the planets from a number of neighbouring stars, the measures being made alternately with the planet east and west of the meridian, so that the observer has been carried in the interval by the earth's rotation through a distance of several thousands of miles, and the planet thus appears alternately on one side and on arts, as far as literary presentation is concerned, are extremely difficult to communicate, and glass blowing is an art of that class; it is, nevertheless, an art of the highest importance to scientific students—more particularly research students—and yet not more than about one in a hundred becomes really proficient in this auxiliary handicraft in the chemical and physical laboratory, while only a very moderate percentage attain tolerable dexterity. Glass working at the lamp, we take it, is, as Mr. Bolas says in the handy treatise before us, "specially calculated to lead to an intelligent study of the reasons for and against various modes of manipulation, and to an appreciation of the importance of economy in effort. . . . To surgical and dental students, as also all students of the more delicate handicrafts, a preliminary training in glass working should be specially useful, especially from the point of view of early acquiring ambidexterity." Practical work in all the sciences rests ultimately on accurate mechanical operations; and however ingenious one may be in original suggestion, he must also be able to execute the needful manipulative work, or somebody must do it for him. That Mr. Bolas is fully conscious of the magnitude of the task he has undertaken may be gathered from a passage on page 10, where he says: "The harmony of action between the two hands of an expert glass worker is probably beyond everything in technology; as, for example, when a longish tube, unequal in diameter at the two ends, is softened in the middle and then operated on, say by blowing in at one end. Not only must the two hands rotate the piece at the same angular rate while before the blowpipe, but each half must be balanced on the hands. When taken from the flame for blowing, the rotation must be maintained, and both hands must move in such exact correspondence as to put no unintentional strain on the soft part." All through the book the author thus indicates difficulties in every detail of the art and suggests means of overcoming them. It is, therefore, very gratifying to come across a work sufficiently practical to make not only a laboratory and workshop guide to the various phases of glass working at the blowpipe, but also, to some extent, technically educational in the real sense of the term—"as leading towards an understanding why each particular operation is done, and as facilitating that interdrift of method from craft to craft which is so conducive to progress." Those who desire to acquire artistic skill in the use of the blowpipe as a modelling tool—a tool acting with equal facility for relief or intaglio—will find ample suggestions in this book, suggestions and instructions which will enable them to model figures, faces, and expressions, as Venetian artists did in days gone by.

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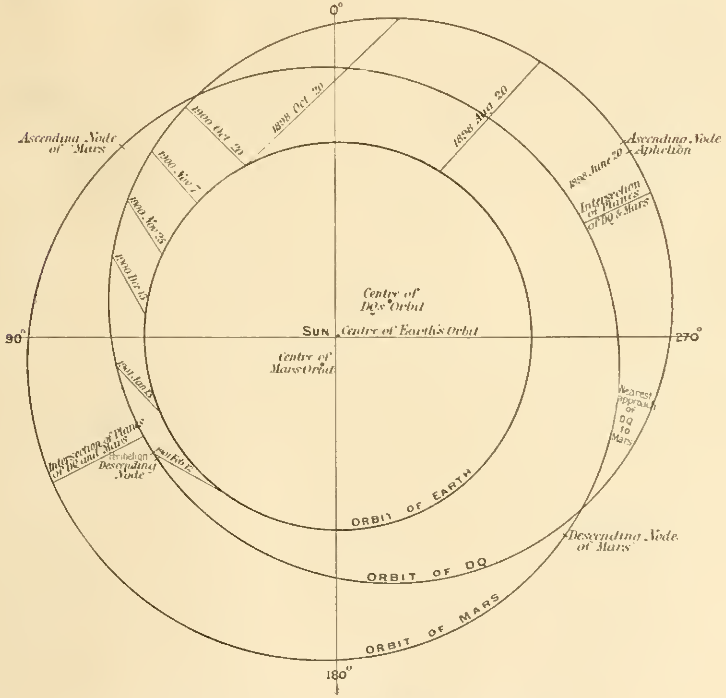

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Another way in which DQ will assist in improving our knowledge of the sun's distance is by the perturbations which the earth produces on it, which will be very considerable, and which will give an accurate determination of the earth's mass compared with the sun's, and hence of the latter's distance. But this method will not be available for many years; it will, however, in the long run, give very accurate results.

It might at first sight appear that DQ will make still closer approaches to Mars than it does to the earth, but this is not the case; owing to the fact that the orbits are so much inclined to one another, and the unfavourable position of the line where their planes intersect one another (in longitudes 115° and 295°), they do not approach more nearly than 0·23 in astronomical units.

As viewed from Mars the motion of DQ would be very singular, for sometimes Mars would overtake DQ, sometimes it would be overtaken by it, sometimes DQ would be in inferior conjunction with the sun, sometimes in opposition to it, sometimes in Mars' equator, sometimes at his poles.

As viewed from the earth there is one feature in which DQ differs from all the other superior planets; they are in all cases retrograding when in opposition, but DQ when in perihelion has a velocity whose resolved part in the plane of the ecliptic is 18·95 miles per second, while that of the earth in the same longitude is only 18·78 miles per second. DQ is therefore gaining on the earth instead of being left behind, and it will therefore be slowly advancing in longitude; it will have a rapid southward motion in latitude in consequence of its high inclination which will amount to about $1\frac{1}{3}°$ per day. When in opposition near aphelion it will retrograde in longitude $\frac{1}{2}°$ per day as was the case at its discovery; there will necessarily be an intermediate position where it will be exactly stationary in longitude at the instant of opposition, and the earth and planet will travel on side by side with the same velocity, maintaining for some days an almost constant distance.

It has been suggested that DQ may have only recently been introduced into its present orbit by perturbations, but this does not seem to me to be possible if its minimum distance from the earth be 0·14, for the perturbations by the earth at this distance though considerable, would not be able to change the orbit *per saltum*, and the giant planet Jupiter, the great disturber of the minor planets, never approaches DQ more nearly than 3·2, at which distance it would likewise be unable to effect any sudden great change in the orbit.

Many of the relations I have referred to above are illustrated in the diagram. To picture the orbits of DQ and Mars correctly, we must imagine them rotated about their lines of nodes through angles of eleven degrees and two degrees respectively. In the case of DQ the upper left hand portion of the orbit will be the highest above the plane of the paper, in the case of Mars the lower left hand portion.

I have now dealt with the relations of the new planet to ourselves as fully as our present knowledge of its orbit appears to warrant. A more accurate computation, based on a larger series of observations, will be awaited with keen curiosity; after which its past and future history may be traced with a closer approach to precision than is possible at present.

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THE NOVEMBER METEORS.

Prof. E. C. Pickering, in Circular No. 31 of the Harvard College Observatory, points out that it is very important that a continuous watch should be kept during the two or three days in which the Earth is passing through the denser portion of the meteor stream. This can only be done by establishing a series of stations in various longitudes, so that during the entire time one or more of these stations shall fulfil the conditions that the radiant point shall be above the horizon and the sun below. The watch should be begun on the evening of November 11th, and continued each night until the shower is clearly past. Prof. Pickering recommends all observers to note the following particulars:—

Name of observer, location of station, post office address, time of beginning and ending of observations, interruptions by clouds or other causes, condition of sky, as clear, hazy, passing clouds, &c. He then adds the following directions:—

The Constellation Leo with Stellar Standards of Reference.

"The observations most desired are those required to determine the frequency of the meteors. They are of

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; he colour, B=blue, G=green,
an R=red; the class, L Leonid,
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to the adjacent star . Su work can be done equally well
elsewhere, and should n t terfere with the hourly count
mentioned above."

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PHOTOGRAPH OF THE NEBULOUS REGION ROUND [illegible] 37 CYGNI.

By Isaac Roberts, D.Sc., F.R.S.

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NEBULA ♅ V 37 CYGNI.

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

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By Isaac Roberts, d.sc., f.r.s.

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Some photographs of the region have been taken with portrait lenses, having apertures up to six inches in diameter and focal distance of thirty inches, but the scale of such photographs is too small for showing structural details in a satisfactory manner; two of these were taken by Dr. Max Wolf in the latter half of the year 1891, and were published in Knowledge.

The photograph annexed was taken with the twenty-inch reflector, and exposure of the plate during two hours and fifty-five minutes on the 10th October, 1896, and it will be seen that the structural details of the nebulosity are delineated upon it on a scale that will enable astronomers in the future to detect, and correlate, any changes that may take place in the nebulosity or in the stars that surround or are involved in it. The whole extent of the nebulosity that appears to be connected, or is in proximity to that shown on the photograph would require a larger plate than this to cover it, but there is no indication of a symmetrical aggregation of the nebulosity such as is visible in the majority of nebulæ that are known to exist in many parts of the sky.

There are several indications of fission, and also some evidence of *loci* of vortical disturbance in different parts of the nebulosity, and therefore much matter of great interest to the astronomers of the distant future is herein recorded.

It will be observed, on close examination of the photograph, that nearly the whole surface area of this vast cloud of nebulosity is covered with stars, ranging in magnitude between the ninth and the seventeenth; but very few of them can, with certainty, be pronounced as being actually involved in, and forming part of, the nebulosity. The hundreds of apparently finished stars are probably placed between us and the nebulosity, and if this be the true inference, what must be its dimensions and distance from the solar system? The answer, if one could be given, would be bewildering, for, so far as it is known up to the present time, not one of the stars referred to has a sensible parallax, and therefore the distance from the earth of the nearest of them would be practically infinite; consequently, if the nebulosity is at a greater distance than the stars, we are left entirely without data to enable us to form even the crudest idea of the extent of this part of space. If the question should be asked: What evidence is there for the assumption that the stars are between us and the nebulosity? my answer would be that, if the stars were beyond the nebulosity, their photo-discs would, on the negative, appear less bright, and their margins be more or less nebulous; whereas only those stars which appear involved in the nebulosity present these appearances. Of course it is a fair subject for argument that those nebulous stars which appear to be involved in the nebulosity are not so in reality, but seem thus because they are beyond it in our line of sight. But this argument is much weakened, if not entirely destroyed, when we find on examination of the negative that those faint, star-like condensations are not only nebulous themselves but they follow the curvatures found in various parts of the nebulosity; thus we are driven to infer that the stars are the nearer bodies to us, and that the nebulosity lies beyond the stars.

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occulting body, at minimum, has still a portion projected outside the central globe. I stated, however, that I was only dealing with central eclipses. Without going into calculations, which are somewhat operose, and for which I have not just now the time, it can be seen that we can get any variety of curve, from an almost straight line with slight depression in centre to a deeply hollow curve. The first results when only a very small portion of the bright central globe is cut off or obscured, and the last when the occulting body is nearly the same size as the primary, and when, at minimum, a small portion only (as seen from the earth) lies outside the bright globe. To get the exact shape at minimum one would require to calculate the change in light for several positions of the occulting body very close together; in fact, for more frequent intervals.

E. E. Markwick, Col.

◆

LIGHT CURVES OF OCCULTING BODIES.

To the Editors of Knowledge.

Sirs,—On page 183 of the August number of Knowledge is the suggestion of working out the curves for bodies which occult each other, as shown in variable stars. In the case of β Lyræ, this has been done by Prof. G. W. Myers, Urbana, Illinois (University of Illinois), who presented his results at the "Conference," held at the Yerkes Observatory, in 1897, October. The agreement between the Argelander light curve and the Myers theoretical curve was very remarkable. Chas. H. Rockwell.

The Observatory, Tarrytown, New York,
9th August, 1898.

◆

WEASEL AND YOUNG.

To the Editors of Knowledge.

Sirs,—About Midsummer I was talking with a friend in the country, when something crossed the road quite near us. On being followed it resolved itself into an old weasel and a young one; the parent, having seized the latter behind the ear, was leading or dragging her charge at a gallop. The animals disappeared under some loose pieces of wood, and by moving one of these gently I was enabled to secure the young weasel in my handkerchief. This wrapper was afterwards very attractive to the parent, who could detect the odour left by the other, and she came quite boldly all around it, posing in the most interesting attitudes, and with a prettily-earnest expression of face.

On the next day I saw her lead another young one for quite twenty yards along the road. A farmer friend tells me that the old weasels (and foxes also) always lead their young in this particular manner.

It would be interesting to learn whether this habit prevails in the carnivora generally; it does not appear to occur in the vegetable eaters. Charles A. Witchell.

Science Notes.

Acetylene gas was, during last month, put through a somewhat severe ordeal at the Botanical Gardens, Edgbaston, where a garden party assembled to witness a demonstration of the new illuminant there introduced into the houses. Prof. Hillhouse has studied the light from two points of view—injury to plants from evolved gases, and relations with colour. He had failed to see the smallest sign of any of those injurious effects which the combustion of coal-gas had upon plants, while the most critical colours, so far as artificial illuminants were concerned, came out of the ordeal with success—the mixed shades of mauve and magenta being as perfectly displayed as with the arc light, and the various shades of yellow could hardly be more distinguished in ordinary sunlight.

Appalling possibilities for crime were suggested by Sir J. Crichton Browne in his inaugural address to the Pharmaceutical Society this session. A connoisseur of poisons could, by keeping his own microbes, slaughter hundreds of innocent people without the slightest fear of his crime coming to light. Even in a most minute post-mortem examination, many of the comparatively new organic poisons defy detection.

◆

The annual exhibition of the Royal Photographic Society of 1898 does not, we think, mark any decided advance in true photography. There is much in the exhibition that is beautiful, and many of the studies display admirable and clever work, but notwithstanding the general excellence of the exhibits there is not one photograph which can be singled out and branded as a masterpiece. If this forty-third exhibition of the Royal Photographic Society is to be of peculiar benefit to photographers, the benefit should lie in clearing up the vexed question as to whether the unworked photograph is to rank side by side with the "faked" photograph. In this exhibition prominent positions have been given to studies so "worked up" that the veriest tyro can see that shadows, high-lights, and much detail are the result of paint and pencil. The influence of this upon the average photographer, whether he sends in an exhibit, or whether he merely attends the exhibition to learn, must be deleterious.

◆

We learn from a report recently issued by the Board of Agriculture, that the total amount distributed during the financial year, 1897-8, to institutions in this country for agricultural education and research was seven thousand two hundred pounds, as compared with seven thousand in the previous year. Four colleges—namely, University College of North Wales, Bangor; Durham College of Science; University College of Wales, Aberystwyth; and Reading College—each received eight hundred pounds, and the remainder was distributed in varying amounts down to a minimum of fifty pounds. Considering that thirty-two separate counties share in this grant, it will be apparent that experimental work in cultivating the soil in this country is economically performed as far as the Government is concerned.

◆

Some very interesting ornithological news has lately been received from New Zealand. A fourth specimen of *Notornis Mantelli*, a large flightless rail, has been captured. The last specimen of *Notornis* was captured some twenty years ago, and it has long been considered extinct by most people, although a few have clung to the idea that the species yet lived hidden in some of the great marshes of New Zealand. The name *Notornis* was originally given by Owen to some fossil bones discovered in the North Island, New Zealand. In 1849, a few years later, Mr. W. Mantell obtained in the Middle Island a freshly-killed specimen of a flightless rail which was declared to be of the same species as Owen's *Notornis*. A second specimen was obtained in 1851, and a third in 1879. The present specimen was killed by a dog in the bush adjoining Lake Te Anau. The skin and all parts of the bird have been carefully preserved, so that we may look forward to having some exceedingly valuable details concerning this interesting bird. The fact that this fourth specimen was a young female proves that the bird is by no means extinct, and also that it is not easy to find.

◆

Electric traction is likely in the near future to become a new power in the transmission of the "mail." Such an electro-postal line as has been recently proposed would be a kind of cannon, emitting bullets in the form of cars, which can be stopped instantly at a particular station by simply pressing a button at headquarters. Mr. MacGurty, a well-known engineer, has constructed a small tram line, about two miles in length, along which he can easily run an electric car at the rate of two hundred and forty miles an hour, or four miles a minute. These special railroads, it is suggested, should be built preferably above ground, with stations at frequent intervals, each station being in charge of an electrician, who would receive the whole, or part, of the contents of the car, and also be in communication with neighbouring stationmasters.

◆

During last month the International Conference of Scientific Literature met at the Hotel Métropole, and Professor Rücker, in proposing "Science in all Lands," said that "Science had become the most cosmopolitan of all the professions." The Royal Society has a regular organization for recognizing merit outside the nation to which men belonged, and great scientific triumphs are recognized as being triumphs, not for one nation, but for the world. The Royal Society, in 1864, commenced its catalogue of scientific papers, arranged according to the names of the authors, but a catalogue of subjects would be of even greater utility. Such an undertaking is beyond the power of any one society or country, hence the necessity for international co-operation. It is something to know that the scheme is progressing satisfactorily, and that there is a fair prospect of its being completed in such a way as will tend to cement more firmly than at present the union of international science.

◆

In England the annual military and naval expenditure has increased in the last ten years by nine millions nine hundred thousand pounds, while in the same period the annual education budget has only been increased by about three million pounds. Sums spent for these purposes by the Great Powers show rather interesting results :—

	WAR.	EDUCATION.
England	£40,650,000 ...	£10,140,000
Germany... ...	32,840,000 ...	12,120,000
France	36,570,000 ...	7,920,000
United States ...	16,700,000 ...	36,890,000

Thus, the most civilized nations of the world spend about four pounds in military preparation for every pound in fortifying youth for the battle of life—the United States being one notable exception.

◆

Lord Lister, at the opening of the new Pathological Laboratories, Liverpool, championed the cause of vivisection. "It seemed," said he, "the veriest common sense that the more practically familiar a man was with the structure and working of the marvellously complicated mechanism of the human body the better fitted he was to deal with its disorders. . . . Some, perhaps, might be disposed to object to such researches because they involved the sacrifice of animal life, but this was as nothing compared with what occurred for the supply of food to man. . . . Anæsthetics had come to the aid of experiments on animals. They prevented disturbance from the struggles of the animal, and they bestowed upon the operator the unspeakable comfort of knowing that it felt no pain." Such operations painlessly conducted, it is gratifying to know, have, by indicating the precise functions of different parts of organs, already led to the saving of many human lives.

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

Robins and Honeysuckle.—The Robin, like the Marsh Tit, is partial to the red juicy berries of the honeysuckle, and this year several Robins have come to my plant for the fruit. On the other hand, the Sparrows, which actually roost in the honeysuckle and a covering hop, never touch the berries.—Charles A. Witchell, Eltham.

The Memory of the Partridge.—This year a niece of mine, aged eleven, successfully brought up a brood of ten Partridges, and they flew off three weeks ago. One day last week she joined her father, who was shooting two miles from home, and, to her great surprise, came across the identical covey. They immediately recognized their young mistress, and followed her about from field to field, and the next morning had all returned to their old quarters by the hall door.—Jos. F. Green.

Further Notes on Birds observed on the Yenisei River, Siberia. By H. Leyborne Popham, M.A. (*The Ibis*, October, 1898, pp. 489-520.)—In a very interesting article under this title Mr. Popham describes how he found the first nest and eggs of the Curlew Sandpiper.

On the Orcadian Home of the Garefowl (Alca impennis). By Alfred Newton. (*The Ibis*, October, 1893, pp. 587-592.)—In this article Prof. Newton describes what was undoubtedly the true breeding place of the last pair of Great Auks in Orkney. The last of these Great Auks was destroyed in 1813. The breeding place is an islet off Papa Westray, on which Prof. Newton has lately landed, after several abortive attempts, in the company of several friends.

Report on the Movements and Occurrence of Birds in Scotland during 1897. By T. G. Laidlaw (*Annals of Scottish Natural History*, October, 1898, pp. 200-217). This report has been carefully compiled from twenty-four Light Station Schedules, and from schedules and notes from twenty-two other observers in different parts of Scotland.

The Great Sheerwater at St. Kilda (*Annals of Scottish Natural History*, October, 1898, p. 233). Mr. Henry Evans records the capture by some fishermen of a specimen of this bird at St. Kilda on August 7th, 1897.

Baillon's Crake in Caithness (*The Field*, October 8th, 1898).—Mr. W. Arkwright, of Thurso, records that he shot a female of this very rare species at Thurso, in September.

Erratum.—In the October number of Knowledge, p. 234, the Rev. William Serle's name was unfortunately printed as Scole.

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.*

◆

It really seems as if an effective rat poison will soon be easily procurable. In the bacteriological laboratory attached to the agricultural department of the Russian Government a disease broke out among the rats kept for experimental purposes, and soon spread rapidly among the whole stock. An examination of the spleen and liver of the victims brought to light a new bacillus, which was duly isolated and cultivated, and it has been found that any mouse or rat inoculated with the prepared virus invariably succumbs. Pigeons, rabbits, and other creatures appear to be immune from its effects.

AN IRISH SUPERSTITION.

By Frances J. Battersby.

A QUAINT old book, written by Sir Henry Piers of Insternaght in 1682, and entitled "A Chroragraphical Description of the County West Meath," gives the following account of the "Connagh worm," which may prove interesting to some readers of Knowledge.

"We have a certain reptile found in our bogs called by the Irish the 'Connagh worm.' This is an ugly worm, sometimes as thick as a man's thumb, about two or three inches long, having, as all reptiles have, many short feet, a large head, great goggle eyes and glaring, between which riseth or jutteth forth one thick bristle, in shape like a horn, which is prominent and bendeth forward about three-quarters of an inch. Whatever beast happeneth to feed where this venomous worm hath crept (some say if he do but tread there) is certainly poisoned, yet may be infallibly cured if timely remedy be applied; the case is twofold, yet in effect but one, both proceeding from the very worm itself. Some there are that take this worm and putting it into the hand of a new-born child close the hand about it, tying it up with the worm closed in it till it be dead. This child ever after, by stroking the beast affected recovers it, and so it will if the water wherein the child washes be sprinkled on the beast. I have known a man that thus would cure his neighbour's cattle tho' he never saw them.

"The other method of cure, which I like much better, is by boring an augur-hole in a well-grown willow tree, and in it imprisoning, but not immediately killing the worm, so close by a wooden peg that no air may get in, and therein leaving him to die at leisure. The leaves and tender branches of this tree ever after if bruised in water, and the affected beast therewith be sprinkled, he is cured. The All-wise and Ever-gracious God having thus in his Providence ordered it that not only this venomous reptile, but divers others, and who knows if not all, did we know the right method of using them, should have in themselves their own antidotes, that so we might have a remedy at hand as the poet sayeth—'*Unæ eademque manus vulnus opemque ferat.*'"

The first time I saw the "reptile" it was brought to me by a country girl, who had picked it up by the aid of two sticks as it was crossing a road, as she was afraid to handle it. Subsequently, a friend brought me several specimens taken off a fuchsia in her garden, and there were few seasons for many years in which two or three specimens were not obtained by the first finder, now grown fearless of its "poisonous" powers. Last autumn a neighbouring clergyman's daughter walking near a ditch "saw her little dog barking and snapping at a most curious looking creature with staring goggle eyes."

We made many inquiries amongst our labourers and country folk as to what this so-called "reptile" could be, and the various accounts proved very amusing. One man said "he had seen one years ago, about three inches long, and as thick as two black slugs put together; it had a round head like a cat's, and goggle eyes." He was afraid to touch it as its eyes glared like a frog's, and said it bit or stung cattle, when their heads swelled up, and a man was once bit on the leg, which swelled up, and he nearly died.

A labourer said that once, having taken his dinner to a field, he was going to fetch the tin basin in the evening, when he found a Connagh sitting in it, glaring at him; and this informant, when offered a reward for a specimen, said he would not touch one for ten shillings. The most reliable and graphic account we obtained was from a woman who thirty years ago saw upon a stem of meadow sweet a creature three or four inches in length, almost black, and banded. She let it climb on a stick. "When it stretched itself, its head came to a point like a leech; when it pulled in the front part, the head seemed very large, and the eyes could not be seen. As it crawled towards her they were glaring and banded across in an odd way, and it had a thing like a gooseberry thorn in its tail." It fell off the stick, and when she came home her father reproved her for not having killed the Connagh by smashing it with a stone, "as now it would sting the cattle."

All these accounts pointed to the larva of the elephant hawk moth, and upon a fine specimen having been brought us this season, the last informant at once identified it with the Connagh named by her father. A friend of the writer told her of an old man who brought her a caterpillar of the elephant hawk moth which he called by the dreaded name. It seems certain, then, that the dreaded "Connagh worm" is nothing more than a harmless caterpillar.

There are two models of the "Connagh" in the Dublin Museum at present. They are studded with coloured stones, and supposed to have been used as charms in days gone by.

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Notices of Books.

The Mammals, Reptiles and Fishes of Essex. By Henry Laver, M.R.C.S., F.S.A., F.L.S. (London: Simpkin, Marshall & Co., 1898.) This catalogue of the vertebrate fauna of Essex, excluding the birds, will, like all local lists, prove of value to students of geographical distribution. It is published under the *ægis* of the Essex Field Club, being the third of a series of special memoirs for which this enterprising and enthusiastic body of naturalists is responsible. We are glad that Mr. Laver has given considerable attention to the fishes of Essex; there is still room for work in this direction, but though some species will doubtless have been omitted from the catalogue before us, a good beginning has now been made. The publication of the work will certainly encourage the study of natural history in Essex.

Text-Book of Entomology. By Alpheus S. Packard, M.D., Ph.D., Professor of Zoology and Geology at Brown University. (New York: The Macmillan Company.) 18s. net. Professor Packard's volume deals with the anatomy, physiology, embryology, and metamorphoses of insects, and will prove eminently useful to the working entomologist as well as to students in agricultural colleges. It is presumed that the reader already has some knowledge of invertebrate life, and at the outset the relations of insects to other arthropoda are discussed. The whole of the seven hundred and more pages bear evidence to the extent of the knowledge which Prof. Packard has accumulated through thirty years of assiduous labour. Though the greater part of the volume, perhaps, is taken up with minute and careful accounts of technical detail, some of the subjects would, we are sure, prove of the greatest interest to every intelligent reader. Thus, on p. 111 the question of how flies and other insects are able to walk up, or run with the body inverted, on smooth surfaces, is dealt with. A series of instantaneous photographs, showing the mode of progression of a beetle, on p. 112, is another instance of information which would be popular anywhere. The theory of insect flight, exemplified also by instantaneous photographs after Marey, is a charming piece of reading, and these are but a few instances which afford evidence enough that the amateur entomologist will find much in this important volume which he will be able to understand and appreciate.

Text-Book of Zoology. By H. G. Wells, B.Sc. (LOND.), F.Z.S., F.C.P. Revised and enlarged by A. M. Davies, B.Sc. (LOND.) (London: W. B. Clive.) 6s. 6d. The changes which have taken place during the five years since Mr. Wells wrote the first edition of his "Text-Book of Biology"—changes not only in the way in which several of the subjects dealt with in the book are regarded, but also in the syllabus of the Intermediate Science Examination of the London University—have made an extensive revision of the volume desirable. This work has been entrusted to Mr. Davies, a teacher who has had great experience in preparing students for the particular examination the requirements of which the book is designed to meet. While keeping to the original plan and method, Mr. Davies has re-written large parts of the book and superintended the re-drawing of the illustrations. Though written for one examination, and consequently somewhat brief in its exposition of important and interesting questions, the book provides a satisfactory introduction to zoology, and with the help of the remarkably clear figures an intelligent student should find his task easy.

SHORT NOTICES.

The Process of Creation Discovered. By James Dunbar. (Watts & Co.) 7s. 6d. We fear that Mr. Dunbar's treatise has length without breadth. After brushing aside the nebular and meteorite hypotheses as false, baseless, incapable of demonstration, and groundless fictions, he enunciates "the new theory of evolution," in which "the only elements employed or necessary in the formation of the sun, solar system, and universe are those composing atmospheric air and water—the two distinct forms of matter which nature invariably employs in all its works, from the largest suns to the smallest asteroids that exist." Our author has devoted ten years to the formation and suitable presentation of his views on this debatable and interminable subject of the evolution of worlds. Those who have plenty of leisure and sufficient curiosity may extract lively entertainment out of Mr. Dunbar's mental somersaults.

Wireless Telegraphy. By Richard Kerr, F.G.S. (Seeley & Co.) Portraits. 1s. At present a widespread interest prevails in wireless telegraphy, and therefore any readable literature on the subject in handy form is welcome. The book before us has been prepared for busy people who have time to do no more than catch a glimpse of the new inventions which are from time to time subordinated to the routine of daily life. A very vivid picture is given of the unique career of Lindsay, who anticipated by half a century the mode of telegraphy which is now attracting so much attention. The merits of the book from a purely technical point of view may be easily conjectured when it is stated that Mr. Preece has contributed an admirable preface, in which he gives a brief history of the latest discovery of electrical science.

What is Science? By the Duke of Argyll. (David Douglas.) Like many other writers on this subject, the Duke of Argyll recognizes the humiliating limitations of scientific knowledge. Although we may revel in so-called great discoveries, and regard with feelings of pride the wonderful advances made during the nineteenth century, we have after all to reconcile ourselves to the fact that we are as far away from the real divination of Nature's phenomena as were our forefathers—our new positions being only so many blind alleys. The reader who likes occasionally to ponder over and compare the known and the unknown will find the Duke good company, and at the same time see by what means our author arrives at the conclusion that the ratio of our scientific knowledge to the fund of information locked up in Nature's casket is as the one grain of sand is to the number of grains of sand on the earth's surface.

Astronomy for the Young. By W. T. Lynn, B.A., F.R.A S. (Stoneman.) Illustrated. 6d. It is doubtful whether such a pamphlet as this would make interesting reading to children. The author endeavours in the space of about sixty very brief pages to make clear to young people the elements of astronomy. When we point out that the earth, the moon, the sun, the planets, comets and meteors, and the stars all come in for a share of this restricted territory, it will be apparent how infinitesimal is the first aid here given to the comprehension of so vast a subject. The day has, we think, gone by when the young could be tempted with such a thin intellectual beverage as Mr. Lynn here offers.

Studies in Plant Life. By Eleanor Hughes-Gibb. (Griffin & Co.) Illustrated. 2s. 6d. An endeavour is here made to treat Botany from the optimistic side, and, as such, the book will afford real assistance to those who can derive pleasure from the study of Nature in the open. Technical terms are studiously avoided, and the reader is taught to look upon a flower as a kind of friend. Such a book as this will tend to rouse in the mind that feeling of awe which the wonders of Nature generally inspire when revealed by a teacher who knows how to present facts to the student. The literary style of the book is commendable, and the volume will be found easy reading to all classes of knowledge-hunters.

Teachers who are in the habit of imparting instruction by the aid of natural objects would do well to acquaint themselves with some cabinets of animal, vegetable, and mineral produce put together for this purpose by Messrs. Cox & Co. These cabinets contain from two to three hundred, or more, good specimens of the elements, ores, foodstuffs, manufactured articles, oils, gums, and so on, which are of daily use in life, and each of which, with the aid of notes supplied in a handbook, is sufficient for a lesson. By this arrangement a large amount of material is neatly and orderly stowed away in a presentable case, portable enough to be easily carried about—a system in pleasing contrast with the higgledy-piggledy way in which food for the mind is heaped up in some seminaries.

BOOKS RECEIVED.

Celestial and Terrestrial Globes, in case. (Philips.) 12s. 6d.

The Secret of the Poles. By H. Champion. (White & Pike.) Illustrated. 1s. net.

Diet and Food. By Alexander Haig. (Churchill.) Illustrated. 2s.

Practical Mechanics. By S. H. Wells. (Methuen.) 3s. 6d.

Provident Societies and Industrial Welfare. By E. W. Brabrook. (Blackie.) 2s. 6d.

The Structure and Classification of Birds. By F. E. Beddard, F.R.S. (Longmans.) Illustrated. 21s. net.

Aids in Practical Geology. By Prof. Cole. (Griffin.) Illustrated. 10s. 6d.

Eclipses of the Moon in India. By Robt. Sewell. (Sonnenschein.) 10s. 6d. net.

Second Stage Mathematics. By W. Briggs. (Clive.) 3s. 6d.

The Discharge of Electricity through Gases. By J. J. Thomson, F.R.S. (Constable.) 4s. 6d. net.

The Living Organism. By Alfred Earl. (Macmillan.) 6s.

Social and Political Economy. By Thos. Judge. (Simpkin.) 3s. 6d.

Skiagraphic Atlas. By John Poland. (Smith, Elder.) 5s.

Carpentry and Joinery. By F. C. Webber. (Methuen.) 3s. 6d.

Seismology. By John Milne, F.R.S. (Kegan Paul.) 5s.

Qualitative Chemical Analysis. By Chapman Jones. (Macmillan.) 6s.

The Illustrated Annual of Microscopy. (Percy Lund & Co.) 2s. 6d.

The Reliquary and Illustrated Archæologist. (Bemrose.) 12s.

Skertchly's Geology. Revised by J. Monckman. (Murby.) 1s. 6d.

Report of the South-Eastern Union of Scientific Societies, 1898.

THE SMELL OF EARTH.

By G. Clarke Nuttall, B.Sc.

A BRIGHT fine evening after a day of rain is one of Nature's compensations. The air is peculiarly sweet and fresh, as though the rain had washed all evil out of it. The mind, relieved from the depressing influence of continuous rain, is exhilarated, and, above all, the strong smell of the earth rises up with a scent more pleasing than many a fragrant essence. In the town, indeed, this earthy smell is often obscured by the bricks and mortar which cover the land, and by the stronger, less wholesome, odours of human life, but in the country it has full sway, and fills the whole air with its presence. Even a slight shower, particularly after drought, is sufficient to bring out the sweet familiar smell of the land and thrust it upon our notice.

The smell of freshly-turned earth is often regarded by country lovers as one of the panaceas for the ills of the flesh, and "follow a plough-share and you will find health at its tail" has proved a sound piece of advice to many a weakly town-sick one, over whose head the threatenings of consumption hung like the sword of Damocles, though it is possible that it is the fresh air, and more especially the sunshine, which are the saving media, and not the mere smell.

But what do we know about this characteristic smell of the soil? Can we regard it as the mere attribute of the soil as a simple substance, such an attribute as is, for instance, the peculiar smell of leather, or the odour of indiarubber; or can we go deeper and find that it is really an expression of complexity below?

Strangely enough this is the case, for the smell of damp earth is one of the latest signposts we have found which lead us into a world which, until recently, was altogether beyond our ken. It points us to the presence, in the ground beneath us, of large numbers of tiniest organisms, and not merely to their presence only, but to their activity and life, and reveals quite a new phase of this activity. A handful of loose earth picked up in a field by the hedgerow, or from a garden, no longer represents to us a mere conglomeration of particles of inorganic mineral matter, "simply that and nothing more"; we realise now that it is the home of myriads of the smallest possible members of the great kingdom of plants, who are, in particular, members of the fungus family in that kingdom, plants so excessively minute that their very existence was undreamt of until a few years ago.

Some faint idea of their relative size, and of the numbers in which they inhabit the earth, may be gleaned from the calculations of an Italian, Signor A. Magiora, who, a short time ago, made a study of the question. He took samples of earth from different places round about Turin and examined them carefully. In ordinary cultivated agricultural soil he found there would be eleven millions of these germs in the small quantity of a gramme, a quantity whose smallness will be appreciated when it is remembered that a thousand grammes only make up about two and a quarter pounds of our English measure. Thus, a shovelfull of earth would be the home of a thousand times eleven millions of bacteria—but the finite mind cannot grasp numbers of such magnitude. In soil taken from the street, and, therefore, presumably more infected with germs, he calculated that there was the incredible number of seventy-eight million bacteria to the gramme. Sandy soil is comparatively free from them, only about one thousand being discovered in the same amount taken from sandy dunes outside Turin.

But though the workers were hidden yet their works were known, for what they do is out of all proportion to what they are; in fact they perform the deeds of giants, not those of veriest dwarfs. "By their works shall ye know them" might be a fitting aphorism to describe the bacteria of the soil. And the nature of their deeds is widely various, for though the different groups are members of one great family, yet, like the individuals of a human family that is well organized, they have each of them their special vocation. In the spring time, when the sun warms the chilly earth, they act upon the husks that have protected the seeds against the rigours of the winter, and crumble them up so that the seedling is free to grow; they break down the stony wall of the cherry and plum which has hitherto imprisoned the embryo; and then, when the young plant starts, they attach themselves to its roots, assist it to take in all sorts of nutriment from air and soil, and thus help it in its fight through life, and when its course has run they decently bury it. They turn the green leaves and the woody stem and the dark root back into the very elements from which they were built up; they effect its decay and putrefaction, and resolve it into earth again. "Dust to dust, ashes to ashes," is the great life work of the earth bacteria.

But up to the present the fresh smell of the earth, the smell peculiar to it, has not been in any way associated with these energetic organisms, and it is quite a new revelation to find that it is a direct outcome of their activity. Among the many bacteria which inhabit the soil, a new one, hitherto unknown, has been just recently isolated and watched. It lives, as is usual with them, massed into colonies, which have a chalky-white appearance, and as it develops and increases in numbers it manifests itself by the familiar smell of damp earth, hence the name that has been given it—*Cladothrix odorifera*. Taken singly it is a colourless thread-like body, which increases numerically by continuous sub-divisions into two in the direction of its length. It derives its nutriment from substances in the soil, which either are, or have been, touched by the subtle influence of life, and in the processes of growth and development it evolves from these materials a compound whose volatilizing gives the odour in question. This compound has not yet been fully examined; it is not named, nor have all its properties been satisfactorily elucidated, but two facts concerning it stand out clearly. One is that it is the true origin of the smell that we have hitherto attributed to earth simply; and the other, that it changes into vapour under the same conditions as water does. Therefore, when the sun, shining after the rain, draws up the water from the earth in vapour form, it draws up, too, the odorous atoms of this newly-found compound, and these atoms, floating in the air, strike on our olfactory nerves, and it is then we exclaim so often, "How fresh the earth smells after the rain."

Though moisture, to a certain extent, is a necessary condition of the active work of these bacteria, yet the chief reason why the earthy smell should be specially noticeable after the rain is probably because this compound has been accumulating in the soil during the wet period. We only smell substances when they are in vapour form, and since the compound under consideration has precisely the same properties in this respect as water, it will only assume gaseous form when the rain ceases. The bacteria have, however, been hard at work all the time, and when the sun shines and "drying" begins, then the accumulated stores commence their transformation into vapour, and the strong smell strikes upon our senses. For the same reason we notice a similar sort of smell, though in a lesser degree, from freshly-turned earth. This is more moist than the earth at the surface, and hence, on exposing it, evaporation immediately begins, which quickly makes itself known to us through our olfactory nerves.

It may also have been remarked that this particular odour is always stronger after a warm day than after a cold one, and is much more noticeable in summer than in winter. This is because moderate warmth is highly conducive to the greater increase of these organisms, and, in fact, in the summer they are present in far larger numbers and exhibit greater vitality than in the winter, when they are often more or less quiescent.

Two other characteristics of *Cladothrix odorifera* are worthy of notice as showing the tenacity with which it clings to life. It is capable of withstanding extremely long periods of drought without injury; its development may be completely arrested (for water in some degree is a necessity with all living things, from highest to lowest) but its vitality remains latent, and with the advent of water comes back renewed activity. But besides drought it is pretty well proof against poisons. It can even withstand a fairly large dose of that most harmful poison to the vegetable world, Corrosive Sublimate. Hence any noxious matter introduced into the soil would harm it little ultimately; the utmost it could do would be to retard it for a time.

This, then, is the history of the smell of earth as scientists have declared it unto us, and its recital serves to further point the moral that the most obvious, the most commonplace things of everyday life—things that we have always taken simply for granted without question or interest—may yet have a story hidden beneath them. Like signposts in a foreign land, they may be speaking, though in a language not always comprehended by us, of most fascinating regions, regions we may altogether miss to our great loss, if we neglect ignorantly the directions instead of learning to comprehend them.

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THE HOOKS ON THE MANDIBLE OF THE HONEY BEE AND THE GIZZARD OF THE ANT.

By Walter Wesché.

In Knowledge for October, 1895, will be found a drawing from my pencil of the hooks on the mandible of the honey bee, which is the only occasion, so far as the writer knows, that this process has been figured. The hooks are nine in number, and in many mandibles carefully examined I have not found this number to vary; they are absent in the queen and the drone, and in all the wild bees that I have had an opportunity of inspecting. The rib of chitine running across the hollow of the mandible is present, as are also hairs (in some large humble bees short and bristly), but not in any degree modified to the form of hooks; neither is there any indication of their presence on the mandibles of the common wasp or hornet.

What their use is, is at present unknown. Mr. Frederick Enock says that they are undoubtedly highly specialized, and he "can only wonder at their object." Sir John Lubbock did not know of them, and had no idea as to their use. Mr. T. W. Cowan, to whom I had the pleasure of showing them, now agrees with me that they are hooks, and highly specialized, and says that they possibly may be used in drawing out wax, the mandible undoubtedly being used in cutting it, when forming the comb. I hazarded a suggestion in 1895 that they might be used in clustering, by hooking on to the claws of the bee above, but I understand that this theory is not tenable. Perhaps, after all, they may be of the same use to the bee, as is the iron hook to the man who has lost a hand, and be used in drawing objects out of the hive, or in the care and removal of larvæ—but whatever their use, it must be one of great importance to the worker bee, as otherwise it is impossible to account for their modification—an importance equalling that which has developed the hooks on the wings.

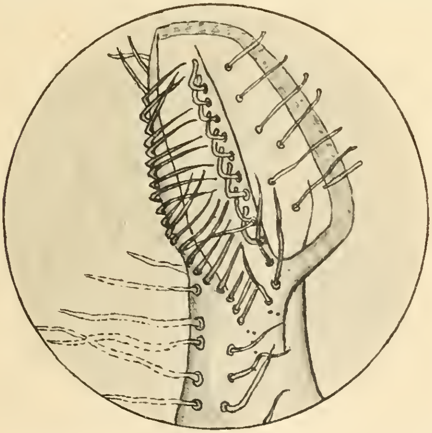

Fig. 1.—Hooks on the Mandible of the Honey Bee (*Apis melifica*) × 140.

The Gizzard of an Ant.

This has been many times figured and described. In McCook's most interesting work on the honey ant of California, there is an elaborate drawing of the intestine and gizzard. The drawing here reproduced is from *Lasius niger*, the common black ant of our gardens, seen often stroking and "milking" the aphides. The gizzard is very much the same in appearance as that of the honey ant, but the latter is stated to be chitinous, while the gizzard of *L. niger* seems to me to be calcareous, though I have been unable to verify this by chemical test. It is very brittle, will not take methyl blue stain, and cannot be recommended as a good microscopic object, as the edges will not define, or at any rate I failed to make them. In texture it reminded me of the "dart," in the sexual organs of the common snail.

Fig. 2.—Gizzard of Ant (*Lasius niger*) × 100.

In this case also, the use of the organ is not known; ants are generally supposed to feed on fluids, and I believe a good deal of discussion has taken place at various times on the subject.

The organ consists of four separate parts, the lower portion of each being far less soluble in a solution of caustic potash than the upper—and I have often found the upper part quite dissolved away in the preparation of a whole mounted insect. I have not been able to find the gizzard in the common sugar ant (*Diplorhoptrum domestica*), or in *Myrmica lævinodis*, both of which have stings, though this seems no bar to its presence, as the honey ant has also a sting.

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BOTANICAL STUDIES.—VI.

SELAGINELLA.

By A. Vaughan Jennings, f.l.s., f.g.s.

The life-history of the little spleenwort, which formed the subject of our last study,[*] showed that in the true ferns the plant with which we are familiar is the real Sporophyte generation. The fern-plant proper produces no Archegonia and Antheridia, such as our previous examination of the moss might have led us to expect; but a large number of similar spores are developed in simple spore-cases on the

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[*] Knowledge, September, 1898.

under sides of the fronds. If the spores are allowed to germinate under proper conditions they grow into little green cellular structures, the so-called *Prothalli*, which lead a short but independent existence, form true Archegonia and Antheridia, and constitute, therefore, the real *Oöphyte*, or egg-bearing stage in the life-cycle. In other words, the Oöphyte is a reduced, simplified, and transitory stage in comparison with the highly-specialized, long-lived Sporophyte which we see at its highest in the tree-ferns of the Tropics.

If we look round for other types to help us in tracing the course of development of higher plant-life, we naturally turn first to those relatives of the ferns which are commonly known as the "horse-tails," "club-mosses," "quillworts," and "pill-worts." Of all these, there is no doubt that we can most easily obtain the information we want from observation of the genus *Selaginella*.

The species included under this name are for the most part spreading, low-growing plants with creeping stems, sending off more or less upright shoots. The structure of their tissues is in general like that of ferns: they have a well developed fibro-vascular system; leaves (usually of two kinds) of several cell-layers in thickness and with distinct midribs; and roots developed on slender cylindrical outgrowths of the stem known as *rhizophores*.

In our own country we have only one species, *S. selaginoides*, which is not uncommon in the moist and rocky parts of our mountain districts. So many foreign species are, however, now in cultivation and easily obtainable, that there can be no trouble in getting material for study. The specific differences are mainly those of leaf arrangement and internal stem structure, and will raise no difficulty in our line of observation. Several of the illustrations here used are of *Selaginella spinulosa*, A. Br., a common species in the Swiss mountains, not unlike our native form in size and general habit.

If we commence, as in the case of the fern, by looking at the mature plant (Figs. I and K), with a view to finding the nature of its reproductive organs, we find that toward the tips of the erect shoot the leaves are closely crowded together, forming spikes or cones.

These leaves do not show any brown groups of spore-cases on their under side like the fern-fronds, but if they are stripped off, or if a section is cut along the axis of the spike, it will be found that they differ from the ordinary leaves in bearing a very distinct sporangium at the inner and upper aspect of the leaf base. Closer observation shows that these sporangia are distinctly of two kinds. Those nearer the tip are transversely oval, single-chambered sacs; green at first, then yellow, splitting across when ripe and discharging a yellow dust (Fig. M). Those nearer the base of the cone are larger, and each consists of four rounded or slightly angular lobes, one resting on the other three in the manner in which the round cannon balls of olden artillery were piled; or, to put it geometrically, the centre of each corresponding in position to one of the solid angles of a tetrahedron.[*]

Here, then, we meet with a very distinct difference between this plant and the fern. There are two kinds of sporangia instead of one. The next step is to look at the contents of these two sporangia.

At the base of the cone, if it is fairly ripe, some of the "tetrahedral" groups will be found in the act of splitting along the lines separating the four lobes, and it will be seen that each segment contains a single large spore. This spore is rounded externally, but flattened somewhat on the three internal faces where it was in contact with its sister spores, and its external coat is covered by angular projections. The contents of the upper, simple spore-cases appear as a yellow dust; but if this is looked at with a microscope it will be found to consist, not of single spores, but of groups of four, arranged in the same "tetrahedral" fashion as the large ones. There are, then, two kinds of spore as well as two kinds of sporangia. The smaller are termed *Microspores*, and their cases, *Microsporangia*. The larger are known as *Macrospores*, and, similarly, their enclosing envelopes as *Macrosporangia*.[*]

These fern-like plants with two kinds of spores are called *Heterosporous*, while those with only one kind, such as the true ferns, are known as *Homosporous*. The distinction is not one of merely descriptive value for the purposes of the systematic botanist, but represents a fundamental differentiation of the greatest importance. This will be seen clearly if, as in the case of the fern, we follow the germination and resulting growth of these different spores.

When macrospores have been kept for some time on moist soil, it will be found that the thick protective wall has split, and there is a small projection of soft colourless tissue at the ruptured tip. No green leaf-like cell plates, similar to the fern-prothallus, make their appearance; yet in time young green seedlings of Selaginella, with upgrowing stems, and the characteristic rows of leaves, make their appearance, evidently rising from the macrospore. The fact that such young Selaginella-sporophytes seem to arise directly from a macrospore suggests two possibilities. Either the Oöphyte, or egg-bearing generation, has been entirely lost (in which case we have no explanation of the microspores), or it is so much reduced and concealed as only to be discoverable by careful microscopic investigation. The latter is the true explanation.

Even before the rupture of the spore-wall in germination, the protoplasmic contents of the spore, rich in food materials, will be found to be in part sub-divided by cell walls, forming a definite, if minute and simple, tissue. Similarly, the little colourless papilla which projects from the germinating spore is a distinct cellular outgrowth, and will be found to bear on its margin organs like the archegonia of the fern oöphyte, though less definite in outline and less complete in structure. We have, in fact, a small and simplified prothallus; one that commences its growth within the parent spore; is fed by the food material contained in the spore, never developing roots and green colouring-matter so as to lead an independent existence, but yet containing the egg-cells necessary for the continuation of the plant's being. The diminishing importance of the oöphyte stage observed in the ferns is here carried a step further. The prothallus is no longer a separate and individual plant, but is reduced to a small, colourless group of cells, living at the expense of the food material stored up in the spore.

In the fern it will be remembered that all the spores were alike; that all, on germination, could produce green prothalli; and that all of these were similar, and produced both archegonia and antheridia. It is true that in some genera prothalli are produced which bear only antheridia, but this seems to be only an abnormal condition, changeable by alteration of surrounding conditions, and

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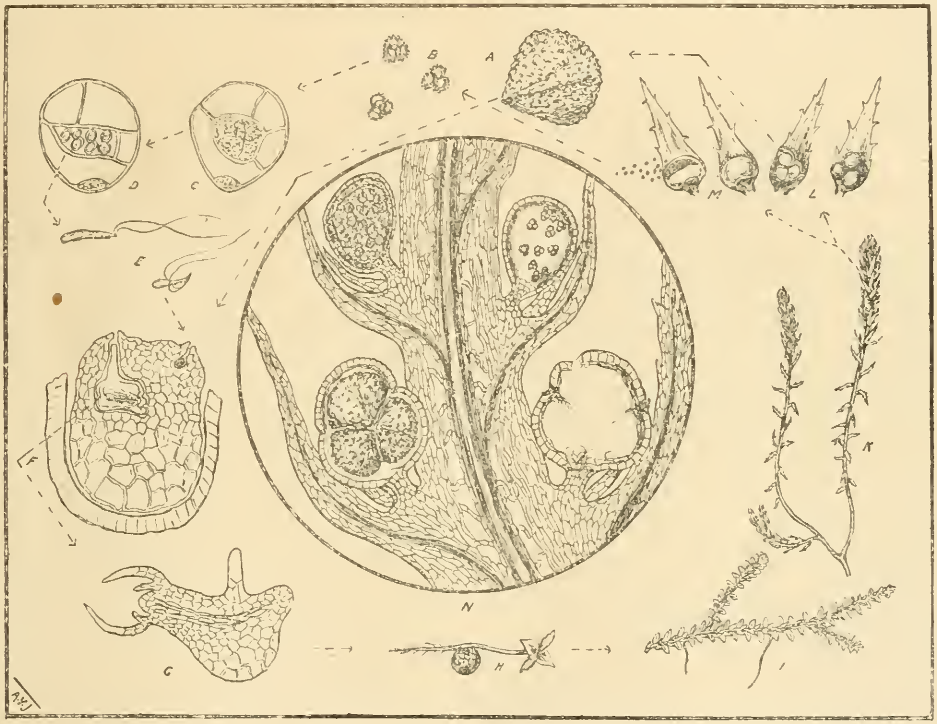
[*] This tetrahedral arrangement results from a difference in the division-planes of the cell from which the spore-group is formed. Thus, if a spherical cell is divided by a transverse wall, and the two segments become rounded off, a pair of cells like a figure eight is produced. If now each of these becomes similarly divided, but one in a horizontal plane and the other in a vertical one, it is evident that the resulting cells will naturally acquire this peculiar grouping.

[*] The terms *Megaspores* and *Megasporangia*, recently introduced, are more classically accurate, but the meaning in this case is identical.

by no means constant. As a general rule one may say that the "homosporous" condition in the ferns is always associated with an independent prothallus, producing both archegonia and antheridia. Here we have large special spores that produce rudimentary prothalli bearing egg-cells.

It is natural, therefore, to turn to the microspores to discover the origin of the spermatoids which fertilize these egg-cells; and it is not difficult to assure oneself that such spermatozoids are developed from the microspores. A very close study of the changes taking place within these spores is necessary to a full understanding of their nature, and requires more elaborate observation. Such examination leads, however, to this conclusion: that the whole contents of the microspore are not used up in the formation of the spermatozoid. The early division of the microspore contents shuts off a portion, the so-called "vegetative cell," which seems to be of no further use. There is still, that is to say, inherent in the spore, the tendency to develop a prothallus-tissue, but this never grows to any extent. It remains merely as a vestige—a remnant of the ancestral cell-tissue on which the antheridia were formed.

The spermatozoids are set free by the breaking of the spore-wall, and the development of the embryo-plants resulting from their contact with the egg-cells can be observed in sections of prothalli in their later stages. The dividing egg-cell soon becomes a definite cell-tissue, in which can be distinguished the young stem growing-point with its first-formed leaves, the commencing root, and a row of cells known as the *suspensor*, which is of interest as occurring here and in higher plants, but not in other cryptogams. The details of development of this little embryo from the egg-cell are very complicated, but for our present purpose we need only note that it can be traced through its various stages to such a form as Fig. H, and that this in turn grows into the Selaginella plant.



A.—Macrospore of *Selaginella spinulosa*, A. Br. B.—Microspores of the same species. C. and D.—Stages in the division of a Microspore: the mother-cells of the Spermatozoids in the centre, the "Vegetative," or "Prothallus" Cell at the lower pole. E.—Spermatozoids. (Highly magnified.) F.—Section of a Macrospore after germination, showing the Cellular Mass (Prothallus) produced by the sub-division and outgrowth of its contents. On the right side above is an unfertilized Archegonium, and on the left side a developing embryo, resulting from fertilization of a similar organ. G.—Later stage of an Embryonic Plant. The apical growing point, with a pair of young leaves and ligules, to the left. H.—A young Sporophyte of *S. helvetica*. I. K.—Procumbent and ascending portions of the mature Sporophyte of *S. spinulosa*. The terminal leaves of the up-growing shoots bear the Sporangia at their bases, and are crowded together to form a spike or cone. L and M.—Detached leaves from the fertile spike, showing the Macro- and Micro-Sporangia, entire and dehiscent. N.—Part of a section through a fertile spike of *S. spinulosa*, showing in different stages of development the Microsporangia above and Macrosporangia below. [Fig. C, D, E, after Belajeff; F and G, after Pfeffer; H, after Bischoff. The rest original.]

The question of the origin of the heterosporous type is full of interest, but we have little evidence to indicate the lines of its evolution. It is impossible to say whether a tendency to differentiation of the spores into two kinds brought about the separation of sexes in the prothalli, or if the acquirement of diœcious conditions in the oöphyte stage was followed by modification of the spores. That the establishment of the heterosporous condition dates far back in the world's history is proved by the fossils of our coal-fields, which show that it existed in some of the great tree-like ancestors of Selaginella and its allies, which flourished in the swamps round the Carboniferous seas.

All we can pretend to show in this sketch is that this little mountain "moss," so much less conspicuous than its cousins the ferns, yet contains, for those who care to look at it, the evidence of a great change in organic evolution, which has modified the whole course of plant development, and made our trees and flowers what they are to-day.

It is possible that among the upland districts that form the home of the little Selaginella we may find a better known and more conspicuous member of the plant-world to supply the next link in the chain.

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NOTES ON COMETS AND METEORS.

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

Comet Perrine-Chofardet.—This comet was discovered on September 13th by Perrine, and on the following night by Chofardet. It was visible in the morning sky, and situated a few degrees north of the "sickle" of Leo. Moving rather quickly to the south-east, in the direction of the sun, it was increasing in brilliancy, but assuming a position much less favourable for its observation. It came to perihelion on October 20th, and in November its motion will have carried it so far into the southern sky that it will cease to be visible in our latitude. The following is from an ephemeris by Berberich (*Ast. Nach.* 3520).

Date.		R.A.		Declination.		Distance in millions of miles.	Brightness.
1898.		h.	m.	°	′		
October	18	13	29·8	− 6	10	128	8·7
November	3	15	25·9	27	44	131	4·0
,,	19	17	27·0	38	42	145	1·3
December	5	19	12·5	−40	36	170	0·5

Wolf's Comet is moving slowly to the south-west in Monoceros, but it is a faint object even in powerful telescopes.

The Expected Shower of Leonid Meteors.—The absence of moonlight at the middle of November is a highly favourable circumstance, and a pretty abundant display of meteors should be observed if the weather is clear on the morning of November 15th. In 1832, November 12th, Dawes observed "most astonishingly brilliant meteors from the east, with little intermission for about an hour, when a thick fog supervened." In 1865 many meteors were seen at Greenwich and other places, but the shower could not rank as one of first-class importance. Though 1899 and 1900 will furnish the richest displays, there will be many of these objects seen in the present month. Observations should not be commenced before 11 p.m., as the radiant will not rise until shortly before that hour, and the most brilliant exhibition of meteors will probably occur in the early hours of the 15th. But a look out should be maintained also on the mornings of November 14th and 16th, especially by those observers who wish to study the scientific aspects of the phenomenon. There will probably be more Leonids seen than Perseids in a pretty active return of the August stream; but we are scarcely justified in assuming that the shower will furnish its thousands of meteors as it did in 1833 and 1866, for the earth traverses the orbit at a point considerably in front of the parent comet, and we know that the most profuse distribution of its material lies on the following or rear side of the comet. Those who watch the ensuing return of the meteors will do well to trace them on several nights and to accurately determine their radiant point, horary number, and time of maximum for each date. In *Ast. Nach.*, No. 3516, E. Abelmann, of St. Petersburg, gives the results of his investigation of the orbit of the associated comet (Tempel 1866 I.) and meteoric swarm. He corroborates the previous researches of Adams and Newton, and concludes that the orbits of the meteors and parent comet have nearly coincided with each other from a very remote time. He finds that the longitude of the node is increased 31·5′ during one revolution, or about 1·5° in a century. "As the stream has been observed for about one thousand years, its line of apses has revolved in that time about fifteen degrees, but a glance at the form of the orbit shows that this motion of the apse would alter the solar distance of the stream at the descending node very little from the earth's distance from the sun, so that for many ages yet the continued visibility of the star shower will not be thereby affected. In front of the comet there seems to be no train of dense matter, as at its passage through the node in 1865, the earth was at a comparatively small distance from the comet, and meteors were only remarked in small abundance. At the earth's passage through the node in 1867, again, only a meagre meteoric display was visible." Prof. Abelmann seems to have overlooked the splendid showers of Leonids seen in America both in 1867 and 1868, and has apparently also underrated the strength of the system in that part of the orbit which precedes the cometary nucleus. The observation in 1898 ought to produce important evidence on the latter point.

The Meteoric Shower of Biela's Comet.—This event, so brilliantly presented in 1872 and 1885, and seen in fairly conspicuous character in 1892, may return again in 1898, on November 23rd or 24th. But the period of six years, elapsed since 1892, is less than that of the parent comet, though the year 1898 corresponds with the thirteen-year interval between 1872 and 1885. The average period of Biela's comet, derived from observations between 1772 and 1852, was 6·71 years, but the time was apparently shortening, for between 1772 and 1826 it was 6·76 years, while between 1826 and 1852 it was only 6·62 years. It is most unfortunate that the comet has not been re-observed since 1852, and that we can only judge its exact whereabouts by the most brilliant return of the meteoric system with which it seems to be intimately connected. On November 23rd next the earth will probably become involved in that section of the stream just preceding the comet, and the shower may quite possibly be a very plentiful one, for in 1838 the earth crossed the orbit far in the van of the comet, and yet a rich display occurred. But the precise character of the approaching *rencontre* cannot be defined. The period of thirteen years between the shower of 1872 and 1885 may not apply with equal force to future returns. In 1872 the earth was immersed in the material lying in the wake of the comet, while in 1885 it was involved with that in front of it, so that in 1898 we shall pass yet further in front, and possibly too far in advance of the cometary nucleus to witness a really imposing flight of meteors. If, however, the period of revolution has decreased since 1852, and the meteoric stream is in process of distending itself along the orbit, then a fine display may occur this year. In any case, it should be attentively looked for on the nights of November 23rd and 24th. The moon will be in a gibbous phase, and visible during the greater part of the night. There will, however, be several hours of dark sky before sunrise, and these should be fully utilized. The radiant point of the shower, being near γ Andromedæ, is visible during the whole night. Prof. Abelmann has recently pointed out, as Schulhof had previously done, that a great disturbance of this system will be felt in 1901–2 by a near approach to Jupiter. The node will be decreased 6·2 degrees, so that a shower will, for some years thereafter, occur on November 17th. In 1904 or 1905 it may be possible to witness the Leonids and Andromedes in simultaneous play. This will provide an interesting event and allow comparisons to be made between the swift streak-leaving meteors and the slow-trained meteors, for the visible aspect of the objects forming the two systems are as widely dissimilar as they can well be. Every meteoric observer will, we are assured, be on the alert on November 15th and 23rd-24th next, in order to gather as many facts as possible of the phenomena that will be displayed. I am inclined to believe that the Leonids will be best seen soon after midnight on the night following the 14th, while the Andromedes will be most numerous just before sunrise on the 24th, or in the early evening of that date.

THE FACE OF THE SKY FOR NOVEMBER.

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

Recent experience seems to indicate that the Sun will be well worth careful observation for spots and faculæ, and, in the event of a large spot making its appearance, auroræ may be looked for about the time of its passage across the central meridian.

Mercury is an evening star throughout the month, but he is too far south for easy observation in our latitudes. He will be at greatest eastern elongation (21°) on December **3rd.** On November **20th,** at 8 a.m., he will be in conjunction with Venus, Mercury being 1° 18′ to the north.

Venus is an evening star, but, on account of her great southerly declination, is badly placed for observation after sunset. She will be stationary on the **11th** at 10 a.m., and will afterwards rapidly approach inferior conjunction, which is due on December **1st** at 5 p.m. At the beginning of the month she sets about a hour later than the Sun.

Mars rises late in the evening in the north-east, and, as will be seen from the diagram given last month, he traverses an eastward path through Cancer. During the month his apparent diameter increases from 8·8″ to 11·2″, and his horizontal parallax from 8·4″ to 10·5″. On the **8th** his distance from us will be the same as that of the sun. At the middle of the month 0·9″ of his disc will be illuminated. He will rise about half-past nine on the **1st,** and about eight o'clock at the end of the month.

Jupiter is a morning star, but he is not sufficiently removed from the Sun to permit observations of his satellites before the **12th.** At the middle of the month he rises about two and a half hours before the Sun, his apparent diameter being only 28·8″.

Saturn remains an evening star during the month, but the time of conjunction with the Sun is so near that he can scarcely be regarded as observable to those who have not a perfectly clear horizon to the south-west. At the middle of the month he sets about an hour after the Sun.

Uranus is an evening star until the **25th,** when he arrives at the point of conjunction with the Sun. He may be considered as not observable.

Neptune rises shortly before 7 p.m. at the beginning of the month, and about 5 p.m. towards the end. He is a little more than 1½° north-east of ζ Tauri.

The Moon will enter her last quarter on the **6th** at 2.28 p.m.; will be new on the **14th** twenty-one minutes after midnight; will enter her first quarter on the **20th** at 5.5 p.m.; and will be full on the **28th** at 5.32 a.m. The most interesting occultation during the month will be that of 19 Piscium, Mag. 5·2, which will take place at a convenient time on the **22nd.** The disappearance will occur at 7.9 p.m., at a point 25° east of the north point (30° from vertex); and the reappearance at 8.13 p.m., at 268° east of the north point (260° from vertex).

Conveniently observable minima of Algol will occur on the **17th** at 10.12 p.m.; and on the **20th** at 7 p.m.

Mira Ceti will probably remain a naked eye star throughout the month.

Attention may be called to the recent development of the central condensation of the Great Nebula in Andromeda, which is now well situated for observation. This is not a reappearance of the "new" star of 1885, but is probably a temporarily increased brightness of the central point of the nebula, which is known to be variable.

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 October Problems.

No. 1.

(By J. Jespersen.)

1. K to B2, and mates next move.

No. 2.

(By C. Planck.)

Key-move—1. Kt to B6.

If 1 . . . K×Kt (B6),	2. Q to B6ch, etc.
1 . . . K×Kt (Kt6),	2. Q to B4, etc.
1 . . . P (or B) ×Kt (Kt6),	2. Q to K5ch, etc.
1 . . . B×P,	2. Q×KtPch, etc.
1 . . . P×Kt (B6),	2. Kt to R4ch, etc.
1 . . . B to Ktsq, etc.,	2. Q to B4ch, etc.

Correct Solutions of both problems received from H. Le Jeune.

Of No. 1 only, from G. G. Beazley, A. E. Whitehouse, Alpha, W. W. Stead, W. Clugston, W. de P. Crousaz.

Of No. 2 only, from H. S. Brandreth.

[The above pair have evidently proved very difficult. One of the most expert of our solvers at first pronounced the two-mover beyond him.]

Abdul Hamid.—If 1. K to Q3, the Pawn checks.

H. S. Brandreth.—1. P to B7 is met by K to B5.

G. F. T.—After 1. Kt to Kt6ch, K to K3; 2. Kt to Kt5ch is not mate.

Alpha.—The composers should be proud.

A. Firth.—Book of games received with thanks and noticed below.

A. C. Challenger.—Congratulations on your double success. Thanks for the problems. We are inclined to doubt our solvers endorsing your opinion as to the sui-mate being "not difficult."

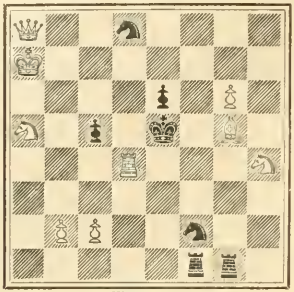
N. E. Meares.—Problems received with thanks. We will examine, and hope to publish them shortly.

PROBLEMS.

No. 1.

By A. C. Challenger.

Black (7).



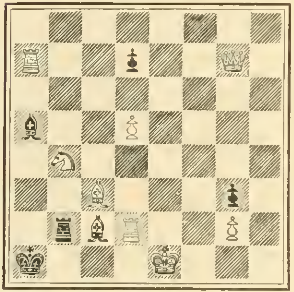
White (9).

White mates in two moves.

No. 2.

By P. H. Williams.

Black (5).



White (9).

White compels Black to mate in six moves.

[Black's first three moves are forced; after that there are two variations.]

We have received a little book of sixty pages, entitled "Games of the Counties and Craigside Chess Tournament, 1898." It will be remembered that Mr. A. Burn was the winner of this tournament last Christmas, Mr. Bellingham being second. These two players, in conjunction with Mr. H. E. Atkins, the amateur champion, have annotated nearly the whole of the games in this selection. There is a report of the tournament, and a photograph of all the players engaged. It is an excellent shilling's worth, obtainable at that price from the Hon. Sec., Mr. A. Firth, Bryn-y-Bia, Llandudno.

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CHESS INTELLIGENCE.

The Amateur Tournament at Salisbury, promoted by the Southern Counties Chess Union, was successfully concluded on September 20th. The score sheet in Class I. reads as follows:—

J. H. Blake (Southampton)	7½	Tie for 1st and 2nd.
W. Ward (City of London)	7½	
W. H. Gunston (Cambridge University)	7	3rd prize.
G. E. H. Bellingham (Dudley) ...	6	4th prize.
Dr. Bleiden (City of London)	5½	
R. Loman (Metropolitan)	5½	
F. J. H. Elwell (Southampton) ...	5	
C. H. Sherrard (Stourbridge)	4½	
B. D. Wilmot (Birmingham)	3½	
A. Rumboll (Bristol)	2	
A. L. Stevenson (Kent)...	1	

It will be seen that the scoring at the top was extremely close. Mr. Gunston, who played better than he has in public for some time past, led for the greater part of the contest. Mr. Bellingham took some risks against the three players above him, and lost to them all. An accident had also affected his health, and is sufficient to account for his comparatively low position. Mr. Wilmot did not do nearly so well as at Craigside in the winter. The remainder came out roughly in order of merit. In Class II., Mrs. Fagan, of the London Ladies' Club, secured a most creditable victory with the fine score of nine wins and two losses.

It now seems certain that an international tournament will be held in London next year; £500 has already been subscribed. It will probably be a two-round tournament, limited to sixteen or eighteen players.

Mr. Steinitz recently played nineteen games simultaneously at the Hastings Chess Club, winning sixteen and drawing the other three.

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CONTENTS.

EDITORIAL.

Upon completing with the present issue the twenty-first volume of Knowledge, the duty again devolves upon us of offering our acknowledgments to the host of friends who have so kindly contributed to our columns during the year; and also our assurance that the vigorous child conceived in the fertile brain of Richard A. Proctor has attained its majority (in volumes though not quite in years), in perfect health and strength; and, further, that it enters upon its future full of promise, and confident, at least, that it will seek to deserve a continuance of that hearty support so freely accorded it in the past.

In presenting the customary announcement of some of the leading projects included in our New Year's work, we have first to say that the January Number will contain a beautiful drawing of Saturn specially drawn for us by Mons. E. M. Antoniadi, who will also contribute an article entitled "Considerations on the Planet Saturn"; and that further photographic plates are in our hands from Dr. Isaac Roberts. The spectroscopic results obtained during the recent solar eclipse will, of course, be fully considered in our columns as soon as they have been worked out; and Mr. Maunder is arranging for a continuance of the photographic studies of the lunar surface.

Much attention will be given during the next two or three years to meteorological and cometary astronomy, as these branches of our work are entering upon an important epoch. We have accordingly arranged with Mr. W. F. Denning to continue his interesting column of Notes on Comets and Meteors. The Face of the Sky will be limned each month by Mr. A. Fowler, who has conducted this column with so much care since the lamented death of Mr. Herbert Sadler. We hope the following writers will also be found among our astronomical contributors in 1899:—Miss Agnes M. Clerke; Mons. C. Easton; Mr. J. Evershed; Mr. J. E. Gore; Prof. E. C. Pickering; and Mr. W. Shackleton.

The Rev. Thomas R. R. Stebbing, who has been portraying the Karkinokosm during the year with such marked success, purposes to complete the general outline of the study in two more chapters, and then to add some touches of light and shadow to the picture in subsequent essays.

Sir Edward Fry and Miss Agnes Fry have written a monograph, which will appear in Knowledge during the year, on "The Mycetozoa, and some questions which they suggest." The articles on these very interesting organisms, which are referred neither to the plants nor to the animals, will be fully illustrated from drawings by Miss Fry.

Prof. Grenville A. J. Cole has formulated a new series of original geological papers under the general title of "Secrets of the Earth's Crust"; and arrangements are in progress for the appearance of a new series of original studies on the "Treatment and Uses of Anthropological Data," with the object of stimulating interest in a somewhat neglected subject.

Commencing with the January Number, Mr. J. H. Cooke will contribute a monthly column of Notes devoted to Practical Microscopy; and among further contributions may be mentioned a series of articles on Electricity; "Two Months on the Guadalquivir": an account of a recent ornithological trip in the south of Spain, by Mr. Harry F. Witherby; a sketch of the Great Pitch Lakes in America, illustrated with some fine photographs by Sir Benjamin Stone, M.P.; and further contributions from Mr. A. Vaughan Jennings, Mr. R. Lydekker, Mr. Alex. B. MacDowall, Mr. H. Snowden Ward, the Rev. A. S. Wilson, and other writers.

VOLCANOES OF THE NORTH.

By Grenville A. J. Cole, m.r.i.a., f.g.s., *Professor of Geology in the Royal College of Science for Ireland.*

The north-east corner of Ireland is eminently a plateau country. When we enter Belfast Lough from the sea, the irregular rounded hills of Down find a contrast on the western side in the broad-backed braes of Antrim. Dark cliffs of basalt can be seen high upon the slopes, with here and there a gleam of chalk beneath them. One or two deep valleys have been cut through the plateau by the streams that seek the sea; but the general crest is level, some one thousand one hundred feet above the water, until the whole mass dies away into a series of rounded domes, far away towards Moira in the south.

The conspicuous black scarp runs round the coast to Garron Point; it is broken on the back of the ancient gneiss of Torr; and then it reappears, in its fullest grandeur, between Ballycastle and the Giant's Causeway. We may follow it yet further, to the grim cliffs above the lowland of Lough Foyle; and then we may trace these southward up the Roe, to the noble heights above Dungiven and the tableland at Moneymore. Within this circuit of one hundred and fifty miles, the country is uniformly covered with basaltic rocks. They dip down towards the low-lying basin of Lough Neagh, but form rapidly rising moorlands as we move again outward from the water. Even on the western shore of the lake, where their width is only some five miles, the basalts find room for the production of the characteristic uplands, clothed with gorse and heather.

The plateaux thus cover almost all the County of Antrim, and an important part of the County of Londonderry; but the scarped nature of their outer edge shows that they must have formerly extended further. On the east, the flat top of Scrabo Hill, near Newtownards, recalls the features of the plateaux; and inspection shows that we have here a thick mass of basalt, protecting the soft red sandstones of the district. This hill is nine miles from the main scarps above Belfast. On the west, again, there is a remarkable outlier on the northern summit of Slieve Gallion, one thousand five hundred feet above the sea, from which the hillside falls rapidly on all sides. We look away from it westward, across a wild country, worn out of the older rocks, and can picture the basalt as stretching on in old times, until it met the rim of its basin in the very heart of Donegal.

It is little wonder that such broad expanses of uniform rock, lying in beds, tier upon tier, with an obvious tendency to weather out as plateaux, were compared by many older geologists with regularly stratified aqueous deposits. The type of scenery common in County Antrim is thus repeated among the limestone hills of Sligo, a district of inland scarps and massive tablelands; and most of us are familiar with such features in the stratified Pennine Chain of England. Werner, reasoning from the isolated sheets of basalt in central Germany, asserted that such rocks were precipitated from solution in water; and his views obtained a remarkable hold upon men who were content to make theories, rather than to undertake laborious observations. These "Neptunian" doctrines were part of a system which, as Lyell quaintly remarks, "had not the smallest foundation, either in Scripture or in common sense,"[*] and were refuted by Werner's French contemporaries, Guettard, Faujas de St. Fond, and Desmarest. Faujas, in his fine folio work,[*] attributes much of his information to an elderly cleric, the Abbé de Mortesagne, whose enthusiastic and picturesque letters are printed in full. In another letter we find M. Ozy, a chemist of Clermont-Ferrand, attributing his own enlightenment as to the volcanic nature of his country to the visit of "Olzendorff," an Englishman, and "Bowls," an Irishman, who came out in 1750 to study the lead mines of Auvergne. May we not presume that the "M. Bowls" was acquainted with Antrim and the Giants' Causeway, and found in the perfectly preserved craters round the Puy de Dôme the verification of opinions formed in Ireland?

The matter has more interest than would at first appear; for the earliest printed appreciation of the volcanic origin of the Irish basalts seems to be contained in the second edition of a highly speculative work, by John Whitehurst, published in 1786. Whether "Olzendorff" or "Bowls" was the direct instructor of M. Ozy, the views propounded by them from the summit of the Puy de Dôme were extremely novel in 1750.[†] The "Irlandois" was probably the William Bowles who wrote a treatise on Spain in 1776, and whose mineral collection is known to have been sold in 1830.

The story of the struggle against the Wernerians, and of the ultimate triumph of the supporters of volcanic action, is well told by Portlock.[‡] The Liassic shale of Portrush in Ireland has been baked by intrusive sheets of dolerite, and has come to resemble the compact basalt of the district. Its fossiliferous character made the Wernerians hail it as a basalt containing marine shells, and as an obvious proof of their contentions. Kirwan, who established the first important mineral collection in Dublin, supported this unhappy view. Playfair published the true explanation in 1802, before he had visited the district; but the error lingered on for another fifteen years. Even now, when the igneous origin of the plateau-basalts is everywhere accepted, questions arise as to the vent or vents from which such broad masses were erupted.

There is no doubt that the great mass of the basalts of north-eastern Ireland were poured out as lava-flows upon a terrestrial surface. Despite later faults and dislocations, the relation of the lower streams to this old land-surface can again and again be seen. In the beautiful sections along the Antrim coast, some of which are naturally cut and some due to quarrying, the following Mesozoic rocks appear in order:—Trias, Lower Lias, Upper Cretaceous. The basalts are found lying upon an eroded surface of Chalk, and occasionally overstep on to the Triassic sandstones, as they do at Scrabo Hill. A layer of reddened flint gravel constantly intervenes between the basalt and the chalk, representing the material that covered the surface, as a product of subaërial decay, before the eruptive epoch opened. We can picture, then, a country of low chalk downs, the dark beds of the Lias and the red-brown Trias occasionally showing in the valleys. Trees grew in sheltered places, and streams collected the flint nodules in their courses, washing them out of the general soil-cap of the country. In the great period of stress, which gave rise to the Pyrenees and the Juras, and ultimately to the Alpine system, the north of Ireland and the west of Scotland became broken by a series of fissures, up which molten lava flowed. These fissures remain to us as an amazing series of dykes, traversing the area in a

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[*] "Principles of Geology," Vol. I. (1830), p. 69.

[*] "*Recherches sur les volcans éteints du Vivarais et du Velay,*" Grenoble and Paris, 1778.

[†] *See* Sir A. Geikie, on Guettard and Desmarest, "Ancient Volcanoes of Great Britain" Vol. I., preface.

[‡] "Rep. on Geol. of Londonderry, etc." (1843). pp. 37-44.

north-westerly and south-easterly direction. The great Cleveland dyke, which cuts the Jurassic strata of Yorkshire, must be included among them; and outlying members occur about Lough Erne, and even in the County of Galway. Sir A. Geikie* estimates that the "dyke-region embraces an area of upwards of forty thousand square miles—that is, a territory greater than either Scotland or Ireland, and equal to more than a third of the total land surface of the British Isles." This, however, is but a small matter, compared with the whole region involved in the volcanic activity of early Cainozoic times. Suffice it that, as a detail in the general overflow, the downs of Antrim and Londonderry became buried in successive lava-flows.

Even the advocates of "fissure-eruptions," as a means of flooding a whole province with lava, now regard the molten rock as flowing from a number of points along the track, each centre resembling an ordinary volcanic vent. The flows coalesce in the hollows, mount upon their predecessors, spread now this way, now that, and eventually obliterate all the features of the landscape. New vents may break through this rudely stratified accumulation, and may sometimes build up true scoria-cones on the surface, as their action becomes more irregular and explosive. A country deluged with lava from small "puys," like those on the central plateau of France, may finally come to possess a few isolated volcanic mountains, from which the last products are ejected. When all dies down, when denudation works its will, the separated cones are all but swept away. Perhaps their mere necks, filled with crystalline lava or with coarse agglomerate, remain standing out above the earlier fields of lava. Then the latter become cut into by the streams; the buried landscapes are in places restored to light; while the masses left between the newly cut valleys have the form of tablelands and plateaux, capped by the relics of the flows.

In our northern volcanic area these successive events can be followed out. While many of the dykes never reached the surface, others may easily have been responsible for the basaltic flows. Olivine-basalts and basaltic andesites, sometimes retaining a glassy structure in their groundwork, sometimes of almost doleritic texture, cover the irregular surface of the chalk. Their lower portions have often become columnar, where they contracted on cooling in contact with the loose flint gravels (Fig. 1). The separate lava-streams can be traced out in the great cliff-sections, and are seen to dovetail into one another, each great basaltic "stratum" being formed of several adjacent and overlapping flows. Steam-bubbles, globular in form, or elongated by the flow of the molten mass, or strikingly irregular, are everywhere in evidence, especially near the surfaces of the flows. In many cases, white nests of zeolites, chalcedony, or opal, have formed within them, and probably began to fill up the cavities as soon as the lavas came to rest. Often the upper part of a flow is rubbly and irregular, while the lower part, which cooled more slowly, has assumed a bold columnar structure, so that the flow appears at a distance to consist of two distinct types of lava. This feature is conspicuous on the bold headlands round the Giant's Causeway; and the Causeway itself is the basal portion of a stream of similar character.

The Giant's Causeway owes its fame to the exquisite regularity of its columnar structure, and to the neatness of its curving cross-joints. The east coast of Skye, or the cliffs of Loch-na-Keal, in Mull, may produce nobler volcanic landscapes; while the isolated relic of a massive lava-flow, now forming the Isle of Staffa, is far more wild and picturesque. But the district of the Giant's Causeway must always remain as a perfect museum for the student, and the black dykes that jut out into the water are as characteristic in the landscape as the flows themselves.

Fig. 1.—Columnar Basaltic Lava-flow, resting upon old land-surface of denuded Chalk. Quarry at Whitehead, Belfast Lough. Typical Section in the Antrim Plateaux. The lava has been subsequently denuded, and boulder-clay has been deposited across the whole. Photographed by Mr. R. Welch.

The majority of the dykes that are revealed in the fine series of sections along the scarps of Antrim cut through both the chalk and the lower lava-flows. They form black and often sinuous bands, traversing the quarry-faces; and their mere abundance is in the highest degree impressive. The lava-flows that may have been connected with their rise have often been entirely swept away. But we have clear evidence that pauses occurred in the activity at various points, for the lava-sheets that remain are often separated by bands of red earth, which are the products of the weathering of one flow before the next was poured out across its surface. These layers, well known also among the black cliffs of Skye, form striking lines of colour in the sections. The broad red band, running along the cliffs east of the Causeway, cannot fail to strike every visitor, and points to a time of general rest throughout the district. By its means, as exposed here and at other places, the eruptive series has been divided into two stages;

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* Work quoted, Vol. II., p. 121.

and the dykes that cut this ferruginous zone can safely be referred to the upper basaltic stage.

This period of quiet must have been, indeed, a long one. Lakes were formed, and forests grew, on the crumbling surface of the earlier flows. Red and brown nodular iron-ores, like those still forming in the lakes of Sweden, are quarried above Glenarm from between the lower and upper lavas. Clay-beds, with numerous plant-remains, occur here and in other places; and bauxite, a sediment rich in aluminium hydrate, forms a valuable ore of aluminium. The pale colour of the bauxite, unlike that of the bauxite of southern France, suggests that it was derived in this case from volcanic rocks rich in alumina but poor in iron; and a very suggestive conglomerate occurs in association with it near Glenarm. A stream of the quiet period seems here to have washed down pebbles of white and decomposing rhyolite, a lava rich in silica, and far removed in nature from the basalts. A centre of rhyolitic eruption probably lay at no great distance; and at Templepatrick and Tardree, in the neighbourhood of Antrim town, we have clear proofs of the invasion of rhyolite into the lower basaltic series.[*]

The eruption of dark basic matter seems, indeed, to have been successfully interrupted, and the contents of another reservoir of molten rock penetrated locally through the the surface. In writing of the Mourne Mountains,[†] we have shown how the granite in that area is probably of Cainozoic age, and how it truncates one series of basic dykes, and is itself cut by a second series. The rhyolites of Antrim almost certainly belong to the same epoch, and have a similar chemical composition. A few cones were reared locally upon the devastated surface of the country, and their white flanks and vitreous lavas must have contrasted strangely with the earlier basalts, which were now reddening and decaying all around them. Denudation, however, made short work of these little cones, and their relics were subsequently buried under the upper series of the basalts. Their products now appear, thanks to later weathering, in some force around Tardree, which is one of the most interesting volcanic districts in the whole of the British Isles.

Though Sir A. Geikie regards the group of rocks here exposed as entirely intrusive, the great variety of glassy lavas that occur on the plateau of Sandy Braes seems to indicate volcanic action at the surface. We have no need to go to Lipari or to Hungary for specimens of red fluidal rhyolites, or spherulitic pitchstone, or black perlitic obsidian. While the main layer of obsidian has broken up into isolated blocks, which are decomposing into yellow sand, a fragmental rock hard by, formed of pumiceous particles and blocks of compact brown rhyolite, seems to be a true tuff, and to indicate explosive action. Down at Ballypalidy, a little to the east, rhyolitic fragments, as has often been pointed out, occur in beds of iron-ore among the basalts; and the locality, like Glenarm, has become famous by the abundance of associated plant-remains.

These remains, preserved in the deposits of a period of repose, are unfortunately all that we have to guide us as to the age of the whole series of eruptions. Formerly, the flora was regarded as Miocene, and the close resemblance between the sequence of volcanic phenomena in Antrim and in Auvergne in the Miocene period makes the suggestion tempting to the petrographer. But Mr. Starkie Gardner, who has dealt with the whole evidence from Ireland, Mull, and even further north, has decided in favour of placing the leaf deposits as far back as the early Eocene. The scenery of our district in Eocene times was thus in strange contrast to that of the London and Hampshire basins; but the Cleveland Dyke, crossing England beneath the surface, shows how nearly the peace of eastern lands was threatened.

When the upper basalts spread across the country, new centres of eruption were set up, Intrusive masses penetrated all the earlier rocks, and came here and there to the surface as volcanic necks. The one striking object among the inland plateaux of County Antrim is the huge mass of Slemish, one thousand four hundred and thirty-seven feet above the sea, which forms so conspicuous and strange a feature above the basaltic moorland. This sheer ridge of rock is composed of dolerite, rising through the earlier lavas; and doubtless at one time a great cone of volcanic material lay about it. At Carnmoney, near Belfast, a far smaller neck breaks through the Mesozoic strata, and another rises as a dome-shaped mass above the romantic valley of Cushendall. At Carrick-a-rede, and at other points upon the Causeway coast, necks full of "bombs of basalt, with pieces of chalk and flint," point to more violent phases of eruption.[*] Though nothing like a true cone or crater remains in the whole Irish area, disguised though the details may be by the effects of denudation and post-Eocene earth-movement, we cannot doubt the cumulative evidence as to the volcanic origin of the landscape.

We still must send our students to Auvergne—or to Catalonia, if they prefer it—to see how a few puys may deluge a whole land with lava. But the wonder with which we look across our great moorlands of the north will not be diminished by the comparison. The far blue crag of Slemish, standing out in the clear highland air, will only become associated for us with days stranger and more distant than those in which St. Patrick pastured his sheep beneath its wall.

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CHRISTMAS CUSTOMS OF SHAKESPEARE'S GREENWOOD.

By GEORGE MORLEY,

Author of "Leafy Warwickshire," etc.

THE first signs of the approaching custom of "keeping Christmas" may be observed as early as the middle of October in the parlour of many a rustic cot in leafy Warwickshire. In the wide and warm ingle-nook (and the ingle is still to be met with in sundry cottages and farmsteads of this stationary greenwood) a small pyramid of sawn log-wood may be seen standing to dry, and in the middle of the room, or in a recess, the great green or yellow marrow is suspended by gay-coloured ribbons from a hook in the rafter—the recipient of many admiring glances, and many wishes for a slice out of it when it shall be served as a Christmas dish.

As the stuffed chine of pork is, among the peasantry of this greenwood, the customary sign observed at the mothering, so the ribbon-decorated marrow is one of the symbols of the Christmas custom. The marrow is grown to a giant size (the larger the more honour to the grower, and the more plentiful the feast), is hung up in the house-parlour until the eve of the festival, and is then prepared and stuffed.

Another custom preparatory to the great feast of the year is the gathering of crabs, and the stewing of them for a winter dish. In this we have an ancient custom,

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[*] *See* Sir A. Geikie, work quoted, Vol. II., p. 205; and G. Cole, "Rhyolites of the County of Antrim," *Sci. Trans. R. Dublin Soc.*, Vol. VI. (1896), p. 105, &c.

[†] KNOWLEDGE, Vol. XXI., p. 123.

[*] Sir A. Geikie, work quoted, p. 277; see also *ibid*, p. 271.

handed down for at least three hundred years, and in use at the end of the nineteenth century.

Shakespeare was evidently well acquainted with the crab-lore of his native woodland, for not only does he make Caliban say, in "The Tempest" (Act ii., scene 2):—

"Let me bring thee where crabs grow,"

but in the well-known lines:—

"When roasted crabs hiss in the bowl
Then nightly sings the staring owl,
To-who;
To-whit, to-who, a merry note,
While greasy Joan doth keel the pot."

he alludes to this very winter dish, the annual making of which is a welcome custom to many a rustic housewife in the poet's own neighbourhood to this day.

The custom of "the Thomasing," though not now (in its old state) so prevalent as formerly in the out-of-the-way villages and hamlets of Warwickshire, is still in extensive use in a new guise and under newer methods. "Goin' a Thomasin'" is literally going begging for Christmas gifts.

Similar in design to the custom of the "Maying," the rule at the Thomasing (which, as its name implies, was always observed on St. Thomas's Day) was to make a circuit of the villages in procession, and with a little rustic song at the door of cottage, farm, and hall, to bring the greetings of the festive season to the inmates, and to plead for gifts with which to "keep Christmas"; a plea which was, and is, seldom disregarded by the kind-hearted farmers and county people, despite contrary seasons, increased rates and taxes, and falls in prices.

Perhaps the prettiest part of the custom which is now synonymous with the old Thomasing is that in which the homely carols are sung at the doors of the larger village houses. In the silences of the dark greenwood (for the carolling is chiefly performed at night) the voices of the singers, many of whom are choristers of the parish church, sound peculiarly attractive; and the very quaintness of the rhymes and the tune (which are of their own making) materially enhance the effect.

One Christmas night, a few years since, I heard the carollers raising their voices through the dim and silent woodland and caught the words of their rhyme, which were as follows—sung to a lilting, swaying tune, which, owing to the scene and time, had something sweet, and yet strange, about it:—

"Little Cock Robin sat on a wall,
We wish you a Merry Christmas
And a great snowfall;
Apples to eat
And nuts to crack,
We wish you a Merry Christmas
With a rap, tap, tap."

When a repetition of the "rap, tap, tap" is executed as a finale to the verse, the doors of the houses are knocked, and the plea for Christmas gifts made and responded to. Their gifts secured, the dim and quiet landscape rings with the verses of the beautiful Christmas hymn, "While Shepherds Watched their Flocks by Night," given by the singers as a sort of thank-offering for value received.

As it was formerly the custom at the ingathering of the corn-harvest to commemorate the event by duologues in costume, so at the Christmas feast in each year a band of Warwickshire peasants was wont to appear in the farmsteads and perform various acts of mummery to the assembled company. The mask and the mummer, however, are now seen only at rare intervals in the farm kitchen; and what, in the past, was a decidedly picturesque entertainment (formed and carried out by the humbler folk for the delectation of their betters) has now been taken up by the betters themselves; and in "The Hall" of most villages in Shakespeare's greenwood it is the custom to organize theatricals and pieces of mummery, and perform them before aristocratic guests from Christmas Day to Twelfth Night.

Though their mummeries are now things of the past, the rustics still number among their customs the venerable one of bringing in the Yule-log. It would be surprising if it were not so, in a county where the sered and wasted remnants of the ancient Forest of Arden stand around in such variety and abundance—ready grown for the axe and the hand of the woodlander. The peasant for his cottage parlour, the farmer for his spacious kitchen, and the squire for his stately hall, vie with one another in securing the largest, the firmest, and the dryest log for the Christmas hearthstone: each according to his requirements and the size of the fireplace in their respective domiciles.

With the humbler true-born native of Shakespeare's greenwood, whose mind is still overlaid with a cloudy texture of superstition, any wood will do for the yule-log but the wood of the wych elm. This must never be burnt in the house for fear "the old 'ooman," who is thought to inhabit that tree, should come down in vengeance upon those who dare to desecrate and destroy her branches. It used to be the custom to preserve a piece of the previous year's brand with which to light the log.

Though not so greatly in vogue, as in the days of the Squire Cass of "Silas Marner," the drinking of glasses of elder wine on Christmas morning is still observed with unfailing regularity in many isolated cots by the wood or on the waste; and if the morning be winterly it is a "cup that cheers."

With the passing of the Christmas festivities and the arrival of New Year's Eve, the musical dwellers of leafy Warwickshire again go in procession to the doors of the village houses and sing their greetings (in the dark and stilly night) to the occupants of cottage, farm, and hall. If only on account of the quaintness of their rhymes, the custom of "singin' the New Year in" deserves to be preserved, and some record kept of the lines used for the occasion; especially so as there is a likelihood that it may become rarer each year owing to the change of manners even in rural districts.

For five years I have not heard the carollists singing their New Year's greetings; but on New Year's Eve in 1893 I chanced to be on the skirts of a village and came upon a group trilling the following quaint lines:—

"The roads are very dirty,
My boots are very thin;
I have a little pocket
To put a penny in.
God send you happy,
God send you happy,
Praise the Lord to send you all
A Happy New Year."

"God bless the master of this house,
God bless the mistress true;
And all the little children,
Around the table, too.
And send you a Happy New Year,
And send you a Happy New Year;
God bless you all,
Both great and small,
And send you a Happy New Year."

Sung in the last hour of the last day in the year, and in the silence of a dim green world where men thin away to the utmost insignificance, these quaint and homely lines of blessing for friend and neighbour (sung in a befitting minor key), form an appropriate ending to the year's customs of Shakespeare's greenwood; a county so rich in historic, poetic, and romantic associations, in traditions and legends, in folk-lore, customs, and dialect, that, turn whichever way you will, something new and interesting is invariably to be found.

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THE COLOURS OF COWRIES.

By R. LYDEKKER.

AMONG all the treasures of the shell-cabinet few are more generally attractive than the cowries, or kauris (*Cypræa*), which form the type of a family by themselves. Rivalling the olives in the brilliancy of their polished enamel, they exceed those shells in the beauty and diversity of their coloration, while their form in the adult state is so peculiar as to attract the attention of even the most unobservant. Possibly, the very fact that many of them, like the tiger and Surinam-toad cowry, are so common as to be employed as decorative objects for our chimney pieces, has, to a certain extent, detracted in popular estimation from their many striking peculiarities. But even if this be so, a moment's comparison with any other shell will at once show how different they really are. And if rarity be an additional attraction, some, among the couple of hundred or so of living species, are worthy of attention even from this not very elevated standpoint. Take, for instance, the prince cowry (*C. princeps*) and the spotted cowry (*C. guttata*), examples of which have sold respectively for forty and forty-two pounds each; while the beautiful orange cowry, used as a head ornament by the chiefs of the Friendly Islands, formerly fetched about twenty pounds, although good specimens can now be bought at from three pounds to five pounds. Other species claim attention on account of their commercial uses, the ring cowry being employed by the islanders of Eastern Asia for personal adornment, for weighting their fishing nets, and as a means of exchange; while in the latter respect the well-known money cowry has a still more extensive use over a large part of Asia.

But it is from the peculiarities of their structure and coloration that these beautiful shells must claim our attention in the present article. Taking any common species, such as the one shown in the centre of Fig. 1, it will be seen that the upper surface of the shell approaches more or less to an egg-shape, with a notch at each extremity forming the terminations of the mouth below. Somewhat to the right of the middle line in most species runs a straight or slightly sinuous streak over which the pattern of the rest of the upper surface does not extend, this line marking in the living animal the limits of the right and left lobes of the so-called mantle, which during activity extend upwards from the foot on which the creature crawls to envelope the rest of the shell. Compared with an olive, in which it is relatively small, the shell of an adult cowry differs by the almost or complete absence of a distinct spire; while on the under surface the narrow mouth of the shell (not, be it understood, of the animal) is remarkable for the series of vertical ridges, or "teeth," with which its edges are armed.

Now, since almost all other univalve shells related, even remotely, to the cowries, have a more or less elongated spire at the hinder or upper end, the enquirer naturally seeks to find out the reason for the disappearance of this part in the members of the present group. In a fully adult specimen of the common black-spotted tiger cowry no trace at all of the spire can be detected, but in the equally common Surinam-toad cowry a more or less distinct remnant, partly buried in the abundant cement, is observable even in the adult. In Scott's cowry, of which an adult specimen is shown in the centre of Fig. 2, the spire is much more pronounced; and in a half-grown specimen of the same species (left side of the same figure) it is so elongated as to project considerably beyond the hinder extremity of the shell. The same specimen also shows that in immature examples of this species the hinder extremity of the right margin of the shell is expanded into a wing-like extension, recalling the wing-shells, or *Strombidæ*. In both the adult and the young of Scott's cowry the coloration is very similar; but in the young shell shown on the right of Fig. 2, which belongs to the Surinam-toad cowry, there is a difference both in form and in colour from the adult. In form the shell has a distinct spire, and a thin outer lip; and if a still younger example were selected it would be found that these characters were still more exaggerated, the mouth being entirely devoid of teeth, and the outer lip quite thin and sharp. Moreover, whereas the upper surface of the adult shell has a broad dark brown margin, and the central area spotted with light brown on a ground of dark brown, the young exhibits dark and light transverse bands, with a certain amount of mottling.

Young cowries, then, are much more like ordinary shells than are the adult, and clearly indicate that the latter belong to a highly modified or specialized type. The alteration is produced by the expansion of the mantle-lobes of the adult, which deposit a shining enamel over the entire shell, eventually concealing, more or less completely, the spire, and thus totally modifying the original form. A young cowry is, indeed, much more like an olive or a melon-shell; but, as a matter of fact, neither of the two latter are the nearest relatives of the *Cypræidæ*, among which are the *Strombidæ*, or wing-shells. And in this connection the near resemblance of the young of Scott's cowry (Fig. 2, *a*) to a wing-shell is decidedly worthy of note, as suggestive of a direct affinity between the wing-shells and the cowries.

Turning now to the interesting problem of coloration, the first feature that must attract the attentive observer is that the striking pattern developed on the shells of most cowries is seldom seen by the animals themselves, for the reason that by the time the creature is fully protruded from its shell, the upper surface of the latter is more or less completely concealed by the fleshy lobes of the mantle. Accordingly, it would seem to be apparent that the colouring of these molluscs is developed for the purpose of protection, and not for the admiration of the different individuals or sexes of the same species. It might, indeed, be urged that as the lobes of the mantle are coloured similarly to the shell, or even more intensely, the colours are visible to the animals, and are therefore designed for mutual admiration. But had this been the object, it would surely have sufficed to restrict the coloration to the outer surface of the mantle-lobes, and not to have extended it on to their inner surfaces, from which it is deposited on the shell. As regards the utility of the cowry type of coloration for protective purposes, I have never enjoyed the opportunity of seeing the living molluscs in their native haunts, nor have I come across any description from those who have. Cowries, which are mostly tropical or sub-tropical animals, are, however, described as living in shallow water not far from the shore, and feeding on zoophytes; and, so far as one can judge, their colours ought to harmonize well with the hues of the denizens of a coral-bank, or a mass of sea-anemones, many of which are more or less similarly spotted. If this explanation prove to be the true one, we can readily see why both the shells and the hard parts of cowries partake of the same striking types of coloration.

Turning now to the consideration of the various types of coloration met with among cowries, it may be mentioned, as a preliminary, that among mammals spots and stripes are frequently met with in the young which disappear in the adult. Many species of deer and swine, for instance, which are spotted or striped with white in youth become more or less completely uniform in mature age ; while the lion and the puma frequently exhibit traces of dark spotting in the cub stage. In these animals, therefore, it is evident that a spotted or striped coat is the original type, and a uniform tint the more advanced form. In cowries, on the other hand, it seems that transverse dark banding was the original type of coloration, and that from such banded type two later modifications have taken place. In the one of these, spotting of various kinds has resulted, while in the other a more or less uniform colour has been the final result. The primitive banded type serves to connect the cowries with less specialized shells, a young Surinam-toad cowry being strikingly like a melon-shell, both in form and colouring, while the faint banding observable in young specimens of Scott's cowry recalls the colours of many of the wing-shells, to which, as already mentioned, the former approximates in form.

The proof that banding was the original type of cowry coloration is easy, seeing that it obtains in the young of the great majority of species. Fig. 2, *b*, exhibits the striped stage of the Surinam-toad cowry, which, in the adult, as already said, has chestnut spots on a dark ground in the central area of the upper surface. In Fig. 3, *a*, are shown the adult and immature conditions of the common lynx cowry, the former of which is variously spotted, while the latter still retains distinct transverse dark and light bands. Still more striking is the difference between the immature and adult conditions of the lesser false Argus cowry, as shown in Fig. 4, the latter exhibiting small white spots on a dark ground, while the former is banded with dark and light, without the slightest trace of spotting. It will be observed that this species of cowry is of a long narrow shape, and it would seem, for two reasons, probable that that is the primitive form of cowries ; the short and broad shape, as shown in Fig. 1, *a*, being a later modification. One of the reasons in favour of this view is that almost all cowries which retain the primitive banding in the adult condition are of the long form. Among such may be mentioned the little wasp cowry (Fig. 3, *b*), the mole cowry (*C. talpa*), remarkable for its tawny back and dark brown base, and one variety of the carnelian cowry (*C. carneola*), as well as the orange-tipped cowry (*C. isabella*). Again, in the true Argus cowry (Fig. 6), which develops peculiar ringed spots in the adult condition, the primitive bands are still more or less distinctly traceable at all ages.

To exemplify the second reason for the same view, we may take the serpent's-head cowry, of which the adult is shown in Figure 1, *a*. Here we see the short round type in its full development, the coloration being chocolate brown above and below, with the central area of the back finely spotted with white. If, however, we take a young individual of this species, it will be noticed that the shape of the shell is comparatively long and narrow, while the colouring is in the form of bands. Many other instances might be cited, but the foregoing are sufficient for my present purpose.

I may accordingly pass on to notice briefly some of the more striking types of coloration presented by adult cowries, and here I must deplore the circumstance that editorial commands restrict the number of illustrations to my article.* Banded cowries have been already mentioned, but it may be added that, from the intensity of the colours, the wasp cowry (Figure 3, *b*) is not improbably the culmination of this type. On the other hand, in the flesh-coloured carnelian cowry, of which there is both a long and a short form, the bands tend to become very indistinct ; and it may be suggested that the short form is not far removed from the ancestral type of the beautiful orange cowry, which is one of the few uniformly coloured species ; such uniformly coloured forms indicating, as already said, one line of specialization.

Among the spotted cowries several types are noticeable. Firstly, we have species in which the back of the shell is simply spotted with black or brown, among them being the tiger cowry (*C. tigris*), the panther cowry (*C. pantherina*), and the much smaller lynx cowry (*C. lynx*). As all these have a comparatively short and wide shell they indicate an advanced type. Next, we have white-spotted cowries, such as the false argus (*C. cervus*), the lesser false argus (Fig. 4), and the fallow-deer cowry (*C. vitellus*) ; and as the two former are long-shaped, while the latter is comparatively short, they seem to indicate a medium stage of evolution.

From the black- and brown-spotted types seem to have originated another group represented by the map and nutmeg cowries (*C. mappa* and *arabica*, Fig. 5), in which the spots are retained along the margins of the back of the shell, the central area of which is more or less finely reticulated or vermiculated, the map cowry taking its name from the width and sinuosity of the line between the mantle lobes. In the typical nutmeg cowry the reticulations are very nutmeg-like, but in other specimens more or less distinct pale spots are dotted all over the central area, till in the variety *histrio* (Fig. 1, *c*) the spots are the dominant feature, being only separated by thin lines, so as to form a kind of network, or honeycomb arrangement. Perhaps the colander cowry (Fig. 3, *c*) may be regarded as an offshoot of this type.

But another modification may apparently also be traced to the *arabica-mappa* stock, the members of which are intermediate between the long and the short types. As already said, these cowries have the central area of the back reticulated or white-spotted, and lighter than the black-spotted margin. And from such a type the transition is easy to the modification presented by the serpent's-head cowry (Fig. 1, *a*), and the Surinam-toad cowry, in which the central area is white- or chestnut-spotted, while the margin and much of the under surface is dark brown. The great width and shortness of these cowries afford further evidence of their high degree of modification. Obviously the chestnut-bordered cowry (Fig. 1, *d*) is another member of this group in which chestnut spots have been superadded to the normal white-spotted central area. Apparently a special development of this type may be recognized in the white ring cowry (*C. annulus*), the yellow ring from which it takes its name marking the line of division between the original spotted central area and the dark area. Finally, from the ring cowry may easily be derived the money cowry, in which the ring has all but disappeared, while the marginal area has developed a series of rugosities, apparently connected with the filaments on the margins of the mantle lobes, which scarcely intrude on to the central area. Whether these two white species have a habitat different from that of their brethren is a subject well worth the investigation of those who have the opportunity.

Omitting mention of certain other sub-types on account of limitation of space, this part of the subject may be concluded by brief reference to the true argus cowry (*C. argus*, Fig. 6), which, from its elongated form and the retention of barring, is evidently an ancient type specially distinguished by the ring-like form of the spots.

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* I am indebted for the photographs from which these illustrations were taken to Mr. N. M. Richardson, of Monte Video, near Weymouth.

All the above-mentioned species (together with a host of others) are members of the typical genus *Cypræa*, distinguished by the smooth and shining enamel, and the circumstance that the teeth of the mouth do not extend across the whole of the lower surface, as shown in Fig. 1, *d*. There are, however, other cowries differing from these by the development of rugosities on the back, and the extension of the teeth of the mouth right across the lower surface. Both these features may safely be regarded as indications of greater specialization than exists among any of the typical cowries. One type is represented by the pustuled cowry (Fig. 1, *b*), in which the ornamentation on the upper surface takes the form of small spherical pustules, frequently of a bright red colour, when they recall a fragment of wood overgrown with fungi. In the second, and still more advanced modification, the ornamentation of the back assumes the form of transverse ridges, which in some species (Fig. 1, *e*) are comparatively wide apart, and separated by a considerable interval in the middle line, whereas in others, like the little European cowry (*Trivia europæa*), they are so closely approximated, and so nearly meet in the middle line, as to give the idea of a small and neatly-parted head of hair.

Even these by no means exhaust the modifications which the cowry type is capable of assuming, as witness the pure white "poached egg," and the "weaver's shuttle," both members of the genus *Ovula*, and the latter remarkable for the elongation of the two extremities of the mouth into tube-like processes. Both these, as well as certain other allied types, depart from the ordinary cowry type by their white or pinkish colour, and are therefore evidently specialized modifications. In the case of the weaver's shuttle the colour is probably produced to harmonize with the sea-fans, upon which these molluscs are parasitic; but further information in regard to the reason for the absence of colour is requisite in the case of the other kinds.

One result of the necessarily brief dissertation on cowries is to show how short-sighted was the idea prevalent some years ago that the shells were of no importance in the study of molluscs, and that attention must be restricted to the soft parts (the so-called "animal") alone. A wider grasp of the subject shows that nothing in Nature is unworthy of our best attention, and is sure to yield results of more or less absorbing interest if only we approach the subject with unbiassed and unprejudiced minds.

References to Plate.

Fig. 1.—*a*. Serpent's-head Cowry (*Cypræa caput-serpentis*). *b*. Pustuled Cowry (*Pustularia pustulata*), upper and under views. *c*. Histrio Cowry (*C. arabica histrio*). *d*. Chestnut-bordered Cowry (*C. helvola*), upper and under views. *e*. Radiate Cowry (*Trivia radians*).

Fig. 2.—*a*. Scott's Cowry (*Cypræa scotti*), young and adult. *b*. Surinam-Toad Cowry (*C. mauritanica*), young.

Fig. 3.—*a*. Adult and Immature of Lynx Cowry (*Cypræa lynx*). *b*. Wasp Cowry (*C. asellus*). *c*. Colander Cowry (*C. cribraria*).

Fig. 4 —Immature and Adult conditions of the Lesser False Argus Cowry (*Cypræa exanthema*).

Fig. 5.—Nutmeg *(a)* and Map *(b)* Cowries (*C. arabica* and *mappa*).

Fig. 6.—The Argus Cowry *(Cypræa argus)*.

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Notices of Books.

A Classification of Vertebrata. By Hans Gadow, M.A., F.R.S., etc. (A. & C. Black.) 3s. 6d. net. The extent to which knowledge increases in all departments of scientific study is nowhere more impressively brought home to one than in the changing classifications which these advances make necessary in the domains of biology. Of course, the practical aim of any system of classification is sorting and grouping; and the ideal system is one which expresses briefly all that is known of the race history and development of the creatures dealt with. To mitigate the discrepancies as much as possible, chiefly owing to the bewildering mass of fossil reptiles which have come to light, Dr. Gadow has "arranged the reptiles in numerous sub-classes, and these again in orders, while for the host of fishes 'divisions,' and for the birds 'divisions' and 'legions' have been resorted to as intermediate groups between sub-classes and orders." An interesting table on p. 61 accentuates in the most marked way what has been said about the necessity of elaborations in systems of classification which are not very recent. The table shows there are, in all, some twenty-four thousand two hundred and forty-one recent species of vertebrate forms to be arranged; of these, nine thousand eight hundred and eighteen are birds, and two thousand seven hundred and two, mammals. The fishes number no fewer than seven thousand three hundred and twenty-eight.

Krōmscōp Colour Photography. By Frederic Ives. (London: The Photochromoscope Syndicate, Limited.) The problem of reproducing in permanent form the colour of objects is a popular one. Many attempts at solving it have been made, with varying amounts of success, but none of them have been successful in obtaining coloured prints of natural or artificial objects. Three processes which have up to the present gone farthest in this direction are:—(1) The process of Prof. Lippman, by means of which beautifully coloured photographs are obtained on glass by interference effects. (2) Prof. Joly's process, in which an object is photographed through a glass, having fine lines closely ruled upon it, coloured in the primary colours. The colourless picture thus obtained is afterwards projected through a similar glass, with the result that the colours are reproduced. (3) The Krōmscōp of Mr. Ives, by which three negatives are taken through three glasses coloured with the primary colours. These negatives are afterwards combined in one picture. The colours of an object are thus first analysed and then synthesised. This method gives excellent results, and is the only one which has so far been successsully placed on the market. The little booklet which Mr. Ives has written gives full particulars concerning the construction and method of using his instrument, and with the various appendices, which comprise expressions of opinion on the theory of colour by several physicists, should be useful in popularizing his method of reproducing natural colours.

Stories of Starland. By Mary Proctor. (Potter and Putnam Company, New York; G. W. Bacon & Co., Ltd., London.) Miss Proctor has written a very delightful little book on astronomy for children. "I like it awfully" was the verdict of one small boy upon it. Very simply and clearly she tells—or, rather, her little brother Harry elicits from her—the principal facts about what we see in sun and moon and sky in the daytime or at night. Very many stories and legends, such as are told by the Indian and Australian peoples, are mixed up with the sterner facts of scientific astronomy, and some of these are not generally known, whilst the rest will bear repetition. The story of the meteor that was claimed by the landlord as flying game and the tenant as ground game, the Custom House authorities intervening, ought to be true if it is not really so. In a book for children the illustrations might have well been rendered more numerous than they really are. It was a pity, too, to insert "the moon" on page 50, and we must confess that we fail to recognize the aspect. Perhaps, too, the fearfully complicated system of canals on Mars, represented on page 71, might with advantage have

Fig. 1.

Fig. 2.

Fig. 3.

Fig. 4.

Fig. 5.

Fig. 6.

THE COLOURS OF COWRIES.

For Description of Illustrations, see page 272.

been left altogether to the imagination of the children, or, at least, relegated to the legends. The "scenery on the moon," on page 52, rather mystifies children, as the craters are shown from a lunar standpoint, and they fail to see "how the photographer got there." But all these belong to the first part of the book. The second part, telling the stories of the summer and winter stars, are extremely good —well written and well illustrated—and should lead many of the children of this generation to consider the heavens.

Geology for Beginners. By W. W. Watts, M.A., etc. (Macmillan.) Illustrated. 2s. 6d. As Secretary of the British Association Committee on Photographs of Geological Interest, Prof. Watts has had exceptional opportunities of obtaining good pictures for his work on geology. A glance through this charming little volume affords the fullest evidence that he has availed himself of his position. No book on the market, at the modest price at which the publishers have issued this introduction to a most fascinating subject, compares with it in its profusion of beautifully reproduced original illustrations. In the three hundred and thirty-nine pages, there are no fewer than three hundred and nine illustrations. Each chapter is provided with a concise summary and a carefully graduated set of questions which should prove of great service to teachers. Beginning with the familiar and easily observed aspects of the earth, Prof. Watts takes the pupil along pleasant roads, by easy stages, to those more difficult subjects which are best studied in the laboratory. But, with the instincts of a true teacher, each difficulty is cleared up as it is encountered; and we have no hesitation in saying that the student who works conscientiously through this book will find himself equipped with a working knowledge of geology which will not only help him in understanding the problems of Nature but will provide him with a new pleasure in life. The index is more complete than any we have seen in an elementary work.

The Studio. This magazine, devoted to art, abounds in illustrations so excellent that they alone render it a remarkable shilling's-worth. The art enlarged on and illustrated embraces a wide area. We are charmed with designs of pots and book-covers, or instructed in all varieties of brush and pencil work, while artists of Japan, as well as samples of the schools of the Continent and of England, are before us. It may be to this breadth of purpose that a lack of definite instruction is to be traced. We should certainly like to see a vigorous dealing with some of the art absurdities of our day, but whether mediævalism outdone, as in "Decoration for a Library," or truly classic beauty, the "Studio" loves all art, and all who are called artists, in its pages.

English National Education: a Sketch of the Rise of Public Elementary Schools in England. By H. Holman. (The Victorian Era Series: Blackie & Son.) 2s. 6d. This is an admirable sketch of the history of a great subject, and its author is to be congratulated upon the skill in compilation which has enabled him to present a vast mass of detail without submerging the main purpose of the book. That it is yet overweighted with much ineffective detail in the shape of a long array of projects unfulfilled must be admitted, yet it is an interesting and instructive study to follow the main lines of the case against popular education, which remained practically the same throughout, but which crumbled steadily away so soon as its supporters were forced to give their reasons, and it was reserved for Sir Charles Adderley to furnish the most insane argument in defence of the lost cause. Mr. Holman has paid an eloquent tribute to the services of Sir James P. Kay-Shuttleworth, the first secretary of the Committee of Council for Education, "a post for which he was probably by far the best qualified man in the country"; and he has also generously commended the labours of Mr. Arthur H. Dyke Acland, a recent Vice-President of the Council. "Of the work of Mr. Acland it would be difficult to speak too highly, for he has probably studied more, worked more, and suffered more for the cause of education than any other non-educationist (in the technical sense)." This testimony will only confirm the widespread regret among the friends of education at the impending retirement of Mr. Acland from the House of Commons. It is in the main a sorry story which Mr. Holman has to tell of wasted time, wasted money, and wasted opportunities, which will not bear reflection in its relation to the present day keenness of the struggle for the world's markets. A supreme Council of Education was set up in Prussia in 1787, and an elementary school law was adopted in Upper Canada in 1816; while in the mother country it was shown in the Report of a Royal Commission rather more than thirty years ago, that more than eight hundred thousand children, out of a total of one and a half million scholars, were attending schools which were notoriously inefficient. What might not Britain's position have been now if a little common sense had entered into the solution of the education problem a hundred years ago. Mr. Holman's book is certainly disfigured by ungenerous references to Matthew Arnold and to Owen, as well as by an imperfect index; but for directness of aim as a continuous narrative of the facts it is a valuable addition to the series.

Outlines of Vertebrate Palæontology for Students of Zoology. By Arthur Smith Woodward. (Cambridge University Press.) Illustrated. 14s. To rightly understand the varied problems which the study of zoology presents, the student who has mastered the elementary parts of his subject must not only acquaint himself with the facts of embryology but should also enter somewhat minutely into the past history of life on the globe. Hitherto this has not been an easy task, necessitating as it did references to, and a search among, many books and serials dealing with other subjects as well, but Mr. Smith Woodward, by the publication of his book, has abolished these trying and time-occupying experiences. He has brought together, in rather more than four hundred pages, all the facts which the student is likely to require. The more important points and generalizations are alone printed in large type; purely technical and descriptive information is set forth in small type. The classification adopted is mainly that of the British Museum Catalogues of Fossil Vertebrata, but where the recent progress of research has made it desirable, certain modifications have been adopted. The text is accompanied by two hundred and twenty-eight illustrations, a fair proportion of which are original. The final chapter of the book is given to a general sketch of the whole subject from the geologist's point of view, and in it Mr. Woodward rightly insists that, "owing to the imperfection of the geological record and the incomplete exploration of most formations, any statement now formulated may eventually prove to be quite a partial account of the facts, and every conclusion must be more or less provisional and tentative." Several other limitations are clearly set forth and deserve to be widely known. Mr. Woodward's book will be of real service to students of zoology and geology.

SHORT NOTICES.

Poultry for the Table and Market versus Fancy Fowls. Third Edition. By W. B. Tegetmeier, F.Z.S. (Horace Cox.) Illustrated. 2s. 6d. Mr. Tegetmeier is a veteran in the art of poultry rearing. Nearly forty years ago he published a book on profitable as distinguished from fancy or ornamental poultry. The County Councils have availed themselves of reprints from pages of this work for instruction in technical education, a fact which stamps the work as authoritative. Housing, feeding, hatching, rearing chickens, diseases of poultry, and fallacies of poultry farming, are among the many items dealt with, and the present edition has been made more useful by including an account of the mode of raising turkeys in the open.

Outlines of the Earth's History. By Nathaniel Southgate Thaler. (Heinemann.) Illustrated. 7s. 6d. The author states in the preface to his book that most other text-books lead the student to believe that Nature's workings have ended, "rather than something is endlessly doing," and that the present condition of the earth is stationary instead of being a stage in an unending procession of events. That such notions are erroneous may be proved by noting the imperceptible change wrought in a certain place during a space say of twenty years, especially in a volcanic district. The method of putting out in interesting sentences the history of our planet will commend itself to the reader who desires amusement combined with instruction. The author endeavours to prove that the changes which have taken place on the earth during the many million years in which our planet is supposed to have existed, are always going on, and will do so until the end. The book seems a clear exponent of the agencies which are involved in the mutations of our planet, and may be recommended as good reading for all interested in natural phenomena.

Ackworth Birds. By Major Walter B. Arundel. (Gurney & Jackson.) This is a list of one hundred and forty-nine species of birds observed in the district of Ackworth, Yorkshire. The author has divided the book into four parts, dealing with permanent residents, regular summer residents, regular winter residents, and visitors. The local names of the birds are given, as well as a brief description of the habits of each species. The book will be of little interest save to those who live in the district. Whether or no the book contains a complete list of the birds which have been observed in the district we must leave to those well acquainted with Ackworth to judge.

The Birds of Montreal. By Ernest D. Wintle. (London: Wheldon & Co.) This is a similar book to the preceding one, and deals with two hundred and fifty-four species of birds observed in the vicinity of Montreal. The author has published this list, which is the work of fifteen years' observation, "with a view to induce others to publish lists of birds occurring in various districts of the Province of Quebec, which would give us a better knowledge of the avifauna of the province, as some species occur and breed in only certain sections of it." Some sporting sketches, compiled by David Denne, are printed at the end of the book.

Radiography. By R. T. Bottone. (Whittaker & Co.) Illustrated. 3s. A welcome addition to the literature on radiography. The book does not call for much comment, but it may be safely recommended to those who desire to have by them a trustworthy account of the steps that have led up to the discovery and application of the so-called X-rays. It is lucid and accurate, all the statements made by Mr. Bottone, as may be expected, having been verified by personal experiment. Instructions are given for constructing X-ray apparatus, and the subject matter is brightened by excellent photographs of the results obtained in this absorbing branch of science.

Applied Geology. By J. V. Elsden, B.Sc.(Lond.). (The "Quarry" Publishing Co.) Part 1. 5s. This unpretentious little book is part of a series of articles still appearing in the "Quarry." Practical works on geology are scarce, and therefore Mr. Elsden's book will be all the more acceptable. The price is rather high for such a slim volume, but the matter more than compensates for this otherwise prohibitive figure. Mr. Elsden has made it his study to bring together problems which confront the practical geologist, and he gives ample rules and graphic methods for their solution. Rules, for example, for calculating the thickness of strata, calculation of true dip by formulæ and by graphic construction, and he also marshals many facts from allied sciences into a form peculiarly adapted to the geologist concerned in the development of the mineral resources of the earth.

The Unconscious Mind. By Alfred T. Schofield, M.D., M.R.C.S. (Hodder & Stoughton.) 7s. 6d. Although this book is mainly a compilation from other treatises on similar subjects, students of mental physiology and psychology will find here much useful matter happily arranged in logical sequence. The many examples of phenomena from every-day life are undeniably interesting and instructive. The author, not without success, endeavours to put in a handy shape the more important literature of life and mind. The references at the foot of each page, and the list of works of reference given at the end of the book, testify to our author's diligent and steadfastness of purpose in endeavouring to render humanity service in the search for the source of conduct, of instinct, of tact, and the thousand qualities that make us what we are. According to Dr. Schofield the *unconscious mind* is the greater part of mind, consciousness being the illuminated disc on which attention is rivetted on account of its brightness, as if it were all, whereas in the shades around stretch mental faculties—deeper, wider, loftier, and truer.

The Fern World. By Francis G. Heath. (The Imperial Press.) Illustrated. 5s. Eighth Edition. The present edition of this well-known book has been thoroughly revised, and is now issued at a price within reach of the majority of book-buyers. Mr. Heath's picturesque descriptions of fern-life are enriched by the interpolation of coloured plates, which, since the last edition appeared, have been re-drawn. Many aspects of fern-life find a place in these pages—the germs, conditions of growth, classification, distribution, uses, folk-lore, and so on.

Carpentry and Joinery. By Fredk. C. Webber. (Methuen & Co.) Illustrated. 3s. 6d. Forms one of a series of works on technical science under the co-editorship of Dr. Garnett and Prof. Wertheimer. The subject is treated on practical lines, and includes geometry, carpentry, joinery and staircasing, and handrailing. The drawings are intended not only as illustrations to the text, but also as a guidance to the foreman in executing a piece of work which he has under control in his workshop. Mr. Webber, following the lead of many others, begins with geometry, and in twenty-five pages gives the student a glimpse of many branches of that complex science, about as much as can be learnt in one week's study. It is a great mistake to suppose this can be of any practical use to a skilled artizan. Fig. 16, p 13, cannot be drawn from the instructions given. The author is woefully deficient in literary ability; he apparently does not know how to distinguish between *letters* and the points and lines they represent.

We have on our table some beautiful specimens of fossils from the Middle Eocene—Barton, Hants—sent to us by Mr. R. Charles, a naturalist who has collected large numbers, particularly of Barton Mollusca, and, although not a dealer in the ordinary sense, he is prepared to supply collectors at the most popular prices. Each specimen is named, boxed, and located.

BOOKS RECEIVED.

From Matter to Man. By A. Redcote Dewar. (Chapman & Hall.) 3s. 6d.

Cressy and Poictiers. By J. G. Edgar. (Ward, Lock & Co.) Illustrated. 3s. 6d.

London in the Reign of Victoria. By G. Laurence Gomme. (Blackie.) 2s. 6d.

A Middle Algebra. By Wm. Briggs and G. H. Bryan. (Clive.) 3s. 6d.

The Renaissance of Girls' Education in England. By Alice Zimmern. (A. D. Innes & Co.) 5s.

The Groundwork of Science. By St George Mivart. (Murray.) 6s.

The Encyclopædia of Sport, Vol. II., Leo-Z. Edited by the Earl of Suffolk and F. G. Aflalo. (Lawrence & Bullen.) Illustrated.

Elementary Text-Book of Botany. By S. H. Vines. (Sonnenschein.) Illustrated 9s.

How to Avoid Tubercle. By A. T. Tucker Wise, M.D. (Baillière, Tindall & Cox.)

How to make Lantern Slides. By S. L. Coulthurst. (Dawbarn & Ward.) Illustrated. 1s. net.

The Story of Geographical Discovery. By Joseph Jacobs. (Newnes.) Illustrated. 1s.

A List of European Birds. By Heatley Noble, F.Z.S. (R. H. Porter.) 3s. net.

Handbook for Literary and Debating Societies. (Hodder & Stoughton.) 3s. 6d.

Practical Inorganic Chemistry for Advanced Students. By Chapman Jones. (Macmillan.) 2s. 6d.

Birds of the British Isles. By John Duncan. (Walter Scott.) Illustrated. 5s.

The Farmer and the Birds. By Edith Carrington. (G. Bell & Sons.)

Humane Science Lectures. Various authors. (G. Bell & Sons.) 1s.

Photograms of 1898. (Dawbarn & Ward.) 1s. net.

A First Algebra. By Dr. W. T. Knight. (Relfe Bros.) 6d.

The Story of the Cotton Plant. By F. Wilkinson. (Newnes.) Illustrated. 1s.

An Introduction to Practical Physics. By D. Rintoul. (Macmillan.) Illustrated. 2s. 6d.

First Stage Practical Inorganic Chemistry. By F. Beddow. (Clive.) Illustrated. 1s.

First Lessons in Modern Geology. By the late A. H. Green. Edited by J. F. Blake. (Clarendon Press.) Illustrated. 3s. 6d.

Chemistry for Schools. By C. Haughton Gill. (Stanford.) Illustrated. 4s. 6d.

Molesworth's Metrical Tables. (Spon.) 2s.

The Slide Rule. By R. G. Blaine. (Spon.) 2s. 6d.

Comparative Photographic Spectra of Stars to the Three and a Half Magnitude. By Frank McClean, F.R.S. (Dulau.) 7s. 6d.

Spectra of Southern Stars, with Tables and Plates. By Frank McClean, F.R.S. (Stanford.) 10s.

Science Notes.

Sir Clements Markham pleads urgently for funds for a national expedition to the Antarctic regions which, according to Sir John Murray, should be furnished with as much as one hundred thousand pounds, and towards this, we understand, the Council of the Royal Geographical Society have promised to head the list with five thousand pounds. It is to be feared that unless the more wealthy of our countrymen come forward with the necessary aid in undertakings of this kind our prestige as pioneers in voyages of discovery will be eclipsed by adventurers of other countries. Our own rich Government spends so much on powder and smoke that it cannot afford to extend a helping hand in matters of this kind. Mr. Cornelius Vanderbilt has generously fitted out an expedition to explore the flora of Porto Rico, and it is earnestly hoped that many rich men in this country may emulate his example by contributing to the fund which Sir Clements Markham and others so ardently desire for so laudable a purpose.

◆

A Parliamentary blue-book on the Ordnance Survey has just been issued, and shows progress of that important work up to 31st March, 1898. We gather from the report that in 1899 there will be available to the public for the first time a *one-inch* outline map of the whole of the country, prepared on one uniform system, and with its principal details nearly up to date.

◆

From the catalogue of Messrs. Johnson, Matthey & Co., Hatton Garden, London, we learn that "In furtherance of scientific research, professors and recognized scientific investigators will with pleasure be supplied with metals of the platinum group, in moderate quantities, and for periods to be arranged, free of charge, on condition that the precious metals are ultimately returned (in any form), and that the results of the investigations are furnished."

◆

An expedition, the main purpose of which is to determine the vertical distribution of ocean life by a series of open nets, has been organized, and consists of Mr. George Murray, Mr. V. H. Blackman, and Dr. Gregory, of the British Museum; Mr. J. E. S. Moore, Dr. Sambon, and Mr. Highley, an artist, complete the staff of the expedition. Prof. Agassiz and his school contend that the oceanic fauna is confined to the surface and bottom belts and that the vast intervening zone is devoid of life. Sir John Murray and others hold that there is no such barren belt, and that the oceans are inhabited throughout their whole depth. The *Oceana* has been chartered for a short cruise, beginning work on the West Coast of Ireland, at the edge of the one-hundred-fathom platform. Continuous observations will be made with a chain of tow-nets till, when the depth reaches two thousand fathoms, the series will include thirty-eight tow-nets. Experiments with various forms of self-closing nets will be made for the sake of comparisons, and, if time permit, some deep-sea trawling will be done.

◆

An expedition has been sent out to investigate the fauna of the island of Sokotra, about one hundred and fifty miles east-north-east of Cape Guardafui. Mr. W. R. Ogilvie Grant, of the British Museum, Dr. Forbes, of the Liverpool Museum, and Mr. Cutmore, a taxidermist, have sailed for Aden, where the Indian Marine guardship, *Elphinstone*, placed at the disposal of the party, will convey them to the island and back to Aden on the termination of their stay. The botany of Sokotra is fairly-well known owing to the visit made to it by Prof. Balfour in 1880, when he gave special attention to the flora; but from the zoological point of view the island is almost unexplored.

In France there are two villages completely lighted by acetylene. There are also ten factories engaged in the manufacture of the *carbide*, formed by the action of the electric current on a mixture of lime and coke dust, the reduced calcium combining with the excess of carbon. The resulting calcic carbide easily decomposes in presence of water and yields the powerful illuminant acetylene. The carbide in the States is produced by electric power derived from the Falls of Niagara, and similar means are employed at Neuhausen, Switzerland. The Schuckert Electrical Manufacturing Company, Nuremberg, will soon be able to turn out carbide sufficient to give two hundred million cubic feet of acetylene annually.

◆

In the annual report which has just been published by the Meteorological Council, it is shown that during the last twelve months fifty-five per cent. of their forecasts were correct, twenty-six per cent. were nearly so, six were failures, and thirteen partially so. These failures were largely due to the fact that we do not possess observing stations in the Atlantic. The observers have no means of noting the approach of a depression until it is quite near the coast. It is something, however, to know the results are becoming more and more correct as the number of observatories where the distribution of atmospheric pressure and the direction of the wind are noted by skilled observers increases. In Ireland and the west and north of Scotland the forecasts are unsatisfactory, and will remain so till more stations are established on the Atlantic.

◆

While the inhabitants of Great Britain consume eighty-six pounds of sugar per head, the Russians are credited with only eight and a quarter pounds. A recent official report states that the beet-sugar industry was carried on in Russia as far back as the year 1800. In 1897 the production of sugar in Russia was six hundred and forty-four thousand nine hundred tons, of which four hundred and eighty-four thousand tons were required for her own population; and in 1896 some one hundred and fifty thousand tons were exported to Europe, most of which, of course, found its way to London.

◆

A very encouraging report of the analyses of sugar-beet grown at Romney Marsh, Kent, has been given recently by a firm of sugar refiners of Liverpool. Experiments, it appears, have been conducted at the place named under the cognizance of the Board of Agriculture, and the results tend to prove that the district is highly suitable for the sugar industry.

◆

There were several interesting exhibits at the opening meeting of the Linnean Society. Prof. Howes showed the living eggs of *Sphenodon*, the remarkable lizard of New Zealand. This reptile is noted for the pineal eye under the skin in the centre of its forehead, as well as for its relationship to extinct forms; and the development which will now at last be worked out ought to prove of an interesting character. Some photographs were shown by Mr. Allan Crossman of his common buzzard and the large chicken which this bird of prey hatched and brought up. One remarkable point, apart from the triumph of maternal instinct, is that the buzzard has learned to eat the chicken's food, while the chicken shows a predilection for flesh, and will help its foster-mother to kill sparrows. The double tusk of an elephant, shown by the president, Dr. Günther, offered a problem as to whether it was a case of reduplication, or whether the milk tusk had not been shed and had persisted.

There is a generally accepted idea that metals have smells, since if you take up a piece of metal at random, or a coin out of your pocket, a smell can usually be detected. But Prof. W. E. Ayrton finds that as metals are more and more carefully cleaned, they become more and more alike in emitting *no* smell, and, indeed, when they are very clean, it seems impossible for the best of noses to distinguish any one of these metals from the rest, or even to detect its presence. The smell associated with metals, and hitherto regarded as being due to the metals themselves, is really due to the presence of some impurity, usually a compound of carbon and hydrogen. Much misapprehension has also prevailed with respect to the diffusion of smells. The passage of a smell is generally far more due to the actual motion of the air containing it than to the diffusion of the odoriferous substance through the air. If the breath is held, without in any way closing the nose either externally or by contracting the nasal muscles, no smelling sensation is experienced, even when the nose is held close to pepper, or a strong solution of spirits of hartshorn. Prof. Ayrton has also carried out experiments on the power of different substances to absorb various scents from the air, and finds that many of the old beliefs have to be exactly reversed. Thus, grains of natural musk lose their fragrance at a comparatively rapid rate when exposed to the air. The popular statement that a grain of musk will scent a room for years is, therefore, not supported by laboratory experience. The way in which some smells cling to various substances is very remarkable. No amount of rubbing would remove the smell of rose leaves from glass.

◆

A French scientist has been making observations recently upon double-yolked eggs, a number of which were incubated for a certain time and then examined. In twenty per cent. neither of the yolks developed, but were found to be joined to one another by a considerable surface, and the germ discs or cicatriculæ were close together. In the rest, the yolks were free or but slightly joined, while the cicatriculæ were in most cases remote from one another. In a third of the eggs, one yolk only developed, and it was sometimes that at the "big end," sometimes that at the "little end" which failed; but the most remarkable feature was that one of the yolks had produced a double monstrosity. The remainder of the specimens showed more or less development in both yolks, and in a case where both embryos were normal, though the former were joined, the cicatriculæ were in their proper position at the north pole, as it were, of the yolk. Other examples showed one normal chick and one incompletely grown; while in one case, and this in an egg laid by the same fowl, as in the previous case of a similar character, there was one normal chick and a double monstrosity. The usual idea is that the chickens we occasionally see preserved in spirits with four wings, and as many legs, and perhaps two heads, are formed from two yolks in a single egg, which have produced a double monstrosity owing to pressure. But pressure would hardly account for such merging of two component chicks as often takes place. The researches referred to show that in two cases it was a single yolk or cell which, irrespective of the second, produced the double embryo. These particular eggs, then, show in one and the same example two kinds of twins, two young ones produced together, and one egg-cell producing two young ones.

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Andrée's system of steering balloons has recently been tested by Mr. Perceval Spencer. A drag rope, five hundred feet long and about one hundred pounds in weight, was used, the balloon being fitted with a "steering sail." A *Times* reporter says that "We satisfied ourselves that to steer a balloon to some extent by this method is perfectly feasible . . . for not only can one so direct the balloon as to avoid obstacles, but the even altitude maintained by the use of the trail rope lessens the waste of gas; for it must be remembered that though the friction of the trail rope drags the balloon down, the balloon is also relieved of ballast to the extent of the rope that is on the ground—two opposing forces that tend to keep the balloon in equilibrium at a certain elevation."

◆

According to the *Mining and Scientific Press* the following are the relative values of the rarer metals, the prices given being per one pound avoirdupois of each metal :—

Gallium	$68,600	Erbium	$3,675
Vanadium	10,780	Ruthenium	2,695
Rubidium	9 800	Niobium	2,450
Thorium	8,330	Rhodium	2,450
Glucinum	5,800	Barium	1,960
Calcium	4,900	Titanium	1,102
Lanthanum	4,900	Zirconium	1,040
Lithium	4,900	Osmium	1,040
Indium	4,410	Uranium	980
Tantalum	4,410	Palladium	560
Yttrium	4,410	Tellurium	490
Didymium	4,410	Chromium	490
Strontium	4,200	Gold	300
Arium	3,675		

Gold, therefore, is not by any means the most precious of metals, taking only the twenty-seventh place according to this list, and, weight for weight, gallium commands a price about two hundred and thirty times that of gold.

Obituary.

Mr. Latimer Clark, F.R.S., whose death occurred on Sunday, the 30th October, was a distinguished civil and electrical engineer. Born at Great Marlow, in 1822, he commenced a career of success as assistant engineer under Robert Stephenson at the building of the Britannia and Conway tubular bridges, an account of which he published some years later. In the capacity of electrical engineer he superintended the construction and laying of more than one hundred thousand miles of submarine cable in various parts of the world, and invented the Clark standard coil, as well as numerous telegraphic improvements. A joint paper by Mr. Clark and Sir Charles Bright, contributed to the British Association in 1861, was the means of putting electrical measurement on a firm basis. From suggestions made in this paper, a committee, in which Lord Kelvin was the leading spirit, evolved a rational system of electrical units—the terms "volt," "ampère," "ohm," and so on, being adopted as the result of their deliberations. Mr. Clark was also the first to introduce the pneumatic system of transmitting postal and telegraph matter. As fourth president of the Society of Telegraph Engineers (now the Institution of Electrical Engineers), in his inaugural address in 1875 he gave a valuable account of the early history of the electric telegraph. The deceased gentleman, with Robert Sabine, was joint author of "Electrical Tables and Formulæ," a standard work, and, in collaboration with the late Mr. Herbert Sadler, produced a book on "Double Stars." He was also well known as the designer of a cheap transit instrument, useful not merely as a model for teaching purposes, but as a means of determining true time. Mr. Clark was elected a Fellow of the Royal Society in 1889, and he was also a Chevalier of the Legion of Honour.

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

Barred Warbler in Lincolnshire.—On September 5th I shot an immature female of the Barred Warbler (*Sylvia nisoria*), at North Cotes. The bird was feeding on a bunch of brambles in a ditch not far from the coast. It was very wild, flying a considerable distance when flushed. The wind was east, very light, with fine hot weather. The only other migrants seen were a Willow-Wren and a young Spotted Flycatcher.—G. H. Caton Haigh, Grainsby Hall, Great Grimsby.

[The Barred Warbler is an inhabitant of Central Europe. This is but the thirteenth example recorded in the British Islands, and all have been taken in autumn, from August to November.—H. F. W.]

Bewick's Swans in Suffolk.—On the 14th November a Bewick's Swan was shot at Benacre, Suffolk. It weighed twelve and a half pounds, and measured, flexure twenty inches, and total length thirty-six inches. Another was shot at the same place on the 31st October. They are being set up by Quatremain, of Stratford-on-Avon.—Jos. F. Green, West Lodge, Blackheath, 16th November, 1898.

Common Dipper at Hillington (*The Field*, November 12th, 1898).—Sir W. H. B. Ffolkes records that he shot a specimen of *Cinclus aquaticus* on November 9th, at Hillington, in Norfolk. The bird was apparently of the normal British form, and not of the dark Scandinavian form (*C. melanogaster*) which is usually found in our eastern counties in winter.

White's Thrush in Warwickshire (*The Field*, November 5th, 1898).—Mr. Peter Spicer, a taxidermist, of Leamington, reports that a specimen of *Turdus varius* has been sent to him for preservation by the Earl of Aylesford, on whose estate, near Coventry, the bird was shot in October. This Siberian Ground Thrush has been obtained a good many times in England in winter, but only once before in October.

Pectoral Sandpiper in Kent.—At a meeting of the British Ornithological Club, held on October 19th, Mr. N. F. Ticehurst exhibited a male of *Heteropygia maculata*, obtained on August 2nd last, between Lydd and Rye. This species has been observed in Great Britain more frequently than any other American species of wader, and nearly all the occurrences have been on the east coast in autumn or winter.

Eider Duck in Donegal (*Land and Water*, November 12th, 1898.)—Mr. T. A. Bond, of Londonderry, reports that a female of this bird, which is rare in Ireland, was shot on the east coast of Donegal in the first week in November.

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.*

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Letters.

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

SUGAR-BEET INDUSTRY IN ENGLAND.

To the Editors of Knowledge.

Sirs,—In the last number of your very esteemed journal you described the efforts made this year to create an interest in the growing of sugar-beet, and for the establishing of a beet-sugar industry in this country. You had the kindness also to mention my name as being associated with this question. I supplied about four hundred farmers in England, Scotland, and Ireland gratuitously with sugar-beet seed, gave them my advice free, and have analyzed upwards of five hundred parcels of sugar-beet. These beetroots were grown almost in every county in the United Kingdom, and the result is a remarkable success, as regards weight and saccharine contents, which both exceed by far the figures received from Germany, Austria, France, etc.

You also mentioned the statements of Sir John Lawes and Sir Henry Gilbert in their pamphlet on this subject. I must say I differ in my views from these gentlemen. That we can grow better beetroots in this country than on the Continent I have distinctly proved by my extensive experiments. I have further shown that our acreage of roots is higher than on the Continent. Finally, I have proved (and letters from authorities are in my hands) that the figures given in my book "Sugar," relating to the cost of growing sugar beetroots, are exact. Facts speak best. My tabulated statement and report about my beet-growing experiments this year in England, Scotland, and Ireland will appear about the beginning of December next, and it will show conclusively that it is possible in this country—(1) to grow sugar-beetroot profitably; (2) to manufacture our own sugar from home-grown sugar-beet with great advantage, and be independent of the Continent.

Sigmund Stein.

THE SMELL OF EARTH.

To the Editors of Knowledge.

Sirs,—I have read with interest, though I can hardly say with conviction, Mr. Clarke Nuttall's article on "The Smell of Earth."

Can Mr. Nuttall explain the smell of damp sandstone? It is one of many phenomena, very familiar, but which appear inexplicable.

If it be alleged that the smell is not that of the stone but of the occluded gases, the difficulty is only removed one step. Again, clay has a smell of its own, and I know no satisfactory explanation of the well-known odours of iron, copper, etc.

Highlands, Putney Heath, S.W. G. B. Longstaff.

[The smell of damp sandstone, has, I believe, at present received no satisfactory explanation; indeed the whole of our scientific knowledge of "Smells" is still in a very elementary stage. To say that a substance has its own peculiar smell because it gives off certain gaseous particles is, in such cases as iron, copper, sandstone, etc., merely begging the question. With reference to the smell of damp earth, the new theory is based on the researches of M. Berthelot and M. G. André, and the particular bacterium has been later identified by Herr Rullmann. Your correspondent will find more definite reference in "Technical Mycology," by Dr. Franz Lafar (tr. C. Salter), the first volume of which is already published by Messrs. Griffin & Co. (*see* "Iron Bacteria"), a second volume being still in the press.—G. C. N.]

EVOLUTION IN BIRD SONG.

To the Editors of Knowledge.

Sirs,—With reference to the interesting suggestion made by Mr. Witchell, in his article on "Evolution in Bird-song," in your September issue, that human ideas of the "crescendo" in singing may possibly have been borrowed from the nightingale, it is certainly interesting to note how frequently musicians, and more especially the older claricinists, have taken their themes from birds. Thus we have "Le Coucou," by Daquin, "Le Ramage des Oiseaux," by Dandrieu, and "Le Rappel des Oiseaux," by Ramsau, to mention only a few examples, while many instances might be cited where bird-calls have been introduced in orchestral works. Nevertheless, in these cases, we have a direct artificial imitation of various bird-calls. It is, however, otherwise with a "nuance" like the "crescendo," which, belonging as it does to musical dynamics, would scarcely require to be imitated. Rather may we surmise that this grace in singing would spring spontaneously from those physiological causes, viz., nervous energy and muscular tension, which lie at the root of all musical utterance, for, as pointed out by Herbert Spencer,[*] "loudness of tone, pitch of tone, quality of tone, and change of tone, are severally marks of feeling, and, combined in different ways and proportions, serve to express different amounts and kinds of feelings." W. Alfred Parr.

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Perhaps the young weasels mentioned by Mr. Witchell were being taught how to run. Jos. F. Green.

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M. C[illegible] L[illegible]

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Sun-spot on edge. Power 120.
Where S cuts the penumbra -

Sept. 2nd, 1 p.m. Sept. [illegible] a.m. Sept. 4th, 8 a.m. 1898.

They were taken with a four-inch equatorial and a solar prism, and are therefore subject to the inversion peculiar to such prisms; this may be rectified by viewing the reflection of the drawings in a looking-glass. The power used was one hundred and twenty. The last drawing by mistake makes the spot a little too short.

Jamaica, Maxwell Hall.
October 24th, 1898.

VARIABLE STARS.

To the Editors of Knowledge.

Sirs,—I think there is no real point in dispute between me and Col. Markwick but I may perhaps suggest that some variables may be really of the eclipse-type, though not usually so classed.

If the obscuring body is a close satellite and the obscured star is very distant, the position of the earth in its orbit would practically make no difference in the phenomena. But suppose that the obscuring body is a very distant satellite, or belongs to a different system, but happens to be almost in the direct line between the earth and the bright star, the amount of obscuration might depend on the earth's position in its orbit, and the period of the variable star would be very nearly one year. Now, as a matter of fact, the number of variable stars with a period of nearly one year seems larger than chance will account for. Is the excess due to this cause?

With ordinary eclipse variables we may expect, on the tidal theory, a slow increase of the period, accompanied by a slow diminution in the amount of the variation. But at the same time the movements of the sun and the star through space would probably render the eclipse either more or less central and thus complicate the phenomena.

Whether the cause which I have suggested will afford the true explanation of what I may call annual variables, will I think chiefly depend on the result of observations as regards their spectra at different periods.

W. H. S. Monck.

VARIABLE STARS IN GLOBULAR CLUSTERS.

By Miss Agnes M. Clerke,

Author of "The System of the Stars," "A Popular History of Astronomy during the Nineteenth Century," etc., etc.

Globular clusters are, perhaps, the most fascinating of telescopic objects. Their silver radiance delights the eye; the mystery of their constitution allures thought. What, we instinctively ask ourselves, is the reality corresponding to the strange and beautiful appearance of "balls of stars"? Are the luminous particles composing them *suns* in any true sense? What are their mutual relations? Is their aggregation destined to be permanent? Do they form stable systems, or merely temporary societies undermined by forces tending towards dissolution? Some indications on these points have been gathered, but definite information is still to seek. Only within the last few years, indeed, have the objects in question been brought within the scope of organized research.

There need be no hesitation, however, in affirming that swarming stars belong to the same cosmic family as solitary stars—that they are spherical masses of intensely heated matter, radiating into space by means of suitably adapted photospheric apparatus. But they are unlikely to be *solar* suns. Many are sensibly, probably all are sub-sensibly nebulous. They stand, then, presumably at an earlier stage of development than our own luminary, and may be greatly less dense proportionately to their brilliancy. The nature of their spectra ought here to prove of decisive import. Too dim for separate examination, they, nevertheless, reinforce each other sufficiently, where the stars run together in the central "blaze," to give intelligible results with powerful appliances. The early efforts to obtain them, made by Sir William Huggins and Dr. Vogel, at a time when no adequate means were available, can now at last be carried out with good promise of a successful issue.

In our present ignorance of their distance from the earth we are unable to determine the scale of these jostling suns. A rough calculation, however, shows that an enormous remoteness would correspond to standard—that is, to solar light-power.

The grand southern cluster ω Centauri has been thoroughly investigated from one hundred and fifty negatives taken at Arequipa. Prof. Pickering may well call it "the finest in the sky." He adds that it lies just within the border of the Milky Way, and appears to the naked eye as a hazy star of the fourth magnitude. It has a diameter of about forty minutes. Over six thousand stars have been counted on one of the photographs, and the whole number is much greater.[*] If we assume it to be seven thousand, then the average lustre of the *particles* contained in a single *drop* of light equivalent to a fourth-magnitude star comes out at 13·6 magnitude. But our own magnificent orb, actually of minus 25·5 magnitude (according to Pickering's estimate), if removed so far as to have a parallax of only one-hundredth of a second, would still take eleventh stellar rank. Only a remoteness three-and-a-third times greater still, implying a light journey of over eleven hundred years, could render it faint enough to pass in the crowd of the assemblage in the Centaur. The possibility that it may be plunged thus deep in the void cannot be gainsaid, since the spatial unit fixed by measurements of the parallactic pendulum-swing of the nearer stars has yet to be applied to the galactic world in all its length and breadth; but, as Kepler said, "the pill is a big one to swallow."

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[*] Harvard College Observatory Circular, No. 33.

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M. Cordelia Leigh.

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To the Editors of Knowledge.

Sirs,—With reference to Mr. Maunder's interesting article on this subject in the October number, I beg to send you enclosed a drawing I made of the spot when very near the Sun's eastern limb, September 2d. 6h., and other drawings September 3d. 2h., and September 4d. 1h., all G. M. T.

Sunspot in 3*f* edge. Power 120.
Edge of Sun cuts the penumbra ?

Sept. 2nd, 1 p.m. Sept. 3rd, 9 a.m. Sept. 4th, 8 a.m. 1898.

They were taken with a four-inch equatorial and a solar prism, and are therefore subject to the inversion peculiar to such prisms; this may be rectified by viewing the reflection of the drawings in a looking-glass. The power used was one hundred and twenty. The last drawing by mistake makes the spot a little too short.

Jamaica, Maxwell Hall.
October 24th, 1898.

VARIABLE STARS.

To the Editors of Knowledge.

Sirs,—I think there is no real point in dispute between me and Col. Markwick, but I may perhaps suggest that some variables may be really of the eclipse-type, though not usually so classed.

If the obscuring body is a close satellite and the obscured star is very distant, the position of the earth in its orbit would practically make no difference in the phenomena. But suppose that the obscuring body is a very distant satellite, or belongs to a different system, but happens to be almost in the direct line between the earth and the bright star, the amount of obscuration might depend on the earth's position in its orbit, and the period of the variable star would be very nearly one year. Now, as a matter of fact, the number of variable stars with a period of nearly one year seems larger than chance will account for. Is the excess due to this cause?

With ordinary eclipse-variables we may expect, on the tidal theory, a slow increase of the period, accompanied by a slow diminution in the amount of the variation. But at the same time the movements of the sun and the star through space would probably render the eclipse either more or less central and thus complicate the phenomena.

Whether the cause which I have suggested will afford the true explanation of what I may call annual variables, will I think chiefly depend on the result of observations as regards their spectra at different periods.

W. H. S. Monck.

VARIABLE STARS IN GLOBULAR CLUSTERS.

By Miss Agnes M. Clerke,

Author of "The System of the Stars," "A Popular History of Astronomy during the Nineteenth Century," etc., etc.

GLOBULAR clusters are, perhaps, the most fascinating of telescopic objects. Their silver radiance delights the eye; the mystery of their constitution allures thought. What, we instinctively ask ourselves, is the reality corresponding to the strange and beautiful appearance of "balls of stars"? Are the luminous particles composing them *suns* in any true sense? What are their mutual relations? Is their aggregation destined to be permanent? Do they form stable systems, or merely temporary societies undermined by forces tending towards dissolution? Some indications on these points have been gathered, but definite information is still to seek. Only within the last few years, indeed, have the objects in question been brought within the scope of organized research.

There need be no hesitation, however, in affirming that swarming stars belong to the same cosmic family as solitary stars—that they are spherical masses of intensely heated matter, radiating into space by means of suitably adapted photospheric apparatus. But they are unlikely to be *solar* suns. Many are sensibly, probably all are sub-sensibly nebulous. They stand, then, presumably at an earlier stage of development than our own luminary, and may be greatly less dense proportionately to their brilliancy. The nature of their spectra ought here to prove of decisive import. Too dim for separate examination, they, nevertheless, reinforce each other sufficiently, where the stars run together in the central "blaze," to give intelligible results with powerful appliances. The early efforts to obtain them, made by Sir William Huggins and Dr. Vogel, at a time when no adequate means were available, can now at last be carried out with good promise of a successful issue.

In our present ignorance of their distance from the earth we are unable to determine the scale of these jostling suns. A rough calculation, however, shows that an enormous remoteness would correspond to standard—that is, to solar light-power.

The grand southern cluster ω Centauri has been thoroughly investigated from one hundred and fifty negatives taken at Arequipa. Prof. Pickering may well call it "the finest in the sky." He adds that it lies just within the border of the Milky Way, and appears to the naked eye as a hazy star of the fourth magnitude. It has a diameter of about forty minutes. Over six thousand stars have been counted on one of the photographs, and the whole number is much greater.[*] If we assume it to be seven thousand, then the average lustre of the *particles* contained in a single *drop* of light equivalent to a fourth-magnitude star comes out at 13·6 magnitude. But our own magnificent orb, actually of minus 25·5 magnitude (according to Pickering's estimate), if removed so far as to have a parallax of only one-hundredth of a second, would still take eleventh stellar rank. Only a remoteness three-and-a-third times greater still, implying a light journey of over eleven hundred years, could render it faint enough to pass in the crowd of the assemblage in the Centaur. The possibility that it may be plunged thus deep in the void cannot be gainsaid, since the spatial unit fixed by measurements of the parallactic pendulum-swing of the nearer stars has yet to be applied to the galactic world in all its length and breadth; but, as Kepler said, "the pill is a big one to swallow."

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[*] Harvard College Observatory Circular, No. 33.

The mechanical arrangements of globular clusters entirely baffle our narrow conceptions of what is feasible and workable. Instead of the neatly finished aspect betokening orderly revolution round an attractive centre, they present, very commonly, ravelled edges, a radiated conformation, and dark vacancies of curiously definite shapes. An *escape of stars* is strongly suggested; and the conjecture might even be hazarded that the removal of stellar material thus effected is the immediate cause of the inward dilapidation manifestly progressing in visibly tunnelled spheres. The two symptoms indeed appear to be correlated. Three imposing groups—M 13, in Hercules, M 3, in Canes Venatici, and M 5, in Serpens, may serve as examples. All have curvilinear appendages, and all show pierced, and, as it were, excavated interiors. On the other hand, ω Centauri and 47 Toucani, an exquisite ornament of the southern pole, are compact within and without. No perforations are visible in them, and on Bailey's plates they came out almost perfectly circular. Here the twofold marks of dissolution are together absent, as in other cases they are together present.

By far the most remarkable discovery, however, yet made about globular clusters is that about one in five of them are literally crammed with variable stars. Their abundance is such, that as many as a hundred—in Prof. Barnard's words*—"have been found in a space in the sky that would be covered by a pin's head held at the distance of distinct vision." The pictures affording this wonderful revelation were taken at Arequipa, with the thirteen-inch Boyden telescope, an instrument rendered available for either visual or photographic employment by the adjunct of a reversible crown lens. Its fine qualities are not allowed to "rust" in disuse. Hundreds of exposures, from one up to six hours in duration, have been made with it for the purposes of this special enquiry, the results of which have been published in successive "Harvard Circulars." They are most nearly complete for ω Centauri. In this cluster, out of about three thousand stars accessible to separate study, no less than one hundred and twenty-five proved markedly, and, for the most part, very rapidly variable. A large majority, in fact, run through their changes in less than twenty-four hours. The periods of one hundred and six have, so far, been ascertained; only eight among them exceed a day's length, while three fall short of seven hours. One of these belongs to No. 91 of the blinking battalion, which, springing up to a maximum once in six hours and eleven minutes, is at present the quickest of known variables. U Pegasi, until lately the claimant of that distinction, is outrun by many components of clusters.

As will be seen by referring to Circular No. 33, printed in abridged form lower down, Prof. Pickering divides the short-period variables in ω Centauri into four classes, distinguished by the forms of their light-curves. The first largely predominates. The objects constituting it increase with extreme swiftness, and decline by comparison slowly. No. 45, for instance, with a period of 14h. 8m., sextuples its brightness in a single hour, and that on the clock-stroke, all these stars being characterized by exemplary punctuality; in other cases the rise may be still more rapid, but closer inquiry is precluded by the needful duration of photographic exposures.

Some of the ω Centauri variables show humped light-curves, indicating abortive secondary maxima, like those of δ Cephei and η Aquilæ; and one exceptional case has been noted, in which the rule of an ascent quicker than the descent is reversed.

Besides ω Centauri, three stellar globes—M 5, M 3, and M 15—have yielded a copious harvest of rapidly-changing stars. The first includes about nine hundred components that can be individualized and watched; eighty-five among them are conspicuously variable. Two were visually discovered as such by Mr. David Packer, of Birmingham, in 1890. They have been identified by Prof. Barnard as Nos. 42 and 84 of the Harvard register, and might be called companion objects, since each alike fluctuates to the extent of a magnitude and a-half in a period of twenty-six days. Dr. Common, about the same time, obtained photographic indications of variability throughout the cluster*; but so delicate an enquiry could scarcely be prosecuted under the muffled skies of Ealing. The perfect conditions at Arequipa were indispensable to success—a success enhanced by Prof. Barnard's confirmatory work with the forty-inch Yerkes refractor. "These cluster variables," he remarks,† "seem to form a distinct class from the ordinary variable stars. It is very interesting to watch one of them in a powerful telescope, and to see with what quickness it passes through its light-variation. One of the small stars in M 5, whose period is 12h. 31m., seems to be dormant for a large part of the time, as a very faint star, invisible in ordinary telescopes. It begins to brighten, and in two or three hours has risen nearly two magnitudes, and faded again to its normal condition; while another and larger star, quite near it, seems to require a month or more to go through its light fluctuation."

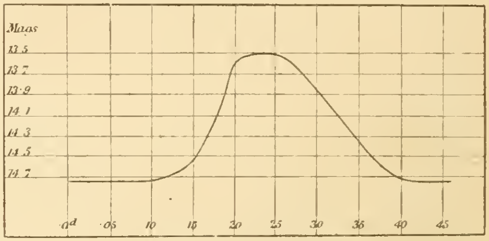

FIG. 1.—Light-Curve of No. 18 Messier 5.

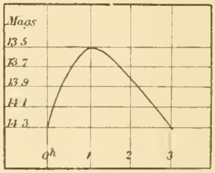

FIG. 2.—Maximum of No. 12 Messier 5. A long minimum is indicated.

Most of the eighty-four variables in M 5 are doubtless of the type dominant in ω Centauri. They traverse their cycle in a few hours, ranging through a couple of magnitudes by very unequal gradations. From a datum-level of obscurity, they spring up almost suddenly, and with the regularity of a flash-light, then sink back at a more leisurely rate. The stationary intervals apparent to the eye are, however, shown photographically to be marked by the progress of slow variation. Absolute pauses are short and rare. No. 18, of which the light-curve is given in Figure 1, illustrates the peculiarities of the class. Its period is 11h. 7m. 52s., its limiting magnitudes 13·5 to 14·7. Probably no other star equally faint has been pursued throughout its phases. During nearly five hours it remains semi-extinct, but needs no more than an hour and quarter for a triple gain of light, which it

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* See his recent admirable address on "Astronomical Photography," p. 26.

* *Monthly Notices*, Vol. L., p. 517; *Nature*, Vol. L., p. 448.

† *Astr. Nach.*, No. 3519.

loses again in about four hours.[*] Figure 2 represents the maximum of No. 12 in this cluster. The further sections of its curve appear to include a protracted minimum, but had not been traced out at the date of publication. A specific resemblance is evident between Nos. 18 and 12, as between Nos. 42 and 84.

Prof. Barnard was greatly struck, in the course of his scrutiny of M 5, with a number of "inky black spots" near, but not in its densest parts, recalling the analogy of the model northern cluster, M 13 Herculis. Even the minor group is described as "a gorgeous object," faintly visible to the naked eye,[†] with a *gross* diameter, so to speak, of about nineteen minutes of arc.[‡]

M 3, the beautiful radiated star-throng in Canes Venatici, contains the largest proportion of variables of any cluster yet examined. One in seven—one hundred and thirty-two in all—of the nine hundred components separately discernible on the Arequipa plates fluctuate extensively. Their laws of change, however, have received up to the present only preliminary attention. The same may be said of the fifty-one variables in M 15. This is a cluster in Pegasus, considered by Dr. Roberts to be strongly nebulous. The stars, moreover, imprinted on a negative taken November 4th, 1890, exhibit an arrangement "in curve lines, and patterns of various forms, with lanes or spaces between them."[§]

The absence of variables from most globular clusters accentuates the wonder of their abundance in others. Nor is it possible to discover any corresponding differences of state or aspect. Thus in 47 Toucani, an exact analogue on a slightly reduced scale of ω Centauri, the causes of variability seem to be strictly localized. A *nest* of six changing stars was at once brought to light by comparisons of Prof. Bailey's plates, but none are scattered at large through the assemblage, which is otherwise made up of perfectly stable components. Still more remarkably, only two out of two thousand stars rigidly tested in the great Hercules globe have proved variable, and that to an insignificant extent; whereas nearly one per cent. of the visible populace of heaven shine more or less unsteadily. Now, this last cluster is not only generally nebulous, but many of its outlying members are separately provided with luminous appendages; so that the disconnection of nebulosity from variability in light, already tolerably obvious, is, by these fresh experiences, emphatically re-affirmed. Another fact of interest, albeit likewise of negative import, is that M 80, the cluster in Scorpio illumined in 1860 by the blaze of a "new star," is exempt from the slightest suspicion of actual variability. Nor has the phenomenon been met with in any "irregular" group, such as the Pleiades, the "Beehive," the chromatic cluster about κ Crucis, or the blazonry in the sword-handle of Perseus.

To what, then, can it be ascribed? Prof. Pickering makes the "provisional" suggestion that the key to the enigma may be found in the relation to the line of sight of a common plane of revolution, axial or orbital. Irregular collections, in this view, possess no such fundamental plane; while spherical assemblages show effects of variability depending upon its approach to coincidence with our visual ray. The hint is of tempting significance; it opens up possibilities of insight into cluster-mechanism such as might have been deemed desperate of attainment from any other point of view. Yet there are fatal objections to its unconditional adoption. It implies two rationales of stellar variability—the spot-theory, and the eclipse-theory. In the first, the period is determined by the rotation of a single body, in the second, by the mutual revolutions of a pair. Bodies variable through axial movement are necessarily assumed to be brilliant on one side, comparatively obscure on the other. Piebald suns, however, may be dismissed from consideration as mere mathematical postulates. They serve conveniently as the basis of formulæ, but lie apart from physical reality. A degree of interior mobility, indeed, utterly inconsistent with the presence of fixed dark areas, is indispensable to the maintenance of *white* radiation. For it must be remembered that these clustered stars are unvarying in their variability. They do not brighten unawares, or casually "hide their diminished heads." The phases of each are settled once for all by unalterable law.

The eclipse-hypothesis of short-period variability stands on a very different footing. There is at any rate good reason for holding stars of the δ Cephei class to be genuine spectroscopic binaries, with synchronizing light-and-motion periods. But no agreement between their epochs of minimum and of possible eclipse has been established, to say nothing of other glaring incongruities and improbabilities. In addition, eclipsing couples of the authentic Algol stamp *are not forthcoming among aggregated stars*. Yet they should, on the geometrical theory, abound and super-abound. Their apparent absence must be accounted for in any plausible speculation as to the causes of variability in globular clusters.

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VARIABLE STARS IN CLUSTERS.

Circular No. 33 of the Harvard College Observatory deals with the results of a systematic search by Prof. S. I. Bailey for variable stars in globular clusters. The whole number of stars examined was nineteen thousand and fifty, of which five hundred and nine are variable. This amounts to one variable in thirty-seven stars, or nearly three per cent. It does not follow, however, that clusters in general contain more variable stars than occur elsewhere, for, if we except the four clusters, ω Centauri, Messier 3, Messier 5, and Messier 15, which together contain three hundred and ninety-three variables, an average of seven per cent., the remaining nineteen clusters have one hundred and sixteen variables among thirteen thousand three hundred and fifty stars, or less than one per cent. There is a very striking difference between the results obtained in clusters equally rich in stars, as, for example, between Messier 13, the great cluster in Hercules, where an examination of one thousand stars shows two variables, one in five hundred; and Messier 3, where, among nine hundred stars, one hundred and thirty-two are variable, one in seven. A common plane of revolution, orbital or axial, of the different systems or individuals of star clusters, and the relation of that plane to the line of sight, might provisionally be suggested as a possible explanation.

The periods and light curves of several variables in other clusters have been determined, but the study of those in ω Centauri is well advanced. This cluster may be called the finest in the sky. It lies just within the borders of the Milky Way. There are no bright stars near. To the naked eye it appears as a hazy star of the fourth magnitude. It has a diameter of about forty minutes. The brightest individual stars in this region are between the eighth and ninth magnitude. Over six thousand stars have been counted on one of the photographs, and the whole number is much greater. Only about three thousand,

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[*] The co-ordinates are given by Pickering in *Astr. Nach.*, No. 3354.

[†] R. Sprague, "Popular Astronomy," Vol. I., p. 408.

[‡] Barnard, *Astr. Nach.*, No. 3519.

[§] "Photographs of Star-Clusters and Nebulæ," p. 119.

however, are sufficiently bright and well separated to serve for comparison in the discovery of variables. Of these three thousand, one hundred and twenty-five are variable. One hundred and fifty photographs of the cluster have been taken with the thirteen-inch telescope, and already ten thousand measures have been obtained, about half of which have been made by Miss E. F. Leland.

Although the results are at present provisional, it is not probable that the final results of the discussion will materially alter the conclusions. Of the hundred and six variables in ω Centauri whose periods have been determined, ninety-eight have periods less than 24h. The longest period is that of No. 2, 475d., the shortest that of No. 91, 6h. 11m. Three have periods less than 7h. Of the eight having periods of more than 24h., two have periods between one and two days, two between two and three days, one of four days, one of fifteen days, one of one hundred and fifty days, and one of four hundred and seventy-five days.

The largest range in variation is about five magnitudes, and no star has been included whose light changes do not amount to half a magnitude.

The light curves of the ninety-eight stars whose periods are less than twenty-four hours may be divided into four classes. The first is well represented by No. 74. The period of this star is 12h. 4·3m., and the range in brightness two magnitudes. Probably the change in brightness is continuous. The increase of light is very rapid, occupying not more than one-fifth of the whole period. In some cases, possibly in this star, the light remains constant for a short time at minimum. In most cases, however, the change in brightness seems to be continuous. The simple type shown by No. 74 is more prevalent in this cluster than any other. There are, nevertheless, several stars, as No. 7, where there is a more or less well marked secondary maximum. The period of this star is 2d. 11h. 51m., and the range in brightness one and a half magnitudes. The light curve is similar to that of well-known short-period variables as δ Cephei, and η Aquilae. Another class may be represented by No. 126, in which the range is less than a magnitude, and the times of increase and decrease are about equal. The period is 8h. 12·3m. No. 24 may perhaps be referred to as a fourth type. The range is about seven-tenths of a magnitude, and the period is 11h. 5·7m. Apparently about sixty-five per cent. of the whole period is occupied by the increase of the light. This very slow rate of increase is especially striking from the fact that in many cases in this cluster the increase is extremely rapid, probably not more than ten per cent. of the whole period. In one case, No. 45, having a period of 14h. 8m., the rise from minimum to maximum, a change of two magnitudes, takes place in about one hour, and in certain cases, chiefly owing to the necessary duration of a photographic exposure, there is no proof, at present, that the rise is not much more rapid.

The marked regularity in the period of these stars is worthy of attention. Several have been studied during more than a thousand, and one during more than five thousand periods, without irregularities manifesting themselves.

A few words may be added in regard to the kind of clusters in which variables have been found. Up to the present time they have not been found in any except dense globular clusters, of which Messier 3, Messier 5, and the great cluster in Hercules may be taken as examples. The number of such clusters within the reach of ordinary instruments is not great. Of the clusters given in the table, N. G. C. 104, 362, 5139, 5272, 5904, 6093, 6205, 6266, 6626, 7078, and 7089, may be described as highly condensed; 1904, 5986, 6397, 6656, 6723, 6752, 6809, and 7099, as moderately condensed; and 3293 and 4755, as open clusters. 869 and 884, the clusters in the sword-handle of Perseus, are little more than regions relatively rich in stars.

The first group, of eleven highly condensed clusters, having a total of eleven thousand nine hundred and eighty stars, has four hundred and sixty-two variables, or one in twenty-six. The second group, of eight moderately condensed clusters, has forty-six variables among four thousand seven hundred and forty-one stars, one in one hundred and three. The two open clusters furnish no variables, and the region of three square degrees around N. G. C. 869 and 884 only one.

Thus far the only regions which are found to be especially rich in variable stars are condensed clusters, but even here only in relatively few cases. These dense clusters are commonly called globular, and many of them are such. In some cases, however, as ω Centauri, the form is somewhat elliptical.

N. G. C. 6266 is the most striking example of a highly condensed cluster which is irregular in form. This irregularity is intensified in the distribution of the variables. The cluster is much compressed on the south side. For a distance of one minute from the centre the distribution of the stars seems to be about equal, but if a line be drawn east and west through the centre, and the stars within one minute of this line are omitted, there are two hundred and fourteen stars south, and three hundred and fifty-four stars north, within four minutes of the central line. In this cluster are twenty-six variables, of which nineteen are north of the central line, and seven south. Excluding those within seventy inches, there are fifteen north, and only one south.

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BOTANICAL STUDIES.

VII.—ABIES.

By A. Vaughan Jennings, f.l.s., f.g.s.

The results of our study of the mode of reproduction and life-history of Selaginella (Knowledge, November, 1898) may be shortly recapitulated as follows :—The plant bears two kinds of sporangia (*macrosporangia* and *microsporangia*) instead of only one, as in the Ferns, and these contain two kinds of spores (macrospores and microspores) ; the large spores *seem* to give rise to the new plant but only by means of an excrescence of tissue which proves to be the representative of the Prothallus or Oöphyte of the Fern, here reduced, colourless, rootless and dependent on the spore ; that this protuberance contains true, but rudimentary, Archegonia, the egg-cells of which are fertilized by spermatozoids developed from the microspores, which also show a tendency to form a still more rudimentary prothallus.

In passing on to the Mountain Pine, the *Abies excelsa* which clothes the slopes of our European mountains, we are crossing a great gap in the series of plant types : and yet, while we do not know the forms which bridge the gulf, once more the use of patience and a microscope has shown how these widely different types can be compared, co-related, and brought into line with the other plants we have been examining.

In botanical classification the gap we are crossing is that between the *Cryptogamia* and *Phanerogamia.* All the types we have so far studied belong to the former division. The name suggested itself to the early naturalists as one to express the fact that the lower plants have no conspicuous " flowers " such as characterize the majority of the higher forms.

If we take the term Phanerogamia to mean the higher plants, in which the organs of reproduction are readily distinguishable, we may again make two series:—The *Gymnosperms*, in which the seeds are not enclosed in a special case, and the *Angiosperms*, in which they are so protected. Our pine-tree belongs to the former section, and the flowering plants to the latter.

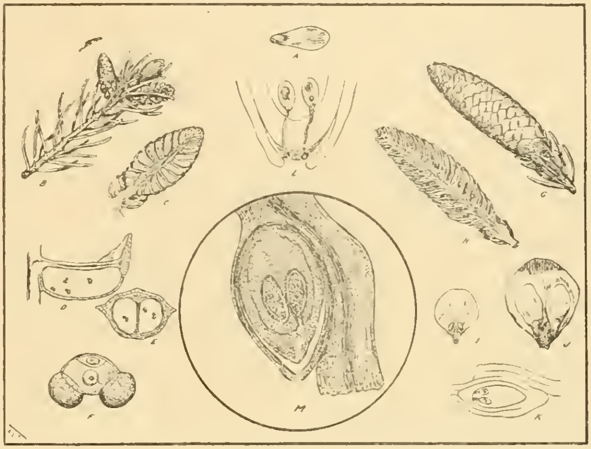
Among the Gymnosperms are included three groups:—The strange *Gnetaceæ* (with the *Ephedra* recalling a "horse-tail," and the weird *Welwitschia* of African deserts, reminding us of nothing but a certain coal-fossil), which we cannot now dwell on; *Cycads*, the beautiful feathery tropical plants recalling the tree ferns in growth, which we must refer to later on; and *Conifers*, including the firs, pines and larches, the yew, the cypress and the juniper.

Restricting ourselves to our type, and omitting all details as to the structure of the vegetative part of the plant, we start with the fact that the pine is a woody exogenous tree, with persistent narrow leaves, and a fructification in the form of *Cones*.

A cone is only a prolongation of the axis of a branch bearing numerous closely-crowded leaves which differ from other leaves in form, and carry the reproductive organs. The cone-leaves, or "*scales*," are in fact *sporophylls* just as much as those of the Selaginella spike, but are more closely set and more specially modified for their particular function. In the species of the *Selaginella* we examined we found that in the same cone similar leaves might bear different kinds of spore cases; *Macrosporangia* containing four large *Macrospores*, or *Microsporangia* with a number of little *Microspores*, also in groups of four. In the pine we find the difference carried a step further; these two kinds of spores are developed on distinct cones.

In *Abies excelsa* the young shoots in the early spring bear groups of small cones (one-half to one inch long) of a yellow-white colour. A section with a knife along one of these shows that each of the close-set scales carries on its under side a double sporangium, filled when ripe with pale yellow dust. This dust consists of "*pollen-grains*," or *Microsporangia*. The quantity produced is incredible, and at the time of ripening the air of the pine woods is full of it, blowing in golden clouds before the slightest breeze. The grains may fall so thickly as to cover the surface of lakes in the neighbourhood, and may be carried enormous distances by the wind.

The reason for the great buoyancy of the pine pollen will be found on examining some under the microscope. The main part consists of a mass of protoplasm, covered by a firm wall, but this is expanded at two points into a pair of large inflated wings, forming round chambers containing air. Examination with a higher power and suitable staining will show that the spore does not consist of a single cell. There is a portion cut off from the rest by a curved wall, and each part contains a nucleus. In other words, before the germinating activity of the pollen-grain has commenced, it has a tendency, however slight, to form a cell tissue, in fact, a "prothallus," as we found to be also the case, in a somewhat greater degree, with the microspore of Selaginella.



A.—Seed of *Abies excelsa*. B.—Fertile branch of the same plant bearing male cones. C.—Longitudinal section through one of the cones, showing the Microsporangia on the under sides of the Microsporophylls (leaves of the cone). D. E.—Longitudinal and transverse sections of a Microsporophyll, showing the double Sporangium on the under side of the leaf, with Microspores in the cavity. F.—A Microspore ("pollen-grain") highly magnified. The central portion contains Protoplasm, and the nucleus which is subsequently active in fertilizing the egg-cell. The small cell cut off above is the vegetative cell representing the Prothallus, and the rounded side outgrowths are the accessory air chambers that assist in dispersion of the pollen by wind. G. H—Fertile branches bearing female cones, from the outside and in section. I. J.—Scales of the cones in young and older stages, seen from the inner side. Each carries a pair of ovules at the base. K.—Diagrammatic section through a scale and its ovule, showing the Integument, Micropyle, Nucellus, Embryo-sac, and Archegonia. L.—Diagrammatic section of the apex of an ovule showing the same structures, with pollen-grains seated on the nucellus, and sending down their tubes to the Archegonia. M.—Longitudinal section of the base of an ovuliferous scale, drawn from an actual preparation, showing the same structures, and the course of a pollen tube.

Turning to the female cones, which are larger and of a deep red colour when young, we find that if one of the scales is stripped off, it will be found to bear at its base, on the upper or inner side, a pair of pale oval bodies, which are the *macrosporangia* or *ovules*. In scales from ripe cones these have become seeds, and each has a membranous "wing," which assists its carriage by wind as do the air-sacs of the pollen-grain. One cannot, however, see much resemblance between these ovules and the Selaginella macrosporangia, and there is no sign of the contained macrospores. If any such correspondence is to be established, it must be done by cutting thin sections through them, longitudinally, and as near the middle plane as possible, for microscopic examination. What we find then, is that the whole is composed of a soft cellular mass, which, however, can be seen to consist of different tissues.

The outer layers form a covering (*integument*) to an inner oval cell-mass, the *nucellus*; but at the lower extremity the integument is absent, leaving a little round gateway, the *micropyle*. Lying in the nucellar tissue is, again, an elongated structure, the *embryo-sac*, which represents a macrospore. It develops within itself, even at an early stage, a cellular tissue, called the *endosperm*, which may be compared with the prothallus tissue of the Selaginella macrospore. When we examine the dark bodies lying near its lower end, we find in each a large, nucleated *egg-cell*, or *oösphere*, with a group of small cells at the apex, that may well represent the neck-cells of an *archegonium*.

The only question remaining is whether this series of comparisons is supported by observations on the subsequent history of the different parts.

When one of the pollen-grains, which are blown in countless numbers round the cones, comes to rest at the micropyle of an ovule it adheres there owing to the presence of mucilaginous material at the apex of the nucellus, and its activity commences. While the small cell which we regarded as representing a rudimentary prothallus remains passive, the other throws out a tube which grows down through the nucellar tissue toward the archegonium. The protoplasm passes down with the growing tube, and finally, when the latter reaches the archegonium, the active nucleus of the microspore passes into the protoplasm of the egg-cell, fuses with its nucleus, and thus forms the compound nucleus from which the new plant subsequently arises.

We may, then, regard our comparison between the embryo-sac and pollen-grain of the pine with the *Macrospore* and *Microspore* of *Selaginella* as proved, and we see that in spite of the great gulf between Cryptogams and Phanerogams we can still trace the continuity of the organs and processes of reproduction.*

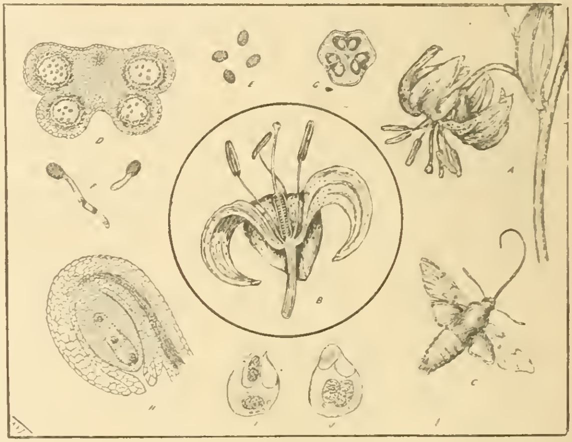
VIII.—LILIUM.

In conclusion, it will be our work to examine the corresponding parts of a typical flower and see if we can carry the series of comparisons yet a step further and bring the highest representatives of plant life into line with their lower and earlier relatives.

The one chosen for illustration here is the Mountain Lily (*Lilium martagon*). The specimens were collected in July, at a height of between six thousand and seven thousand feet in the Eastern Alps, and the moth is drawn from a specimen taken in the same locality, though not actually seen visiting the flower.

We noted that the Pine belonged to the *Gymnosperms* or naked-seeded plants, because the ovules and seeds are carried on the free surface of scales and not enclosed in a special case. The Lily, on the other hand, belongs to the *Angiosperms*, because the ovules and seeds are contained within the walls of an enclosing "ovary." It is, however, the possession of a "flower" which one naturally regards as the distinctive feature of the Angiosperms, and we have to ask at once, what is a flower, and what parts of it, if any, correspond with the structures we have seen in the Pine or in Selaginella?

We may regard a flower as a shortened axis bearing whorls (or spirals) of leaves, the upper of which are modified in connection with the essential organs of reproduction, and the lower specialized for purposes accessory to the process. If we imagine a pine cone shortened, its upper scales bearing ovules, those below pollen-sacs, and the lowest become barren, expanded, soft, and green or coloured, we should have (details apart) the structural plan of a flower. It would be impossible to say why the lower leaves should become so altered if we knew nothing of the relationship between flowers and insects. Though almost everyone has now a general idea of the important part played by insects in securing the cross-fertilization of plants, yet few recognize that the attraction of insects is, biologically speaking, the reason for the very existence of true flowers. The pine tree casts its myriad spores to the wind and has no need of petals to its cones, and in the same way the wind-fertilized angiosperms bear small and inconspicuous flowers without a coloured perianth. Fertilization by this method is uncertain, and an immense amount of pollen has to be produced. With the greater certainty attainable through the agency of insects there is greater economy, but the plant must make its flowers attractive, and often form those curious devices and traps to make the insect do its work, the study of which forms so fascinating a chapter in biological study. In our mountain lily the plant's assistant seems to be usually a day-flying moth, *Macroglossa stellatarum*, known in Switzerland as the "Taubenschwanz" or "pigeon-tail." There are nectaries or honey-glands at the base of the perianth, and a long fold or half-closed tube leads to them along the middle of the petals. The moth, hovering below the flower, has to pass its long tongue down this tube in its efforts to get at the honey, and in doing so becomes dusted over by the shaking anthers above with the pollen, which it afterward carries to another flower.



A.—Flower of *Lilium martagon* (drawn from a specimen collected in July near Davos Platz). B.—Median vertical section of the same, showing (*a*) three of the Perianth Leaves; (*b*) three of the *Microsporophylls* (*stamens*); (*c*) the three united *Macrosporophylls* (*carpels*), constituting the ovary in the centre, prolonged above as the style with its terminal stigma. Growing on the central axis of the ovary are the rows of *Macrosporangia* (*ovules*). C.—*Macroglossa stellatarum*, the Moth which effects the cross-fertilization of the plant (drawn from a specimen taken in the same locality). D.—Transverse section of the *Microsporangium* (*anther*), with *Microspores* (*pollen-grains*) developing in the four chambers. E. and F.—Microspores (pollen-grains) at rest and in germination; in F observe the presence of three nuclei. G.—Transverse section of the Ovary, showing the Macrosporangia (ovules) growing from the central axis formed by infolding of the edges of the Macrosporophylls (carpels). H.—A longitudinal section of a Macrosporangium (ovule), showing the two coats separated at the apex to form the *Micropyle*, the central tissue of the *Nucellus*, and the *Macrospore* (embryo-sac) enclosed in it. In the latter are seen, at the lower (apical) end, the *egg-cell* with its two *synergids* (the group representing an archegonium); in the centre the nucleus of the embryo-sac, and at the opposite pole the *antipodal cells*. I. J.—The end of the pollen-tube coming in contact with the egg-cell, showing the fusion of the sperm-nucleus of the former with the germ-nucleus of the egg-cell. [I J, after Strasburger. The rest original.]

We must, however, put aside the moth and the petals

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* The recent discovery that in some Cycads and in the "Gingko" ("Maidenhair tree") the contents of the pollen tube actually form ciliated motile spermatozoids, is of the greatest value in bridging this gulf, and one of the most striking results of detailed microscopic study.

and the picturesqueness, and settle down to work on the essential parts of the flower.

First, the *Stamens.* The two anther-sacs with their yellow dust-like pollen recall at once the pollen-sacs of the pine, and if we were right in regarding those as microsporangia, there is no reason why we should not use the same term here. The stamens are, in fact, "*microsporophylls*," or microspore-bearing leaves; the anthers, *microsporangia*, and the pollen-grains *microspores.* Thin transverse sections of the anther can be easily made for the microscope, and there is no difficulty in observing the two-layered wall, and the four enclosed chambers.

In ripe anthers the chambers will contain loose pollen-grains, but in those in the immature stage, the pollen-grains will be seen developing in groups of four by the division of a single "mother-cell," thus resembling the microspore formation in Selaginella. The ripe pollen-grains appear to consist of a single cell, and if they are stained and mounted, it will be found that such is the case; but there are *two nuclei*, a fact of great interest when we remember that the pollen-grains of the pine had also two nuclei, one of which was contained in a special cell, separated by a wall from the rest of the cell-contents. This we regarded as equivalent to the group of cells in the Selaginella microspore, a rudimentary male prothallus. Here, though no cell-walls are formed, we cannot help looking on the second nucleus as the last relic of the vanished prothallus.

The apical part of the flower we find occupied by an elongated, slightly three-sided structure, the *ovary.* A cross-section of this shows it to contain three chambers, each with a double row of ovules growing from the central column formed by the meeting of the three division walls. Though it may not appear so at first sight, the whole is really composed of three specialized leaves, the *carpels* or *macrosporophylls.* If we imagine a scale like that of the pine cone to bear a row of ovules along each side-margin and then to be folded down the middle so as to bring the two rows of ovules together, a single-chambered ovary would be formed such as is seen in a pea-pod. If, however, there were three carpels placed like the sides of a triangle, and these were all similarly folded, with the inturned walls in contact, a three-chambered ovary like that of the lily would result. The carpels are, in fact, sporophylls, each with a row of macrosporangia along the margins, and the three compacted together in this manner form the ovary.

By cutting a number of sections across the whole ovary it is probable that one of the six possible ovules in each slice will be cut near the middle plane, and the following structures can then be observed.

There is a central tissue mass, the *nucellus*, but it is enclosed in this case by a *double integument* which is absent at the apex, leaving, as before, a little passage or *micropyle.* As in the pine, also, there is a large oval *embryo-sac* or *macrospore*, lying in the nucellus; but here we find important differences between the present type and the conifer. Instead of containing a mass of cells, the "prothallus," the sac here contains protoplasm, with large fluid "vacuoles." A large nucleus will be seen near its centre, and there is a group of three round nucleated cells at each end of the sac. The group of three, at the end furthest from the micropyle, called the "*antipodal cells*," must be regarded as the last trace of a prothallus tissue. The group at the opposite pole consists of two small cells side by side, close to the apex of the macrospore, and below the micropyle; and a third larger cell below them. Its position would suggest that it corresponds to the *egg-cell* of the pine-ovule, and observation of the fertilization process proves this to be the case. During this process the two smaller cells, or *synergids*, are inactive, and they seem to have no special duty to perform, so that we are perhaps safe in regarding them as the last relics of the neck of an archegonium.

When the pollen-grains have become attached to the stigma they throw out *pollen-tubes*, which grow down through the tissues of the style till they reach the neighbourhood of the ovules, and their tips pass through the micropyle. The end of the tube at this stage may be seen to contain two or three nuclei, but it will be found that only one of these is the fertilizing agent. When the end of the tube is in contact with the macrospore its end wall is absorbed; the active, or sperm-nucleus, passes in and fuses with egg-nucleus, but the other nuclei in the pollen-tube remain passive. This, of course, tends to support the view that they represent the merely vegetative cells of the ancestral prothallus.

After fertilization the embryo-sac becomes filled with a tissue of cells serving for nourishment for the embryo plant, and this tissue is known as the *endosperm.* From its formation at this stage, however, it is evidently a different thing from the endosperm in the pine, which is the macrospore-prothallus.

At this point we must leave the story of the lily, as the subsequent divisions of the compound nucleus, and its gradual growth into an embryo in the seed, and finally into a new lily-plant, are all matters apart from our special purpose.

What we have found is that by a careful study of the minute details of the flower we can prove the presence there of parts corresponding to those observed in the higher flowerless plants. We have found that even in the highest plants we can trace the relics of that "alternation of generations" which is so characteristic of the life-history of the moss and the fern. Though, from the moss upward, through the series of types we have studied, the Sporophyte stage has become ever more and more predominant, and the Oöphyte stage ever less and less, the microscope shows it to be still there though hidden away among the secrets of the ovule and the pollen-grain.

NOTES ON COMETS AND METEORS.

By W. F. Denning, f.r.a.s.

New Comet.—Mr. W. R. Brooks, of Geneva, N.Y., discovered a pretty bright comet in the constellation Draco at R.A. 14h. 35m. 10s., Dec. + 60° 26′ on the evening of October 20th. It was moving rapidly to the S.E., and after travelling through Hercules, crossed the equator on November 17th, and reached its perihelion six days later. The comet appeared to be about 4′ or 5′ in diameter, with very decided central condensation, and about equal to a star of seven and a-half magnitude. There is no reason to suppose that the orbit deviates sensibly from a parabola. During the first half of December the comet will be situated in the north-western borders of Sagittarius, and its apparent motion will have become very slow. The following is an ephemeris by Möller of Kiel for Berlin mean midnight :—

Date.	R.A.			Declination.		Distance in millions of miles.	Bright-ness.
1898.	h.	m.	s.	°	′		
December 1	18	15	45	−11	51·0	141	0·3
,, 3	18	16	37	−13	7·4	145	0·2
,, 5	18	17	22	−14	19·7	150	0·2
,, 7	18	18	2	−15	28·4	154	0·2
,, 9	18	18	37	−16	33·9	158	0·2
,, 11	18	19	10	−17	36·3	161	0·2

Denning's Comet (1881 V.).—In *Ast. Nach.*, 3524, Dr. Berberich gives a sweeping ephemeris for this comet, which is computed to return to perihelion on February 10th, 1899. The conditions are, however, unfavourable to its observation, for it will necessarily be extremely faint, and only discernible in some of the large telescopes employed in our chief Observatories. On December 6th the comet will be in about R.A. 286·5°, Dec. − 27° or 31° east of the sun, and much too near that luminary to allow of its detection.

The November Leonids of 1898.—November weather in the English climate is proverbially bad, but it is seldom that the skies are so clouded and so thoroughly unfavourable for observation as they proved between November 8th and 15th in the present year. It is doubtful, therefore, whether the Leonid shower has been successfully observed anywhere in England. On November 13th and 14th dense fogs prevailed in many parts of the country. At the time of writing (November 15th) reports have only been received from a few stations, but these are of a disappointing character. At Bristol the sky was pretty constantly obscured either by cloud or fog during the whole of the second week of the month, and the only suitable opportunity for securing an observation occurred on the morning of November 13th after 3 a.m. Meteors were, however, by no means frequent on that occasion, only seven being observed in an hour, and the Leonids were not represented amongst them. At 4h. 4m. a.m. a brilliant flash lit up the sky, and was probably due to the outburst of a very large meteor, but the observer was watching the eastern region from an open window, and the flash evidently had its origin in the opposite quarter. Mr. H. J. Townsend, writing from Leeds, says that the Leonids were lost in the fogs which enveloped that district just at the important time, and Mr. W. E. Besley makes a similarly unfavourable report from Middlesex. On the night of the 10th, however, at 11h. 29m., he saw a swift, streak-leaving meteor, about equal in brightness to Sirius, passing from 98° + 45° to 63½° + 47°. This may possibly have been a Leonid, though its direction of flight was from a point several degrees below the radiant in the "Sickle." Two minutes later he registered a meteor of mag. 1½, shooting to just S. of β Aurigæ from a radiant S. of θ Ursæ. Should the bad weather have negatived the efforts of English observers generally, it is still satisfactory to think that the atmospheric conditions on the Continent and in America may have been more favourable. We shall look forward with interest to descriptions of the shower as witnessed at these distant places. It would be a matter for great regret if the Leonids came and went without being adequately recorded.

Meteoric Shower on September 25th, 1898.—M. A. Hausuy, of the Observatory at Meudon, near Paris, writes that four persons belonging to the Society for the Navigation of the Air noticed that shooting stars were surprisingly frequent on September 25th, 1898. They were first noticed at 9 p.m., when they were appearing at the rate of one per minute. The numbers afterwards increased, until at 2 a.m. on the morning of September 26th the maximum was reached, the rate being three or four per minute. The moon was ten days old at the time and shining brightly; the meteoric shower must therefore have been of very special character to have asserted itself in the strength assigned. From the indications afforded by the paths, M. Hausuy says the radiant was probably situated in Triangulum.

Large Meteor.—The Indian papers contain accounts of a fireball seen at Calcutta and other places on the evening of October 4th at 6h. 20m. It moved very slowly from W.S.W. to E., and it occupied about 10 seconds in its long horizontal flight. It was five or six times as bright as Venus. Another account from Calcutta says the meteor passed from S.W. by W. to N.E., lighting up the whole face of the Esplanade and Government House almost as brightly as an electric search-light. The nucleus emitted a sapphire-blue colour, but its material prior to vanishing became red. The meteor was noticed at Sitarampur, two hundred and forty miles from Calcutta, travelling from S.W. to N.E. It was obviously a fine object of its class, and one of those slow-moving fireballs directed from radiants in the western sky.

The Geminids.—This well-known annual shower will recur on December 10th to 12th, and there being no interference from moonlight it ought to be very favourably observed. It does not, like the Leonids and Andromedes, occasionally present very imposing spectacles, but it is more frequent in its apparitions, and will sometimes furnish thirty or forty meteors in an hour.

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THE FACE OF THE SKY FOR DECEMBER.

By A. Fowler, F.R.A.S.

SOLAR activity continues to furnish surprises for those who make regular observations, notwithstanding that the minimum of sunspots, under normal conditions, is so near. The Sun will be at its least distance from the earth on the **31st** at 10 P.M. On the **13th** there will be a partial eclipse of the Sun, but, as it will not be visible in this country, particulars are considered unnecessary.

Mercury is an evening star in the early part of the month, arriving at greatest eastern elongation (21°) on the **4th**. He is, however, too low for observation in our latitudes. He will be in inferior conjunction on the **21st**.

Venus will be at inferior conjunction with the Sun on the **1st**, and will afterwards be a morning star. On the **17th** she will rise about two hours before the Sun. She will be stationary on the **21st**.

Mars rises soon after 8 P.M. at the beginning of the month, and about 6 P.M. at the end. He is a conspicuous object in Cancer, and, as will appear from the diagram of his path given in the October number, his motion will be direct until the **10th**, when he is stationary, and afterwards retrograde. His apparent diameter increases from 11·2″ on the **1st** to 13·8″ on the **31st**, and his horizontal parallax from 10·6″ to 13·1″.

Jupiter is a morning star. During the month he traverses a direct path in the following part of the constellation Virgo. Towards the end of the month he will rise shortly before 3 A.M.

Saturn may be considered not observable this month. He will be in conjunction with the Sun on the **6th**, and will afterwards be a morning star.

Uranus is a morning star, rising about two hours before the Sun towards the end of the month.

Neptune may be observed during the whole of the night. He will be in opposition on the **15th**, and on that date will be about 50′ north of ζ Tauri.

Conveniently observable minima of Algol will occur on the **7th** at 11.54 P.M.; on the **10th** at 8.43 P.M.; on the **13th** at 5.32 P.M.; and on the **30th** at 10.25 P.M.

Mira Ceti may, perhaps, continue as a naked eye star throughout the month.

The Moon will enter her last quarter on the **6th** at 10.6 A.M.; will be new on the **13th** at 11.43 A.M.; enter her first quarter on the **20th** at 3.22 A.M.; and will be full on Tuesday, the **27th**, at 11.39 p.m. On the **27th** she will be totally eclipsed, and the following data may be useful:—

	h.	m.	
First contact with shadow ...	9	47·8	G. M. T.
Beginning of totality ...	10	57·4	,,
Middle of totality	11	42·1	,,
End of totality ...	12	26·8	,,
Last contact with shadow ...	13	36·4	,,

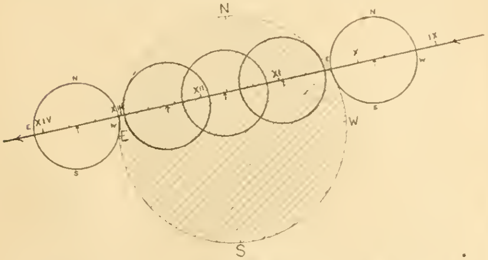


Diagram showing the path of the Moon through the Earth's Shadow, December 27th.

The first contact on the Moon's limb is at an angle of 112° from the north point towards the east, and the last at 95° towards the west. The magnitude of the eclipse, that is, the distance at mid-totality from the Moon's most immersed limb to the boundary of the shadow nearest to the opposite limb, divided by the Moon's diameter, will be 1·383. The eclipse is illustrated in the above diagram, showing the part of the shadow traversed by the Moon, and indicating also the points of contact and the times of occurrence of the principal phases. During the eclipse there will be occultations of sixteen stars, ranging in magnitude from 8·7 to 9·5, for which particulars will be found in the "Companion to the Observatory."

On the **29th** there will be an occultation of ζ Cancri, the disappearance taking place at 10.1 p.m., 92° from the north point (130° from the vertex); and the reappearance at 11.16 p.m., 303° from the north point (334° from the vertex), reckoned through east.

◆

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 November Problems.

No. 1.

(By A. C. Challenger.)

1. Q to Kt7, and mates next move.

No. 2.

(By P. H. Williams.)

1. B to K5, P to Q3.
2. Q to QB7, P × B.
3. Q to B3, P to K5.
4. B to Q3, P × B (or A).
5. Q to Bsqch, R to Kt8.
6. Kt to B6, R × Q mate.

(A.)

4. P to K6.
5. Q to Bsqch, R to Kt8.
6. R to K2, R × Q mate.

Correct Solutions of No. 1 have been received from H. S. Brandreth, G. G. Beazley, W. de P. Crousaz, D. R. Fotheringham, H. Le Jeune, J. M'Robert, A. E. Whitehouse, W. Clugston.

J. M'Robert.—Received solution too late to acknowledge last month.

Alpha.—The reply to 1. Q to B6 is Kt to Kt7, a cleverly provided defence. The Indian puzzle which you send is very pretty, but it has become evident that our solvers will not attempt anything longer than a three-move problem.

G. F. T., and *W. B. Stead.*—If 1. Q to B3, K × R, and there is no mate.

N. E. Meares.—We insert your 3-move problem below.

Mr. Bolton's 11-move mate is too long for this column.

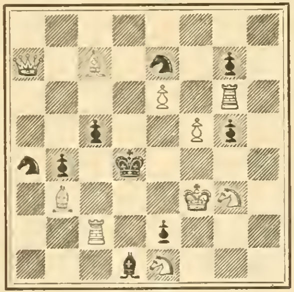
[With regard to problem No. 2, our worst fears have been realized. It is evident that the readers of Knowledge are not attracted by sui-mates, and they will not be published in future. At the same time we may quote the opinion of the best problem judges to the effect that there is more scope for originality in the sui-mate than in the direct mate. Every possible phase of the latter has now been exhausted.]

PROBLEMS.

No. 1.

By F. W. Andrew.

Black (9).



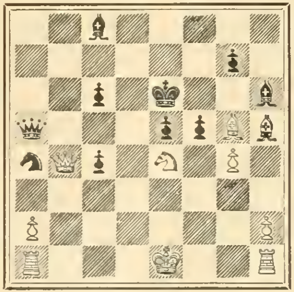
White (10).

White mates in two moves.

No. 2.

By N. E. Meares.

Black (10).



White (10).

White mates in three moves.

[We consider it advisable to state that Castling is allowed in this problem; also that the key-move is a check. In spite of this the problem is well worth trying, some of the mates being very pretty. The composer is anxious to know whether any of our readers have ever seen the *four-fold* idea carried out: *i.e.*, a position similar to the above, but containing the second move R to KBsq, which he has failed to get. Solutions of this problem will not be considered correct unless White's second moves are given correctly in every case.]

The following game was played at the Craigside Tourney last winter. The notes indicated by letters are by Mr. Bellingham; those referred to by numerals are by the Chess Editor.

"Queen's Gambit" Declined.

WHITE. (E. Macdonald.)	BLACK. (C. Y. C. Dawbarn)
1. P to Q4	1. P to Q4
2. P to QB4	2. P to K3
3. P to K3	3. Kt to KB3
4. Kt to KB3	4. P to QB4
5. Kt to QB3	5. Kt to QB3
6. B to Q3	6. B to K2
7. Castles	7. P to QR3 (*a*)
8. P to QKt3	8. Kt to QKt5 (*b*)
9. B to K2	9. QP × P } (1)
10. KtP × P	10. BP × P }
11. P × P	11. Castles
12. Kt to K5!	12. Kt to B3 (2)
13. Kt × Kt	13. P × Kt
14. R to Kt1	14. P to B4 (3)
15. P to Q5	15. P × P
16. P × P	16. Q to Q3 ? (*c*)
17. P to KKt3 (*d*)	17. R to R2 ?
18. B to KB4	18. Q to Q2
19. P to Q6	19. B to Q1
20. B to B3	20. B to Kt2
21. B × B	21. R × B
22. Q to B3 (4)	22. B to Kt3
23. Kt to R4!	23. KR to Kt1
24. Kt × B	24. R × Kt
25. R × R (5)	25. R × R
26. Q to R8 check	26. Kt to K1 (*e*)
27. R to K1	27. K to B1
28. B to K3 (6)	28. R to B3 (*f*)
29. B to Kt5!	29. R to B1 (7)
30. Q × P	30. P to KB3
31. B to B4	31. R to Kt1 (8)
32. R to Q1 (9)	32. P to Kt4
33. B to K3	33. R to B1 (10)
34. Q × R (*g*)	34. Q × Q
35. P to Q7	35. Q to Q1
36. B × Pch	36. K to B2
37. B to Kt6	37. Q × B
38. P Queens	38. Resigns.

NOTES.

(*a*) Threatening 7. . . . P × BP; 8. B × P, P to QKt4; 9. B to K2, P to B5, with a majority of Pawns on the Queen's side.

(*b*) Premature.

(1) The question whether the double exchange of Pawns is good in such positions has never been definitely settled. White is generally left with a centre somewhat difficult to protect, but gains freedom for action in compensation. In the present position, Black, having already wasted a move, should certainly avoid opening the game.

(2) The Knight should at least wait to be driven. The exchange not only leaves Black with an isolated Pawn, but blocks his open QB file. I should suggest instead 12, . . . Kt to Q2.

(3) Black should retain his command of the point at his Q4. He might try 14. . . . Q to R4, 15, B to Q2, B to Kt5.

(*c*) We prefer . . . B to B4.

(*d*) An exceedingly powerful reply, which gives White a winning advantage.

(4) White's conduct of all this part of the game is quite in the best style. Every move tells.

(5) In such a position the more pieces there are exchanged on the Queen's side the better White is pleased.

(*e*) If 26. . . . Q to Ksq, White wins by 27. Q × Qch, Kt × Q; 28. P to Q7.

(6) If 28. R to K7, Q to B3 threatening mate.

(*f*) Of course if 28. . . . Q or R × P, White replies B × P! Also if 28. . . . Q to B3, 29. Q × Q, R × Q; 30. P to Q7 as before (Ch. Ed.).

(7) For if 29. . . . R to Kt3 (or 29. . . . P to B3, 30. R to K7 wins). 30. R to K7, Q to B3, 31. Q × Q and wins.

(8) Probably with some idea of getting a mating position if White proceeds with R to K7.

(9) Anticipating Black's next move.

(10) 33. . . . Kt to B2 would lose on account of 34. Q to R7, afterwards taking the Pawn.

(*g*) A beautiful sacrifice which decides the game.

[Mr. Macdonald's play in this game certainly does not account for his low position in the tourney score.

Mr. Steinitz might have played this game.]

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